RB408.4-24

VRC: R408.4

Proponents: Dean Bragg, Orange County VA Building department, representing Building inspector

2021 Virginia Residential Code

R408.4 Access. Access shall be provided to all under-floor spaces. Access openings through the floor shall be not smaller than 18 inches by 24 inches (457 mm by 610 mm). Openings through a perimeter wall shall be not less than 16 inches by 24 inches (407 mm by 610 mm). Where any portion of the through-wall access is below *grade*, an areaway not less than 16 inches by 24 inches (407 mm by 610 mm) shall be provided. The bottom of the areaway shall be below the threshold of the access opening. Through wall access openings shall not be located under a door to the residence. See Section M1305.1.3 for access requirements where mechanical *equipment* is located under floors.

Reason Statement:

DHCD Staff Note:

The proposal does not appear to make any changes to Section R408.4. Staff has made several attempts to reach the proponent over the course of several days, for clarification of intent, with no avail.

Justification for Prohibiting Self-Latching Crawl Space Doors Without an Internal Release

The proposed change to the building code, which prohibits self-latching mechanisms on crawl space doors unless they are equipped with a means to be opened from the inside, is a critical and necessary measure to protect human life and safety. This is not a matter of convenience, but a proactive step to prevent a foreseeable and potentially catastrophic hazard.

A crawl space, by its very nature, is a confined and often hazardous environment. It is a space where workers, such as HVAC technicians, plumbers, and electricians, must perform essential maintenance and inspections. The current widespread use of self-latching mechanisms, which secure the door upon closing, creates a grave risk of accidental entrapment. A worker could easily enter the space, have the door close behind them, and find themselves unable to exit due to a lack of an internal release.

The consequences of such an entrapment are severe. The confined, often unventilated space presents a risk of suffocation, and a trapped individual could suffer from dehydration, hypothermia, or panic. This risk extends beyond professional workers to anyone who might enter the space.

Furthermore, a significant and tragic risk exists for children. A crawl space can appear as an enticing and mysterious hiding place to a curious child. The self-latching mechanism, designed to secure the door, serves as a trap. Once inside, a small child would not have the strength or the understanding to manipulate an external latch. The silent nature of such an accident—a door closing and latching behind them—can mean that a child's absence goes unnoticed until it is too late. This code change directly addresses this severe and preventable risk, ensuring that homes are not outfitted with hidden hazards for the most vulnerable members of our families.

This principle of internal release is a well-established safety standard in other confined spaces, such as car trunks and refrigerators, where entrapment poses a known risk. Applying this proven safety measure to crawl spaces is a consistent and logical extension of existing public safety policy.

The addition of an interior release mechanism, whether it be a simple latch, a handle, or a push bar, provides a simple, inexpensive, and elegant solution to this life-threatening problem. This building code update represents a logical evolution of our safety standards. It acknowledges that a minor design change can avert a major tragedy. The minimal cost and effort required to implement an internal release mechanism are immeasurably outweighed by the value of a single human life. Therefore, we must stand in defense of this code change as a fundamental step toward ensuring the safety of our communities. This change would not require an entirely new code but rather a simple adjustment to code R408.4.

Cost Impact: The code change proposal will not increase or decrease the cost This building code update represents a logical evolution of our safety standards. It acknowledges that a minor design change can avert a major tragedy. The minimal if any altered cost and effort required to implement an

internal release mechanism are immeasurably outweighed by the value of a single human life.

RB408.4-24 – Staff Summary

Proponent: Dean Bragg, Orange County VA Building department, representing Building inspector

Brief Description: Appears to intend to prohibit self-latching crawl space doors without an internal release.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/06/2026

Support: None

Opposition: Dennis Hart, representing himself; and Kyle Kratzer, representing himself.

Discussion:

Florin Moldovan (DHCD staff) provided that the proposal does not show any changes to the code and DHCD staff were not able to reach the proponent for clarification.

DHCD Staff Note:

This proposal, as submitted, does not show any changes to the existing code text. Staff have made several attempts over the course of several days to contact the proponent for clarification of intent, but without success.

EC-1301-24

VCC: SECTION 1301, [E] 1301.1, [E] 1301.1.1, 1301.1.1.1

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2021 Virginia Construction Code

SECTION 1301
GENERAL

[E] 1301.1 Scope. This chapter governs the design and construction of buildings for energy efficiency.

[E] 1301.1.1 Criteria. Buildings shall be designed and constructed in accordance with the *International Energy Conservation Code* .

Revise as follows:

1301.1.1.1 Changes to the *International Energy Conservation Code* (IECC). The following changes shall be made to the IECC :
-Proposal Note: While some content in items 1-5, 13-20, and 22-25 is not shown or may appear unstricken, these items are proposed to be deleted entirely. Other items in the list (6-12, 21, and 26-33) that are not shown remain unchanged.

1. ~~Add Section C402.1.6 to the IECC to read:~~

   ~~**C402.1.6 Groups F, S, and U.** Appendix CD may be used as an alternative to the *building thermal envelope* provisions of this code for Groups F, S, and U.~~

2. ~~Add an exception to the first paragraph of Section C403.7.7 of the IECC to read:~~

   ~~**Exception:** Where a grease duct serving a Type I hood is installed in accordance with Section 506.3 of the *International Mechanical Code*, motorized or gravity dampers shall not be installed.~~

3. ~~Add Section C403.2.2.1 to the IECC to read:~~

   ~~**C403.2.2.1 Dwelling unit mechanical ventilation.** Mechanical ventilation shall be provided for dwelling units in accordance with the *International Mechanical Code* .~~

4. ~~Delete Section C403.7.5 and Table C403.7.5 of the IECC.~~

5. ~~Delete Sections C404.5 through C404.5.2.1 of the IECC, including Tables.~~

13. ~~Add Appendix CD to the IECC to read:~~ (DELETE ENTIRE APPENDIX CD, INCLUDING ITEMS NOT SHOWN IN APPENDIX)

   ~~**APPENDIX CD**~~
   ~~**BUILDING ENVELOPE REQUIREMENTS**~~

   ~~**CD101 Scope**~~

   ~~**CD101.1 General.** These provisions shall be permitted as an alternative to building thermal envelope requirements for *building* areas containing uses that are classified as Group F, S or U.~~

   ~~**CD102 Building Envelope Requirements**~~

   ~~**CD102.1 Insulation and fenestration criteria.** The building thermal envelope shall meet the requirements of Tables CD102.2(1) and CD102.3 based on the climate zone specified in Chapter 3CE. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table CD102.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.~~

   ~~**CD102.2 Specific insulation requirements.** Opaque assemblies shall comply with Table CD102.2(1) .~~

CD102.2.1 Roof assembly. The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table CD102.2(1) , based on *construction* materials used in the roof assembly.

Exception: Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25.4 mm) or less and where the area weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in Table CD102.2(1) .

Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.

CD102.2.2 Classification of walls. Walls associated with the building envelope shall be classified in accordance with Section CD102.2.2.1 or CD102.2.2.2.

TABLE CD102.2(1)OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD

TABLE CD102.2(2)METAL BUILDING ASSEMBLY DESCRIPTIONS

CD102.2.2.1 Above-grade walls. Above-grade walls are those walls covered by Section CD102.2.3 on the exterior of the *building* and completely above grade or walls that are more than 15 percent above grade.

CD102.2.2.2 Below-grade walls. Below-grade walls covered by Section CD102.2.4 are basement or first-story walls associated with the exterior of the *building* that are at least 85 percent below grade.

CD102.2.2.3 Above-grade walls. The minimum thermal resistance (*R*-value) of the insulating material(s) installed in the wall cavity between the framing members and continuously on the walls shall be as specified in Table CD102.2(1) , based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with Table CD102.2(1) . "Mass walls" shall include walls weighing at least (1) 35 pounds per square foot (170 kg/m^2) of wall surface area or (2) 25 pounds per square foot (120 kg/m^2) of wall surface area if the material weight is not more than 120 pounds per cubic foot (1,900 kg\m^3).

CD102.2.4 Below-grade walls. The minimum thermal resistance (*R*-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table CD102.2(1) and shall extend to a depth of 10 feet (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

CD102.2.5 Floors over outdoor air or unconditioned space. The minimum thermal resistance (*R*-value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in Table CD102.2(1) , based on construction materials used in the floor assembly. "Mass floors" shall include floors weighing at least (1) 35 pounds per square foot (170 kg/m^2) of floor surface area or (2) 25 pounds per square foot (120 kg/m^2) of floor surface area if the material weight is not more than 12 pounds per cubic foot (1900 kg/m^3).

CD102.2.6 Slabs on grade. The minimum thermal resistance (*R*-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors shall be as specified in Table CD102.2(1) . The insulation shall be placed on the outside of the foundation or on the inside of a foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table.

CD102.2.7 Opaque doors. Opaque doors (doors having less than 50-percent glass area) shall meet the applicable requirements for doors a specified in Table CD102.2(1) and be considered as part of the gross area of above-grade walls that are part of the building envelope.

CD102.3 Fenestration. Fenestration shall comply with Table CD102.3 .

TABLE CD102.3BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CD102.3.1 Maximum area. The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in Table CD102.3 . The skylight area shall not exceed the percentage of the gross roof area specified in Table CD102.3 .

CD102.3.2 Maximum U-factor and SHGC. For vertical fenestration, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CD102.3 , based on the window projection factor. For skylights, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CD102.3 The window projection factor shall be determined in accordance with Equation CD-1

PF=A/B

$$PF = A/B$$

where: **(Equation CD-1)**

PF = Projection factor (decimal).

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

Where different windows or glass doors have different PF values, they shall each be evaluated separately, or an area-weighted PF value shall be calculated and used for all windows and glass doors.

CD102.4 Air leakage.

CD102.4.1 Window and door assemblies. The air leakage of window and sliding or swinging door assemblies that are part of the building envelope shall be determined in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 , or NFRC 400 by an accredited, independent laboratory, and labeled and certified by the manufacturer and shall not exceed the values in Section 402.4.2 of the 2006 IECC.

Exception: Site-constructed windows and doors that are weatherstripped or sealed in accordance with Section CD102.4.3.

CD102.4.2 Curtain wall, storefront glazing and commercial entrance doors. Curtain wall, storefront glazing and commercial glazed swinging entrance doors and revolving doors shall be tested for air leakage at 1.57 pounds per square foot (psf) (75 Pa) in accordance with ASTM E283 . For curtain walls and storefront glazing, the maximum air leakage rate shall be 0.3 cubic foot per minute per square foot (cfm/ft^2) (5.5 m^3/h × m^2) of fenestration area. For commercial glazed swinging entrance doors and revolving doors, the maximum air leakage shall be 1.00 cfm/ft2 (18.3 m^3/h × m^2) of door area when tested in accordance with ASTM E283 .

CD102.4.3 Sealing of the building envelope. Openings and penetrations in the building envelope shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and location. Joints and seams shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials spanning joints between construction materials shall allow for expansion and contraction of the construction materials.

CD102.4.4 Outdoor air intakes and exhaust openings. Stair and elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be equipped with not less than a Class I motorized, leakage-rated damper with a maximum leakage rate of 4 cfm per square foot (6.8 L/s – C m^2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance with AMCA 500D.

Exception: Gravity (nonmotorized) dampers are permitted to be used in *buildings* less than three stories in height above grade.

CD102.4.5 Loading dock weather seals. Cargo doors and loading dock doors shall be equipped with weather seals to restrict infiltration when vehicles are parked in the doorway.

CD102.4.6 Vestibules. A door that separates conditioned space from the exterior shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time.

Exceptions:

1. *Buildings* in Climate Zones I and 2 as indicated in Figure C301.1 and Table C301.1 .
2. Doors not intended to be used as a *building* entrance door, such as doors to mechanical or electrical equipment rooms.
3. Doors opening directly from a sleeping unit or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

CD102.4.7 Recessed luminaires. When installed in the building envelope, recessed luminaires shall meet one of the following requirements:

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.
2. Type IC or non-IC rated, installed inside a sealed box constructed from a minimum 0.5-inch-thick (12.7 mm) gypsum wallboard or constructed from a preformed polymeric vapor barrier, or other airtight assembly manufactured for this purpose, while maintaining required clearances of not less than 0.5 inch (12.7 mm) from combustible material and not less than 3 inches (76 mm) from insulation material.
3. Type IC rated, in accordance with ASTM E283 admitting no more than 2.0 cubic feet per minute (cfm) (0.944 L/s) of air movement from the conditioned space to the ceiling cavity. The luminaire shall be tested at 1.57 psf (75 Pa) pressure difference and shall be labeled.

CD102.5 Moisture control. All framed walls, floors and ceilings not ventilated to allow moisture to escape shall be provided with an approved vapor retarder having a permeance rating of 1 perm ($5.7 \times 10\text{-}11$ kg/Pa· s · m^2) or less, when tested in accordance with the dessicant method using Procedure A of ASTM E96 . The vapor retarder shall be installed on the warm-in-winter side of the insulation.

Exceptions:

14. Change the *Building* located in Climate Zones 1 through 3 as indicated in Figure 301.1 and Table R301.1 to read:

2. In *construction* where moisture or its freezing will not damage the materials. 3. Where other approved means to avoid condensation in unventilated framed wall, floor, roof and ceiling cavities are provided.		Wood frame wall *R*-Value 15 or 13+1[h]

15. Change the frame wall *U*-factor categories for Climate Zones 3A, 4A and 5A in Table R402.1.2 to read:

		Frame Wall *U*-Factor
		0.079

16. Add an exception to Section R401.3 of the IECC to read:

Exception: Where approved, certificates for multifamily dwelling units shall be permitted to be located off-site at an identified location.

17. Change Section R402.2.4 of the IECC to read:

R402.2.4 Access hatches and doors. Access doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weatherstripped and insulated in accordance with the following values:

1. Hinged vertical doors shall have a minimum overall R-5 insulation value.
2. Hatches and scuttle hole covers shall be insulated to a level equivalent to the insulation on the surrounding surfaces.
3. Pull down stairs shall have a minimum of 75 percent of the panel area having R-5 rigid insulation.

Access shall be provided to all equipment that prevents damaging or compressing the insulation. A wood-framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed, the purpose of which is to prevent the loose-fill insulation from spilling into the living space when the attic access is opened and to provide a permanent means of maintaining the installed R-value of the loose-fill insulation.

18. Change the title of the “Insulation Installation Criteria” category of Table R402.4.1.1 ; change the “Shower/tub on exterior wall” category of Table R402.4.1.1 , and add footnotes “c” and “d” to Table R402.4.1.1 to read: (PROPOSAL NOTE: Delete remainder of item #18, including changes to Tables)

19. Change Section R402.4.1.2 of the IECC to read:

R402.4.1.2 Testing. The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be conducted by a Virginia licensed general contractor, a Virginia licensed HVAC contractor, a Virginia licensed home inspector, a Virginia *registered design professional*, a certified BPI Envelope Professional, a certified HERS rater, or a certified duct and envelope tightness rater. The party conducting the test shall have been trained on the equipment used to perform the test. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

Note: Should additional sealing be required as a result of the test, consideration may be given to the issuance of a temporary certificate of occupancy in accordance with Section 116.1.1 .

During testing:

1. Exterior windows and doors and fireplace and stove doors shall be closed, but not sealed beyond the intended weatherstripping or other infiltration control measures.
2. Dampers, including exhaust, intake, makeup air, backdraft and flue dampers, shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, if installed at the time of the test, shall be open.
4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open.

20. Change Section R402.4.1.3 of the IECC to read:

R402.4.1.3 Leakage rate. When complying with Section R401.2.1 , the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 3 through 5, when tested in accordance with Section R402.4.1.2 .

22. Change the last paragraph of Section R403.3.5 of the IECC to read:

A written report of the results of the test shall be signed by the party conducting the test and provided to the code official. The licensed mechanical contractor installing the mechanical system shall be permitted to perform the duct testing. The contractor shall have been trained on the equipment used to perform the test.

23. Change Section R403.3.7 of the IECC to read:

R403.3.7 Building cavities. *Building* framing cavities used as ducts or plenums shall comply with VRC Section M1601.1.1 .

24. Change Section R403.7 of the IECC to read:

R403.7 Equipment and appliance sizing. Heating and cooling equipment and appliances shall be sized in accordance with ACCA Manual S or other approved sizing methodologies based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies.

Exception: Heating and cooling equipment and appliance sizing shall not be limited to the capacities determined in accordance with Manual S or other approved sizing methodologies where any of the following conditions apply:

1. The specified equipment or appliance utilizes multi-stage technology or variable refrigerant flow technology and the loads calculated in accordance with the approved heating and cooling methodology fall within the range of the manufacturer's published capacities for that equipment or appliance.
2. The specified equipment or appliance manufacturer's published capacities cannot satisfy both the total and sensible heat gains calculated in accordance with the approved heating and cooling methodology and the next larger standard size unit is specified.
3. The specified equipment or appliance is the lowest capacity unit available from the specified manufacturer.

25. Change Section R406.3.2 to read:

Section N1106.3.2 (R406.3.2) Onsite renewables are included. When onsite renewable energy is included for compliance using the Energy Rating Index (ERI) analysis per Section N1106.4 (R406.4), the building thermal envelope shall be greater than or equal to levels of energy efficiency and solar heat gain coefficient in Table N1102.1.2 (R402.1.2), with a ceiling U-factor of 0.026 and a frame wall U-factor of 0.060, or Table N1102.1.3 (R402.1.3), with a ceiling R-value of 49 and a wood frame wall R-value of 20 or 13+5.

Reason Statement: **The purpose of this proposal is to make Virginia's energy efficiency standards for new construction "at least as stringent as" the latest IECC for new commercial and residential construction. It would remove past weakening amendments to the IECC for new construction. (Efficiency standards for construction involving existing buildings are left for separate consideration.)**

Virginia's residential building code has been behind the IECC's energy efficiency standards for over a decade -- since the 2012 IECC update. Virginia is even farther behind today since it failed to strengthen code standards for key building efficiency measures in the cycles that have followed. To make matters worse, in the 2021 cycle, it rolled back standards to 2006 levels for several broad categories of commercial buildings (F,S & U) which appear may include some data centers – the largest users of electricity in the state which threaten to upend rates for all Virginians. That rollback was not supported by any substantial evidence concerning the many types of buildings; nor has there been any substantial evidence for any of the other weakening amendments that would be eliminated by this proposal. Each weakening amendment is allowed to roll forward cycle after cycle, despite the IECC being reaffirmed or made even more stringent.

The IECC has repeatedly tightened energy efficiency standards over the past 20 years. Apart from a relaxation of ceiling insulation standards for some zones between the 2021 and 2024 cycles, the IECC has resisted pleas to weaken efficiency standards. Evidence of practical experience and new technologies has supported the IECC's continued enhancement of efficiency standards.

On the other hand, in the 2024 cycle the IECC introduced new levels of design and equipment flexibility to give builders a greater variety of ways to meet the overall levels of efficiency required. The increase in energy efficiency options while still improving overall efficiency strongly undercuts arguments to retain past weakening amendments. Indeed, retaining those outdated amendments would undercut the overall efficiency targets set by the IECC as weaker prescriptive standards would undermine Simulated Performance and ERI energy savings targets.

Improving energy efficiency in new buildings is important to occupants and users —whether owners or tenants or employees

or producers of goods or services --, since it would help them save money and energy, increase indoor comfort, make for healthier buildings, and improve workplaces for decades. Greater energy efficiency will also serve the public by reducing pressure on utilities to raise rates in order to build and operate more energy delivery capabilities, and by reduce the air pollution that drives climate impacts and other harms to Virginia's health, property and economy.

Importantly, the U.S. Department of Energy and the Pacific Northwest National Laboratories have analyzed energy efficiency standards for residential and commercial building codes for more than 20 years. They have consistently found that full adoption of the IECC and ASHRAE updates so far this century will save energy and money. They have also found that, by reducing building energy usage, these model code updates will reduce pollution, including climate pollution.

Adoption of this proposal is vital to properly implementing Virginia law. Sections 36-99A and 36-99B of the Virginia Code states that building codes are required to "protect the health, safety and welfare of the residents of the Commonwealth" and that adjustments to reduce construction costs must nevertheless be "consistent with recognized standards of health, safety, energy efficiency and water efficiency." VIRGINIA ACTS OF ASSEMBLY – 2021 SPECIAL SESSION I, CHAPTER 425, Section 1 (referred to herein as "H2227"), which was enacted in 2021, calls for adoption of energy efficiency standards that are "at least as stringent" as the latest IECC considering factors such as consumer costs "over time" and air pollution. The accumulated evidence from DOE and PNNL leave no doubt that weakening amendments should be removed from the energy efficiency standards applicable to new residential and commercial construction.

This proposal attempts to delete only standards that are not "at least as stringent" as the latest IECC. If any of the proposed deletions are beneficial and "at least as stringent" as the latest IECC, we would discuss amending this proposal.

Cost Impact: The code change proposal will increase the cost

Fully implementing the latest IECC will add to construction costs. However, as DOE and PNNL have shown, building owners, residents and users will save money and energy for decades after the buildings are constructed. Thus, the net costs will be reduced.

Further, as discussed in the Reason section, Virginia law states that construction costs should be minimized "consistent with" the latest model codes and that cost considerations must reflect the cost savings over time, not just initial costs. Further, building codes must be designed to serve the public's health, safety and welfare, including the benefits from reducing air pollution.

EC-1301-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club – Virginia Chapter

Brief Description: Deletes all the existing Virginia amendments to the International Energy Conservation Code applicable to new commercial and residential construction.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second and third Energy Sub-Workgroup meetings on September 29, 2025, and November 14, 2025, respectively.

Energy Sub-Workgroup Membership and Representation:

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members in attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce

- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Bill P introduced the proposal which would eliminate all of Virginia's weakening energy code amendments for new construction and emphasized that this would not affect existing buildings. He further noted that this proposal would require any retained deviations from the model IECC to be re-justified each cycle.

Eric L said Virginia is unusual in perpetuating decades-old amendments whose original analyses are obsolete; significant "weakening" provisions should be reconsidered.
Justin K agreed in principle, arguing that perpetual carry-overs distort baseline cost-effectiveness analyses and make future upgrades appear larger than they are.
Chelsea H supported the proposal, warning that Virginia's many amendments, combined with new IECC trade-off options, could markedly reduce overall efficiency.
Bill P added that DOE/PNNL studies show each IECC update yields net occupant savings, so realigning with the model code benefits consumers.
Andrew C opposed "wiping the slate clean," stressing that 2021 Virginia amendments reflect local consensus and that only a handful of states adopt the IECC unamended. He linked code costs to housing affordability.
Steve S viewed the proposal as an indirect attempt to force full adoption of the IECC.
Jeff Brown (DHCD staff) addressed previous comments regarding carrying forward amendments approved in previous code cycles in Virginia, noting that existing amendments are part of the legally approved regulation; wholesale deletion would override prior Board decisions.

Ron C said many cost-impact statements lack concrete figures, making statutory evaluation difficult.

Sub-Workgroup members in attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Bill P stated that this proposal deletes Virginia amendments to the IECC. Many parts of this proposal have already been discussed separately so there is no need to discuss them in this proposal.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Bob Shippee, Sierra Club; Eric Lacey, RECA; Sydney Roberts, SEEA; Justin Kosher, PIMA; and Jason Vandever, NAIMA.

Opposition: Steve Shapiro, AOBA/VAMA; Andrew Clark, HBAV; Dennis Hart, representing self; Rick Hinson, representing self; and Tread Willis, representing self.

Discussion:

Bob S provided an overview of the proposal.

a. **Eric L** pointed out that this proposal attempts to address a lot of the other things that are attempted in other later proposals on the agenda. What this proposal does is start Virginia on the path of catching up with the rest of the International Energy Conservation Code (IECC) which is several iterations behind.
b. **Sydney R** commented that SEEA has worked with the Pacific Northwest National Lab to do independent analysis of the impact of adopting the 2024 IECC on home buyers in Virginia and the payback is very short.
c. **Steve S** raised the concern that this proposal is getting rid of all the amendments that the Board has adopted trying to balance energy efficiency and affordability.
d. **Andrew C** stated that we have reached the point of diminishing returns with balancing energy efficiency with cost of living.

DHCD Staff Note:

- The proposal was originally placed on the agenda for the second General Stakeholder Workgroup (GSW) meeting. The proponent requested for the proposal to be carried over to the third GSW meeting to allow for additional collaboration with interested stakeholders.
- Portions of this proposal conflict with code change proposals REC-R402.1.2-24, REC-R402.1.2(1)-24, and REC-R404.1-24, all of which received a Non-Consensus recommendation.
- Portions of this proposal conflict with proposal EC-C402.1.6(1)-24, which was reviewed by stakeholders at the third GSW meeting on January 5, 2026, where it received a Consensus Approval recommendation.

EC-C402.1.6-24

VCC: 1301.1.1.1

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2021 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the *International Energy Conservation Code* (IECC). (Portions of code section not shown remain unchanged.)

The following changes shall be made to the IECC :

1. ~~Add Section C402.1.6 to the IECC to read:~~

   ~~**C402.1.6 Groups F, S, and U.** Appendix CD may be used as an alternative to the *building thermal envelope* provisions of this code for Groups F, S, and U.~~

13. ~~Add Appendix CD to the IECC to read:~~

   ~~**APPENDIX CD**~~
   ~~**BUILDING ENVELOPE**~~
   ~~**REQUIREMENTS**~~

   ~~**CD101 Scope**~~

   ~~**CD101.1 General.** These provisions shall be permitted as an alternative to building thermal envelope requirements for *building* areas containing uses that are classified as Group F, S or U.~~

   ~~**CD102 Building Envelope Requirements**~~

   ~~**CD102.1 Insulation and fenestration criteria.** The building thermal envelope shall meet the requirements of Tables CD102.2(1) and CD102.3 based on the climate zone specified in Chapter 3CE. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table CD102.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.~~

   ~~**CD102.2 Specific insulation requirements.** Opaque assemblies shall comply with Table CD102.2(1) .~~

   ~~**CD102.2.1 Roof assembly.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table CD102.2(1) , based on *construction* materials used in the roof assembly.~~

   ~~**Exception:** Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25.4 mm) or less and where the area weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in Table CD102.2(1) .~~

   ~~Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.~~

   ~~**CD102.2.2 Classification of walls.** Walls associated with the building envelope shall be classified in accordance with Section CD102.2.2.1 or CD102.2.2.2.~~

   ~~**TABLE CD102.2(1)**~~

   ~~**OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, *R*-VALUE[a] METHOD**~~

CLIMATE ZONE	3	4 EXCEPT MARINE	5 AND MARINE 4
Roofs			
Insulation entirely above roof deck	R-15ci	R-15ci	R-15ci
Metal buildings (with R-5 thermal blocks[a,b])	R-19	R-19	R-19
Attic and other	R-30	R-30	R-30
Walls, above grade			
Mass	R-5.7ci[c,e]	R-5.7ci[c]	R-7.6ci
Metal buildingb	R-13	R-13	R-13 + R-13ci
Metal framed	R-13	R-13	R-13 + R-3.8ci
Wood Framed and other	R-13	R-13	R-13
Walls, below grade			
Below-grade walld	NR	NR	NR
Floors			
Mass	R-5ci	R-10ci	R-10ci
Joists/framing	R-19	R-19	R-19
Slab-on-grade floors			
Unheated slabs	NR	NR	NR
Heated slabs	R-7.5 for 12" below	R-7.5 for 12" below	R-7.5 for 24" below
Opaque Doors			
Swinging	U-0.70	U-0.70	U-0.70
Roll-up or sliding	U-1.45	U-1.45	U-1.45

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement

a. Thermal blocks are a minimum R-5 of rigid insulation which extends 1-inch beyond the width of the purlin on each side, perpendicular to the purlin.

b. Assembly description can be found in Table CD102.2(2) .

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90 , ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2-°F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for perimeter insulation according to the heated slab-on-grade construction.

e. Insulation is not required for mass walls in Climate Zone 3A located below the "Warm-Humid" line, and in Zone 3B.

TABLE CD102.2(2)METAL BUILDING ASSEMBLY DESCRIPTIONS

ROOFS	DESCRIPTIONS	REFERENCE
R-19 + R-10	Filled Cavity Roof Thermal blocks are a minimum, R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin.	ASHRAE/IESNA 90.1-2004 Table A2.3
R-19	Standing seam with single insulation layer. Thermal blocks are a minimum R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin. This construction R-19 insulation batts draped perpendicularly over the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins.	ASHRAE/IESNA 90.1-2004 Table A2.3
Walls		
R-13	Single insulation layer The first layer of R-13 insulation batts is installed continuously perpendicular to the girts and is compressed as the metal skin is attached to the girts.	ASHRAE/IESNA 90.1-2004 Table A2.3
R-13 + R-13ci	Double insulation layer The first layer of R-13 insulation batts is installed continuously perpendicular to the girts and is compressed as the metal skin is attached to the girts.	ASHRAE/IESNA 90.1-2004 Table A2.3

For SI: 1inch = 25.4 mm.

CD102.2.2.1 Above-grade walls. Above-grade walls are those walls covered by Section CD102.2.3 on the exterior of the *building* and completely above grade or walls that are more than 15 percent above grade.

CD102.2.2.2 Below-grade walls. Below-grade walls covered by Section CD102.2.4 are basement or first-story walls associated with the exterior of the *building* that are at least 85 percent below grade.

CD102.2.4 Below-grade walls. The minimum thermal resistance (*R*-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table CD102.2(1) and shall extend to a depth of 10 feet (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

CD102.2.3 Above-grade walls. The minimum thermal resistance (*R*-value) of the insulating material(s) installed in the wall cavity between the framing members and continuously on the walls shall be as specified in Table CD102.2(1) , based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with Table CD102.2(1) . "Mass walls" shall include walls weighing at least (1) 35 pounds per square foot (170 kg/m^2) of wall surface area or (2) 25 pounds per square foot (120 kg/m^2) of wall surface area if the material weight is not more than 120 pounds per cubic foot (1,900 kg/m^3).

CD102.2.5 Floors over outdoor air or unconditioned space. The minimum thermal resistance (*R*-value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in Table CD102.2(1) , based on construction materials used in the floor assembly. "Mass floors" shall include floors weighing at least (1) 35 pounds per square foot (170 kg/m^2) of floor surface area or (2) 25 pounds per square foot (120 kg/m^2) of floor surface area if the material weight is not more than 12 pounds per cubic foot (1900 kg/m^3).

CD102.2.6 Slabs on grade. The minimum thermal resistance (*R*-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors shall be as specified in Table CD102.2(1) . The insulation shall be placed on the outside of the foundation or on the inside of a foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table.

CD102.2.7 Opaque doors. Opaque doors (doors having less than 50-percent glass area) shall meet the applicable requirements for doors a specified in Table CD102.2(1) and be considered as part of the gross area of above-grade walls that are part of the building envelope.

CD102.3 Fenestration. Fenestration shall comply with Table CD102.3 .

TABLE CD102.3BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	3	4 EXCEPT MARINE	5 AND MARINE 4
Vertical fenestration (40% mximum of above-grade wall)			
U-factor			
Framing materials other than metal or without metal reinforcement or cladding			
U-Factor	0.65	0.40	0.35
Metal framing with or wihtout thermal break			
Curtain Wall/Storefront *U*-factor	0.60	0.50	0.45
Entrance Door *U*-factor	.90	.85	.80
All Other *U*-factor[a]	.65	.55	.55
SHGC-All Frame Types			
SHGC: PF < 0.25	.25	.40	.40
SHGC: 0.25 < PF < 0.5	.33	NR	NR
SHGC: ≥ 0.5	0.40	NR	NR
Skylights (3% maximum)			
Glass			
U-Factor	0.90	0.60	0.60
SHGC	0.40	0.40	0.40
Plastic			
U-Factor	1.30	1.30	1.30
SHGC	0.35	0.62	0.62

NR = No Requirement, PF = Projection Factor (See Section CD102.3.2)

a. All others includes operable windows, fixed windows and non-entrance doors.

CD102.3.1 Maximum area. The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in Table CD102.3 . The skylight area shall not exceed the percentage of the gross roof area specified in Table CD102.3 .

CD102.3.2 Maximum U-factor and SHGC. For vertical fenestration, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CD102.3 , based on the window projection factor. For skylights, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CD102.3 The window projection factor shall be determined in accordance with Equation CD-1

PF=A/B

$$PF = A/B$$

where: **(Equation CD-1)**

PF = Projection factor (decimal).

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

Where different windows or glass doors have different PF values, they shall each be evaluated separately, or an area-weighted PF value shall be calculated and used for all windows and glass doors.

CD102.4 Air leakage.

CD102.4.1 Window and door assemblies. The air leakage of window and sliding or swinging door assemblies that are part of the building envelope shall be determined in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 , or NFRC 400 by an accredited, independent laboratory, and labeled and certified by the manufacturer and shall not exceed the values in Section 402.4.2 of the 2006 IECC.

Exception: Site-constructed windows and doors that are weatherstripped or sealed in accordance with Section CD102.4.3.

CD102.4.2 Curtain wall, storefront glazing and commercial entrance doors. Curtain wall, storefront glazing and commercial glazed swinging entrance doors and revolving doors shall be tested for air leakage at 1.57 pounds per square foot (psf) (75 Pa) in accordance with ASTM E283 . For curtain walls and storefront glazing, the maximum air leakage rate shall be 0.3 cubic foot per minute per square foot (cfm/ft^2) (5.5 m^3/h × m^2) of fenestration area. For commercial glazed swinging entrance doors and revolving doors, the maximum air leakage shall be 1.00 cfm/ft2 (18.3 m^3/h × m^2) of door area when tested in accordance with ASTM E283 .

CD102.4.3 Sealing of the building envelope. Openings and penetrations in the building envelope shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and location. Joints and seams shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials spanning joints between construction materials shall allow for expansion and contraction of the construction materials.

CD102.4.4 Outdoor air intakes and exhaust openings. Stair and elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be equipped with not less than a Class I motorized, leakage-rated damper with a maximum leakage rate of 4 cfm per square foot (6.8 L/s – C m^2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance with AMCA 500D.

Exception: Gravity (nonmotorized) dampers are permitted to be used in *buildings* less than three stories in height above grade.

CD102.4.5 Loading dock weather seals. Cargo doors and loading dock doors shall be equipped with weather seals to restrict infiltration when vehicles are parked in the doorway.

CD102.4.6 Vestibules. A door that separates conditioned space from the exterior shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time.

Exceptions:

1. *Buildings* in Climate Zones I and 2 as indicated in Figure C301.1 and Table C301.1 .
2. Doors not intended to be used as a *building* entrance door, such as doors to mechanical or electrical equipment rooms.
3. Doors opening directly from a sleeping unit or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

CD102.4.7 Recessed luminaires. When installed in the building envelope, recessed luminaires shall meet one of the following requirements:

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.
2. Type IC or non-IC rated, installed inside a sealed box constructed from a minimum 0.5-inch-thick (12.7 mm) gypsum wallboard or constructed from a preformed polymeric vapor barrier, or other airtight assembly manufactured for this purpose, while maintaining required clearances of not less than 0.5 inch (12.7 mm) from combustible material and not less than 3 inches (76 mm) from insulation material.
3. Type IC rated, in accordance with ASTM E283 admitting no more than 2.0 cubic feet per minute (cfm) (0.944 L/s) of air movement from the conditioned space to the ceiling cavity. The luminaire shall be tested at 1.57 psf (75 Pa) pressure difference and shall be labeled.

CD102.5 Moisture control. All framed walls, floors and ceilings not ventilated to allow moisture to escape shall be provided with an approved vapor retarder having a permeance rating of 1 perm (5.7 × 10-11 kg/Pa· s · m^2) or less, when tested in accordance with the dessicant method using Procedure A of ASTM E96 . The vapor retarder shall be installed on the warm-in-winter side of the insulation.

Exceptions:

1. *Buildings* located in Climate Zones 1 through 3 as indicated in Figure C301.1 and Table C301.1 .
2. In *construction* where moisture or its freezing will not damage the materials.
3. Where other approved means to avoid condensation in unventilated framed wall, floor, roof and ceiling cavities are provided.

Reason Statement: This proposal would remove an unsupported rollback of minimum envelope energy efficiency standards for commercial Categories F, S and U. That rollback, which was granted over strong objections in the 2021 Code Cycle, is contained in 1301.1.1.1, C402.1.6 and Appendix CD. [The proposal was called Appendix CB when introduced. It also did not include some references to the “2004” ASHRAE, which the draft 2024 Base Document appears to have added.]

Removing the rollback is required because applicable law requires Virginia’s building code to be consistent with or at least as stringent as

the IECC. Appendix CD moves the code backwards by more than 15 years overriding multiple Board-approved and IECC-approved updates since 2006. Failing to eliminate Appendix CD would waste energy, raise occupancy costs, potentially harm employees, increase air pollution, including climate pollution, and harm the "health, safety and welfare" of the residents of Virginia both now and for the decades these inefficient buildings are operated.

Moreover, the record underlying the rollback proposal showed that (a) no substantive evidence was submitted, in the 2021 cycle, that would support the decade-plus rollback for the 120+ types of buildings covered by the proposal; (b) builders successfully implemented Board-approved IECC standards for 2009, 2012, 2015 and 2018, and ASHRAE standards for every update since 2006; (c) U.S. DOE and PNNL had found that full implementation of the 2021 IECC standards and each update of IECC or ASHRAE efficiency standards from 2009-2018 would save energy and money; (d) far from suffering under unreasonable burdens, the warehouse market was booming under the then-effective 2018 IECC; and (e) there were no findings or analysis by either the proponent or the Board to support approving the non-consensus proposal.

1. Virginia Law Requires Consistency with Model Building Codes

Section 36-99A requires implementation of building code standards that "protect the health, safety and welfare of the residents of the Commonwealth, and that minimize costs "consistent with" recognized national standards, which in Virginia means the IECC.

> The provisions of the Building Code and modifications thereof shall be such as to protect the health, safety and welfare of the residents of the Commonwealth, provided that buildings and structures should be permitted to be constructed, rehabilitated and maintained at the least possible cost consistent with recognized standards of health, safety, energy conservation and water conservation, including provisions necessary to prevent overcrowding, rodent or insect infestation, and garbage accumulation; and barrier-free provisions for the physically handicapped and aged.

As recognized by the 2021 NOPR, keeping the code up to date with "recognized standards of health, safety, energy conservation and water conservation" is critical. Construction costs should be reduced where possible, but only to the extent "consistent with" the IECC's "energy conservation" standards. Backtracking to weaker, out-of-date standards is not permissible.

Pursuant to 2021 legislation, VIRGINIA ACTS OF ASSEMBLY – 2021 SPECIAL SESSION I, CHAPTER 425, Section 1 ("H2227"), the Board was directed to **"**consider adopting Building Code standards that are at least as stringent as those contained in the new version of the IECC." Factors to be considered are "the public health, safety, and welfare benefits of adopting standards that are at least as stringent as those contained in the IECC, including potential energy savings and air quality benefits over time compared tothe cost of initial construction." Nothing in H227 authorized approval of less stringent standards.

In 2022, at the request of certain builders, the GA adopted HB1289, which directed the Board "to consider during the next code development cycle, revising the Uniform Statewide Building Code…to provide an exemption from any requirements in the energy efficiency … for the following use and occupancy classifications pursuant to Chapter 3 of the 2018 Virginia Construction Code: (i) Section 306, Factory Group F; (ii) section 311, Storage Group S; and (iii) Section 312, Utility and Miscellaneous Group U."**[1]**

HB1289 called for consideration of an exemption, but it did not alter the statutory standards for building codes prescribed by 36-99A and H2227. Since the legislature did not change the applicable legal standards, its direction "to consider" is bound by otherwise applicable laws, which require adoption of code standards that protect the "health, safety and welfare" of Virginians, minimize costs "consistent with" national model codes, and be "at least as stringent" as the IECC.

2. No credible support was provided the rollback of code standards.

The proponent's supporting statement for the rollback proposed in the last cycle was very brief and conclusory. Neither the proponent nor any other participant provided any reasonable basis for rolling back conservation standards for any type of building. While Appendix CD would reduce some builders' construction costs, nothing demonstrated that the proposal would meet the relevant statutory standards of serving Virginians' "health, safety and welfare" or minimizing costs "consistent with" energy conservation standards or achieving energy efficiency "at least as stringent" as the latest IECC.

Since the 2006 IECC, the IECC adjusted and the Board repeatedly approved updated standards to recognize new industry developments and public needs. Nothing presented in the 2021 Cycle plausibly justified overturning all those decisions by the IECC and the Board.

In support of cutting back standards for dozens of types of buildings within the 3 broad categories Groups F, S and U, the proposal's Reason Statement and Cost Impact statement provided (a) two, sketchy examples of hypothetical buildings' compliance costs with no information about energy or energy cost savings; (b) a few generalized statements that some builders find compliance challenging and that some the affected buildings are "not heated or cooled to normal heating and cooling temperatures" or are "vacant" some of the time

or might have “open doors” part of the time (which the IECC already addresses by exempting or reducing efficiency standards for buildings with such characteristics). There are absolutely no details about the energy usage, efficiency, costs, and characteristics of any 120+ types of buildings that are covered by the efficiency rollback.

Section 306 Factory Group F identifies over 50 types of factories; Section 311 Storage Group S lists over 60 types of storage facilities; and Section 312 Utility and Miscellaneous Group U identifies over a dozen categories. Some of the facilities store products (*e.g.*, food) that are temperature sensitive and require a great deal of energy (lessened only by energy efficiency) to achieve temperature goals. Other buildings involve manufacturing, greenhouses and other operations, which have still different energy and energy-efficiency profiles. Yet, apart scant information about two hypothetical warehouses, the proposal for the rollback provided no details or analysis of any other types of buildings or their energy footprints, available technologies, employee and customer needs, compliance costs, energy cost savings, pollution reductions or other factors relevant to the extreme, multi-group proposal.

The proposal provided no contextual information about its two hypothetical warehouses while omitting critical information. For example, it failed to disclose the huge volume of air to be heated and cooled in the two illustrations of warehouses: roughly 2.5 million cubic feet for the 100,000 Sf warehouse, and 144,000 cubic feet for the 7500 SF warehouse. Even the building claiming to heat only 60 degrees (assuming that temperature is not raised *after* the building is inspected) would require a huge amount of energy to achieve and maintain the targeted 60 degrees for 2.5 million cubic feet of space. Nor did the proponent address the huge, overall energy cost and use increases (waste) or pollution increases from rolling back established and new efficiency standards for multiple categories of buildings.

The proposal to return to 2006 standards claimed harms that ignored the 2021 IECC’s flexibility provisions which exempt unheated and low-conditioned buildings and permitted buildings to be subdivided into an exempt unheated portion and a separate heated portion if, for example, heating for an office or other work area is needed. It also ignored ASHRAE’s flexibility for low energy buildings.[2] The 2024 IECC also provides flexibility.

The proponent failed to compare the impact of its proposed standards to the many IECC standards it would override or to ASHRAE efficiency standards, which Appendix CD also undercuts.

Nor did the proponent provide data contradicting the many findings by DOE and PNNL that updates since 2006 would save energy and energy costs. The proponent’s brief assertions about possible implementation being more difficult and possibly less attractive are too vague or irrelevant to support the extreme proposal. Had there been legitimate technical implementation problems, they would have been raised in the IECC and ASHRAE processes in each cycle from 2009 through 2018.

The proposal did not address or explain how Virginia had successfully implemented the higher conservation standards embodied in IECC updates from 2009-2018 or explain why the 2021 standards are unreasonable.

In fact, the evidence presented showed that the warehouse business was booming in the years the 2018 IECC standards were in effect. See, for example:

- **“Need for speed: Developers race to build warehouses amid site shortage,”** https://www.virginiabusiness.com/article/need-for-speed/ (Dec. 31, 2021) (“Geoff Poston [of Hampton Roads] likens the current market for building, buying and leasing warehouses and distribution centers to the mid-1800s California Gold Rush: Everybody wants in.” The problem is land, not demand or ability to construct.);
- **“Making it rain: Increased e-commerce fuels wave of distribution centers,”** https://www.virginiabusiness.com/article/making-it-rain/ (April 29, 2021) (“For Hanover County Economic Development Director Linwood Thomas, things couldn’t get much better. ‘It’s really been a perfect storm,’ Thomas says. That storm — the good type — is a deluge of distribution centers and warehouses that have opened recently or are currently in the pipeline for the county of about 108,000 residents, located about 20 miles north of Richmond.… Over the past two years or so, Hanover has added about 1.5 million square feet of new space and about 80% of that has been leased. ‘Then, we’ve got another almost 4 million square feet proposed in the next 24 months. These are tangible products that will put us over 5.5 million square feet of new space, which is huge,’ says Thomas, noting that the new space will represent a nearly VASE% increase over the county’s existing stock of 13.8 million square feet of industrial/warehouse space.”);
- **“Industrial boom: Virginia continues to see more warehouses and distribution centers**,” https://www.virginiabusiness.com/article/industrial-boom/ (July 27, 2018)(“While Hampton and Southwest Virginia area also benefiting, …. Richmond’s industrial warehouse market is currently undergoing a “golden age” in the distribution sector, according to a recent report from CBRE.”)
- And, more recently, according to a Cushman and Wakefield survey, the Northern Virginia market for warehouse/distribution

stayed strong in 2023, but weakened in 2024 – after the rollback took effect**.** https://assets.cushmanwakefield.com/-/media/cw/marketbeat-pdfs/2024/q1/us-reports/industrial/nova_americas_marketbeat_industrial_q1-2024.pdf?rev=6c6aad03f7024473b0a153e7bad3b0ca

Other considerations that require deleting Appendix CD and Section 402.1.6 which operationalizes Appendix CD, thereby returning to full compliance with the latest IECC, include:

The IECC's code provisions are built upon the hard work, expertise and negotiations of hundreds of industry and efficiency experts, architects, engineers, trade associations, environmental experts, government bodies and public review processes. They consider technological developments, costs, benefits and practicality. Nothing in the IECC standards was arbitrarily arrived at. It makes accommodations are made for different types of buildings and usage patterns, including low-energy building, through different standards, exemptions and performance alternatives.

DOE and PNNL have consistently found that ASHRAE and IECC standards save money for building users through energy savings compared to initial construction costs. https://www.energycodes.gov/sites/default/files/2021-07/Cost-effectiveness_of_ASHRAE_Standard_90-1-2019-Virginia.pdf (The Commercial Energy Efficiency chapter of the 2021 IECC (International Code Council, ICC 2021) allows users to either follow the provisions in the IECC or use Standard 90.1-2019 as an alternative compliance path.) In its 2023 Report "Impacts of Model Energy Codes" (PNNL-33251), PNNL found that, if fully implemented from 2010-2040, IECC's 2009-2021 commercial energy codes would save 8.16 Quads of energy and $78.22 billion (2021 dollars).

In its report"Energy and Energy Cost Savings Analysis of the 2021 IECC for Commercial Buildings" (September 2022)(PNNL-32816), PNNL found that full implementation the 2021 edition of the IECC for commercial buildings would result in site energy savings of 12.1% at the aggregate national level compared to the 2018 IECC edition. In addition, on a national weighted average basis, the 2021 IECC is 6.5% more efficient for site energy use than Standard 90.1-2019. The 2021 commercial IECC also provides a nationally aggregated energy cost savings of 10.6% and greenhouse gas emissions savings of 10.2% as compared to the 2018 edition. Warehouses were projected to save 8.4% energy on-site, with a 6.9% (energy cost index) savings and a 7.1% emissions reduction. (See also https://www.energycodes.gov/determinations for recent and past determinations.)

In its report "Energy and Energy Cost Savings Analysis of the 2018 IECC for Commercial Buildings December 2018" (December 2018) (PNNL-28125), PNNL found that compared to the 2015 IECC, implementing the 2018 IECC would cause warehouses to save energy (11.1% EUI reduction) and energy costs (16.7% ECI reduction). That is more than was projected for commercial buildings generally.

In its report "Energy and Energy Cost Savings Analysis of the IECC for Commercial Buildings (August 2013) (PNNL-22760)", PNNL found that commercial buildings generally and warehouses specifically would save energy and energy costs by implementing the 2012 IECC compared to the 2006 and 2009 IECC**.** **"**On a weighted national basis, the 2009 IECC results in 8.7% energy savings over the 2006 IECC, and the 2012 IECC results in 18.6% energy savings over the 2006 IECC." For warehouses, the EUI savings from 2012 over 2006 would be 36.9% (with plug-and-process loads) to 41.1% (without plug-and-process loads), and 40.5% energy cost savings (without plug-and-process loads).

The proponent's supporting statement did not address energy savings or energy cost increases, over time, to building users or the impacts of rising energy costs, which are likely to occur as climate change drives up ambient temperatures.

The proponent provided no evidence on how the public, including building occupants, communities and residents of the Commonwealth – would be affected by exempting these three large categories of buildings from all energy conservation requirements. DOE has found, for example, that energy use reductions, under updated IECC standards, would reduce GHG emissions impacts and climate impacts. By reducing peak and off-peak energy demands, keeping up with the latest IECC would reduce pressure on utilities to raise rates charged to all customers to cover higher priced energy resources.

Despite short-term appeals to builders of reducing construction costs, continuing implementation of the rollback would increase the risk that the buildings would become obsolete more quickly as energy operating costs go up for occupants. Lower rents and vacancies could follow just as they have for older office buildings in many areas.

In sum, C402.1.6. and Appendix CD should be deleted from Virginia's building code, and the code should be restored to being "consistent with" the latest IECC. No substantive information has ever been presented to support rolling back envelope efficiency standards to the 2006 level for three broad categories of buildings.

[1] In the 2021 Cycle, the initial proposal for an exemption was Appendix CB [later changed Appendix CD] was replaced by a proposal for an appendix to rollback building envelope standards to 2006 for F, S and U, which was adopted without discussion even though it was a non-consensus proposal to be approved. The Staff presented a proposal for an exemption simply to assure that that concept was considered as called for by HB 1289. Staff presented no evidence or arguments in support, and that proposal was rejected by the Board.

Cost Impact: The code change proposal will increase the cost

Obviously, there would be cost increases from restoring compliance from the 2006 standards to the latest IECC. The changes in costs are justified by changes in technology, building techniques, energy savings and energy costs, all of which have been reviewed by the IECC, DOE, PNNL and even the Board, which approved updated standards from 2009 - 2018 IECCs, before approving a rollback for 3 groups of buildings.

Although construction costs to builders would go up compared to the 2006 IECC standards in Appendix CD, builders managed to successfully and profitably construct new structures under the IECCs for 2009, 2012, 2015 and 2018. As discussed in the Reason Statement, building warehouses was a booming business under the 2018 IECC commercial envelope standards, which had been adopted in full by the Board. (Warehouse building starts declined, according to a survey, after the rollback took effect in January 2024.)

DOE and PNNL have repeatedly found that implementing updated IECC and ASHRAE standards since 2006 and 2004 would save energy and energy costs for building occupants. Builders can choose to implement either the IECC or ASHRAE. In its 2023 Report "Impacts of Model Energy Codes" (PNNL-33251), PNNL found that, if fully implemented from 2010-2040, IECC's 2009-2021 commercial energy codes would save 8.16 Quads of energy and $78.22 billion of energy costs (2021 dollars).

In its report “Energy and Energy Cost Savings Analysis of the 2021 IECC for Commercial Buildings” (September 2022)(PNNL-32816), PNNL found that full implementation the 2021 edition of the IECC for commercial buildings would result in site energy savings of 12.1% at the aggregate national level compared to the 2018 IECC edition. In addition, on a national weighted average basis, the 2021 IECC is 6.5% more efficient for site energy use than Standard 90.1-2019. The 2021 commercial IECC also provides a nationally aggregated energy cost savings of 10.6% and greenhouse gas emissions savings of 10.2% as compared to the 2018 edition. Warehouses were projected to save 8.4% energy on-site, with a 6.9% (energy cost index) savings and a 7.1% emissions reduction.

In its report “Energy and Energy Cost Savings Analysis of the 2018 IECC for Commercial Buildings December 2018” (December 2018) (PNNL-28125), PNNL found that compared to the 2015 IECC, implementing the 2018 IECC would cause warehouses to save energy (11.1% EUI reduction) and energy costs (16.7% ECI reduction). That is more than was projected for commercial buildings generally.

In its report “Energy and Energy Cost Savings Analysis of the IECC for Commercial Buildings (August 2013) (PNNL-22760)”, PNNL found that commercial buildings generally and warehouses specifically would save energy and energy costs by implementing the 2012 IECC compared to the 2006 and 2009 IECC**.** **“**On a weighted national basis, the 2009 IECC results in 8.7% energy savings over the 2006 IECC, and the 2012 IECC results in 18.6% energy savings over the 2006 IECC.” For warehouses, the EUI savings from 2012 over 2006 would be 36.9% (with plug-and-process loads) to 41.1% (without plug-and-process loads), and 40.5% energy cost savings (without plug-and-process loads).

The scanty cost claims that were presented in support of the Section 402.1.6 and Appendix CD (then called Appendix CB) described two hypothetical warehouses (presumably in Group F) with a square footage and alleged cost savings from reducing insulation in ceilings and walls. There was no information about (a) any of costs or benefits for the many other types of buildings covered by Appendix CD, (b) the energy and energy cost savings that would result from the higher efficiency standards in either the 2021 or 2018 IECC, (c) any justifications for the many other changes embedded in Appendix CD, (d) how the so-called complications of construction had been successfully and profitably complied with for well over a decade, (e) why ASHRAE standards should be rolled back, (f) impacts on climate and other forms of air pollution, or any other issue relevant to the rollback of 8 single-spaced changes of standards. There was no plausibility for the proponent’s assertion that a $42,984 cost savings from weaker insulation would save a project: “That is enough to keep this project from being built.” In fact, weakening building code standards would lower construction cost for competitors, too, giving no advantage to anyone. Indeed, one point of building codes is to prevent builders from trying to undercut their competitors with poorly built buildings -- achieving savings at the expense of meeting recognized standards.

In short, under Virginia law, Section C402.1.6 and Appendix CD should be deleted. Repeated findings by PNNL and DOE show that energy use and energy costs are significantly reduced by implementing updated IECC (and ASHRAE) standards. No meaningful cost-benefit evidence supported the rollback in Appendix CD to standards that are demonstrably less stringent than and not "consistent with" modern IECC and ASHRAE standards. The rollback was entirely based on vague cost reduction claims without consideration of the other factors required by law. It fails to minimize costs to the extent “consistent with” the latest IECC’s standards and to adopt standards at least as stringent as the latest IECC when considering benefits, including user-cost savings over time and pollution reductions, not just costs. If the only issue was how to cut costs for builders then there would be no building codes or building code updates.

Pacific Northwest
NATIONAL LABORATORY

PNNL-31535

Cost-Effectiveness of ANSI/ASHRAE/IES Standard 90.1-2019 for Virginia

July 2021

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U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Acronyms and Abbreviations

AVERT	U.S. EPA AVoided Emissions and geneRation Tool
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BECP	Building Energy Codes Program
CH_4	Methane
CO_2	Carbon Dioxide
DOE	U.S. Department of Energy
E.O.	Executive Order
eGRID	EPA Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FEMP	Federal Energy Management Program
HVAC	Heating, Ventilating, and Air-Conditioning
LCC	Life-Cycle Cost
MMT	Million Metric Tons
N_2O	Nitrous Oxide
NOx	Nitrogen Oxides
NIST	National Institute of Standards and Technology
PNNL	Pacific Northwest National Laboratory
SOx	Sulfur Oxides
UPV	Uniform Present Value

1.0 Highlights

Moving to the ASHRAE Standard 90.1-2019 (ASHRAE 2019) edition from Standard 90.1-2016 (ASHRAE 2016) is cost-effective for Virginia. Standard 90.1-2019 will provide an annual energy cost savings of $0.037 per square foot on average across the state. It will reduce statewide CO_2 emissions by 8.4 MMT (30 years cumulative), equivalent to the CO_2 emissions of 1,824,000 cars driven for one year.

Updating the state energy code based on Standard 90.1-2019 will also stimulate the creation of high-quality jobs across the state. Standard 90.1-2019 is expected to result in buildings that are energy efficient, more affordable to own and operate, and based on current industry standards for health, comfort, and resilience.

The tables below show the expected impact of upgrading to Standard 90.1-2019 from a consumer perspective and statewide perspective. These results are weighted averages for all building types in all climate zones in the state, based on weightings shown in Table 4. The methodology used for this analysis is consistent with the methodology used in the national cost-effectiveness analysis.[1] Additional results and details on the methodology are presented in the following sections.

Consumer Impact	
Annual (first year) energy cost savings, $/ft^2	$0.037
Added construction cost, $/ft^2	-$1.007
Publicly-owned scenario LCC Savings, $/ft^2	3.18
Privately-owned scenario LCC Savings, $/ft^2	2.76

Statewide Impact - Emissions	First Year	30 Years Cumulative
Energy cost savings, 2020$	1,140,000	508,600,000
CO_2 emission reduction, Metric tons	11,940	8,388,000
CH_4 emissions reductions, Metric tons	0.63	445
N_2O emissions reductions, Metric tons	0.085	59
NOx emissions reductions, Metric tons	6.26	4,396
SOx emissions reductions, Metric tons	8.21	5,768

Statewide Impact - Jobs Created	First Year	30 Years Cumulative
Jobs Created Reduction in Utility Bills	92	2,947
Jobs Created Construction Related Activities	214	6,807

[1] National cost-effectiveness report:
https://www.energycodes.gov/development/commercial/cost_effectiveness

The report provides analysis of two LCC scenarios:

- **Scenario 1**, representing *publicly-owned* buildings, considers initial costs, energy costs, maintenance costs, and replacement costs—without borrowing or taxes.
- **Scenario 2**, representing *privately-owned* buildings, adds borrowing costs and tax impacts.

Figure 1 compares annual energy cost savings, first cost for the upgrade, and net annualized LCC savings. The net annualized LCC savings per square foot is the annual energy savings minus an allowance to pay for the added cost under scenario 1. Figure 2 shows overall state weighted net LCC results for both scenarios. When net LCC is positive, the updated code edition is considered cost-effective.

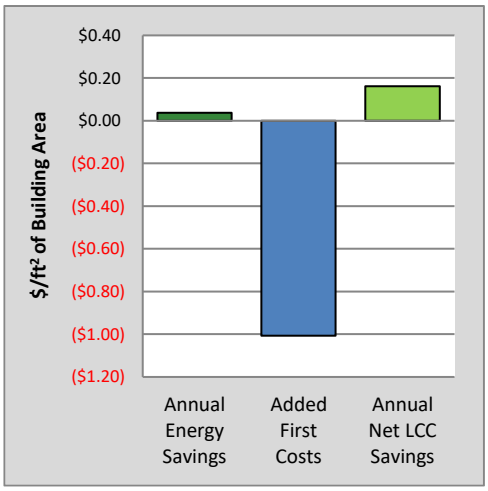


Figure 1. Statewide Weighted Costs and Savings

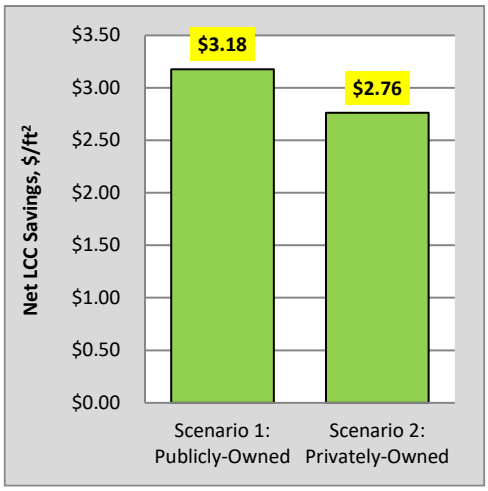


Figure 2. Overall Net Life-Cycle Cost Savings

2.0 Cost-Effectiveness Results for ASHRAE Standard 90.1-2019 in Virginia

This section summarizes the cost-effectiveness analysis results applicable to the building owner. Life Cycle Cost (LCC) savings is the primary measure established by the U.S. Department of Energy to assess the cost effectiveness and economic impact of building energy codes. Net LCC savings is the calculation of the present value of energy savings minus the present value of non-energy incremental costs over a 30-year period. The non-energy incremental costs include initial equipment and construction costs, and maintenance and replacement costs, less the residual value of components at the end of the 30-year period. When net LCC is positive, the updated code edition is considered cost-effective. Savings are computed for two scenarios:

- **Scenario 1:** represents *publicly-owned buildings*, includes costs for initial equipment and construction, energy, maintenance and replacement and does not include loans or taxes.
- **Scenario 2:** represents *privately-owned buildings*, includes the same costs as Scenario 1, with the initial investment financed through a loan amortized over 30 years and federal and state corporate income tax deductions for interest and depreciation.

Both scenarios include the residual value of equipment with remaining useful life at the end of the 30-year assessment period. Totals for building types, climate zones, and the state overall are averages based on Table 4 construction weights. Factors such as inflation and discount rates are different between the two scenarios, as described in the Cost-Effectiveness Methodology section.

LCC is affected by many variables, including the applicability of individual measures in the code, measure costs, measure lifetime, replacement costs, state cost adjustment, energy prices, and so on. In some cases, the LCC can be negative for a given building type or climate zone based on the interaction of these variables. However, the code is considered cost-effective if the weighted statewide LCC is positive.

Table 1 shows the present value of the net LCC savings over 30 years for buildings in scenario 1 averages $3.18 per square foot for Standard 90.1-2019.

Table 1. Net LCC Savings for Virginia, Scenario 1 ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
3A	$3.55	$3.63	$3.65	$4.14	$12.16	$2.48	$3.52
4A	$3.52	$3.60	$3.68	$4.15	$12.14	$1.74	$3.10
5A	$3.36	$3.41	$3.63	$4.20	$12.07	$1.79	$8.29
State Average	$3.53	$3.60	$3.67	$4.15	$12.14	$1.86	**$3.18**

Table 2 shows the present value of the net LCC savings over 30 years averages $2.76 per square foot for scenario 2.

Table 2. Net LCC Savings for Virginia, Scenario 2 ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
3A	$2.97	$2.98	$3.14	$3.50	$11.76	$2.24	$3.09
4A	$2.94	$2.94	$3.17	$3.47	$11.73	$1.57	$2.69
5A	$2.80	$2.78	$3.11	$3.52	$11.67	$1.62	$7.80
State Average	$2.95	$2.94	$3.16	$3.48	$11.74	$1.68	**$2.76**

2.1 Energy Cost Savings

Table 3 shows the economic impact of upgrading to Standard 90.1-2019 by building type and climate zone in terms of the annual energy cost savings in dollars per square foot. The annual energy cost savings across the state averages $0.037 per square foot.

Table 3. Annual Energy Cost Savings for Virginia ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
3A	$0.034	$0.048	$0.064	$0.057	$0.061	$0.047	$0.051
4A	$0.032	$0.042	$0.063	$0.046	$0.060	$0.013	$0.034
5A	$0.031	$0.037	$0.059	$0.047	$0.056	$0.013	$0.053
State Average	$0.033	$0.042	$0.063	$0.048	$0.060	$0.019	**$0.037**

2.2 Construction Weighting of Results

Energy and economic impacts were determined and reported separately for each building type and climate zone. Cost-effectiveness results are also reported as averages for all prototypes and climate zones in the state. To determine these averages, results were combined across the different building types and climate zones using weighting factors shown in Table 4. These weighting factors are based on the floor area of new construction and major renovations for the six analyzed building prototypes in state-specific climate zones. The weighting factors were developed from construction start data from 2003 to 2018 (Dodge Data & Analytics) based on an approach documented in Lei, et al.

Table 4. Construction Weights by Building Type

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
3A	2.5%	1.2%	4.4%	1.8%	0.6%	7.0%	17.6%
4A	6.7%	14.6%	16.4%	7.6%	2.2%	34.8%	82.3%
5A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
State Average	9.2%	15.8%	20.9%	9.4%	2.8%	41.8%	100.0%

2.3 Incremental Construction Cost

Cost estimates were developed for the differences between Standard 90.1-2016 and Standard 90.1-2019 as implemented in the six prototype models. Costs for the initial construction include material, labor, commissioning, construction equipment, overhead and profit. Costs were also estimated for replacing equipment or components at the end of the useful life. The costs were

developed at the national level for the national cost-effectiveness analysis and then adjusted for local conditions using a state construction cost index (Hart et al. 2019, Means 2020a,b).

Table 5 shows incremental initial cost for individual building types in state-specific climate zones and weighted average costs by climate zone and building type for moving to Standard 90.1-2019 from Standard 90.1-2016.

The added construction cost can be negative for some building types, which represents a reduction in first costs and a savings that is included in the net LCC savings. This is typically due to the interaction between measures and situations such as the following:

- Fewer light fixtures are required when the allowed lighting power is reduced. Also, changes from fluorescent to LED technology result in reduced lighting costs in many cases and longer lamp lives, requiring fewer lamp replacements.
- Smaller heating, ventilating, and air-conditioning (HVAC) equipment sizes can result from the lowering of heating and cooling loads due to other efficiency measures, such as better building envelopes. For example, Standard 90.1-2019 has more stringent fenestration U-factors for some climate zones. This results in smaller equipment and distribution systems, resulting in a negative first cost.

Table 5. Incremental Construction Cost for Virginia ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
3A	($1.648)	($1.844)	($1.203)	($1.696)	$0.611	($0.317)	($0.942)
4A	($1.642)	($1.926)	($1.230)	($1.872)	$0.601	($0.338)	($1.021)
5A	($1.574)	($1.849)	($1.252)	($1.885)	$0.605	($0.368)	($0.396)
State Average	($1.644)	($1.919)	($1.225)	($1.838)	$0.603	($0.335)	**($1.007)**

2.4 Simple Payback

Simple payback is the total incremental first cost divided by the annual savings, where the annual savings is the annual energy cost savings less any incremental annual maintenance cost. Simple payback is not used as a measure of cost-effectiveness as it does not account for the time value of money, the value of energy cost savings that occur after payback is achieved, or any replacement costs that occur after the initial investment. However, it is included in the analysis for states who wish to use this information. Table 6 shows simple payback results in years.

Table 6. Simple Payback for Virginia (Years)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
3A	Immediate	Immediate	Immediate	Immediate	10.0	Immediate	Immediate
4A	Immediate	Immediate	Immediate	Immediate	10.1	Immediate	Immediate
5A	Immediate	Immediate	Immediate	Immediate	10.8	Immediate	Immediate
State Average	Immediate	Immediate	Immediate	Immediate	10.0	Immediate	**Immediate**

3.0 Societal Benefits

3.1 Benefits of Energy Codes

It is estimated that by 2060, the world will add 2.5 trillion square feet of buildings, an area equal to the current building stock. As a building's operation and environmental impact is largely determined by upfront decisions, energy codes present a unique opportunity to assure savings through efficient building design, technologies, and construction practices. Once a building is constructed, it is significantly more expensive to achieve higher efficiency levels through later modifications and retrofits. Energy codes ensure that a building's energy use is included as a fundamental part of the design and construction process. Making this early investment in energy efficiency will pay dividends to residents of Virginia for years into the future.

3.2 Greenhouse Gas Emissions

The urban built environment is responsible for 75% of annual global greenhouse gas (GHG) emissions while buildings alone account for 39%.[2] While carbon dioxide emissions represent the largest share of greenhouse gas emissions, building electricity use and on-site fossil fuel consumption also contribute to other emissions, two of which, methane (CH_4) and nitrous oxide (N_2O), are significant greenhouse gases in their own right.

For natural gas combusted on site, emission metrics are developed using nationwide emission factors from U.S. Environmental Protection Agency publications for CO_2, NOx, SO_2, CH_4 and N_2O (EPA 2014).

For electricity, marginal carbon emission factors are provided by the U.S. Environmental Protection Agency (EPA) AVoided Emissions and geneRation Tool (AVERT) version 3.0 (EPA 2020). The AVERT tool forms the basis of the national marginal emission factors for electricity also published by EPA on its Greenhouse Gas Equivalencies Calculator website and are based on a portfolio of energy efficiency measures examined by EPA. AVERT is used here to provide marginal CO_2 emission factors at the State level.[3] AVERT also provides marginal emission factor estimates for gaseous pollutants associated with electricity production, including NOx and SO_2 emissions. While not considered significant greenhouse gases, these are EPA tracked pollutants. The current analysis uses AVERT to provide estimates of corresponding emission changes for NOx and SO_2 in physical units but does not monetize these.

AVERT does not develop associated marginal emissions factors for CH_4 or N_2O. To provide estimates for the associated emission reductions for CH_4 and N_2O, this report uses emission factors separately provided through the U.S. Environmental Protection Agency (EPA) Emissions

[2] Architecture 2030, https://architecture2030.org/2030_challenges/2030-challenge

[3] AVERT models avoided emissions in 14 geographic regions of the 48 contiguous United States and includes transmission and distribution losses. Where multiple AVERT regions overlap a state's boundaries, the emission factors are calculated based on apportionment of state electricity savings by generation across generation regions. The most recent AVERT 3.0 model uses EPA emissions data for generators from 2019. Note that AVERT estimates are based on marginal changes to demand and reflect current grid generation mix. Emission factors for electricity shown in Table 7 do not take into account long term policy or technological changes in the regional generation mix that can impact the marginal emission benefits from new building codes.

& Generation Resource Integrated Database (eGRID) dataset. eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States and the emission characteristics for electric power generation for each of the above emissions can also be found aggregated down to the state level in eGRID (EPA 2021a). The summary emission factor data provided by eGRID does not provide marginal emission factors, but instead summarizes emission factors in terms of total generation emission factors and non-baseload generation emission factors. Non-baseload emission factors established in eGRID are developed based on the annual load factors for the individual generators tracked by the EPA (EPA 2021b). Because changes in building codes are unlikely to significantly impact baseload electrical generators, the current analysis uses the 2019 non-baseload emission factors established in eGRID by state to estimate CH_4 or N_2O emission reductions due to changes in electric consumption.

Table 7 summarizes the marginal emission factors available from AVERT, eGRID and the EPA Greenhouse Gas Equivalencies Calculator.

Table 7. Greenhouse Gas Emission Factors by Fuel Type

GHG	Electricity lb/MWh	Natural Gas (lb/mmcf)
CO_2	1,567	120,000
SO_2	1.194	0.6
NO_X	0.774	96
N_2O	0.012	0.23
CH_4	0.089	2.3

Table 8 shows the annual first year and projected 30-year energy cost savings. This table also shows first year and projected 30-year greenhouse gas (CO_2, CH_4, and N_2O) emission reductions, in addition to NOx and SO_2 reductions.

Table 8. Societal Benefits of Standard 90.1-2019

Statewide Impact	First Year	30 Years Cumulative
Energy cost savings, 2020$	1,140,000	508,600,000
CO_2 emission reduction, Metric tons	11,940	8,388,000
CH_4 emissions reductions, Metric tons	0.63	445
N_2O emissions reductions, Metric tons	0.085	59
NOx emissions reductions, Metric tons	6.26	4,396
SOx emissions reductions, Metric tons	8.21	5,768

3.3 Jobs Creation through Energy Efficiency

Energy-efficient building codes impact job creation through two primary value streams:

1. Dollars returned to the economy through reduction in utility bills and resulting increase in disposable income, and;
2. An increase in construction-related activities associated with the incremental cost of construction that is required to produce a more energy efficient building.

When a building is built to a more stringent energy code, there is the long-term benefit of the ratepayer paying lower utility bills.

- This is partially offset by the increased cost of that efficiency, establishing a relationship between increased building energy efficiency and additional investments in construction activity.

- Since building codes are cost-effective, (i.e., the savings outweigh the investment), a real and permanent increase in wealth occurs that can be spent on other goods and services in the economy, just like any other income, generating economic benefits and creating additional employment opportunities.

Table 9 shows the number of jobs created because of efficiency gains in Standard 90.1-2019.

Table 9. Jobs Created from Standard 90.1-2019

Statewide Impact	First Year	30 Years Cumulative
Jobs Created Reduction in Utility Bills	92	2,947
Jobs Created Construction Related Activities	214	6,807

4.0 Overview of the Cost-Effectiveness Methodology

This analysis was conducted by Pacific Northwest National Laboratory (PNNL) in support of the DOE Building Energy Codes Program. DOE is directed by federal law to provide technical assistance supporting the development and implementation of residential and commercial building energy codes. The national model energy codes – the International Energy Conservation Code (IECC) and ANSI/ASHRAE/IES Standard 90.1 – help adopting states and localities establish minimum requirements for energy-efficient building design and construction, as well as mitigate environmental impacts and ensure residential and commercial buildings are constructed to modern industry standards.

The current analysis evaluates the cost-effectiveness of Standard 90.1-2019 relative to Standard 90.1-2016. The analysis covers six commercial building types. The analysis is based on the current prescriptive requirements of Standard 90.1. The simulated performance rating method is not in the scope of this analysis, as it is generally based on the core prescriptive requirements of Standard 90.1, and due to the unlimited range of building configurations that are allowed. Buildings complying via this path are generally considered to provide equal or better energy performance compared to the prescriptive requirements, as the intent of these paths is to provide additional design flexibility and cost optimization, as dictated by the builder, designer, and owner.

The current analysis is based on the methodology by DOE for assessing building energy codes (Hart and Liu 2015). The LCC analysis perspective described in the methodology appropriately balances upfront costs with longer term consumer costs and savings and is therefore the primary economic metric by which DOE evaluates the cost-effectiveness of building energy codes.

4.1 Cost-Effectiveness

DOE has established standard economic LCC cost-effectiveness analysis methods in comparing Standard 90.1-2019 and Standard 90.1-2016, which are described in *Methodology for Evaluating Cost-effectiveness of Commercial Energy Code Changes* (Hart and Liu 2015). Under this methodology, two metrics are used:

- **Net LCC Savings:** This is the calculation of the present value of energy savings minus the present value of non-energy incremental costs over a 30-year period. The costs include initial equipment and construction costs, maintenance and replacement costs, less the residual value of components at the end of the 30-year period. When net LCC is positive, the updated code edition is considered cost-effective.
- **Simple Payback:** While not a true cost-effectiveness metric, simple payback is also calculated. Simple payback is the number of years required for accumulated annual energy cost savings to exceed the incremental first costs of a new code.

Two cost scenarios are analyzed:

- **Scenario 1** represents publicly-owned buildings, considers initial costs, energy costs, maintenance costs, and replacement costs without borrowing or taxes.
- **Scenario 2** represents privately-owned buildings and includes the same costs as Scenario 1 plus financing of the incremental first costs through increased borrowing with tax impacts including mortgage interest and depreciation deductions. Corporate tax rates are applied.

The cost-effectiveness analysis compares the cost for new buildings meeting Standard 90.1-2019 versus new buildings meeting Standard 90.1-2016. The analysis includes energy savings estimates from building energy simulations and LCC and simple payback calculations using standard economic analysis parameters. The analysis builds on work documented in *Energy Savings Analysis: ANSI/ASHRAE/IES Standard 90.1-2019* (DOE 2021), and the national cost-effectiveness analysis documented in *National Cost-effectiveness of ANSI/ASHRAE/IES Standard 90.1- 2019* (Tyler et al. 2021).

4.2 Building Prototypes and Energy Modeling

The cost-effectiveness analysis uses six building types represented by six prototype building energy models. These six models represent the energy impact of five of the eight commercial principal building activities that account for 74% of the new construction by floor area covered by the full suite of 16 prototypes. These models provide coverage of the significant changes in ASHRAE Standard 90.1 from 2016 to 2019 and are used to show the impacts of the changes on annual energy usage. The prototypes represent common construction practice and include the primary conventional HVAC systems most commonly used in commercial buildings.[4]

Each prototype building is analyzed for each of the climate zones found within the state. Using the U.S. DOE EnergyPlus software, the six building prototypes summarized in Table 10 are simulated with characteristics meeting the requirements of Standard 90.1-2016 and then modified to meet the requirements of the next edition of the code (Standard 90.1-2019). The energy use and energy cost are then compared between the two sets of models.

Table 10. Building Prototypes

Building Prototype	Floor Area (ft²)	Number of Floors
Small Office	5,500	1
Large Office	498,640	13
Stand-Alone Retail	24,690	1
Primary School	73,970	1
Small Hotel	43,210	4
Mid-Rise Apartment	33,740	4

4.3 Climate Zones

Climate zones are defined in ASHRAE Standard 169, as specified in ASHRAE Standard 90.1, and include eight primary climate zones in the United States, the hottest being climate zone 1 and the coldest being climate zone 8. Letters A, B, and C are applied in some cases to denote the level of moisture, with A indicating humid, B indicating dry, and C indicating marine. Figure 3 shows the national climate zones. For this state analysis, savings are analyzed for each climate zone in the state using weather data from a selected city within the climate zone and state, or where necessary, a city in an adjoining state with more robust weather data.

[4] More information on the prototype buildings and savings analysis can be found at www.energycodes.gov/development/commercial/90.1_models

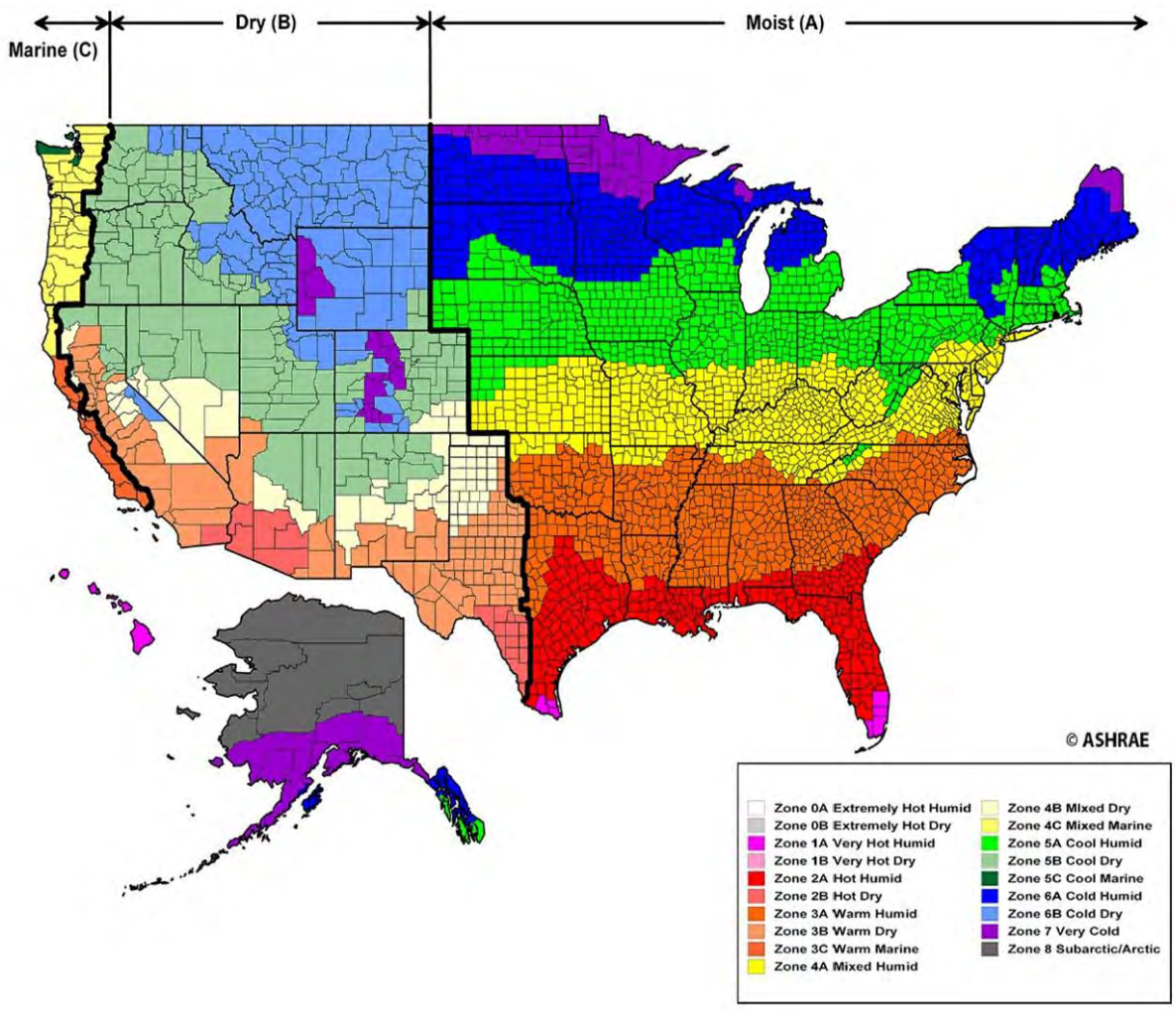


Figure 3. National Climate Zones

4.4 Cost-Effectiveness Method and Parameters

The DOE cost-effectiveness methodology accounts for the benefits of energy efficient building construction over a multi-year analysis period, balancing initial costs against longer term energy savings. DOE evaluates energy codes and code proposals based on LCC analysis over a multi-year study period, accounting for energy savings, incremental investment for energy efficiency measures, and other economic impacts. The value of future savings and costs are discounted to a present value, with improvements deemed cost-effective when the net LCC savings (present value of savings minus cost) is positive.

The U.S. DOE Building Energy Codes Program has established LCC analysis criteria similar to the method used for many federal building projects, as well as other public and private building projects (Fuller and Petersen 1995). The LCC analysis method consists of identifying costs (and revenues if any) and in what year they occur; then determining their value in today's dollars (known as the present value). This method uses economic relationships about the time value of money. Money in-hand today is normally worth more than money received in the future, which is why we pay interest on a loan and earn interest on savings. Future costs are discounted to the

present based on a discount rate. The discount rate may reflect the interest rate at which money can be borrowed for projects with the same level of risk or the interest rate that can be earned on other conventional investments with similar risk.

The LCC includes incremental initial costs, repairs, maintenance, and replacements. Scenario 2 also includes loan costs and tax impacts including mortgage interest and depreciation deductions. The residual value of equipment (or other component such as roof membrane) that has remaining useful life at the end of the 30-year study period is also included for both scenarios. The residual value is calculated by multiplying the initial cost of the component by the years of useful life remaining for the component at year 30 divided by the total useful life, a simplified approach included in the Federal Energy Management Program (FEMP) LCC method (Fuller and Petersen 1995). A component will have zero residual value at year 30 only if it has a 30-year life, or if it has a shorter than 30-year life that divides exactly into 30 years (for example, a 15-year life).

The financial and economic parameters used for the LCC calculations are shown in Table 11.

Table 11. LCC Economic Parameters

Economic Parameter	Scenario 1	Scenario 2
Study Period – Years[1]	30	30
Nominal Discount Rate[2]	3.10%	5.25%
Real Discount Rate[2]	3.00%	3.34%
Effective Inflation Rate[3]	0.10%	1.85%
Electricity Prices[4] (per kWh)	$0.0770	$0.0770
Natural Gas Prices[4] (per therm)	$0.8438	$0.8438
Energy Price Escalation Factors[5]	*Uniform present value factors*	*Uniform present value factors*
Electricity Price UPV[5]	19.17	17.37
Natural Gas Price UPV[5]	23.45	21.25
Loan Interest Rate[6]	NA	5.25%
Federal Corporate Tax Rate[7]	NA	21.00%
State Corporate Tax Rate[8]	NA	6.00%
Combined Income Tax Impact[9]	NA	25.74%
State and Average Local Sales Tax[10]	5.65%	5.65%
State Construction Cost Index[11]	0.887	0.887

[1] A 30-year study period captures most building components useful lives and is a commonly used study period for building project economic analysis. This period is consistent with previous and related national 90.1 cost-effectiveness analysis. It is also consistent with the cost-effectiveness analysis that was done for the residential energy code as described in multiple state reports and a summary report (Mendon et al. 2015). The federal building LCC method uses 25 years and the ASHRAE Standard 90.1 development process uses up to 40 years for building envelope code improvement analysis. Because of the time value of money, results are typically similar for any study periods of 20 years or more.

[2] The Scenario 1 real and nominal discount rates are from the National Institute of Standards and Technology (NIST) 2019 annual update in the *Report of the President's Economic Advisors, Analytical Perspectives* (referenced in the NIST 2019 annual supplement without citation) (Lavappa and Kneifel 2019). The Scenario 2 nominal discount rate is taken as the marginal cost of capital, which is set equal to the loan interest rate (see footnote 6). The real discount rate for Scenario 2 is calculated from the nominal discount rate and inflation.

[3] The Scenario 1 effective inflation rate is from the NIST 2019 annual update for the federal LCC method (Lavappa and Kneifel 2019). The Scenario 2 inflation rate is the 30-year average Producer Price Index for non-residential construction, June 1990 to June 2020 (Bureau of Labor Statistics 2021).

[4] Scenario 1 and 2 electricity and natural gas prices are state average annual prices for 2020 from the United States Energy Information Administration (EIA) *Electric Power Monthly* (EIA 2021a) and *Natural Gas Monthly* (EIA 2021b).

[5] Scenario 1 energy price escalation rates are from the NIST 2019 annual update for the FEMP LCC method (Lavappa and Kneifel 2019). The NIST uniform present value (UPV) factors are multiplied by the first-year annual energy cost to determine the present value of 30 years of energy costs and are based on a series of different annual escalation rates for 30 years. Scenario 2 UPV factors are based on NIST UPVs with an adjustment made for the scenario difference in discount rates.

[6] The loan interest rate is estimated from multiple online sources listed in the references (Commercial Loan Direct 2021; Realty Rates 2021).

[7] The highest federal marginal corporate income tax rate is applied.

[8] The highest marginal state corporate income tax rate is applied from the Federation of Tax Administrators (FTA 2021).

[9] The combined tax impact is based on state tax being a deduction for federal tax and is applied to depreciation and loan interest.

[10] The combined state and average local sales tax is included in material costs in the cost estimate (Tax Foundation 2020).

[11] The state construction cost index is based on weighted city indices from the state (Means 2020b).

5.0 Detailed Energy Use and Cost

On the following pages, specific detailed results for Virginia are included:

- Table 12 shows the average energy rates used.
- Table 13 shows the per square foot energy costs for Standard 90.1-2016 and Standard 90.1-2019 and the cost savings from Standard 90.1-2019.
- Table 14 shows the per square foot energy use for Standard 90.1-2016 and Standard 90.1-2019 and the energy use savings from Standard 90.1-2019.
- Tables 15.A through 15.C show the energy end use by energy type for each climate zone in the state.

Table 12. Energy Rates for Virginia, Average $ per unit

Electricity	$0.0770	kWh
Gas	$0.8438	Therm

Source: Energy Information Administration, annual average prices for 2020 (EIA 2021a,b)

Table 13. Energy Cost Saving Results in Virginia, $ per Square Foot

Climate Zone:	3A				4A				5A			
Code:	90.1-2016	90.1-2019	Savings		90.1-2016	90.1-2019	Savings		90.1-2016	90.1-2019	Savings	
Small Office												
Electricity	$0.584	$0.550	$0.034	5.8%	$0.576	$0.544	$0.033	5.7%	$0.556	$0.525	$0.032	5.8%
Gas	$0.003	$0.003	$0.000	0.0%	$0.002	$0.002	$0.000	0.0%	$0.013	$0.014	-$0.001	-7.7%
Totals	$0.586	$0.553	$0.034	5.8%	$0.578	$0.545	$0.032	5.5%	$0.570	$0.539	$0.031	5.4%
Large Office												
Electricity	$1.186	$1.144	$0.042	3.5%	$1.190	$1.148	$0.041	3.4%	$1.148	$1.111	$0.037	3.2%
Gas	$0.024	$0.017	$0.007	29.2%	$0.016	$0.016	$0.001	6.3%	$0.023	$0.023	$0.001	4.3%
Totals	$1.210	$1.162	$0.048	4.0%	$1.206	$1.164	$0.042	3.5%	$1.171	$1.134	$0.037	3.2%
Stand-Alone Retail												
Electricity	$0.752	$0.681	$0.071	9.4%	$0.756	$0.686	$0.070	9.3%	$0.683	$0.614	$0.069	10.1%
Gas	$0.106	$0.113	-$0.007	-6.6%	$0.099	$0.106	-$0.007	-7.1%	$0.161	$0.171	-$0.010	-6.2%
Totals	$0.858	$0.794	$0.064	7.5%	$0.855	$0.792	$0.063	7.4%	$0.844	$0.785	$0.059	7.0%
Primary School												
Electricity	$0.744	$0.692	$0.052	7.0%	$0.744	$0.699	$0.045	6.0%	$0.671	$0.626	$0.045	6.7%
Gas	$0.093	$0.087	$0.005	5.4%	$0.073	$0.072	$0.001	1.4%	$0.099	$0.096	$0.002	2.0%
Totals	$0.837	$0.779	$0.057	6.8%	$0.817	$0.771	$0.046	5.6%	$0.770	$0.723	$0.047	6.1%
Small Hotel												
Electricity	$0.708	$0.647	$0.061	8.6%	$0.706	$0.647	$0.060	8.5%	$0.678	$0.622	$0.056	8.3%
Gas	$0.188	$0.188	$0.000	0.0%	$0.191	$0.191	$0.000	0.0%	$0.209	$0.209	$0.000	0.0%
Totals	$0.897	$0.835	$0.061	6.8%	$0.897	$0.838	$0.060	6.7%	$0.887	$0.831	$0.056	6.3%
Mid-Rise Apartment												
Electricity	$0.775	$0.755	$0.019	2.5%	$0.783	$0.768	$0.015	1.9%	$0.769	$0.753	$0.016	2.1%
Gas	$0.042	$0.015	$0.028	66.7%	$0.010	$0.011	-$0.002	-20.0%	$0.021	$0.024	-$0.003	-14.3%
Totals	$0.817	$0.770	$0.047	5.8%	$0.792	$0.779	$0.013	1.6%	$0.790	$0.776	$0.013	1.6%

Table 14. Energy Use Saving Results in Virginia, Energy Use per Square Foot

Climate Zone:	3A				4A				5A			
Code:	90.1-2016	90.1-2019	Savings		90.1-2016	90.1-2019	Savings		90.1-2016	90.1-2019	Savings	
Small Office												
Electricity, kWh/ft^2	7.579	7.141	0.437	5.8%	7.481	7.059	0.423	5.7%	7.227	6.817	0.411	5.7%
Gas, therm/ft^2	0.003	0.003	0.000	0.0%	0.002	0.002	0.000	0.0%	0.016	0.017	-0.001	-6.3%
Totals, kBtu/ft^2	26.166	24.692	1.474	5.6%	25.725	24.299	1.425	5.5%	26.258	24.924	1.334	5.1%
Large Office												
Electricity, kWh/ft^2	15.401	14.861	0.540	3.5%	15.453	14.916	0.538	3.5%	14.909	14.432	0.477	3.2%
Gas, therm/ft^2	0.028	0.021	0.008	28.6%	0.019	0.019	0.001	5.3%	0.028	0.027	0.001	3.6%
Totals, kBtu/ft^2	55.391	52.777	2.614	4.7%	54.683	52.769	1.915	3.5%	53.648	51.956	1.692	3.2%
Stand-Alone Retail												
Electricity, kWh/ft^2	9.772	8.848	0.924	9.5%	9.817	8.910	0.908	9.2%	8.864	7.973	0.891	10.1%
Gas, therm/ft^2	0.125	0.133	-0.008	-6.4%	0.118	0.125	-0.008	-6.8%	0.191	0.202	-0.012	-6.3%
Totals, kBtu/ft^2	45.859	43.535	2.323	5.1%	45.257	42.936	2.321	5.1%	49.333	47.458	1.875	3.8%
Primary School												
Electricity, kWh/ft^2	9.667	8.989	0.678	7.0%	9.658	9.077	0.580	6.0%	8.718	8.134	0.584	6.7%
Gas, therm/ft^2	0.110	0.103	0.006	5.5%	0.086	0.085	0.001	1.2%	0.117	0.114	0.003	2.6%
Totals, kBtu/ft^2	43.963	41.026	2.937	6.7%	41.608	39.479	2.129	5.1%	41.430	39.166	2.264	5.5%
Small Hotel												
Electricity, kWh/ft^2	9.201	8.404	0.797	8.7%	9.174	8.398	0.777	8.5%	8.808	8.078	0.730	8.3%
Gas, therm/ft^2	0.223	0.223	0.000	0.0%	0.226	0.227	0.000	0.0%	0.248	0.248	0.000	0.0%
Totals, kBtu/ft^2	53.703	51.004	2.699	5.0%	53.949	51.327	2.622	4.9%	54.846	52.355	2.492	4.5%
Mid-Rise Apartment												
Electricity, kWh/ft^2	10.061	9.810	0.251	2.5%	10.168	9.975	0.193	1.9%	9.987	9.775	0.213	2.1%
Gas, therm/ft^2	0.050	0.018	0.033	66.0%	0.011	0.013	-0.002	-18.2%	0.024	0.028	-0.004	-16.7%
Totals, kBtu/ft^2	39.351	35.234	4.117	10.5%	35.832	35.391	0.441	1.2%	36.521	36.182	0.339	0.9%

Table 15.A. Annual Energy Usage for Buildings in Virginia in Climate Zone 3A

Energy End-Use	Small Office		Large Office		Stand-Alone Retail		Primary School		Small Hotel		Mid-Rise Apartment	
	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$
ASHRAE 90.1-2016												
Heating, Humidification	0.383	0.003	0.532	0.018	0.000	0.090	0.000	0.049	0.343	0.008	0.000	0.050
Cooling	1.032	0.000	2.265	0.000	2.249	0.000	1.981	0.000	2.067	0.000	1.080	0.000
Fans, Pumps, Heat Recovery	0.890	0.000	1.373	0.000	1.522	0.000	1.522	0.000	1.062	0.000	0.660	0.000
Lighting, Interior & Exterior	1.926	0.000	1.962	0.000	3.815	0.000	1.464	0.000	2.142	0.000	1.055	0.000
Plugs, Refrigeration, Other	2.439	0.000	9.269	0.000	2.187	0.000	4.602	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.010	0.000	0.035	0.097	0.015	0.000	0.123	3.058	0.000
Total	7.579	0.003	15.401	0.028	9.772	0.125	9.667	0.110	9.201	0.223	10.061	0.050
ASHRAE 90.1-2019												
Heating, Humidification	0.391	0.003	0.532	0.010	0.000	0.098	0.000	0.043	0.392	0.008	0.000	0.018
Cooling	0.981	0.000	2.099	0.000	2.103	0.000	1.842	0.000	1.944	0.000	1.027	0.000
Fans, Pumps, Heat Recovery	0.818	0.000	1.330	0.000	1.452	0.000	1.391	0.000	1.008	0.000	0.620	0.000
Lighting, Interior & Exterior	1.603	0.000	1.631	0.000	3.106	0.000	1.200	0.000	1.474	0.000	0.901	0.000
Plugs, Refrigeration, Other	2.438	0.000	9.269	0.000	2.186	0.000	4.459	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.010	0.000	0.035	0.097	0.015	0.000	0.123	3.054	0.000
Total	7.141	0.003	14.861	0.021	8.848	0.133	8.989	0.103	8.404	0.223	9.810	0.018
Total Savings	0.437	0.000	0.540	0.008	0.924	-0.008	0.678	0.006	0.797	0.000	0.251	0.033

Table 15.B. Annual Energy Usage for Buildings in Virginia in Climate Zone 4A

Energy End-Use	Small Office		Large Office		Stand-Alone Retail		Primary School		Small Hotel		Mid-Rise Apartment	
	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$
ASHRAE 90.1-2016												
Heating, Humidification	0.289	0.002	0.585	0.009	0.000	0.082	0.000	0.025	0.324	0.009	0.000	0.011
Cooling	1.065	0.000	2.211	0.000	2.281	0.000	2.008	0.000	2.080	0.000	1.134	0.000
Fans, Pumps, Heat Recovery	0.892	0.000	1.433	0.000	1.545	0.000	1.543	0.000	1.068	0.000	0.659	0.000
Lighting, Interior & Exterior	1.887	0.000	1.955	0.000	3.805	0.000	1.408	0.000	2.116	0.000	1.055	0.000
Plugs, Refrigeration, Other	2.439	0.000	9.269	0.000	2.186	0.000	4.602	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.010	0.000	0.036	0.097	0.015	0.000	0.125	3.112	0.000
Total	7.481		15.453	0.019	9.817	0.118	9.658	0.086	9.174	0.226	10.168	0.011
ASHRAE 90.1-2019												
Heating, Humidification	0.297		0.585	0.008	0.000	0.090	0.000	0.024	0.384	0.009	0.000	0.013
Cooling	1.014	0.000	2.060	0.000	2.146	0.000	1.923	0.000	1.953	0.000	1.108	0.000
Fans, Pumps, Heat Recovery	0.823	0.000	1.374	0.000	1.478	0.000	1.436	0.000	1.014	0.000	0.645	0.000
Lighting, Interior & Exterior	1.577	0.000	1.628	0.000	3.099	0.000	1.163	0.000	1.459	0.000	0.901	0.000
Plugs, Refrigeration, Other	2.439	0.000	9.269	0.000	2.186	0.000	4.458	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.010	0.000	0.036	0.097	0.015	0.000	0.125	3.113	0.000
Total	7.059		14.916	0.019	8.910	0.125	9.077	0.085	8.398	0.227	9.975	0.013
Total Savings	0.423	0.000	0.538	0.001	0.908	-0.008	0.580	0.001	0.777	0.000	0.193	-0.002

Table 15.C. Annual Energy Usage for Buildings in Virginia in Climate Zone 5A

Energy End-Use	Small Office		Large Office		Stand-Alone Retail		Primary School		Small Hotel		Mid-Rise Apartment	
	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$
ASHRAE 90.1-2016												
Heating, Humidification	0.564	0.016	0.763	0.016	0.000	0.154	0.000	0.054	0.588	0.015	0.000	0.024
Cooling	0.557	0.000	1.512	0.000	1.133	0.000	1.152	0.000	1.457	0.000	0.686	0.000
Fans, Pumps, Heat Recovery	0.868	0.000	1.408	0.000	1.730	0.000	1.464	0.000	1.061	0.000	0.600	0.000
Lighting, Interior & Exterior	1.890	0.000	1.957	0.000	3.814	0.000	1.402	0.000	2.116	0.000	1.054	0.000
Plugs, Refrigeration, Other	2.438	0.000	9.269	0.000	2.186	0.000	4.602	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.012	0.000	0.037	0.097	0.016	0.000	0.140	3.438	0.000
Total	7.227	0.016	14.909	0.028	8.864	0.191	8.718	0.117	8.808	0.248	9.987	0.024
ASHRAE 90.1-2019												
Heating, Humidification	0.575	0.017	0.763	0.015	0.000	0.166	0.000	0.051	0.678	0.015	0.000	0.028
Cooling	0.520	0.000	1.403	0.000	1.038	0.000	1.088	0.000	1.349	0.000	0.647	0.000
Fans, Pumps, Heat Recovery	0.794	0.000	1.369	0.000	1.644	0.000	1.333	0.000	1.004	0.000	0.579	0.000
Lighting, Interior & Exterior	1.579	0.000	1.629	0.000	3.104	0.000	1.158	0.000	1.459	0.000	0.901	0.000
Plugs, Refrigeration, Other	2.439	0.000	9.269	0.000	2.186	0.000	4.458	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.012	0.000	0.037	0.097	0.016	0.000	0.140	3.439	0.000
Total	6.817	0.017	14.432	0.027	7.973	0.202	8.134	0.114	8.078	0.248	9.775	0.028
Total Savings	0.411	-0.001	0.477	0.001	0.891	-0.012	0.584	0.003	0.730	0.000	0.213	-0.004

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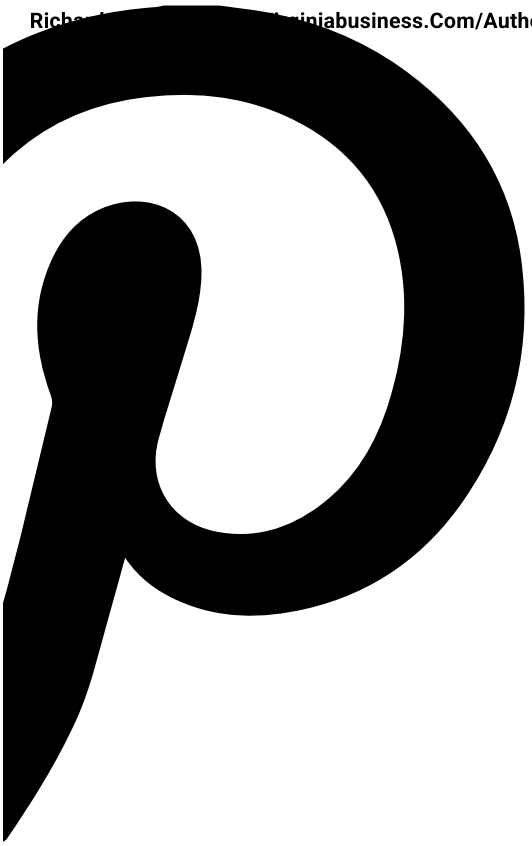
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Industrial boom

Virginia continues to see more warehouses and distribution centers

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When Emser Tile began seeking a location for an East Coast distribution center, the Los Angeles-based company wanted two things: proximity to a port and the ability to quickly service a growing customer base.



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In November 2017, Emser Tile opened a 407,000-square-foot distribution center at the CenterPoin Intermodal Center in Suffolk, which now employs more than 50 workers. It plans to add another 5(to 100 workers as business expands. The center, which has the capacity to expand to 850,000 square feet, ships products up and down the Eastern Seaboard as well as to the Midwest.

"It's ramping up," says Barbara Haaksma, Emser Tile's vice president of marketing. Combining Virginia's "favorable business climate" with the nearby Port of Virginia and its rail and interstate shipping access, "really made our decision pretty easy once it came down to pinpointing locations Virginia's industrial market is booming. Nationally and in Virginia, the growth of e-commerce is driving much of the momentum as online customers order more stuff that needs to be stored and delivered. In the race to shorten delivery times, retailers — both traditional and online — want distribution centers close to population centers.



Virginia's central location on the Eastern Seaboard makes it competitive as a site for these center along with improvements to Richmond's port and the Port of Virginia in Hampton Roads. With more distribution and warehouse centers going up, industry analysts say, industrial vacancies are historic lows in some parts of Virginia, and rents are trending up.

"We've had several years of record-low vacancies and a steady demand from tenants, so landlords they've got a tremendous amount of confidence right now to move forward with spec developmer says Matt Anderson, a senior vice president and partner at CBRE's Richmond office.

While Hampton and Southwest Virginia also are benefiting from the trend, the Richmond region ha seen the largest amount of new construction and deal announcements from distribution and logistics operations statewide in the last couple years.

"Our industrial market is as healthy as it's ever been," says Graham Stoneburner, a senior associat in Cushman & Wakefield|Thalhimer's Richmond office. "E-commerce has really driven the need for more warehouse space and distribution space."

In fact, Richmond's industrial warehouse market is currently undergoing a "golden age" in the distribution sector, according to a recent report from CBRE. It noted that during the first quarter, Richmond set post-recession highs in total construction, at 2.6 million square feet, as well as speculative construction at 918,438 square feet of high-bay warehouse and flex product. The current pipeline is expected to expand the high-bay inventory by more than 2.7 million square feet, 13 percent increase.

For example, Newport Beach, Calif.-based Panattoni Development Co. is building 1 million square feet of speculative warehouse space on 62 acres near the Port of Virginia's Richmond Marine Terminal along Interstate 95.


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"That's the largest spec warehouse to go up in the commonwealth ever," says Anderson, Panattoni's leasing broker. So far, he says, potential tenants looking at the site represent a variety of industries. The only thing they have in common is that they're all "bulk warehouse users who need a large footprint in a good location."

Demand for larger centers

Ever since Amazon began locating the first of its four warehouses and distribution facilities in the Richmond region in 2012, Anderson says: "We've seen this steady demand for these larger regional distribution centers. … We had always been more of a 20,000- to 50,000-square-foot-sized tenant industrial market." But now, he says, there's growing demand for properties in the 200,000-square-foot to 1-million-square-foot range.

Consequently, "You've got a tremendous pipeline of seasoned industrial developers who are bringing quality product to Richmond that we haven't seen in years."

Richmond-based Hourigan Development is building 1.5 million square feet of high-bay warehouse buildings called Deepwater Industrial Park on the 110-acre Alleghany Warehouse Co. site near Philip Morris USA's Richmond Manufacturing Center on Interstate 95.

Richmond developer Devon USA, which last year built a 328,000-square-foot spec warehouse that became Amazon's Hanover County distribution center, is now working on a $20 million, 321,000-square-foot spec warehouse at the James River Logistics Center in Chesterfield County.

Additionally, rents are going up on warehouse spaces with less than 100,000 square feet, Anderson says, because there's less supply in that size range. "I think that's going to create rent growth that will be healthy for the overall economy and gives more confidence to the larger institutional developers. It creates a more competitive landscape for the tenants who are here."

In Southwest Virginia, a number of developers have industrial projects sprinkled up and down the Interstate 81 corridor from Blacksburg to Front Royal. "It's a little more spread out, but it's very active out there," says David Williams, president and CEO at the Richmond office of global commercial real estate company Colliers International.

For example, health-drink manufacturer Humm Kombucha is building a $10 million, 100,000-square-foot brewery in Roanoke to make and distribute its refrigerated probiotic fermented tea beverage to retailers along the East Coast.

In Hampton Roads, the Port of Virginia has been working on $700 million in expansion projects to increase its cargo-handling capacity by 40 percent. That expansion has sparked projects such as a 284,580-square-foot spec warehouse built last year by Panattoni at Suffolk's Virginia Regional Commerce Park. Welspun USA, the American arm of an Indian bath and bedding textiles maker, leased 200,000 square feet of the multitenant warehouse in October, just a few months after it was completed.

Nevertheless, the industrial real estate market in Hampton Roads has been stagnant compared with the development boom seen in Richmond, says Bill Throne, first vice president of industrial properties at Cushman & Wakefield|Thalhimer's Hampton Roads office. A lot of the containers coming into the port's Norfolk and Portsmouth terminals are immediately shipped out to other locations, he says, so there's not as much need for additional warehousing space in the area, even though it's almost all occupied.

"There's not a lot of space out there. We're under 5 percent vacancy," Throne says. "We're really lacking in both absorption and deal velocity. If you look historically, we're doing OK. We're not doing better than we have over the last eight or 10 years, and we're not doing worse."

Boost from economy

As for Richmond's industrial real estate market, Stoneburner expects continued growth in construction and leasing as long as the economy remains vibrant and consumer spending

continues accelerating.

"We're in a good economy right now, and as businesses continue to grow and need to expand thei footprint, they need to buy more things, ship more things. … And as people buy and sell more and businesses grow, you're going to see the industrial market continue to grow."

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For Hanover County Economic Development Director Linwood Thomas, things couldn't get much better.

"It's really been a perfect storm," Thomas says.



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That storm — the good type — is a deluge of distribution centers and warehouses that have opene recently or are currently in the pipeline for the county of about 108,000 residents, located about 2(miles north of Richmond.



Thomas says warehouse and distribution center development has insulated the county during the pandemic.

Over the past two years or so, Hanover has added about 1.5 million square feet of new space and about 80% of that has been leased.

"Then, we've got another almost 4 million square feet proposed in the next 24 months. These are tangible products that will put us over 5.5 million square feet of new space, which is huge," says Thomas, noting that the new space will represent a nearly 40% increase over the county's existing stock of 13.8 million square feet of industrial/warehouse space.

He forecasts the projects will employ about 2,000 workers at buildout, producing $3.3 million in new tax revenues.

Hanover's "perfect storm" of warehouse and distribution center expansions is being repeated throughout Virginia, as the coronavirus pandemic has put e-commerce at the forefront of retail.

Nationwide, consumers spent$861.1 billion online with U.S. retailers in 2020, up 44% from $598 billion in 2019, according to an analysis by Digital Commerce 360, a media and research organization.

Online spending represented 21.3% of total retail sales last year, compared with 15.8% the prior year, according to Digital Commerce 360's analysis.

Virginia has seen more than 10,000 new jobs and more than $1.15 billion in investment tied to distribution centers since 2016, according to the Virginia Economic Development Partnership.

Data from the Virginia Employment Commission indicates that average employment from warehousing and storagein Virginia increased at an average rate of 6.2% per year between the thir quarter of 2015 and the third quarter of 2020, climbing to 32,954 employees statewide, according to VEDP.

Matt Anderson, executive vice president for the Virginia office of Colliers International, a real estat services and investment management firm, has seen it all unfold.


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"We cover a lot of stuff between [Interstate] 95 and the Atlantic Ocean," Anderson says. "Eighteen months ago, we were tracking a little over 5 million square feet of user demand," the amount of warehouse space needed in the marketplace.

Today, Anderson says, user demand in the Richmond market has soared to more than 8 million square feet.

"We had a record year of 4.6 million square feet of industrial leasing last year. We've never seen that much before," Anderson adds.

Down in Norfolk and the Hampton Roads area, it's been much the same story, says Lang Williams, a Colliers senior vice president in Hampton Roads. "We're at a 1.6% vacancy rate, which is at an all-time low since it's been tracked over the past 30 years," Williams says. "We have over 5 million square feet of new construction underway, which is an all-time high."

Anderson, meanwhile, has seen a big shift in how the market is trending.

"Right now, we're seeing more interest from speculative developers than we've ever seen," he says. "It's funny to think that 10 years ago, 100,000 square feet [of warehouse space] was a big deal in our market. Now, we're beginning to see a lot of deals that are 500,000 square feet, a million square feet."

If you're looking for *really* big in Virginia, though, you should turn your gaze toward Suffolk, where Amazon.com Inc. is building a sprawling five-story, 3.8 million-square-foot robotic fulfillment center that will employ about 1,000 workers.

Gregory Byrd, Suffolk's interim economic director, says Ace Hardware, Target and QVC all have distribution facilities in Suffolk, as do other companies.

"The activity is unreal," Byrd says. "Our proximity to the Port [of Virginia] makes being in this area worthwhile for distribution. Our proximity to the port is one of the reasons we get looked at."

Last year, the Port of Virginia completed a three-year, $800 million effort to increase capacity and productivity, and that has attracted developers of distribution centers and warehouses, says Russell Held, vice president of economic development for the port.

The American Journal of Transportation recently reported that the fourth quarter of 2020 was the most productive three-month period in the Port of Virginia's history, with a year-over-year growth of more than 13%.

"During the pandemic, we've become an e-commerce gateway," says Russell Young, director of economic development at the port.

Young, who lives in Suffolk, points to the ongoing construction of the Amazon robotics fulfillment center in his hometown as an example of how e-commerce has spurred economic development in the distribution sector.

Hanover County may never see a distribution center as large as the one Amazon is building in Suffolk.

But Thomas is still in awe of what's coming out of the ground now in Hanover and what's around the bend.

Wegman's, the supermarket chain, is building a $175 million distribution center/regional headquarters near the intersection of Sliding Hill and Ashcake roads that will employ about 700 workers. The first three phases of the development are planned for a maximum of 1.3 million square feet, with a potential for an additional 400,000 square feet.

Several miles north, home improvement retailer Lowe's Cos. Inc. has announced plans for a $50 million distribution center on a 200-acre site north of Hickory Hill Road, along the west side of Interstate 95, that will employ about 100 people. The 1.1 million-square-foot bulk distribution center will provide daily shipments of appliances, riding mowers, grills and other consumer goods.

The mix of groceries and home improvement goods illustrates the wide range of items that are filling warehouse and distribution centers across the state, bound for both retail stores and customers' home.

"The trend of people shopping online is being compounded exponentially and there is a need to have distribution facilities to address those last-mile concerns," Thomas says. "It's been one heck of a run."

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Model Energy Code Determinations

DOE is required by the Energy Conservation and Production Act (ECPA), as amended, to review published editions of the national model energy codes—ANSI/ASHRAE/IES Standard 90.1 and the International Energy Conservation Code (IECC)—and issue a *determination* as to whether the updated edition will improve energy efficiency in commercial and residential buildings, respectively. DOE is provided 12 months to conduct its review and publish its determination in the Federal Register after the updated model code is published. ECPA also requires States to review and/or update their energy codes following the publication of an affirmative DOE determination.

Latest Versions

COMMERCIAL: ANSI/ASHRAE/IES STANDARD 90.1-2022

DOE issued a determination (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001) that Standard 90.1-2022 will achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in commercial buildings of approximately:

- 9.8 percent *site* energy
- 9.4 percent *source* energy

- 8.9 percent *energy cost*

Additional information related to this action, including the official *Federal Register* publication, is available at Regulations.gov (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001).

State Certification

Upon publication of an affirmative determination, ECPA requires States to certify that they have reviewed the provisions of their commercial building code regarding energy efficiency, and, as necessary, updated their codes to meet or exceed the updated edition of Standard 90.1. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. The **State Certification** (/state-status/state-certifications) **deadline for Standard 90.1-2022 is March 06, 2026.**

Supporting Analysis

DOE conducted a technical analysis in support of its determination. This analysis assesses Standard 90.1 compared to the previous edition and estimates the associated savings impacts.

Federal Statute for Commercial Buildings

With each new edition of ANSI/ASHRAE/IES Standard 90.1, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in commercial buildings (42 U.S.C. 6833):

> *(2)(A) Whenever the provisions of ASHRAE Standard 90.1-1989 (or any successor standard) regarding energy efficiency in commercial buildings are revised, the [DOE] Secretary shall, not later than 12 months after the date of such revision, determine whether such revision will improve energy efficiency in commercial buildings. The [DOE] Secretary shall publish a notice of such determination in the Federal Register.*
>
> *(B)(i) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed and updated the provisions of its commercial building code regarding energy efficiency in accordance with the revised standard for which such determination was made. Such certification shall include a demonstration that the provisions of such State's commercial building code regarding energy efficiency meet or exceed such revised standard.*
>
> *(ii) If the [DOE] Secretary makes a determination under subparagraph (A) that such revised standard will not improve energy efficiency in commercial buildings, State commercial building code provisions regarding energy efficiency shall meet or exceed ASHRAE Standard 90.1-1989, or if such standard has been revised, the last revised standard for which the [DOE] Secretary has made an affirmative determination under subparagraph (A).*

RESIDENTIAL: 2024 INTERNATIONAL ENERGY CONSERVATION CODE

On December 20, 2024, DOE issued a determination (https://www.regulations.gov/document/EERE-2024-BT-DET-0007-0001) that the 2024 International Energy Conservation

Code (IECC) will improve energy efficiency in residential buildings. In support of this determination, DOE conducted a technical analysis evaluating the impacts of the updated code (relative to the previous 2021 IECC edition). DOE estimates national savings of approximately:

- 7.8 percent *site* energy savings
- 6.8 percent *source* energy savings
- 6.6 percent *energy cost* savings

Additional information related to this action, including the official Federal Register publication and docket containing public comments received, is available at Regulations.gov (https://www.regulations.gov/docket/EERE-2024-BT-DET-0007).

State Certification

Upon publication of an affirmative determination, States are required to certify that they have reviewed the provisions of their residential building code regarding energy efficiency, and made a determination as to whether it is appropriate for them to revise their code to meet or exceed the updated edition of the IECC. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. **State certifications** (/state-status/state-certifications) **for the 2024 IECC must be submitted by December 30, 2026.**

Supporting Analysis

DOE published a technical analysis in support of its determination. This analysis assesses the 2024 IECC compared to the previous edition and estimates the associated savings impact.

Federal Statute for Residential Buildings

With each new edition of the IECC, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in residential buildings. (42 U.S.C. 6833):

> *(5)(A) Whenever the CABO Model Energy Code*, 1992, (or any successor of such code) is revised, the [DOE] Secretary shall, not later than 12 months after such revision, determine whether such revision would improve energy efficiency in residential buildings. The [DOE] Secretary shall publish notice of such determination in the Federal Register.*
>
> *(B) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed the provisions of its residential building code regarding energy efficiency and made a determination as to whether it is appropriate for such State to revise such residential building code provisions to meet or exceed the revised code for which the [DOE] Secretary made such determination.*
>
> **As a predecessor to the ICC, the Council of American Building Officials (CABO) was responsible for development of the Model Energy Code (MEC). Contemporary energy codes are referred to and published as the International Energy Conservation Code (IECC)®.*

Previous Determinations

Previous DOE determinations (https://www.energycodes.gov/previous-determinations) surrounding building energy codes are available for reference by states and local governments, as well as other interested stakeholders.

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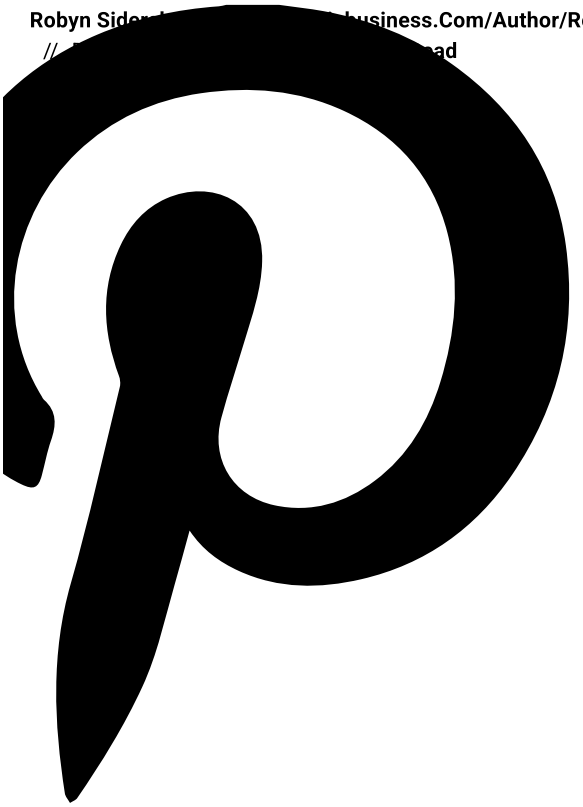
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Top Stories (https://virginiabusiness.com/stories/)

Poston, vice president of Cushman & Wakefield | Thalhimer's Hampton Roads industrial group, say demand has never been greater for industrial real estate (https://virginiabusiness.com/blog/tag/industrial-real-estate/), creating tight market with low vacancy.

"The amount of speculative development of industrial space taking place right now is unprecedented," says Jason El Koubi, interim president and CEO of the Virginia Economic Development (https://virginiabusiness.com/blog/tag/economic-development/) Partnership. "Som of this space will go to manufacturing, but much of the demand is being driven by warehousing (https://virginiabusiness.com/blog/tag/warehousing/) and distribution needs."

One leading factor behind this drive is companies attempting to keep up with e-commerce giant Amazon.com Inc. in getting products to consumers quickly.

Amazon is constantly pushing the envelope, shortening delivery windows from what was once five days to same-day delivery, says Marc Wulfraat, founder and president of Canadian logistics (https://virginiabusiness.com/blog/tag/logistics/) firm MWPVL International Inc.

"That speed to market is a competitive advantage," he says, "but what it requires is that you have more buildings that are closer to urban metro markets."



And adding more buildings and sites is easier said than done, particularly around in-demand markets and locations with ready access to interstates and shipping routes.

"The big difference is we have a lot of institutional developers in the market tying up sites left and right in order to accommodate the demand that they're seeing," says Poston, adding that "all of tha developer demand is just really creating a frenzy."

Running out of land

In Chesterfield County, every piece of property zoned for distribution centers, warehouses or manufacturing facilities is either under contract or in negotiations, says the county's director of economic development, Garrett Hart.

"It's the most active market I've seen in my 40-year career," Hart says. "I'm spending my days tryin to look for property to get more property zoned and in place and ready to go."

But it's not just Chesterfield where industrial sites are scarce and development is booming. Across the commonwealth, the demand for more warehousing and distribution space is causing developers to scramble.

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Geoff Poston with Cushman & Wakefield | Thalhimer says demand for industrial real estate (https://virginiabusiness.com/blog/tag/real-estate/) has never been greater. Photo by Mark Rhodes

"Where I think the demand is different today is there is a shortage, especially in Virginia, of zoned, approved sites that are ready to go," says Mark Hourigan, founder and CEO of Richmond-based construction and development firm Hourigan Development.

In the past several months, hundreds of jobs and millions of dollars in capital investment in warehouses and distribution centers have been announced in Virginia.

Goochland County-based Performance Food Group Co., a Fortune 500 food products distributor, will invest $80.2 million in a new facility in Hanover County. In the first quarter, it will break ground in Ashland on a 325,000-square-foot warehouse (https://virginiabusiness.com/blog/tag/warehouse/), scheduled to be built over 18 months.

Hanover County Director of Economic Development Linwood Thomas says big economic development announcements like that keep coming.

"What will happen over the next 24 to 36 months is about an additional 6 million square feet of new industrial space, warehouse, logistics [and] industrial supply [space]" will be built in the county, he says, which will increase Hanover's current industrial inventory by more than 40%.

Meanwhile, Amazon has facilities popping up all over the state. In Suffolk's Northgate Commerce Park, Amazon is building a nearly $230 million, 3.8 million-square-foot, five-story robotics fulfillment center. It's also constructing a fulfillment center in Henrico County near Richmond Raceway and an import processing center in Chesapeake. Amazon has at least 15 facilities in Virginia, with more coming.

Lang Williams, Colliers International's Norfolk-based senior vice president, works with a lot of developers and companies seeking space.

He says the past 18 months have been "without precedent" in the Norfolk region. "We've really kind of caught up with the rest of the country in terms of just massive demand for all logistics and warehousing space."

The difference now, Williams adds, is that there are two and three companies "practically fist-fighting for space."

"Normally we don't have that problem. Normally, we're pursuing and trying to make a deal. Now, the tenants are scrambling to find a space, no matter the cost, wherever they can get it, because they don't have any options around," he says.

Over the past several years, Virginia localities have been eliminated from consideration for several economic development projects involving warehouses or distribution centers due to a lack of site readiness.

"These sites were unable to meet the project's start-up schedule due to time required to fulfill a number of demands," including due diligence, permitting and utilities and road infrastructure, El Koubi says.

The lack of available, ready sites for warehouse and distribution center (https://virginiabusiness.com/blog/tag/distribution-center/) projects is a statewide problem, he adds, "but more pronounced along the Interstate 95 and 81 corridors as well as Hampton Roads, where demand is higher."

In the Fredericksburg region, less available land means building farther away from I-95, though localities have done a good job pivoting, says Todd Gillingham, vice president of marketing and operations for the Fredericksburg Regional Alliance at the University of Mary Washington.

While alternative distribution routes are available, the lack of available sites "will soon become an obstacle for the Fredericksburg region and much of Virginia," Gillingham says. "I know there have been quite a few projects we lost out on because there wasn't available existing industrial space."

Meeting demand

Joe Marchetti III, Hourigan's president of development, says one of the macro trends he and Mark Hourigan picked up on years ago was the shift to e-commerce.

But the pandemic accelerated everything, he says.

"That's why the pace feels frenetic," Marchetti says.

Clients want to build warehouses and distribution centers as quickly as possible, says Hourigan Development CEO Mark Hourigan, seen at the Richmond construction site for a Lowe's distribution center expected to open in September. Photo by Rick DeBerry

"I think cities like Richmond are becoming the next desired destination for these logistic companies," Hourigan says. "When you can get to 40% of the U.S. population from a single day's drive from the Richmond area, it makes it very desirable. The interstate system, the port system or rail system just add to the really high desirability of our marketplace."

One site Hourigan is working on is for home goods retailer Lowe's at the Deepwater Industrial Park (https://virginiabusiness.com/blog/tag/industrial-park/) in South Richmond. In 2018, Hourigan bought 110 acres of industrial-zoned land, right along Interstate 95.

It's there Hourigan is building a 1.2-million-square-foot Lowe's bulk distribution center. It was initially going to be 560,000 square feet, but early in construction, Lowe's doubled the order. The project is expected to be finished in September.

"One of the big things that we have seen with a lot of end users and tenants is that readiness is that important," Marchetti says. "What that really means to a lot of them is how soon can the building be occupiable and begin moving product into it."

"As these markets evolve and things are happening, the decision windows are shorter and shorter and tighter and tighter," Hourigan says. "If [a developer] is not fairly well down the path, not only [with] your site development, but your utilities, your zoning and maybe even a spec building, then [companies] will move on to the next site that is further along [with] development. It requires [the developer] to invest upfront, to be able to respond in a time frame that some of these companies are looking for.

"The average time from when a user starts looking for their space and when they want to occupy is six to nine months. They are ready to go," Hourigan says. "If you have the right site, and you proceed with a product in high demand, you've got a pretty good shot you're going to land something."

Taylor Chess, president of development for Fairfax-based Peterson Cos., echoes Hourigan and Marchetti.

“COVID has created a lot of chaos, and chaos creates incredible change,” he says. “[COVID] has accelerated so many aspects of business that were going to be happening over the next 10 years, but it’s accelerated that into a really tight timeframe.”

Peterson Cos. started investing in industrial land for data centers, warehouses and distribution centers about eight years ago.

“We were fortunate that we had acquired 275 acres on I-95 in Stafford County to do a major industrial park,” Chess says. Some of that land, in Northern Virginia Gateway, will be used for an Amazon cross-dock fulfillment center that will serve as an East Coast supply chain hub, schedule to open in the second half of this year.

“We’re lucky we have another 180 acres to develop,” Chess says.

The company has also invested in another 150 acres in Winchester, and Chess says Peterson is looking at “multiple other key logistics sites for additional industrial development.”

Building faster

Peterson Cos. is running into the same issue as Hourigan with timelines, however.

“When you talk to the end user of … the buildings, they want to talk about buildings [being delivere tomorrow. They don’t want to talk about building … in two to three years. If you’re two to three year out on a project, they’re not interested in talking,” Chess says.

“Most of the people we talked to want something before the end of 2022. Some people are even looking for mid-2022. If you’re telling them that you can’t have something available for them until 2023 or 2024, they say, ‘I can’t talk about that.’”

Says Poston with Thalhimer: “I think the key thing now, the big driver for people now, is timing. Everybody wants it sooner and sooner.”

But sooner isn’t always possible, especially if there is less land available.

“There’s only but so much land to develop, and quite a few of those projects are about to break ground or launch,” says Williams.

That said, it’s difficult to guess what the landscape will look like in two or three years, he says, “but everything comes in cycles. So, in terms of industrial development in brokerage right now, we’re trying to ride the train while it’s going fast. You never know what’s going to happen around the corner.”

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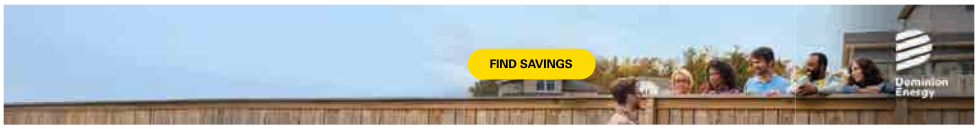
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MARKETBEAT

Northern Virginia

Industrial Q1 2024

CUSHMAN & WAKEFIELD

	YoY Chg	12-Mo. Forecast
4.4% Vacancy Rate	▲	▬
-100K Net Absorption, SF	▼	▬
$15.78 Asking Rent, PSF	▲	▲

Overall, Net Asking Rent

ECONOMIC INDICATORS Q1 2024

	YoY Chg	12-Mo. Forecast
3.4M D.C. Metro Employment	▲	▲
2.9% D.C. Metro Unemployment Rate	▼	▲
3.8% U.S. Unemployment Rate	▲	▲

Source: BLS

Supply: Construction Slowing Down

After over 800,000 sf of new industrial product delivered in 2023, Northern Virginia is likely to see another 620,000 sf completed in 2024. Cabot Real Estate's 8233 Buckeye Dr delivered 91,172 sf vacant this quarter in Manassas. There are currently six projects under construction for a total of 529,720 sf scheduled to deliver over the next year. Loudon County makes up 88% of the pipeline with 468,520 sf under construction in Route 28 Corridor North. None of these projects have reported any preleasing activity.

Northern Virginia registered 99,825 sf of negative absorption in Q1, driven by the warehouse/distribution (W/D) sector which yielded negative 137,516 sf while the office service (OS) sector posted 37,694 sf of positive absorption. Fairfax County accounted for negative 200,440 sf after software company, TD Synnex put 79,000 sf on the sublease market, Goodwill left 30,000 sf at 6441 General Green Way and Fairfax County Schools added 27,000 sf to the sublease market at 619-623 S Pickett St. Manassas registered 109,069 sf of positive absorption after DHL eCommerce took 138,500 sf at 11501 University Blvd.

Demand: Leasing Activity Continues to Drop

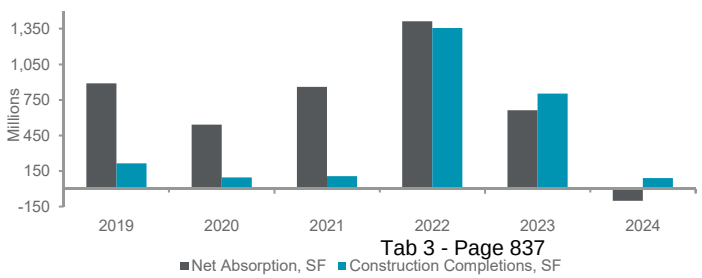
New leasing in Northern Virginia decreased 31% from the fourth quarter of 2023 with 299,061 sf inked in Q1, and was down 60% year-over-year (YOY). W/D facilities accounted for 183,483 sf of the total while OS product yielded 115,658 sf in Q1. Renewal activity was relatively light with only 89,183 sf signed, a 48% decrease YOY and down 86% from Q4 2023. The region's leasing activity continues to decline as demand softens. Since 2020, over 70% of new deals above 100,000 sf or greater have occurred within buildings built after 2017.

Vacancy: Rents Grow Steadily

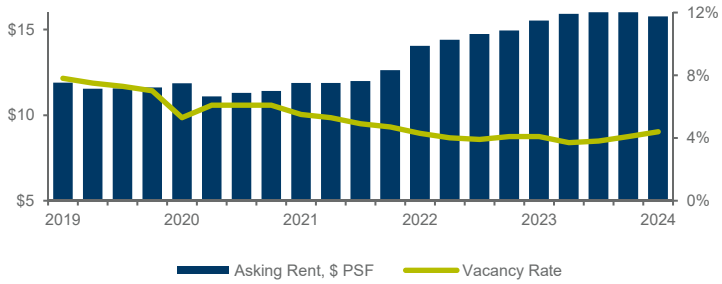
Overall asking rates in Northern Virginia continued to trend upward, finishing the first quarter of 2024 at $15.78 per square foot (psf). Rates are down $0.40 psf from the fourth quarter but up $0.24 psf YOY. OS asking rates rose $1.12 psf YOY to $17.28 psf while W/D increased $0.57 psf to $13.64 psf YOY. Asking rates are skewed amongst the submarkets because newer, more expensive spaces are typically marketed without an asking rental rate but asking rates are continuing to trend upwards especially in Route 28 North.

The average vacancy rate rose 30 basis points (bps) YOY to 4.4%. The OS sector dropped 110 bps to 5.6% while the W/D vacancy rose 90 bps YOY to 3.8%. As mentioned above, a number of W/D tenants put space on the sublease market driving vacancy up.

SPACE DEMAND / DELIVERIES



OVERALL VACANCY & ASKING RENT



MARKETBEAT

Northern Virginia

Industrial Q1 2024

CUSHMAN & WAKEFIELD

MARKET STATISTICS

SUBMARKET	INVENTORY (SF)	OVERALL VACANT (SF)	OVERALL VACANCY RATE	CURRENT QTR OVERALL NET ABSORPTION (SF)	YTD OVERALL NET ABSORPTION (SF)	UNDER CNSTR (SF)	CONSTR COMPLETIONS (SF)	OVERALL WEIGHTED AVG NET RENT
Springfield/I-95	13,429,904	552,627	4.1%	-114,118	-114,118	0	0	$16.31
Route 28 Corridor South	4,320,336	126,639	2.9%	-92,157	-92,157	0	0	$13.21
Route 28 Corridor North	12,665,109	271,939	2.1%	-51,660	-51,660	468,520	0	$15.42
Manassas	8,791,008	520,143	5.9%	120,419	120,419	31,200	91,172	$10.40
Warehouse/Distribution Totals	**39,206,357**	**1,471,348**	**3.8%**	**-137,516**	**-137,516**	**499,720**	**91,172**	**$14.21**
Springfield/I-95	6,140,467	550,090	9.0%	30,607	30,607	0	0	$19.83
Route 28 Corridor South	6,989,260	373,165	5.3%	-24,772	-24,772	30,000	0	$14.81
Route 28 Corridor North	6,963,027	285,752	4.1%	43,206	43,206	0	0	$14.74
Manassas	2,667,323	58,142	2.2%	-11,350	-11,350	0	0	$15.51
Office Service/Flex Totals	**22,760,077**	**1,267,149**	**5.6%**	**37,691**	**37,691**	**30,000**	**0**	**$17.28**
Northern Virginia Totals	**61,966,434**	**2,738,497**	**4.4%**	**-99,825**	**-99,825**	**529,720**	**91,172**	**$15.78**

**Rental rates reflect weighted net asking $psf/year*

KEY LEASE TRANSACTIONS Q1 2024

PROPERTY	SUBMARKET	TENANT	RSF	TYPE
11501 University Boulevard	Manassas	NJ Sullivan	81,304	New Lease
23700 Pebble Run Drive	Route 28 Corridor North	SCP Distributors	29,426	Renewal*
22815 Glenn Drive	Route 28 Corridor North	Cal Closets Retail	27,044	New Lease
6304 Gravel Avenue	Springfield/I-95	Northside Imports	26,229	New Lease

KEY SALES TRANSACTIONS Q1 2024

PROPERTY	SUBMARKET	SELLER / BUYER	SF	PRICE/$ PSF
22900 Indian Creek Drive	Route 28 Corridor North	Foulger-Pratt Corp / JK Moving Services	76,275	$20,000,000 / $262.21
5720-5722 General Washington Drive	Springfield	General Washington LLC / Individual	24,587	$6,015,000 / $244.64

KEY UNDER CONSTRUCTION Q1 2024

PROPERTY	SUBMARKET	MAJOR TENANT	SF	OWNER/DEVELOPER
43035 John Mosby Highway	Route 28 Corridor North	-	232,500	Elion
25435 Pleasant Valley Road	Route 28 Corridor North	-	130,020	Pictor Dulles Logistics Center
44080 John Mosby Highway	Route 28 Corridor North	-	70,400	-

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EC-C402.1.6-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Deletes the Virginia amendment in Appendix CD which currently may be used as an alternative to the building thermal envelope provisions of the code for Groups F, S, and U.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second Energy Sub-Workgroup meeting on September 29, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members in attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce

- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Eric L concurred with **Bill P**, saying the exemption is overly broad and warrants deeper review, especially because it originated from advocacy groups with limited collaboration.

Justin K agrees with **Eric L** and **Bill P**. Anecdotally; PIMA has seen these buildings constructed with higher levels of energy efficiency. There are energy use exceptions in the code already where it would not make sense to put an envelope on a building that's unconditioned or underconditioned. Deleting this and taking a new look may move Virginia's policy goals forward, whereas the way it is currently written may hold back those policy goals.

Chelsea H supports

Andrew C stated HBAV does not have an opinion on this proposal. States HBAV have heard valid arguments for this proposal.

Steve S opposed the measure, asserting that its citation of the 2021 General Assembly implies a mandate to adopt the newest IECC, whereas the legislature only instructed regulators to "consider" the current edition.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Second GSW Meeting — 10/03/2025

Support: Eric Lacey, Responsible Energy Codes Alliance (RECA); Chelsea Harnish, Virginia Energy Efficiency Council (VAEEC).

Opposition: Bryan Holland, National Electrical Manufacturers Association (NEMA); Steve Shapiro, AOBA/VAMA; Mark Graver, City of Waynesboro, Builder, VBCOA Region III; David Beahm, Warren County, VBCOA.

Discussion:

I. **Bill P** provided an overview of this proposal.

II. **Support**
   a. **Eric L** pointed out that the provisions in question are 2006 IECC provisions, allowing roof and wall insulation levels to be reduced by half in certain occupancies and that skylights lose 2.6 times more heat than walls or roofs, making reduced insulation problematic. He further noted that the appendix would reintroduce distinctions between metal-framed and non-metal-framed windows, distinctions that are not present elsewhere in the current code. These added distinctions would create confusion and enforcement problems for code officials. Lastly, he recommended approving the proposal as written to avoid these complications and maintain clarity and consistency in the code.
   b. **Chelsea H** expressed support based on **Eric L's** comments.

III. **Opposition**
   a. **Brian H** stated that NEMA prefers the national consensus process and argued that this should be handled at the national level where subject matter experts from across the country can provide insight.
   b. **Steve S** opposed, noting that the General Assembly directive referenced by the proponent was to "consider" comparable standards, not necessarily adopt them verbatim.
   c. **Mark G** warned that if these provisions are removed, it could lead to excessive insulation requirements being applied to buildings that were never intended to be properly heated (such as utility or storage buildings). He further emphasized the importance of including specific carve-outs or exemptions for certain building types, like utilities, to avoid imposing unnecessary or impractical insulation standards on them.
   d. **David B** stated opposition based on **Steve S'** comments.

DHCD Staff Note:

This proposal conflicts with code change proposal EC-C402.1.6(1)-24, which was reviewed by stakeholders at the third General Stakeholder Workgroup meeting on January 5, 2026, and received a Consensus Approval recommendation.

EC-C405.15-24

IECC: C405.15, C405.15.1, C405.15.2, TABLE C405.15.2, C405.15.2.1, C405.15.2.2, C405.15.3, C405.15.4

Proponents: Steven Shapiro, AOBA/VAMA, representing Apartment and Office Building Association/Virginia Apartment Management Association (stevenishapiro@outlook.com)

2024 International Energy Conservation Code [CE Project]

Delete without substitution:

~~**C405.15 Renewable energy systems.** *Buildings* in Climate Zones 0 through 7 shall comply with Sections C405.15.1 through C405.15.4.~~

~~**C405.15.1 On-site renewable energy systems.** *Buildings* shall be provided with on-site renewable electricity generation systems with a direct current (DC) nameplate power rating of not less than 0.75 watts per square foot (8.1 W/m^2) multiplied by the sum of the gross *conditioned floor area* of all floors, not to exceed the combined gross *conditioned floor area* of the three largest floors.~~

~~**Exceptions:** The following *buildings* or building sites shall comply with Section C405.15.2:~~

1. ~~A *building site* located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 per day (3.5 kWh/m^2/day).~~
2. ~~A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access pathways or occupied roof terrace.~~
3. ~~Any *building* where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the *building* for more than 2,500 annual hours between 8:00 a.m. and 4:00 p.m.~~
4. ~~A *building* with gross *conditioned floor area* less than 5,000 square feet (465 m^2).~~

~~**C405.15.2 Off-site renewable energy.** *Buildings* that qualify for one or more of the exceptions to Section C405.15.1 or do not meet the requirements of Section C405.15.1 with an on-site renewable energy system shall procure off-site renewable electrical energy, in accordance with Sections C405.15.2.1 and C405.15.2.2, that shall be not less than the total off-site renewable electrical energy determined in accordance with Equation 4-11.~~

~~$TRE_{off} = (REN_{off} \times 0.75\ W/ft^2 \times FLRA - IRE_{on}) \times 15$~~ **Equation 4-11**

~~where:~~

~~TRE_{off} = Total off-site renewable electrical energy in kilowatt-hours (kWh) to be procured in accordance with Table C405.15.2.~~
~~REN_{off} = Annual off-site renewable electrical energy from Table C405.15.2, in units of kilowatt-hours per watt of array capacity.~~
~~FLRA = The sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors.~~
~~IRE_{on} = Annual on-site renewable electrical energy generation of a new on-site renewable energy system, to be installed as part of the building project, whose rated capacity is less than the rated capacity required in Section C405.15.1.~~

~~**TABLE C405.15.2 ANNUAL OFF-SITE RENEWABLE ENERGY REQUIREMENTS**~~

~~CLIMATE ZONE~~	~~ANNUAL OFF-SITE RENEWABLE ELECTRICAL ENERGY (kWh/W)~~
~~1A, 2B, 3B, 3C, 4B and 5B~~	~~1.75~~
~~0A, 0B, 1B, 2A, 3A and 6B~~	~~1.55~~
~~4A, 4C, 5A, 5C, 6A and 7~~	~~1.35~~

~~**C405.15.2.1 Off-site procurement.** The building *owner,* as defined in the *International Building Code* , shall procure and be credited for~~

the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-11, with one or more of the following:

1. *Physical renewable energy power purchase agreement.*
2. *Financial renewable energy power purchase agreement.*
3. *Community renewable energy facility.*
4. Off-site renewable energy system owned by the building property *owner.*
5. *Renewable energy investment fund.*
6. *Green retail tariff.*

The generation source shall be located where the energy can be delivered to the *building site* by any of the following:

1. Direct connection to the off-site renewable energy facility.
2. The local utility or distribution entity.
3. An interconnected electrical network where energy delivery capacity between the generator and the *building site* is available.

C405.15.2.2 Off-site contract. The renewable energy shall be delivered or credited to the *building site* under an energy contract with a duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

C405.15.3 Renewable energy certificate (REC) documentation. The property *owner* or owner's authorized agent shall demonstrate that where renewable energy certificates (RECs) or energy attribute certificates (EACs) are associated with on-site and off-site renewable energy production required by Sections C405.15.1 and C405.15.2, all of the following criteria for RECs and EACs shall be met:

1. The RECs and EACs are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years or the duration of the contract in Section C405.15.2.2, whichever is less.
2. The RECs and EACs are created within a 12-month period of the use of the REC.
3. The RECs and EACs are from a generating asset placed in service not more than 5 years before the issuance of the certificate of occupancy.

C405.15.4 Renewable energy certificate purchase. A *building* that qualifies for one or more of the exceptions to Section C405.15.1, and where it can be demonstrated to the *code official* that the requirements of Section C405.15.2 cannot be met, the building owner shall contract the purchase of renewable electricity products before the certificate of occupancy is issued. The purchase of renewable electricity products shall comply with the Green-e Energy National Standard for renewable electricity products equivalent to five times the amount of total off-site renewable energy calculated in accordance with Equation 4-11.

Reason Statement: Remove Section C 405.15, requiring buildings to install on-site renewable energy systems or procure off-site renewable energy equal to 15% of the building's energy use.

This standard established by this code change is infeasible.

Even for new construction, it can be difficult to carve out contiguous space for systems representing 8-10% of the building's energy use. Depending on the size and use of the building, 5% may be a more practical standard. (The 15% threshold may be completely infeasible for smaller building types.)

This can be significantly more challenging for renovations of existing buildings where the space was not planned to accommodate renewable energy systems.

Renewable energy systems compete for limited space with cooling towers, condensing units and other systems, not to mention green rooves and amenity spaces that tenants demand. Multifamily properties may have multiple individual HVAC units with which to contend for limited space.

This code change will increase construction costs and discourage renovations.

The rough cost of a solar energy system is approximately $3 per watt for systems between 50 and 250 kilowatts in size.

- This includes panels, wiring, batteries, and inverters.
- This does not include extremely expensive canopy systems which may be required to achieve higher percentages of building energy use or for buildings over 80 feet in height.
  - Many commercial buildings make use of ballast systems, which employ weights to secure equipment without the need to puncture the roof. Canopy and racking systems come with additional concerns for leaks developing over time as they require a great many roof punctures.
- New solar and canopy systems may additionally trigger very expensive structural upgrades to support the weight of the renewable energy systems.

Section C 405.15 allows for properties which cannot meet the 15% threshold to supplement onsite generation with renewable energy credits (RECs). On the open market, such credits can be secured for approximately $3-4 per MWh. Local credits are far more costly, at around $100-$200 per MWh.

The costs of construction are ultimately passed onto Virginia businesses and renters. The Commonwealth can ill afford to absorb these costs in our current economic climate.

- Commercial office properties across the Commonwealth currently face a vacancy rate of 13%, indicative of a struggling market sector. Urban centers like Arlington and Fairfax in Northern Virginia are facing vacancies in the range of 20-25%. Increasing the cost of commercial office construction will render Virginia less competitive with surrounding states.
- The spike in commercial vacancy rates since the COVID-19 pandemic has led many jurisdictions to pursue converting commercial office properties to multifamily residential use. By driving up the cost of construction, this code change will serve as an impediment to substantial building renovations and conversions.
- Virginia additionally faces a crisis of housing affordability attributable to the failure of the Commonwealth to keep place with housing demand. Driving up the cost of construction will hinder Virginia's efforts to attract new multifamily housing development.

This code change fails to consider the challenges associated with connectivity to the grid, outside of the property owner's control.

Properties installing renewable energy systems must navigate Dominion Virginia Power's net metering and permitting rules and requirements.

Example #1

This large warehouse retail space in Reston is one of the few commercial building types with ample roof space to accommodate renewable energy systems. In the illustration below, you can see that the vendor has depicted the installation of solar panels in almost every available space. Yet, even with this extremely cluttered design, the building would still only be able to achieve 12% of its energy consumption from renewable energy. And this would be at a cost of roughly $1.5 million. Again, this does not factor in the probable necessity of canopy and racking systems and the associated structural work they would require. Additionally, the need to cluster panels in non-contiguous spaces to reach the maximum percentage of building energy consumption supported by renewable energy would require extensive string wiring back to a centralized inverter, creating an additional safety hazard.

Example #2

Member property example #2 is a 712-unit garden-style apartment community in Alexandria, consisting of seven 4-story buildings.

The property averages 4,029,169 kWh of annual consumption, requiring an offset of 604,375 kWh to meet the 15% standard. While the property boasts significant roof and green space to accommodate renewable energy systems, installation would likely require the removal of several trees. This could potentially run afoul of local tree preservation policies/efforts.

Meeting the 15% standard would require a DC system size of 510 kW. The vendor recommends installation of 850 600W solar panels. Applying the $3/watt standard cost, the total comes to approximately $1.5 million.

600W X 850 panels X $3 unit cost = $1,530,000

This property, originally constructed in 1964, operates as market-rate affordable housing, with rents well below market averages. Given its age, it is likely that the property will require substantial renovation in the next 10-15 years. Taking into account the below-market rent levels that such a property can command, the addition of $1.5 million in cost could very well scuttle reinvestment in the property, leading either to substandard housing or a loss of affordable housing stock coveted by the Commonwealth and its jurisdictions.

Example #3

Member property example #2 is an 18-story, 853,000 square foot commercial office tower in Reston.

The property averages 9,458,913 kWh of annual consumption, requiring an offset of 1,418,837 kWh to meet the 15% standard. As depicted above, there is very little usable space on the roof of the office tower itself. The adjoining parking structure could accommodate renewable energy systems with the use of canopy systems, adding approximately $1.50 per watt.

Meeting the 15% standard would require a DC system size of 1,183 kW. The vendor recommends installation of 1,970 600W solar panels. Applying the $3/watt standard cost, plus the additional $1.50 per watt standard for canopy systems, the total comes to approximately $5.3 million.

600W X 1,970 panels X $4.50 unit cost = $5,319,000



Cost Impact: The code change proposal will decrease the cost The deletion of the requirements of section C405.15 will decrease the cost of construction in the general amounts shown in the reason statement by avoiding the costs of on-site renewable energy systems as well as the procurement of off-site credits.

EC-C405.15-24 – Staff Summary

Proponent: Steven Shapiro, AOBA/VAMA, representing Apartment and Office Building Association/Virginia Apartment Management Association

Brief Description: Deletes Section C405.15 (of the 2024 IECC) Renewable energy systems, including its subsections.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the third Energy Sub-Workgroup meeting on November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members in attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman

- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – VAEEC, Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – AOBA/VAMA, Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – AIA-VA, Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Scott P, speaking on behalf of **Steve S,** provided an overview of the proposal which removes the requirements for renewable energy systems because of feasibility issues because rooftop structures are not typically designed for these systems.

Bill P opposed the proposal. **Bill P** sent **Steve S** an alternative to the proposal, which keeps Sections C405.15 and C405.15.1 but eliminates Sections C405.15.2 through C405.15.4.

Dennis H was opposed to **Bill P's** proposed modification to the original proposal as battery storage of these energy systems is very expensive and will increase the cost of construction.

Bill P replied that storage is not required, and the goal is to find a simple way to get solar on rooftops to help lower costs.

Sydney R asked if Appendix CB Solar-Ready Zone of the 2024 IECC could be a consensus alternative.

Eric L opposed the original proposal from **Steve S**.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: William “Rick” Hinson, American Council of Engineering Companies (ACEC); Corian Carney, Independent Alliance of the Electrical Industry (IAEI) - Virginia Chapter; Andrew Clark, HBAV.

Opposition: Bob Shippee, Sierra Club; Joseph Wages Jr., National Electrical Manufacturers Association (NEMA).

Discussion:

I. **Steve S** provided an overview of the proposal.
II. **Discussion**
    a. **Bob S** commented that there is a lot of room for exceptions and flexibility and does not see the need for the deletions.
    b. **Joseph Wages** contributed that the section was shown to be cost effective by Pacific Northwest National Lab analysis.
III. **Support**
    a. **Rick H** and **Andrew C** expressed support.
IV. **Opposition**
    a. **Bob S** and **Joseph W** expressed opposition.

DHCD Staff Note: N/A

EC-C405.17-24

VECC: C405.17 (New), C405.17.1 (New), TABLE C405.17.1 (New), C405.17.2 (New), C405.17.3 (New), C405.17.4 (New), C405.17.5 (New), C405.17.5.1 (New), C405.17.5.2 (New), C405.17.5.3 (New), C405.17.5.3.1 (New), C405.17.5.3.2 (New), C405.17.6 (New)

Proponents: Joseph Wages, representing National Electrical Manufacturers Association (NEMA) (joseph.wages@nema.org)

2021 Virginia Energy Code

Add new text as follows:

C405.17 Electric Vehicle Power Transfer Infrastructure. Parking facilities shall be provided with electric vehicle power transfer infrastructure in accordance with Sections C405.14.1 through C405.14.6.

C405.17.1 Quantity. The number of required EV spaces, EV capable spaces and EV ready spaces shall be determined in accordance with this Section and Table C405.14.1 based on the total number of automobile parking spaces and shall be rounded up to the nearest whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

- 1.Where more than one parking facility is provided on a building site, the number of required automobile parking spaces required to have EV power transfer infrastructure shall be calculated separately for each parking facility.
- 2.Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.
- 3.Installed EVSE spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV ready spaces and EV capable spaces.
- 4.Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV capable spaces.
- 5.Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.
- 6.Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.14.1 shall be used.

TABLE C405.17.1 Required EV Power Transfer Infrastructure. |

Occupancy	EVSE Spaces	EV Ready Spaces	EV Capable Spaces
Group A	10%	0%	10%
Group B	15%	10%	30%
Group E	15%	10%	30%
Group F	2%	0%	5%
Group H	1%	0%	0%
Group I	15%	0%	30%
Group M	15%	10%	30%
Group R-1	20%	10%	70%
Group R-2	20%	10%	70%
Group R-3 and R-4	2%	0%	5%
Group S exclusive of parking garages	1%	0%	0%
Group S-2 parking garages	25%	10%	30%

C405.17.2 EV Capable Spaces. Each EV capable space used to meet the requirements of Section C405.14.1 shall comply with the following:

- 1.A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and electrical distribution equipment.

- 2.Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with Section C405.14.5.
- 3.The electrical distribution equipment to which the raceway or cable assembly connects shall have dedicated overcurrent protection device space and spare electrical capacity to supply a calculated load in accordance with Section C405.14.5.
- 4.The enclosure or outlet and the electrical distribution equipment directory shall be marked: "For electric vehicle supply equipment (EVSE)."

C405.17.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with the following:

- 1.Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.
- 2.Have a minimum system and circuit capacity in accordance with C405.14.5.
- 3.The electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

C405.17.4 EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with the following:

- 1.Have a minimum system and circuit capacity in accordance with Section C405.14.5.
- 2.Have a nameplate rating not less than 6.2kW.
- 3.Be located within 3 feet (914 mm) of each EVSE space it serves.
- 4.Be installed in accordance with Section C405.14.6.

C405.17.5 System and circuit capacity. The system and circuit capacity shall comply with C405.14.5.1 and C405.14.5.2.

C405.17.5.1 System capacity. The electrical distribution equipment supplying the branch circuit(s) serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:

- 1.Have a calculated load of 7.2 kVA or the nameplate rating of the equipment, whichever is larger, for each EV capable space, EV ready space, and EVSE space.
- 2.Meets the requirements of Section C405.14.5.3.1

C405.17.5.2 Circuit Capacity. The branch circuit serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:

- 1.Have a rated capacity not less than 50 amperes or the nameplate rating of the equipment, whichever is larger.
- 2.Meets the requirements of Section C405.14.5.3.2.

C405.17.5.3 System and circuit capacity management. Where system and circuit capacity management is selected in Section C405.14.5.1(2) or Section C405.14.5.2(2), the installation shall comply with Sections C405.14.5.3.1 and C405.14.5.3.2.

C405.17.5.3.1 System capacity management. The maximum equipment load on the electrical distribution equipment supplying the branch circuits(s) serving EV capable spaces, EV ready spaces, and EVSE spaces controlled by an energy management system shall be the maximum load permitted by the energy management system, but not less than 3.3 kVA per space.

C405.17.5.3.2 Circuit Capacity Management. Each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable

spaces controlled by an energy management system, shall comply with one of the following:

- 1.Have a minimum capacity of 25 amperes per space.
- 2.Have a minimum capacity of 20 amperes per space for R-2 occupancies when all automobile parking spaces are EV ready spaces or EVSE spaces.

C405.17.6 EVSE Installation. EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. EVSE shall be accessible in accordance with Virginia Construction Code Section 1107.

Reason Statement: This proposal adds a new section covering Electric Vehicle Power Transfer Infrastructure as a mandatory requirement in Chapter 4 similar to Appendix CG in the 2024 IECC. These requirements were approved by the ICC appointed commercial energy code consensus committee by a two-thirds majority vote during the 2024 IECC development cycle. Adding EV ready requirements to the 2024 VECC-C ensures new commercial parking facilities have the electrical infrastructure necessary for the installation of EV charging equipment at time of construction or any time in the future. This will provide a significant cost and labor savings.

Cost Impact: The code change proposal will increase the cost

The code change proposal will increase the cost of premises-wiring systems and parking facilities for commercial projects. However, the initial cost of EV ready infrastructure is considerably less expensive compared to retrofitting and altering the electrical system and parking facility in the future. The actual cost associated with this proposal is heavily dependent on the scale and scope of the commercial project.

It should be noted NEMA proposals are developed by a member consensus process where both our bylaws and federal regulations prohibit us from discussing prices, costs, and other financial details of electrical products.

Public Comments (PCH) for: EC-C405.17-24

Discussion by Mal Skowron

Oct 2, 2025 23:40 UTC

Tesla supports this proposal to establish required EV capable, EV ready, and EVSE installed percentages in Group A through S-2 commercial occupancy types. EV readiness requirements are an opportunity for cost avoidance as the number of EVs on the roads increases due to driver demand. In the absence of EV capable or EV ready infrastructure, retrofitting parking structures is at least 4 to 6 times more expensive than outfitting parking areas at initial construction, with businesses and residents often bearing these costs. On the other hand, when installed during initial construction, EV charging infrastructure costs are generally less than 1% of the total building construction cost. Given the large percentage of the existing building stock that was constructed without EV readiness in mind, ensuring adequate electrical infrastructure in new buildings will allow the Commonwealth to keep pace with EV demand at least cost. Ensuring that an appropriate number of EV ready spaces is available at non-residential parking structures provides an additional sense of reliability and convenience for current and future EV drivers, and is key to unlocking business owners' ability to offer EV charging services to their visitors, customers, or employees.

The percentages of required EV capable, EV ready, and EVSE installed spaces in this proposal are consistent with the non-mandatory appendix of the IECC-commercial code and went through several rounds of public comment and editorial changes to ensure clarity, consistency, enforceability, and technical soundness. The 2024 IECC-C consensus committee heavily contemplated the variation between occupancy type to reflect how pervasive electric vehicle charging will be for residents, employees, and customers. For example, vehicle charging will be more common at Group A (auditoriums), Group B (offices), Group M (mercantile), and Group E (education) where vehicles are parked for many hours at a time, and therefore have total combined EV readiness requirements of 45%. On the other hand, Groups F (industrial), Group S (storage), and Group U (utility) will typically require less vehicle charging based on fewer parking stalls and occupancy usage outside of employees, therefore EV readiness requirements are less than 7%. R-2 occupancies (large multifamily housing) have 100% EV readiness requirements because that is where vehicles are parked overnight for many hours at a time and retrofitting existing parking spots to provide EV charging is complex and costly.

Proposal # 1354

EC-C405.17-24 – Staff Summary

Proponent: Joseph Wages, representing National Electrical Manufacturers Association (NEMA)

Brief Description: Adds new provisions for electric vehicle (EV) power transfer infrastructure and requires a minimum number of EV spaces, EV capable spaces and EV ready spaces based on occupancy group.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second Energy Sub-Workgroup meeting on September 29, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association (VPGA), Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members in attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith

- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Bill P outlined his EV-readiness proposal, explaining that it mirrors **Joseph W's** submission but adds key definitions to cover the spectrum from full EV chargers to conduit-only "make-ready" infrastructure.

Steve S opposed both versions, arguing that the USBC is a minimum code and that EV provisions exceed the health-and-safety threshold; he recommended creating a dedicated workgroup, noting fire-service concerns about thermal runaway.

Florin Moldovan (DHCD staff) reported that comments from **Andrew Milliken** had been forwarded to the two proponents.

Andrew C said the Virginia Association for Commercial Real Estate also has reservations, particularly about parking-space ratios.

Ron C contended the proposals fall outside the USBC's statutory scope and lack concrete cost data for the required EV stations.

Bill P countered that future-outlet requirements are common in building codes and that EV readiness serves public health, safety, and welfare. He would support forming a workgroup if the proposals do not advance. He further noted that DHCD staff submitted a proposal last cycle to include EV charging requirements at the request of two legislators.

Florin M clarified that, at times, staff will submit proposals on behalf of legislators as a courtesy, but staff do not submit proposals of this nature on behalf of DHCD.

Steve S asked why the reason statement references the residential code; **Bill P** said the intent is to show consistency across occupancy types.

Monica R backed the concept but agreed that a workgroup is needed, calling EV infrastructure essential for resiliency and emergency response.

Florin M confirmed staff will relay the request for an EV-readiness Workgroup to the Board.

Andrew C highlighted the difference between multifamily and one- or two-family dwellings, implying any mandate should distinguish between them.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Second GSW Meeting — 10/03/2025

Support: Bill Penniman, Sierra Club (VA Chapter).

Opposition: Steve Shapiro, AOBA/VAMA; Ron Clements, Chesterfield County; Andrew Clark, HBAV; Mike O'Connor, VPGA/VPCMA; Andrew Milliken, Stafford County Fire Marshal's Office, Virginia Fire Services Board (VFSB) Codes and Standards Committee; Shahriar Amiri, Arlington County.

Discussion:

I. **Brian H** provided an overview of the proposal on behalf of the proponent.
II. **Support**
    a. **Bill P** expressed support.
III. **Opposition**
    a. **Steve S** opposed, stating it goes beyond the "minimum code" and should be in appendices.
    b. **Ron C** opposed, questioning if it's within the state code's scope and citing an inadequate cost impact statement.
    c. **Andrew C** strongly opposed, citing unstudied impacts on utilities, land planning, and development costs.
    d. **Mike O'** opposed, noting federal EV tax incentives have been repealed.
    e. **Andrew M** opposed, raising safety concerns for parking garages, particularly with regard to ventilation and adequate sprinkler systems.
    f. **Shahriar A** opposed, noting safety concerns about EV fires and fumes.
IV. **Brian H** responded to opposition by stating that other states have successfully implemented similar requirements and that guidance exists to avoid the raised concerns. **Brian** further moved to have companion proposal REC-R404.5(1)-24 go forward as non-consensus, as it deals with the same topics but on the residential side.

DHCD Staff Notes:

1. The VRC companion proposal REC-R404.5(1)-24 was also reviewed by stakeholders at the second

Sub-Workgroup meeting, and the second GSW, on October 3, 2025, where it received a Non-Consensus recommendation.

2. This proposal is almost identical with code change proposal EC-C405.17(1)-24, which was reviewed by stakeholders at the third GSW meeting, on January 5, 2026, and received a Non-Consensus recommendation. The excerpt from the January 5, 2026, meeting summary pertaining to EC-C405.17(1)-24 is provided below.

January 5, 2026, **GSW Meeting Summary Excerpt**

Support: Eric Lacey, RECA; Sydney Roberts, SEEA; Joseph Wages, NEMA.

Opposition: Steve Shapiro, AOBA/VAMA; Andrew Clark, HBAV; William "Rick" Hinson, American Council of Engineering Companies (ACEC); Corian Carney, IAEI - Virginia Chapter; D.A. Pierce, VBCOA.

Discussion:

I. **Bob Shippee –** Sierra Club Virginia Chapter, provided an overview of the proposal.
   a. **Sydney R** pointed out that the cost of electric vehicle infrastructure is less during new construction than doing it as a retrofit. It's about 400% less. It's also to supply equipment for multi-family buildings where residents may not have the power or authority to install equipment for themselves.
   b. **Steve S** reiterated that a work group be formed to study all the issues around electric vehicle charging.
   c. **Andrew C** raised the issue that electric vehicle infrastructure not only impacts the cost of a building but also land development for developers.

II. **Support**
   a. **Eric L, Sydney R**, and **Joseph W** expressed support.

III. **Opposition**
   a. **Steve S, Andrew C, Rick H, Cory C,** and **D.A. Pierce** expressed opposition.

EC-C405.17(1)-24

IECC: C405.17 (New), C405.17.1 (New), C405.17.2 (New), C405.17.2.1 (New), C405.17.2.2 (New), C405.17.2.3 (New), C405.17.2.4 (New), C405.17.2.5 (New), C405.17.2.5.1 (New), C405.17.2.5.2 (New), C405.17.2.5.3 (New), C405.17.2.5.3.1 (New), C405.17.2.5.3.2 (New), C405.17.2.6 (New)

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

C405.17 ELECTRIC VEHICLE POWER TRANSFER.

C405.17.1 Definitions. AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.
ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, electric vehicle supply equipment (EVSE), a rechargeable storage battery, a fuel cell, a photovoltaic array or another source of electric current.

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). A designated automobile parking space that is provided with electrical infrastructure such as, but not limited to, raceways, cables, electrical capacity, a panelboard or other electrical distribution equipment space necessary for the future installation of an EVSE.

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An automobile parking space that is provided with a branch circuit and an outlet, junction box or receptacle that will support an installed EVSE.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer, including ungrounded, grounded and equipment grounding conductors; electric vehicle connectors; attached plugs; any personal protection system; and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE SPACE). An automobile parking space that is provided with a dedicated EVSE connection.

C405.17.2 Electric vehicle power transfer infrastructure. Parking facilities shall be provided with electric vehicle power transfer infrastructure in accordance with Sections C405.17.2.1 through C405.17.2.6 and all applicable fire safety regulations.

C405.17.2.1 Quantity. Except to the extent the number of potential chargers is limited by any applicable fire safety regulations, the number of required electric vehicle (EV) spaces, EV capable spaces and EV ready spaces shall be determined in accordance with this section and Table C405.17.2.1 based on the total number of automobile parking spaces and shall be rounded up to the nearest whole number. For R-2 buildings, the C405.17.2.1 requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

1. Where more than one parking facility is provided on a building site, the number of required automobile parking spaces required to have EV power transfer infrastructure shall be calculated separately for each parking facility.

2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.

3. Installed electric vehicle supply equipment installed spaces (EVSE spaces) that exceed the minimum requirements of this section

may be used to meet the minimum requirements for EV ready spaces and EV capable spaces.

4. Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet the minimum requirements for EV capable spaces.

5. Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.

6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.17.2.1 shall be used

Exception: Parking facilities serving occupancies other than R2 with fewer than 10 automobile parking spaces.

TABLE C405.17.2.1—REQUIRED EV POWER TRANSFER INFRASTRUCTURE

OCCUPANCY	EVSE SPACES	EV READY SPACES	EV CAPABLE SPACES
Group A	3%	0%	10%
Group B	3%	0%	10%
Group E	3%	0%	10%
Group F	2%	0%	5%
Group H	1%	0%	0%
Group I	5%	0%	10%
Group M	5%	0%	10%
Group R-1	5%	5%	30%
Group R-2	5%	5%	30%
Groups R-3 and R-4	2%	0%	5%
Group S exclusive of parking garages	1%	0%	0%
Group S-2 parking garages	5%	0%	10%

C405.17.2.2 EV Capable Spaces. Each EV capable space used to meet the requirements of Section C405.17.2.1 shall comply with the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and electrical distribution equipment.

2. Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with Section C405.17.2.5.

3. The electrical distribution equipment to which the raceway or cable assembly connects shall have dedicated overcurrent protection device space and electrical capacity to supply a calculated load in accordance with Section C405.17.2.5.

4. The enclosure or outlet and the electrical distribution equipment directory shall be marked: “For electric vehicle supply equipment (EVSE).”

C405.17.2.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.17.2.1 shall comply with the following:

1. Terminate at an outlet or enclosure located within 3 feet (914 mm) of each EV ready space it serves.

2. Have a minimum system and circuit capacity in accordance with Section C405.17.2.5.

3. The electrical distribution equipment directory shall designate the branch circuit as “For electric vehicle supply equipment (EVSE)” and the outlet or enclosure shall be marked “For electric vehicle supply equipment (EVSE).”

C405.17.2.4 EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.17.2.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with the following:

1. Have a minimum system and circuit capacity in accordance with Section C405.17.2.5.

2. Have a nameplate rating not less than 6.2 kW.

3. Be located within 3 feet (914 mm) of each EVSE space it serves.

4. Be installed in accordance with Section C405.17.2.6.

C405.17.2.5 System and circuit capacity. The system and circuit capacity shall comply with Sections C405.17. 2.5.1 and C405.17.2.5.2.

C405.17.2.5.1 System capacity. The electrical distribution equipment supplying the branch circuit(s) serving each EV capable space, EV ready space and EVSE space shall comply with one of the following:

1. Have a calculated load of 7.2 kVA or the nameplate rating of the equipment, whichever is larger, for each EV capable space, EV ready space and EVSE space.

2. Meets the requirements of Section C405.17.2.5.3.1.

C405.17.2.5.2 Circuit capacity.
The branch circuit serving each EV capable space, EV ready space and EVSE space shall comply with one of the following:

1. Have a rated capacity not less than 50 amperes or the nameplate rating of the equipment, whichever is larger.

2. Meets the requirements of Section C405.17.2.5.3.2.

C405.17.2.5.3 System and circuit capacity management. Where system and circuit capacity management is selected in Section C405.17.2.5.1 or C405.17.2.5.2, the installation shall comply with Sections C405.17. 2.5.3.1 and C405.17.2.5.3.2.

C405.17.2.5.3.1 System capacity management. The maximum equipment load on the electrical distribution equipment supplying the branch circuits(s) serving EV capable spaces, EV ready spaces and EVSE spaces controlled by an energy management system shall be the maximum load permitted by the energy management system, but not less than 3.3 kVA per space.

C405.17.2.5.3.2 Circuit capacity management. Each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capablespaces controlled by an energy management system shall comply with one of the following:

1. Have a minimum capacity of 25 amperes per space.

2. Have a minimum capacity of 20 amperes per space for R-2 occupancies where all automobile parking spaces are EV ready spaces or EVSE spaces.

C405.17.2.6 EVSE installation. EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 (2009 with revisions through February 2018) or UL 2594 (2016). EVSE shall be accessible in accordance with Section 1107 of the International Building Code.

Reason Statement: The purpose of this proposal is to incorporate into Virginia's commercial building code most of the substance of 2024 IECC's Appendix CG, with modifications (a) to substantially reduce the number of affected parking spaces and (b) to assure compliance with all applicable fire safety regulations. Specifically: (1) the percentage of parking spaces requiring EVSE or EV Capable spaces specified by Table C405.17.2.1 Required EV Power Infrastructure is reduced by two-thirds for most categories of occupancies; and (2) language is added to Sections C405.17.2 and C405.17.2.1 to confirm both (i) the primacy of compliance with fire safety regulations and (ii) the fact that such regulations may limit the potential number of spaces that may fitted with EV charging and thus the potential number of parking spaces subject to requirements for EV infrastructure.

While Appendix CG comes with the 2024 IECC, activation of Appendix CG requires inserting language into the Virginia Construction Code for residential construction, which this proposal would do by adding a new Section C405.17.

Adoption of this proposal would benefit occupants and users of new commercial building—whether owners, employees, customers, or visitors—by facilitating convenient electric vehicle charging, which can readily be expanded as the need grows. Implementation would benefit residents and the public with cost savings, pollution reduction (including greenhouse gases, ozone and carbon monoxide) and more equitable access to EVs and EV charging for residents. It would avoid the much higher costs of having to retrofit parking areas and building electrical systems.

Under the proposed Section C405.17, builders would have to provide basic levels of EV charging readiness: EV Capable Space (basic infrastructure for future installation of a branch circuit and charger); or EV Ready Space (basic infrastructure plus a branch circuit, outlet, junction box or receptacle); or EVSE Space (includes actual charging). The number of each type of EV space depends upon the type of building for which parking is provided. The numbers are tailored to reflect expected times for users to stay at a building and the fact that, while most EV charging now occurs at home, many people do not have access to EV charging where they live. Under the proposal, the greatest number of EV-related spaces are required in multifamily residential buildings, but lesser levels are required in other types of buildings. The three types of EV spaces are designed to minimize future EV charging installation costs, since retrofits are much more costly than incorporating EV infrastructure into initial construction.

By agreement among members of the ICC's committee to develop the 2024 IECC, these EV charging requirements were to have been included in the main body of the 2024 IECC (as proposed here). It was shifted to an appendix on appeal. Activating an appendix requires text in the code itself, which is the purpose of this proposal.

Virginians would benefit from a requiring minimum levels of EV charging infrastructure in new construction. EVs have many economic and health benefits for vehicle users. EVs are cheaper to use and maintain compared to vehicles with internal combustion engines (ICE). While most charging currently occurs at home, many EV owners and potential buyers do not have EV infrastructure at their dwellings or even the potential to install charging in the future. Locating at least a minimum number of chargers at places of work and business, will help to alleviate this barrier to EV adoption and afford residents of older buildings access to the benefits of EVs.

Growing EV usage is very important to Virginia for additional reasons. As explained in the ICC commentary accompanying the 2024 IECC, "The U.S. transportation sector accounted for 29 percent of the nation's greenhouse gas (GHG) emissions in 2019." That is specifically due to the traditional predominance of vehicles with internal combustion engines (ICE). Greenhouse gases from charging and operating EVs are less than 30% of GHG emissions from fueling and operating ICE vehicles. https://theicct.org/why-evs-are-already-much-greener-than-combustion-engine-vehicles-jul25/ EVs are also far more energy efficient than burning fuels in vehicle engines.

Reducing GHG emissions is a stated policy goal in Virginia law because climate change is a current and growing danger for Virginians. (See., e.g., § 45.2-1706.1. Commonwealth Clean Energy Policy. "A. The Commonwealth recognizes that effectively addressing climate change and enhancing resilience will advance the health, welfare, and safety of the residents of the Commonwealth. The Commonwealth further recognizes that addressing climate change requires reducing greenhouse gas emissions across the Commonwealth's economy sufficient to reach net-zero emission by 2045 in all sectors, including the electric power, transportation, industrial, agricultural, building, and infrastructure sectors….") Virginia faces growing threats, including more heat-illnesses, disruption of outdoor work, worsening storms, flooding, sea level rise, supply-chain disruption, damage to crops, trees and natural resources, arrival of diseases and pests, etc.

Bringing on EVs will also reduce other air pollutants that also threaten Virginian's health and welfare. ICE vehicles are a major source of

ozone and other pollutants, including carbon monoxide risks in homes with garages.

Providing EV electric infrastructure as part of new construction is no different from the building code's requiring electrical infrastructure for HVAC, machinery and appliances likely to be used in the future or from the code's requiring more efficient equipment and lighting in new buildings.

Facilitating adoption of EVs requires that drivers have access to convenient, cost-effective EV charging. That can most easily be provided as part of new construction. As recognized in the IECC commentary on Appendix CG, it is very costly and complicated to renovate EV charging infrastructure into existing buildings.

The importance of incorporating EV charging into new construction is particularly great in the case of buildings whose parking is governed by condominium or common-interest-area boards, which divergent interests can use high retrofit costs to block EV adoption by some occupants.

Cost Impact: The code change proposal will increase the cost

The cost of installing infrastructure would depend on which of the three types of EV infrastructure is involved. The costs would be lower for an EV Capable Space and not much more for the EV Ready Space option if the electrical room or panel is close to the chosen spaces. Since electricity will be installed anyway (e.g. for garage or parking lighting, fans etc.), it would not be difficult or very costly to go the extra steps during building construction when an electrician is on site.

Construction costs will be reduced over time since retrofitting garages is much more expensive than installing at the outset the basic infrastructure to expand chargers. This has been repeatedly documented by PNNL and others.

Occupant/drivers' costs will also be reduced. EVs are less costly to operate (maintenance and energy) than traditional internal combustion engines, but access to chargers is a problem that deters EV usage. The lack of home charging is a particular barrier, which can be offset by chargers in residential and non-residential locations. Access to overnight charging is particularly important in residences and for long-distance drivers (hotels, motels, and many workers).

Additional savings will result in the form of reduced air pollution and the corresponding health benefits to all members of the public. Fuel combustion in vehicles is one of the major sources of ozone, particulates, CO2, CO, SO2 and other pollutants, which harm health and, in some cases drive climate change. The costs and harms are growing and harming all Virginians.

BLOG

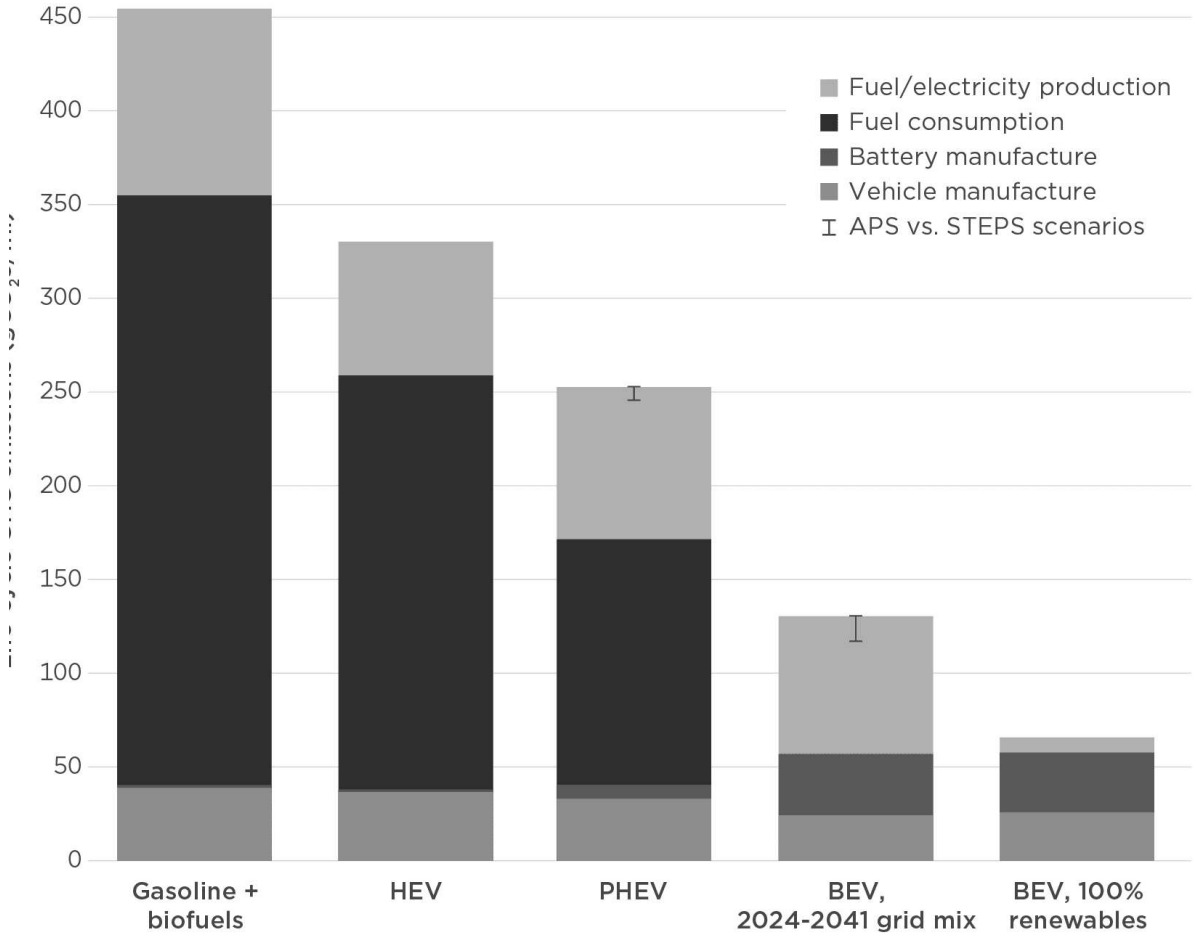
WHY ELECTRIC VEHICLES ARE ALREADY MUCH GREENER THAN COMBUSTION ENGINE VEHICLES

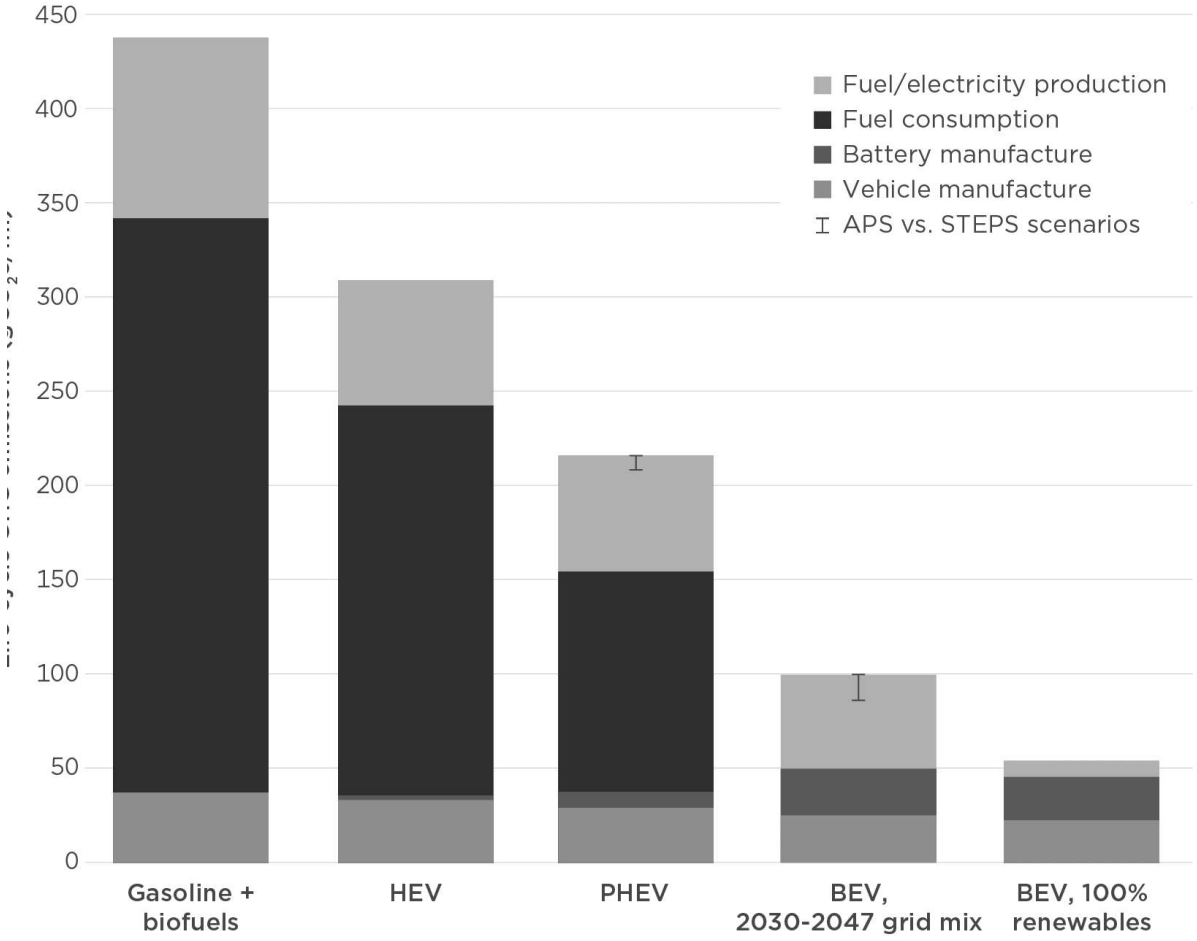
July 24, 2025 | By: Anh Bui

he research is clear: In major markets that make up 70% of global new assenger car sales, today's battery electric vehicles (BEVs) are associated with far fewer greenhouse gas (GHG) emissions than internal combustion ngine vehicles (ICEVs) over their lifetimes. More than that, ICEV tailpipe missions during their operation can exceed the full life-cycle emissions f a BEV, from initial manufacturing to operation to end-of-life. As there re narratives out there—some recent—that may confuse things, allow ne to guide you through the climate benefits one at a time.

et's start with some numbers for the U.S. market. Figure 1, from our aper from last year, shows the estimated life-cycle GHG emissions for a epresentative ICEV and BEV sport utility vehicle (SUV) built in 2024 (left anel) and in 2030 (right panel). When comparing the climate pollution mitted over the lifetime of SUVs built in 2024, the GHG emissions of the BEV SUV with a 300-mile range are 71% lower than the ICEV (the BEV is owered by the average grid mix in the United States from 2024–2041). ooking ahead to the 2030–2047 U.S. average grid mix, BEVs are ssociated with 77% fewer GHG emissions than ICEVs. As the electricity rid becomes still cleaner after 2047, the emissions advantage of BEVs vill only grow. Indeed, several states and cities are approaching their goal f a fully renewable electricity grid.

igure 1. Estimated life-cycle GHG emissions for model year 2024 and 030 SUV


450
400
350
300
250
200
150
100
50
0
Fuel/electricity production
Fuel consumption
Battery manufacture
Vehicle manufacture
APS vs. STEPS scenarios
Gasoline + biofuels
HEV
PHEV
BEV, 2024-2041 grid mix
BEV, 100% renewables


450
400
350
300
250
200
150
100
50
0
Fuel/electricity production
Fuel consumption
Battery manufacture
Vehicle manufacture
APS vs. STEPS scenarios
Gasoline + biofuels
HEV
PHEV
BEV, 2030-2047 grid mix
BEV, 100% renewables

ource: O'Malley and Slowik (2024)

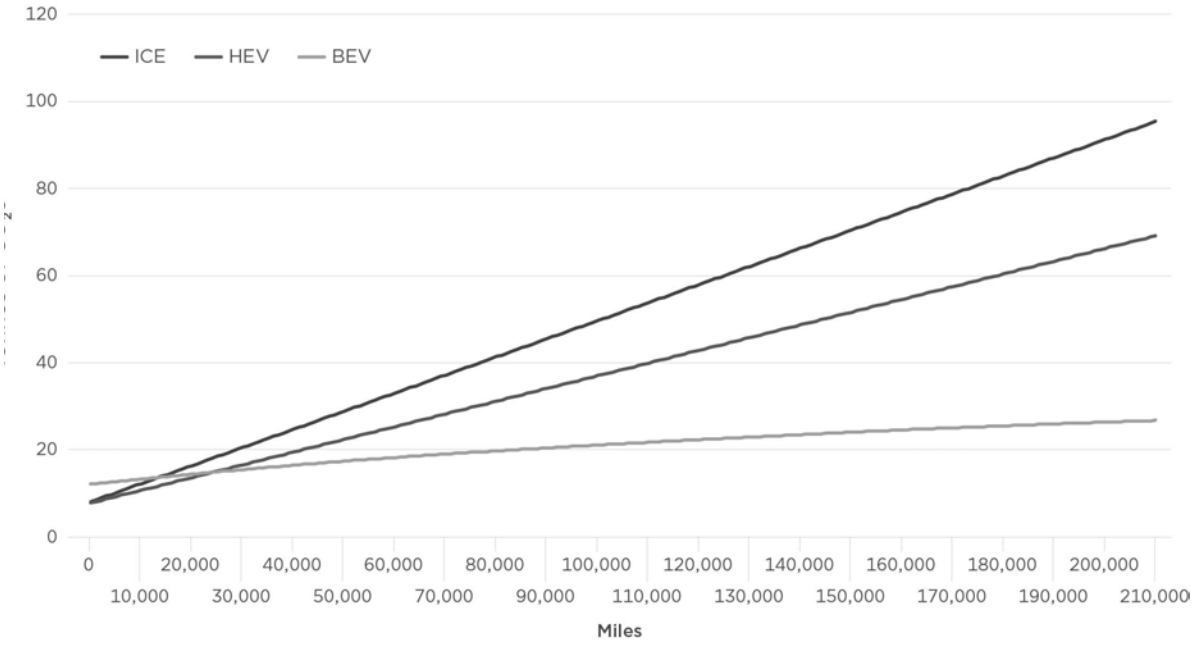
)ur analysis comports with other studies (here's one from 2015 that was pdated in 2020) which found that driving a 300-mile-range BEV with an verage efficiency of 0.31 kWh per mile in every U.S. state had significantly ower life-cycle GHG emissions than the average ICEV. As you can see in igure 1, BEVs outperform all vehicle types, including plug-in hybrid lectric vehicles (PHEVs) and hybrid electric vehicles (HEVs).

ccording to news reports, though, some Americans remain skeptical of he green credentials. Headlines such as this one are no doubt ontributing, but this article refers to a study by Emission Analytics that onsidered tire emissions and not any other emissions, including GHGs. nd the article is refuted by the researcher himself: "They conflate and lur and obfuscate and play fast and loose with the definitions. And that's ompletely wrong."

Inderstanding manufacturing phase emissions

ecause of the emissions from battery manufacturing, electric vehicles tart their life with an "emissions debt" compared with ICEVs. The missions from battery production, which are about 25% of a BEV's life-ycle emissions today, arise from the mining and processing of battery inerals such as lithium, nickel, and cobalt, and the manufacturing of ther battery components. At the end of the manufacturing phase of the ame 2024 SUVs analyzed above, BEVs were associated with slightly more han 12 tonnes of CO_2e (including battery manufacturing) and ICEVs bout 8 tonnes of CO_2e. However, as BEVs have zero tailpipe emissions hen they operate, this debt is typically offset within 1–2 years of driving nd then the gap widens more and more in later years, as shown in igure 2.

igure 2. Estimated tonnes of CO_2e emissions from three 2024 vehicle ypes



ource: Based on analysis in O'Malley and Slowik (2024)

)peration phase emissions: BEVs are without peer

o get a sense of just how much greener BEVs are, it's important to nderstand that BEVs are also more energy efficient than ICEVs. They onvert a greater share of energy into wheels and motion and BEVs equire only about one-fourth (or less) the energy needed to power a omparable ICEV. Meanwhile, the gasoline needed to power ICEVs equires continuous extraction and refining of fossil fuels for as long as he vehicles remain on the road. As I mentioned above, **ICEV tailpipe missions alone can exceed the full life-cycle emissions of a BEV**. By he end of the typical operation phase of a 2024 SUV, we estimated that BEVs have emitted about 130 g CO_2e/mile and ICEVs have emitted more han 450 g CO_2e/mile.

As electric grids continue to shift toward cleaner, renewable sources of nergy, the emissions benefits of the electric vehicles already on the road will become even more pronounced. Moreover, while the environmental mpact of BEVs can be further reduced by recycling their mineral content, eploying new battery chemistries, and extending battery lifetime, imilar improvements are not expected from fossil fuels.

ecycling plays a critical role in reducing the need for new mining ecause it recovers battery materials and cuts down on emissions ssociated with producing a new battery. Each electric vehicle requires nly a relatively small quantity of battery minerals over its entire lifetime. n the United States, we estimate that the operational and announced ecycling capacity should be sufficient to process end-of-life batteries rom BEVs and PHEVs up until 2044. At the same time, advances in attery chemistry are helping to reduce dependence on battery naterials. Battery lifetimes can also be extended through reuse and epurposing.

's just no contest. When you look at the complete picture—including roduction and operation—BEVs already produce about 70% fewer missions than gasoline cars. That is a three-fold advantage of BEVs over CEVs and it will grow to four-fold or more in the future as the grid gets leaner and battery technologies and recycling operations improve. Quite imply, BEVs are a significantly greener transportation option than asoline cars now and in the long term.

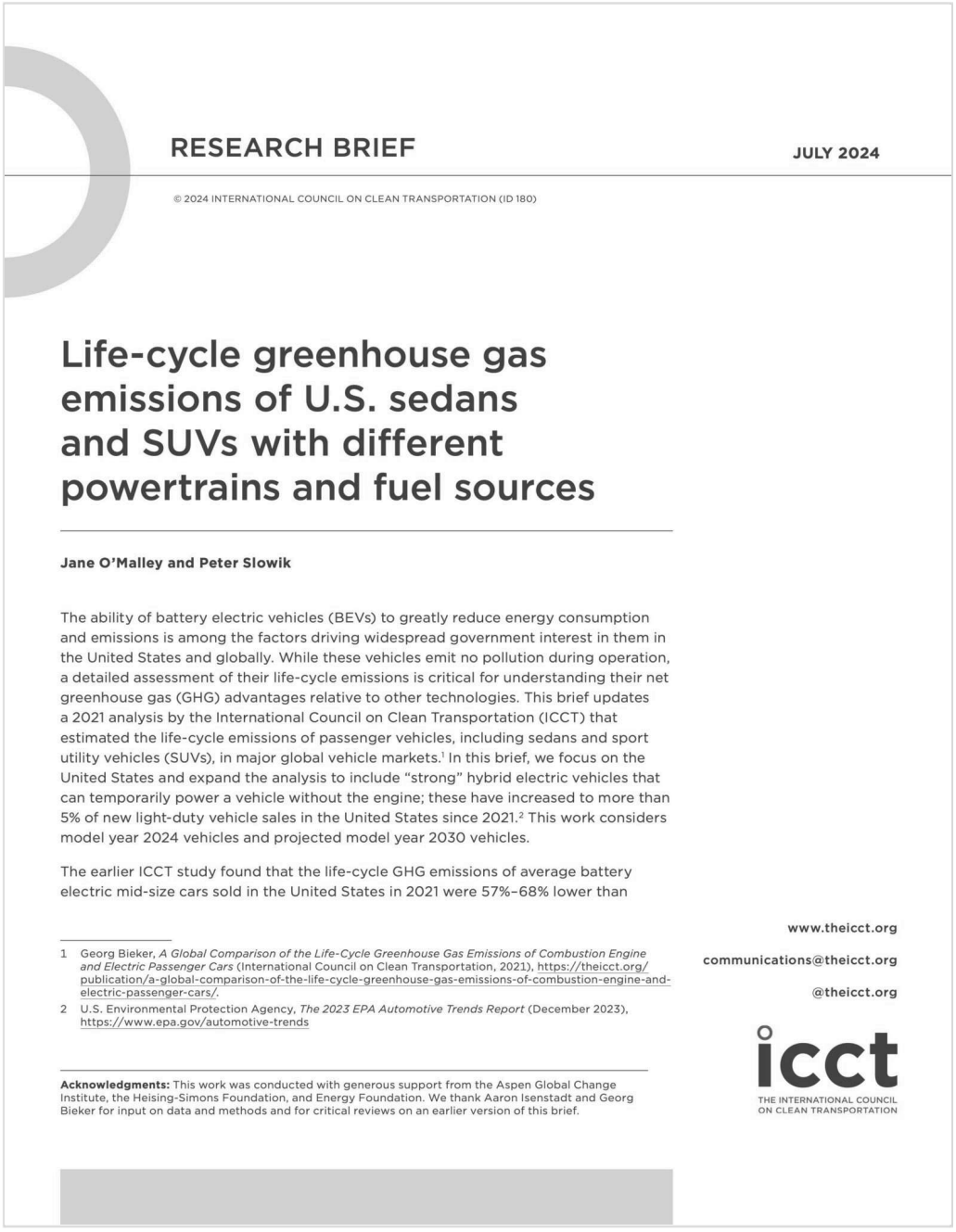
AUTHOR



Anh Bui

Researcher

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RESEARCH BRIEF

JULY 2024

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Life-cycle greenhouse gas emissions of U.S. sedans and SUVs with different powertrains and fuel sources

Jane O'Malley and Peter Slowik

The ability of battery electric vehicles (BEVs) to greatly reduce energy consumption and emissions is among the factors driving widespread government interest in them in the United States and globally. While these vehicles emit no pollution during operation, a detailed assessment of their life-cycle emissions is critical for understanding their net greenhouse gas (GHG) advantages relative to other technologies. This brief updates a 2021 analysis by the International Council on Clean Transportation (ICCT) that estimated the life-cycle emissions of passenger vehicles, including sedans and sport utility vehicles (SUVs), in major global vehicle markets.[1] In this brief, we focus on the United States and expand the analysis to include "strong" hybrid electric vehicles that can temporarily power a vehicle without the engine; these have increased to more than 5% of new light-duty vehicle sales in the United States since 2021.[2] This work considers model year 2024 vehicles and projected model year 2030 vehicles.

The earlier ICCT study found that the life-cycle GHG emissions of average battery electric mid-size cars sold in the United States in 2021 were 57%–68% lower than

1 Georg Bieker, *A Global Comparison of the Life-Cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars* (International Council on Clean Transportation, 2021), https://theicct.org/publication/a-global-comparison-of-the-life-cycle-greenhouse-gas-emissions-of-combustion-engine-and-electric-passenger-cars/.

2 U.S. Environmental Protection Agency, *The 2023 EPA Automotive Trends Report* (December 2023), https://www.epa.gov/automotive-trends

Acknowledgments: This work was conducted with generous support from the Aspen Global Change Institute, the Heising-Simons Foundation, and Energy Foundation. We thank Aaron Isenstadt and Georg Bieker for input on data and methods and for critical reviews on an earlier version of this brief.

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Life-cycle greenhouse gas emissions of U.S. sedans and SUVs with different powertrains and fuel sources

This brief updates a 2021 ICCT analysis and estimates the life-cycle emissions of four common passenger vehicle powertrains in the United States: internal combustion engine (ICE) vehicles, hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and BEVs. It considers

average model year 2024 vehicles and projected model year 2030 vehicles.

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A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars

July 20, 2021

EC-C405.17(1)-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Adds new provisions for electric vehicle (EV) power transfer infrastructure and requires a minimum number of EV spaces, EV capable spaces and EV ready spaces based on occupancy group.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second and third Energy Sub-Workgroup meetings on September 29, 2025, and November 14, 2025, respectively.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association (VPGA), Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members in attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith

- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Bill P outlined his EV-readiness proposal, explaining that it mirrors **Joseph W's** submission but adds key definitions to cover the spectrum from full EV chargers to conduit-only "make-ready" infrastructure.

Steve S opposed both versions, arguing that the USBC is a minimum code and that EV provisions exceed the health-and-safety threshold; he recommended creating a dedicated workgroup, noting fire-service concerns about thermal runaway.

Florin Moldovan (DHCD staff) reported that comments from **Andrew Milliken** had been forwarded to the two proponents.

Andrew C said the Virginia Association for Commercial Real Estate also has reservations, particularly about parking-space ratios.

Ron C contended the proposals fall outside the USBC's statutory scope and lack concrete cost data for the required EV stations.

Bill P countered that future-outlet requirements are common in building codes and that EV readiness serves public health, safety, and welfare. He would support forming a workgroup if the proposals do not advance. He further noted that DHCD staff submitted a proposal last cycle to include EV charging requirements at the request of two legislators.

Florin M clarified that, at times, staff will submit proposals on behalf of legislators as a courtesy, but staff do not submit proposals of this nature on behalf of DHCD.

Steve S asked why the reason statement references the residential code; **Bill P** said the intent is to show consistency across occupancy types.

Monica R backed the concept but agreed that a workgroup is needed, calling EV infrastructure essential for resiliency and emergency response.

Florin M confirmed staff will relay the request for an EV-readiness Workgroup to the Board.

Andrew C highlighted the difference between multifamily and one- or two-family dwellings, implying any mandate should distinguish between them.

Sub-Workgroup members in attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – VAEEC, Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – AOBA/VAMA, Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – AIA, Virginia Chapter, Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Bill P provided an overview of the proposal which introduces new requirements related to electric vehicle charging into the code.

Andrew C asked if commercial or multi-family buildings would override the local zoning ordinance requirements on parking.

Bill P answered that it would not, and it addressed shared parking with gas powered vehicles.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Eric Lacey, RECA; Sydney Roberts, SEEA; Joseph Wages, NEMA.

Opposition: Steve Shapiro, AOBA/VAMA; Andrew Clark, HBAV; William "Rick" Hinson, American Council of Engineering Companies (ACEC); Corian Carney, IAEI - Virginia Chapter; D.A. Pierce, VBCOA.

Discussion:

I. **Bob Shippee –** Sierra Club Virginia Chapter, provided an overview of the proposal.
   a. **Sydney R** pointed out that the cost of electric vehicle infrastructure is less during new construction than doing it as a retrofit. It's about 400% less. It's also to supply equipment for multi-family buildings where residents may not have the power or authority to install equipment for themselves.
   b. **Steve S** reiterated that a work group be formed to study all the issues around electric vehicle charging.
   c. **Andrew C** raised the issue that electric vehicle infrastructure not only impacts the cost of a building but also land development for developers.

II. **Support**
   a. **Eric L, Sydney R**, and **Joseph W** expressed support.

III. **Opposition**
   a. **Steve S, Andrew C, Rick H, Cory C,** and **D.A. Pierce** expressed opposition.

DHCD Staff Notes:

1. The VRC companion proposal REC-R404.5-24 was also reviewed by stakeholders at the second and third Sub-Workgroup meetings, and the third GSW, on January 5, 2026, where it received a Non-Consensus recommendation.
2. This proposal is almost identical with code change proposal EC-C405.17-24, which was reviewed by stakeholders at the second GSW meeting, on October 3, 2025, and received a Non-Consensus recommendation. The excerpt from the October 3, 2025, meeting summary pertaining to EC-C405.17-24 is provided below.

October 3, 2025, GSW Meeting Summary Excerpt

Support: Bill Penniman, Sierra Club (VA Chapter).

Opposition: Steve Shapiro, AOBA/VAMA; Ron Clements, Chesterfield County; Andrew Clark, HBAV; Mike O'Connor, VPGA/VPCMA; Andrew Milliken, Stafford County Fire Marshal's Office, Virginia Fire Services Board (VFSB) Codes and Standards Committee; Shahriar Amiri, Arlington County.

Discussion:

I. **Brian H** provided an overview of the proposal on behalf of the proponent.

II. **Support**

   a. **Bill P** expressed support.

III. **Opposition**

   a. **Steve S** opposed, stating it goes beyond the "minimum code" and should be in appendices.
   b. **Ron C** opposed, questioning if it's within the state code's scope and citing an inadequate cost impact statement.
   c. **Andrew C** strongly opposed, citing unstudied impacts on utilities, land planning, and development costs.
   d. **Mike O'** opposed, noting federal EV tax incentives have been repealed.
   e. **Andrew M** opposed, raising safety concerns for parking garages, particularly with regard to ventilation and adequate sprinkler systems.
   f. **Shahriar A** opposed, noting safety concerns about EV fires and fumes.

IV. **Brian H** responded to opposition by stating that other states have successfully implemented similar requirements and that guidance exists to avoid the raised concerns. **Brian** further moved to have companion proposal REC-R404.5(1)-24 go forward as non-consensus, as it deals with the same topics but on the residential side.

EC-C409-24

VECC: R409 (New), C409 (New)

Proponents: William Abrahamson, representing Phius, Phius Alliance (wabrahamson@gparch.com)

2021 Virginia Energy Code

Add new text as follows:

R409 PASSIVE BUILDING COMPLIANCE OPTION. *R409.1 Phius standard compliance.* *Compliance based on the Phius CORE 2024 of Phius ZERO 2024 (or later) Standard will include performance calculations by Phius-approved software or the use of the Phius Prescriptive Path.*

R409.1.1 Phius documentation. *Prior to the issuance of a building permit, a Phius Design Certification letter must be provided to the code official:*

R409.1.2 Project certificate. Prior to the issuance of a certificate of occupancy, a Phius 2024 (or later) Final certificate must be provided to the code official.

C409 PASSIVE BUILDING COMPLIANCE OPTION. C409.1 Phius standard compliance. Compliance based on the Phius CORE 2024 of Phius ZERO 2024 (or later) Standard will include performance calculations by Phius-approved software or the use of the Phius Prescriptive Path.

C409.1.1 Phius documentation. Prior to the issuance of a building permit, a Phius Design Certification letter must be provided to the code official.

C409.1.2 Project certificate. Prior to the issuance of a certificate of occupancy, a Phius 2024 (or later) Final certificate must be provided to the code official.

Reason Statement: Explicitly including Phius certification as an alternate compliance path allows builders and homeowners to provide high-performing, energy efficient homes governed by rigorous, consistently vetted standards and testing without redundant reporting or conflicting requirements for envelope, mechanical, or plumbing standards.

Buildings constructed to the Phius standard provide superior indoor air quality, resilience during power outages, and an extremely quiet, comfortable indoor environment. Project teams are increasingly adopting passive building principles and the Phius standard for single-family, multifamily, and commercial buildings to achieve Net Zero buildings, resulting in over 7,000 units certified, and totaling over 7.4 million square feet across North America. Project teams are increasingly adopting passive building principles and the Phius standard for single-family, multifamily, and commercial buildings to achieve Net Zero buildings, resulting in over 7,000 units certified, and totaling over 7.4 million square feet across North America.

Phius is a non-profit 501(c)(3) organization committed to making high-performance passive building the mainstream market standard. Phius trains and certifies professionals, maintains the Phius climate-specific passive building standard, certifies and quality assures passive buildings, and conducts research to advance high-performance building**.**

See attached materials for more info on the standard, benefits, and cost impacts.

Cost Impact: The code change proposal will not increase or decrease the cost

This proposal will not incur any additional costs that a construction team would not otherwise elect to incur for their project.

This proposal could reduce soft costs and management costs by reducing redundant compliance checks and has the potential to reduce material costs by allowing builders to right-size the insulation, fenestration, and mechanical equipment based on the detailed energy modeling required by Phius certification.

Attached Files

- **VA Energy Code_PhiusBackgroundInfo.docx**
  https://va.cdpaccess.com/proposal/1547/2256/files/download/1021/
- **Phius Design Certification Letter-Sample.pdf**
  https://va.cdpaccess.com/proposal/1547/2256/files/download/1020/
- **Phius CORE Certificate-Sample.pdf**
  https://va.cdpaccess.com/proposal/1547/2256/files/download/1019/

What is the Phius Standard?

Buildings constructed to the Phius standard provide superior indoor air quality, resilience during power outages, and an extremely quiet, comfortable indoor environment. Project teams are increasingly adopting passive building principles and the Phius standard for single-family, multifamily, and commercial buildings to achieve Net Zero buildings, resulting in over 7,000 units certified, and totaling over 7.4 million square feet across North America. Project teams are increasingly adopting passive building principles and the Phius standard for single-family, multifamily, and commercial buildings to achieve Net Zero buildings, resulting in over 7,000 units certified, and totaling over 7.4 million square feet across North America.

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What is an Alternate Compliance Path in the Energy Code and How does it Involve Phius?

The International Energy Conservation Code allows code officials to deem a particular energy efficiency program to be more efficient than the energy code. By meeting the requirements of these programs, a code official can deem a project to meet the energy code. Phius is one such energy efficiency program.

All buildings built to the Phius standard foreground five principles:

- Using continuous insulation throughout the building envelope to minimize or eliminate thermal bridging.
- Building a well-detailed and extremely airtight building envelope, preventing infiltration of outside air and loss of conditioned air while increasing envelope durability and longevity.
- Using high-performance windows (double- or triple-paned windows, depending on climate and building type) and doors; solar gain is managed to exploit the sun’s energy for heating purposes in the heating season and to minimize overheating during the cooling season.

- Using some form of balanced heat- and moisture-recovery ventilation to significantly enhance indoor air quality.
- Minimizing the space conditioning system because of lower space conditioning loads.

Phius Buildings Provide Myriad Benefits:

Buildings constructed to the Phius standard provide: significant energy savings, lower utility bills, resilience during power outages, superior indoor air quality, and an extremely quiet, comfortable indoor environment.

- **Energy Savings:** Buildings that meet the Phius standard than conventional buildings use up to 60 percent less overall energy than code-built buildings.
- **High Quality Construction**: Phius certified buildings are among the best built buildings in the country. Buildings built to the Phius standard undergo rigorous testing and verification, and a third-party certification process. The Phius standard is aligned with other programs such as DOE's Efficient New Home Program and Energy Star, providing additional quality control.
- **Utility Bill Savings:** According to a Policy Brief by the American Council for an Energy Efficient Economy, one in four low-income households spend at least 15% of their household income on energy bills (which is over twice the amount defined as a high energy bill). The decrease in energy use directly benefits low- income households in terms of their utility bills.[1]
- **Resilience:** Phius construction principles align with an increase in resilience. Phius buildings emphasize the reduction of air flow into and out of buildings along with the elimination of thermal bridges across the building envelope through the use of continuous insulation[2].
- **Clean Air:** Phius buildings are thoroughly air-sealed, which provides two direct benefits. First, it prevents external air pollutants from leaking into the building. This is extremely important when buildings are located near areas with high automobile traffic or in neighborhoods with low air quality. Second, the mechanical systems included within a Phius project constantly cycle in fresh air, filter it, and circulate it throughout the

[1] ACEEE Policy Brief: City Energy Burdens (September 2024): https://www.aceee.org/sites/default/files/pdfs/data_update_-_city_energy_burdens_0.pdf

[2] See "Valuing Energy Efficiency for Energy Resilience" Franconi et.al. https://www.phius.org/sites/default/files/2023-11/Impact%20of%20building%20energy%20efficiency%20on%20resilience%20during%20extreme%20heat%20and%20cold%20events%20during%20a%20power%20outage%20ellen%20franconi%20phiuscon%202023.pdf

buildings and the individual units. The continual replacement of interior air with fresh, filtered air rapidly removes odors

- **Comfortable Indoor Environment:** The integration of superinsulation, air-tight construction, and high-efficiency mechanical systems allow Phius buildings to maintain a comfortable interior temperature and comfortable humidity levels year-round as drafts and cold spots do not exist within the units. Not only are the units within a Phius-certified multi-family building more physically comfortable for residents, but they consume up to 90% less energy on space conditioning than a building of similar construction. Utility bills are also significantly lower, with the monthly cost savings passed on to residents.
- **Noise Reduction:** Super-insulated walls and triple-paned windows significantly increase the soundproofing capability of exterior walls. A joint study performed by NK Architects, a leading firm in Passive House design, and SSA Acoustics, showed that exterior noise penetration in Passive House buildings is reduced by up to 10 decibels. Residents will experience a living environment twice as quiet as a typical building.

Phius Buildings are Cost Competitive:

Cost data from projects completed in other states show that Phius projects are cost-competitive using traditional construction methods compared to buildings built to the energy code.

Data, gathered in Massachusetts and New York, shows that the typical incremental cost of a Phius certified project ranges between 1-4%.

Incremental Cost (over Code Built Homes) For Phius Projects Built Under the Passive House Challenge

Project	Number of Units	Incremental Cost
Bartlett Station/Kinzie	52	1.0%
Depot Village/Hanson Village	48	4.1%
Finch Cambridge	98	1.4%
Harbor Village	30	1.8%
Mattapan Station	135	2.0%

North Commons	53	4.3%
Old Colony; Phase 3C	55	2.8%

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Incremental Cost for NYSERDA Building of Excellence Phius Projects

Project	Units	Incremental Cost
WoodyCrest	45	2.0%
Tree of Life	174	2.1%
425 Grand Concours	277	1.7%
Park Avenue Green	154	7.0%

Phius is Included in Multiple State Energy Codes:

9 States and Municipalities currently include Phius as part of their energy codes: Please see Phius.org to see the specific state energy code. States that Include Phius in their energy code include:

State	Link to Energy Code
Boulder	https://assets.bouldercounty.gov/wp-content/uploads/2017/03/building-code-2015.pdf
Denver	https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Community-Planning-and-Development/Building-Codes-Policies-and-Guides
Chicago	https://www.chicago.gov/city/en/depts/bldgs/supp_info/chicago-energy-conservation-code.html
Illinois	https://cdb.illinois.gov/business/codes/illinois-energy-codes/illinois-stretch-energy-code.html
Maine	https://www.maine.gov/dps/fmo/sites/maine.gov.dps.fmo/files/inline-files/642C006_0.pdf
Massachusetts	https://www.mass.gov/regulations/780-CMR-chapter-115-aa-stretch-energy-code
New York	https://www.nyserda.ny.gov/All-Programs/Clean-Resilient-Building-Codes/NYStretch-Energy-Code-2020
Oregon	https://www.oregon.gov/bcd/codes-stand/Documents/2023-oregon-residential-reach-code.pdf
Washington	https://sbcc.wa.gov/state-codes-regulations-guidelines/state-building-code/energy-code

EC-C409-24 – Staff Summary

Proponent: William Abrahamson, representing Phius, Phius Alliance

Brief Description: Intends to add an additional energy compliance path for commercial and residential buildings based on Phius' software.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the third Energy Sub-Workgroup meeting, on November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
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- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members in attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce

- Dennis Hart
- Eric Lacey
- K.C. Bleile – VAEEC, Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – AOBA/VAMA, Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – AIA, Virginia Chapter, Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

William A, speaking for himself, provided an overview of the proposal which introduces a new, separate compliance path for commercial and residential buildings based on Phius' software.

D.A. Pierce inquired how this is different from the Total Building Performance option already in the code.

William A responded that the Total Building Performance path has a different criteria and reporting path.

Bill P supported the proposal because it offers a way to achieve a net zero energy building.

Dennis H remarked that there is no current path in either the commercial or residential provisions to get to the new Section 409 that is being proposed. Charging statements are needed in the proposal.

Florin Moldovan (DHCD staff) asked the proponent if this new option will also require compliance with all the other energy code requirements; and whether the intent was for this to be a separate and distinct compliance path, in addition to those already allowed by the code?

William A declared that the prescription compliance path is included in Phius, and it is equal to or better than what is required in the 2024 IECC. The intent was for this to be an additional compliance path.

Florin M noted that floor modifications are allowed to be introduced at the General Stakeholder Workgroup Meeting and if that was the intent, recommended to add language to the proposal, in Section C401.2.1, indicating that the Phius path is a separate compliance option as an alternative to the compliance options that already exist.

Mike H, speaking for himself, had concerns regarding certifications that require payment to a private organization which results in a "pay to comply" structure.

Michael R, speaking for himself, asked why the requirements and documentation need to be added to the code as an additional path if this new path already complies with the requirements of the code.

D.A. Pierce vocalized that in Section R405.3.1 Compliance software tools, a building official can accept any software path of compliance so long as it demonstrates that it meets or exceeds the minimum requirements of building codes.

Dennis H reiterated **Mike H's** concern that the proposal is specifically inserting Phius into the code as a "pay to play" option that verifies compliance with the code. There is already a pathway to use software in the code to achieve this. **Dennis H** recommended that Phius provides training to code officials to familiarize them with the software.

Eric L opposed the proposal and opposed stand-alone alternatives.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Jason Vandever, North American Insulation Manufacturers Association (NAIMA); Bob Shippee, Sierra Club – Virginia Chapter; Paul Messplay, Hanover County.

Opposition: Steve Shapiro, AOBA/VAMA; Dennis Hart, representing self; D.A. Pierce, representing self; Shahriar Amiri, Arlington County.

Discussion:

I. Proponent not in attendance. **Florin Moldovan** (DHCD staff) provided an overview of the proposal.
   a. **Jason V** added that Phius has been shown to save money.
   b. **Bob S** contributed that passive houses have lower energy bills and is a great option to add.
   c. **Steve S** noted that it is a proprietary system with a reference standard that may not comply with ICC requirements for reference standards.
   d. **D.A. Pierce**, representing himself, stated that during the Energy Sub-Workgroup it was discussed that there is no fair way to get to this option for compliance.

II. **Support**
   a. **Jason V**, **Bob S**, and **Paul M** expressed support.

III. **Opposition**
   a. **Steve S**, **Dennis H** representing himself, **D.A. Pierce** representing himself, and **Shahriar A** expressed opposition.

DHCD Staff Note:

Based on the proponent's statements during the third Energy Sub-Workgroup meeting, the proposal is intended to add a new compliance option. As written, however, it does not provide a connection between the scoping provisions in Section R401.2, where the allowed compliance options are listed, and the new requirements.

REC-R402.1.2-24

VRC: TABLE N1102.1.2 (R402.1.2), TABLE N1102.1.3 (R402.1.3); IRC: TABLE N1102.1.3 (R402.1.3)

Proponents: DeAnthony Pierce, City of Roanoke, representing Virginia Building & Code Officials Association (deanthony.pierce@roanokeva.gov)

2021 Virginia Residential Code

Revise as follows:

TABLE N1102.1.2 (R402.1.2) MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS

Portions of table not shown remain unchanged.

CLIMATE ZONE	FRAME WALL *U*-FACTOR
3	~~0.079~~ 0.060
4 except Marine	~~0.079~~ 0.060
5 and Marine 4	~~0.079~~ 0.060

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In Warm Humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

   Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum U-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

   1. Above 4,000 feet in elevation above sea level, or

   2. In windborne debris regions where protection of openings is required by Section R301.2.1.2.

TABLE N1102.1.3 (R402.1.3) INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	WOOD FRAME WALL *R*-VALUE[g]
3	~~15 or 13+1~~[g] 20 or 13&5ci or 15&4ci[g]
4 except Marine	~~15 or 13+1~~[g] 20 or 13&5ci or 15&4ci[g]
5 and Marine 4	~~15 or 13+1~~[g] 20 or 13&5ci or 15&4ci[g]

For SI: 1 foot = 304.8 mm.

NR = Not Required.

ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

   Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13&5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab-edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation shall not be required in Warm Humid locations as defined by Figure N1101.7 and Table N1101.7.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13&5" means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section N1102.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

   1. Above 4,000 feet in elevation, or

   2. In windborne debris regions where protection of openings is required by Section R301.2.1.2.

2024 International Residential Code

Revise as follows:

TABLE N1102.1.3 (R402.1.3) INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]
Portions of table not shown remain unchanged.

For SI: 1 foot = 304.8 mm.NR = Not Required, ci = Continuous Insulation.

h. ~~"30 or 19+7.5ci or 20ci" means R-30 cavity insulation alone or R-19 cavity insulation with R-7.5 continuous insulation or R-20 continuous insulation alone.~~ "20 or 13+ 5ci or 15+2.9ci" means R-20 cavity insulation alone or R-13 cavity insulation with R-5 continuous insulation or R-15 cavity insulation with R-4 continuous insulation.

Reason Statement: This proposal is meant to be a replace Virginia's Amended "R-15 or 13+1" wall insulation requirement, which has been in-place since the 2012 Code Cycle.

When the Amendment was adapted, it generally aligned with the requirements in the Model I-Codes. Since than, prescriptive insulation values have incrementally increased in the Model I-Codes, while Virginia's Wall insulation has remained the same.

This proposal will put Virginia’s insulation requirements, roughly in-line with the 2018 Model I-Codes.

Cost Impact: The code change proposal will increase the cost

If adopted, this code change will increase the cost to builders who generally use 2x4 framing, and R-15 batt insulation, since it will require the use of either 2x6 framing, or added continuous insulation on the exterior.

The cost of framing would also increase since window framing around exterior window and door openings would have to be extended, to facilitate the continuous insulation, or if 2x6 studs are used.

2.9 continuous insulation with R-15 batt insulation was determined to be roughly equivalent to R-13 + 5 continuous. Through preliminary research, R-2.9 rigid board insulation was regularly available at retail chains such as Lowes and Home Depot. For this reason, R-15 with 2.9 continuous was added as an option for builders who prefer to build with 2x4 studs, and use R-15 insulation.

Attached Files

- **VBCOA 2024 Code Change Proposal_N1102 Tables.pdf**
  https://va.cdpaccess.com/proposal/1408/2011/files/download/946/

Proponents: VBCOA

2024 Virginia Residential Code

Revise as follows:

SECTION N1102 (R402)
BUILDING THERMAL ENVELOPE

…

TABLE N1102.1.2 (R402.1.2)
MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	3	4 EXCEPT MARINE	5 EXCEPT MARINE 4
CEILING *U*-FACTOR	0.030	0.026	0.026
WOOD-FRAMED WALL *U*-FACTOR	~~0.079~~ 0.060	~~0.079~~ 0.060	~~0.079~~ 0.060

…

TABLE N1102.1.3(R402.1.3)

INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	3	4 EXCEPT MARINE	5 EXCEPT MARINE 4
CEILING *R*-VALUE	38	49	49
WOOD-FRAMED WALL *R*-VALUE	~~15 or 13+1~~ 20 or 13&5ci or 15&2.9ci	~~15 or 13+1~~ 20 or 13&5ci or 15&2.9ci	~~15 or 13+1~~ 20 or 13&5ci or 15&2.9ci

Reason Statement:

This proposal is meant to be a replace Virginia's Amended "R-15 or 13+1" wall insulation requirement, which has been in-place since the 2012 Code Cycle.

When the Amendment was adapted, it generally aligned with the requirements in the Model I-Codes. Since than, prescriptive insulation values have incrementally increased in the Model I-Codes, while Virginia's Wall insulation has remained the same.

This proposal will put Virginia's insulation requirements, roughly in-line with the 2018 Model I-Codes.

Resiliency Impact Statement:

This proposal will increase the resiliency of new homes to withstand exterior temperature extremes, by increasing the overall Building Thermal Envelope of a home. The incremental increase in wall insulation can further assist a home with maintaining its internal temperature longer, when mechanical equipment becomes inoperable in events such as blackouts.

Cost Impact:

If adopted, this code change will increase the cost to builders who generally use 2x4 framing, and R-15 batt insulation, since it will require the use of either 2x6 framing, or added continuous insulation on the exterior.

The cost of framing would also increase since window framing around exterior window and door openings would have to be extended, to facilitate the continuous insulation, or if 2x6 studs are used.

2.9 continuous insulation with R-15 batt insulation was determined to be roughly equivalent to R-13 + 5 continuous. Through preliminary research, R-2.9 rigid board insulation was regularly available at retail chains such as Lowes and Home Depot. For this reason, R-15 with 2.9 continuous was added as an option for builders who prefer to build with 2x4 studs, and use R-15 insulation.

Public Comments (PCH) for: REC-R402.1.2-24

Discussion by Mark Graver

Dec 23, 2025 19:58 UTC

Building technology continues to result in creative and intelligent solutions to the core challenges related to construction. New technologies and materials are created to move the industry forward. One of these core challenges is insulation and related to this, environmental effects related to moisture, air flow, and heat loss/gain. Despite the many methods of construction, conventional framing is generally where "cavity" insulation occurs. Voids have to be filled to address heat loss/gain, moisture has to remain on the outside and expelled from the building interior. Industrial processes have brought us a wide range of insulation types, constantly being refined to create better thermal resistance. The industry has adapted for 100 years from the times of filling these voids with newspaper, straw, and other flammable and inefficient materials. Those days are well behind us, and insulation products continue to advance in new and unexpected ways. However, the basics have not changed for decades. Rigid insulation panels have been in use for over 40 years. Fiberglass batts have been in use for even longer.

Because this proposal does not seek to incorporate an new and affordable technology, and because this proposal is not based on better production standards, leading to more thermally resistant products, there are only two possible explanations as to how such a proposal came to be: fear or overreach. Fear, because there's an ICC standard that VA is not keeping pace with. Or overreach, because of the principle known as mission creep. It is like a combination of the two. However, this does not change the core duty that code professionals must uphold: regulation must be measured and calculated. A standard that continues to change due to mission creep is not a standard at all, it's a moving target based on ever changing opinions of regulators. Regulations are made for the benefit of the persons served. As such, a regulation such as this, with such a high initial cost for conventionally framed structures would increase the cost of a home to a degree that would not serve the average citizens of the Commonwealth of VA. Regulations are most effectively administered and accepted when they represent minimum standards. If the initial cost is too high, the industry and the citizens of the Commonwealth will be harmed. As a counterweight, the building industry could be subsidized to temporarily stabilize a market in the event that a regulation creates too much pressure, but creating a need for subsidies is not proper stewardship.

Retaining a standard that has been in place since the 2012 edition should not be seen as a problem, but should be seen as a sign of stability. Though the building industry is forced to adapt to other irrational standards, stability, where it can be maintained, is preferred. The amended VA code that is in effect is the correct, rational standard that meets the intended and stated purpose of the VA USBC for minimum standards. At this time, adopting a different standard is nothing more than mission creep.

Comment by DeAnthony Pierce

Jan 5, 2026 5:28 UTC

This proposal would align the ceiling and wall insulation values with the 2009 IRC, for Climate Zone 5, and the 2012 IRC for Climate Zones 3 and 4. This is in anticipation of ceiling insulation values returning to R-38 in Climate Zone 3, and R-49 in Climate Zones 4 and 5, based on the Model 2024 IRC and Residential section of the IECC. Virginia now has Climate Zones 3 and 5, starting with the current 2021 Virginia USBC. This proposal leaves R-15 wall insulation in-place, which was first introduced as an amendment beginning in the 2012 VRC, when all of Virginia was recognized as Climate Zone 4 only. The continuous insulation value added to the R-15 in this proposal, was determined to be the rough equivalent of R-13+5 or R-20 batt in 2x6 framed walls. This proposal also resolves a likely unknown hazard for moisture forming in walls built with R-13+1 continuous insulation. This is particularly true in Climate Zone 5, and during colder periods for the majority of the state in Climate Zone 4. Overall, adding continuous insulation for homes constructed with 2x4 wall framing, increases a home's ability to retain both heat and cooling, on the interior, which conserves more energy and saves money from lower heating and cooling needs.

At the request of the VBCOA Energy Conservation Committee, data was provided from the Polyisocyanurate Insulation Manufacturers Association (PIMA), that clarified a continuous insulation equivalent for R-15 batt when compared to R-13+5, and the most optimal level of continuous insulation that can work in all Climate Zones, when R-15 batt is used, to prevent moisture forming in walls. To reiterate: a home built using R-13+1, as currently amended, has a high chance of moisture forming in wall cavities during colder months, and in colder climates. R-15 alone does not conserve the same amount of energy within a home, when compared to a home that has continuous insulation.

ENERGY EFFICIENT CODES COALITION

March 31, 2026

Virginia Department of Housing and Community Development
Division of Building and Fire Regulation
State Building Codes Office

RE: 2024 Code Development Cycle
Support for proposal number REC-R402.1.2-24 as modified (IRC/IECC)
Modification of U-factors and R-values for insulation in frame walls

Sent via email to: codedevelopment@dhcd.virginia.gov

Dear Board of Housing and Community Development members,

The Energy Efficient Codes Coalition (EECC) supports code change proposal REC-R402.1.2-24 as modified (and originally submitted) by the Virginia Building and Code Officials Association (VBCOA) and we encourage you to adopt it.

The proposal would improve the prescriptive minimum insulation requirements for residential frame walls in all climate zones. This change would result in energy savings that would lower the operating costs for homes built to the new requirements for the entire life of the homes.

It would also decrease the likelihood of moisture issues that could result from the current VA energy code requirements due to the potential for unseen condensation and potentially even harmful mold within wall cavities.

We urge your consideration of **REC-R402.1.2-24 as modified.** It would dramatically increase energy savings, occupant health and durability.

Please contact me at amy@energyefficientcodes.org or (989) 513-2169 if you have any questions or would like additional information.

Sincerely,



Amy Schmidt
Executive Director, EECC

PIMA
POLYISOCYANURATE INSULATION MANUFACTURERS ASSOCIATION

3101 Wilson Blvd., Suite 500
Arlington, VA 22201
703.258.0093
www.polyiso.org

March 31, 2026

2024 Virginia Code Development Cycle
Proposal # REC-R402.1.2-24 as modified (IRC/IECC)
PIMA letter of support for modification of U-factors and R-values for insulation in frame walls

Dear Board of Housing and Community Development members,

The Polyisocyanurate Insulation Manufacturers Association (PIMA) respectfully requests the Board of Housing and Community Development (Board) to **approve code change proposal number REC-R402.1.2-24 as modified** (and originally submitted) by the Virginia Building and Code Officials Association (VBCOA).

In summary, the VBCOA proposal would increase the prescriptive minimum insulation requirements for residential frame walls in all climate zones. While insulation requirements can often be viewed through the one-dimensional lens of energy savings, the proposed modifications to the fame wall insulation requirements are also needed to increase the durability of residential homes. Specifically, REC-R402.1.2-24 addresses the following issues and gaps in the current Viriginia Residential Code:

- **Reduce Moisture Risk:** Current minimum insulation requirements for frame walls create the risk for moisture accumulation within the wall assembly.
- **Address Thermal Bridges:** Improved frame wall requirements for continuous insulation will reduce energy loss by reducing the negative impacts of thermal bridges and air leakage and improve the comfort and resiliency of residential homes.
- **Constructable Solution:** The continuous insulation requirements as proposed provide constructable and flexible options for homebuilders.

For the reasons outlined above and explained in more detail below, we urge the Board to approve REC-R402.1.2-24 as modified.

1. **Current Virginia Residential Code minimum insulation requirements for frame walls create the risk for moisture accumulation within the wall assembly.**

The current Virginial Residential Code requires a minimum of R-15 or R13+1ci (continuous insulation). The lack of adequate continuous insulation creates a significant risk for moisture accumulation in cold climates in Virginia (climate zones 4 and 5, and to a lesser extent climate zone 3). In particular, the R13+1ci prescriptive option runs contrary to well-accepted building science principles and falls outside of the model requirements of the International Residential Code for vapor control in wall assemblies for the State's colder climates.

In cold climates, exterior walls without adequate continuous insulation can experience interstitial condensation on the backside of sheathing during cold weather. The risk is highest in climate zone 5, where winter design temperatures are low enough that the sheathing temperature can drop below the dew point of the interior air temperature resulting in condensation within the assembly. Even in climate zones 3 and 4, short periods of extreme cold or high interior humidity can produce condensation within the assembly if the wall is not protected by adequate levels of continuous insulation.[1] Moisture accumulation in frame walls can lead to the premature failure of the assembly as well as mold and mildew growth.

SOLUTION: REC-R402.1.2-24 as modified would establish minimum insulation requirements that significantly reduce the risk for moisture accumulation in frame walls and protect homebuilders, homeowners, and occupants from the severe consequences of wall assembly failures.

Importantly, research supported by the National Association of Home Builders verifies this conclusion:

> "Vladimir Kochkin presented results from monitoring sheathing moisture contents in a broad survey of houses (20+ homes in multiple climate zones), and test hut monitoring work in Maryland (Zone 4A). Many of these walls had exterior foam, to meet requirements in the 2012 IECC. One general pattern that "safer" designs (more exterior continuous insulation/less cavity insulation) generally had lower wintertime moisture contents, but with some exceptions. The results also allay builder concerns that exterior foam impedes drying; drying to the interior was in evidence."[2]

2. **Improving frame wall requirements for continuous insulation will reduce energy loss by reducing the negative impacts of thermal bridges and air leakage and improve the comfort and resiliency of residential homes.**

In traditional construction, frame walls are insulated with cavity insulation only. This allows increased energy loss through thermal bridges—primarily uninsulated wood framing members. Installing adequate levels of continuous insulation significantly reduces energy loss through thermal bridges by separating the framing members from outside conditions.

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[1] For additional explanation, see International Residential Code Table R601.3.1 or Building Science Corporation's technical bulletin, *BSD-163: Controlling Cold-Weather Condensation Using Insulation*, available at: https://buildingscience.com/documents/digests/bsd-controlling-cold-weather-condensation-using-insulation.

[2] Building Science Corporation, *Guidance on Modeling Enclosure Design in Above Frade Walls: Expert Meeting Report* (June 14, 2014), available at: https://buildingscience.com/documents/bareports/ba-1403-guidance-modeling-enclosure-design-above-grade-walls-expert-meeting/view.

Legacy building practices often have higher air leakage rates due to poorly installed, inadequate, or missing air control layers. Air-impermeable continuous insulation products can serve as an excellent air control layer when detailed with sealed or taped joints. Air leakage accounts for 25 to 40 percent of energy used for heating and cooling in a typical residential building.[3] Reducing air leakage through air sealing techniques such as installing continuous insulation can return significant savings to homeowners. Moreover, air leaks are a significant source for moisture transport through building envelope assemblies. Minimizing air leakage can also reduce the risk for moisture accumulation and the associated problems explained above.

Beyond these energy savings and technical justifications, continuous insulation also increases the thermal comfort of residential homes. Occupant comfort, typically considered in the context of daily living, becomes substantially more critical during extreme weather events, power outages, or situations in which severe conditions coincide with power disruptions. According to the Pacific Northwest National Laboratory, homes constructed to modern energy codes (i.e., 2021 International Energy Conservation Code or higher standards) increase the passive survivability for occupants.[4]

For example, researchers found that a home in Atlanta, Georgia (climate zone 3) constructed to the 2021 IECC can maintain habitable conditions during a heat event for 7.0 days and a cold event for 2.3 days. Compare that to an existing home built to less stringent standards, which researchers determined can only maintain habitable conditions during a heat event for 2.7 days and a cold event for 1.4 days.

SOLUTION: REC-R402.1.2-24 as modified would dramatically increase energy savings by minimizing thermal bridges and air leakage as well as provide occupants with a more comfortable and resilient home.

3. **The continuous insulation requirements as proposed in REC-R402.1.2-24 provide constructable and flexible options for homebuilders.**

Across the country and as the standard building practice in several regions, continuous insulation is used and has been applied effectively and reliably for more than a decade. As modified, REC-R402.1.2-24 would increase prescriptive minimum R-value requirements for assemblies with continuous insulation to R13+5ci or R15+4ci. These options are consistent with the minimum

[3] https://www.energystar.gov/ia/home_improvement/home_sealing/AirSealingFS_2005.pdf

[4] Pacific Northwest National Laboratory, *Enhancing Resilience in Buildings Through Energy Efficiency* (July 2023), available at: https://www.energycodes.gov/sites/default/files/2023-07/Efficiency_for_Building_Resilience_PNNL-32727_Rev1.pdf.

requirements enforced in other jurisdictions, which demonstrates the viability of these insulation assemblies as constructable solutions for residential homes. Importantly, the proposal preserves an option for R-15 cavity insulation plus continuous insulation, which we understand is a preferred option for homebuilders in Virginia.

The proposal also establishes consistent requirements across all climate zones in Virginia. This will reduce confusion and ease compliance for homebuilders and trades that work across the State or in multiple regions. Moreover, consistent requirements help product manufacturers, distributors, and other building material sellers to stock appropriate products and ensure homebuilders have ready access to necessary building materials.

SOLUTION: REC-R402.1.2-24 as modified delivers significant benefits to homeowners and occupants while providing homebuilders with constructable and flexibly options for more energy efficient home construction.

4. Conclusion

PIMA strongly encourages the Board to approve REC-R402.1.2-24 as modified. The proposal corrects an important deficiency in the current code requirements for frame wall insulation and provides homebuilders with workable solutions that are consistent across all climate zones in Viriginia. Most importantly, continuous insulation installed at the time of initial construction enhances the month-to-month affordability of homeownership by lowering energy consumption and utility bills, the cost of which continues to rise at an unpredictable pace.[5]

Please contact me at jkoscher@pima.org or (703) 224-2289 should additional information be helpful to Virginia's 2024 code development cycle.

Sincerely,



Justin Koscher
President

[5] https://www.wtkr.com/news/why-is-my-dominion-energy-bill-so-high-whats-behind-the-2026-increase

Submitted Via Email to codedevelopment@dhcd.virginia.gov

April 3, 2026

Louie Berbert, Chair
Virginia Board of Housing and Community Development
600 East Main Street, Suite #300
Richmond, VA 23219

RE: RECA Comments Supporting the Adoption of the 2024 *IECC* for Residential and Commercial Construction in Virginia and Recommending Additional Improvements

Dear Chairman Berbert,

The Responsible Energy Codes Alliance[1] submits these comments in support of the proposed incorporation of the 2024 International Energy Conservation Code (*IECC*) into Virginia's Uniform Statewide Building Code (USBC) for residential and commercial construction. We have been active participants in the current and previous USBC updates and we support the important work of the Department of Housing and Community Development (DHCD) to help ensure safe, affordable, and efficient construction and renovation in the Commonwealth. **As with the 2021 update, the 2024 *IECC* provides cost-effective, energy saving improvements that will benefit Virginians for generations.**

In addition to our general support for the improvements approved through the stakeholder process, we write specifically to recommend two additional changes that have been part of the model energy code for several cycles, but which Virginia has never adopted: (1) We recommend adopting the full wall insulation requirements of the 2024 *IECC*, or at a minimum, the proposed compromise advanced by the Virginia Building Code Officials Association (VBCOA); and (2) we recommend an incremental improvement to envelope air tightness requirements to bring long-term energy saving and comfort benefits to homeowners.

Energy and Cost Savings of the 2024 *IECC*

Adopting the 2024 *IECC* residential provisions will make homes more affordable and comfortable for Virginians, and adopting the *IECC* commercial provisions (including the

[1] RECA is a national coalition of building products manufacturers, trade associations, environmental groups, regional efficiency advocates and other organizations that support the adoption of the latest model energy codes across the country.

alternative to comply with *ASHRAE* Standard 90.1-2022) will help protect businesses against unprecedented increases in energy costs. For the last two decades, the *IECC* has improved in efficiency with every new edition. According to the U.S. Department of Energy, the 2024 *IECC* will reduce energy bills by an average of 6.6% over the 2021 *IECC*.[2] Likewise, buildings constructed to *ASHRAE* Standard 90.1-2022 will cost an average of 8.9% less to operate than buildings constructed to *ASHRAE* Standard 90.1-2019.[3] (Standard 90.1 is incorporated as a compliance option in the commercial chapter of the *IECC*, and the energy savings figures for the *IECC*-Commercial Provisions and Standard 90.1 are typically similar.) As indicated in the summary table of DOE findings below, the owners and occupants of both residential and commercial buildings in Virginia stand to benefit from substantial cost savings with the adoption of the most recent editions of the model codes.

Comparison of Unamended Model Code Energy Cost Savings					
Residential (2024 *IECC*)[4]			**Commercial (*ASHRAE* 90.1-2022)[5]**		
Climate Zone	Energy Cost Savings over 2021 *IECC*	30-year Cost Savings over 2021 *IECC*	Climate Zone	Energy Cost Savings over 90.1-2019	30-year Cost Savings over 90.1-2019
3	**6.08%**	**$2,509**	**3**	**8.9%**	**$1.35/sq.ft.**
4	**6.79%**	**$3,790**	**4**	**9.8%**	**$1.32/sq.ft.**
5	**5.53%**	**$2,496**	**5**	**10.1%**	**$1.38/sq.ft.**

Efficient Homes are Affordable Homes. Home affordability is an important consideration in any code update process, and it is well-documented that homes constructed to the full 2021/24 *IECC* requirements—including the insulation and air sealing requirements—will provide more comfort and lower energy bills for occupants, and these codes have been repeatedly demonstrated to be cost-effective to the consumer.[6] Unlike some

[2] *See* U.S. Dep't of Energy, *Energy Savings Analysis: 2024 IECC for Residential Buildings*, at iv (Dec. 2024).
[3] *See* U.S. Dep't of Energy, *ANSI/ASHRAE/IES Standard 90.1-2022: Energy Savings Analysis,* at vii (Feb. 2024), available at https://energycodes.gov/sites/default/files/2024-02/Standard_90.1-2022_Final_Determination_TSD.pdf.
[4] *See* U.S. Dep't of Energy, *Energy Savings Analysis: 2024 IECC for Residential Buildings*, at iv (Dec. 2024), available at https://energycodes.gov/sites/default/files/2024-12/2024_*IECC*_Determination_TSD.pdf.
[5] *See* U.S. Dep't of Energy, *ANSI/ASHRAE/IES Standard 90.1-2022: Energy Savings Analysis,* at 24, 27 (Feb. 2024), available at https://energycodes.gov/sites/default/files/2024-02/Standard_90.1-2022_Final_Determination_TSD.pdf.
[6] *See, e.g.*, U.S. Dep't of Energy, *National Cost-Effectiveness of the Residential Provisions of the 2024 IECC* (Jan. 2025) (finding an average of $2,954 in savings over 30 years in new residential homes constructed to the 2024 IECC, with an average simple payback period of 2.5 years).

equipment and other components of the building that must be replaced on a regular basis, elements of the thermal envelope such as insulation will last many decades, providing long-term benefits for homeowners. Although we acknowledge the interest of homebuilders and developers in keeping costs low during construction, that interest must be balanced against the owner/occupant's interest in keeping operating costs low over the next 100 years. The most cost-effective time to insulate homes and commercial buildings is at construction, and it is crucially important that Virginia set efficiency requirements that make sense over the expected lifetime of each new home, and not just at the construction phase.

RECA Recommendation 1: Update Residential Wall Insulation Requirements Consistent with the *IECC*.

Virginia currently allows 75% less efficient walls than the 2021/24 *IECC*. In the 2012 USBC update cycle, Virginia elected to not adopt the wall insulation requirements of the 2012 *IECC*, and has not made any improvements in wall insulation requirements since then. Based on U.S. Census data, we estimate that over 250,000 single family homes have been constructed in Virginia since 2012,[7] and all of these homes were not subject to the insulation requirements set through the consensus-based national model code development process. Wall insulation efficiency improved in both the 2012 and 2021 *IECC* updates—neither of which has been adopted by Virginia, despite proposals submitted by RECA and other stakeholders in every code update cycle to meet the national standard.

We recommend that the Board approve Proposal REC-R402.1.2(2)-24 to incorporate the full wall insulation requirements of the 2024 *IECC*. If the Board would prefer to phase in these requirements over multiple code cycles, we recommend adopting Proposal **REC-R402.1.2-24 (as modified)**, which was submitted by VBCOA and is supported by a wide range of stakeholders. This proposal would allow Virginia to catch up to the 2012 *IECC* insulation requirements and would also correct a technical flaw in Virginia's current wall insulation requirement that could lead to durability issues over time.[8] It is important that Virginia act now to improve the thermal envelope of new homes before another 250,000 homes are built to a lesser standard.

RECA Recommendation 2: Update Residential Envelope Air Tightness Requirements Consistent with the *IECC*.

In the 2018 USBC update, Virginia adopted a requirement that each new home receive a blower door test ≤5 ACH50, which had not been required in previous editions of the USBC.

[7] *See* https://www.census.gov/construction/bps/index.html.

[8] Virginia's current prescriptive wall insulation requirement includes an option for an R-13+1c.i. wall assembly, which could increase the risk for condensation within the wall cavity. We believe either the 2024 IECC wall insulation R-value options or the modified proposal REC-R402.1.2-24 would adequately address this technical problem.

While this was a substantial improvement, it was still weaker than the full *IECC* requirement of ≤3 ACH50. Every edition of the *IECC* since 2012 has required new homes to be tested to ≤3 ACH50, but the 2024 *IECC* provides a number of exceptions and workarounds for smaller dwelling units and multifamily buildings that we believe will allow additional flexibility to help homebuilders achieve the improved efficiency. We recommend that the Board approve Proposal **REC-R402.4.1.2-24 to incorporate the full air leakage testing requirements of the 2024 *IECC*.**

In reality, the only significant cost of meeting the envelope air leakage target has already been incorporated into Virginia's USBC—the cost of the test itself. As code users have become more experienced with air sealing techniques and best practices, we have observed improvements in envelope tightness across the country. We are confident that Virginia code users will have no problem achieving ≤3 ACH50 at little to no extra cost, and for smaller dwelling units or complicated designs, the 2024 *IECC* provides several alternatives.[9] We recommend that Virginia adopt the air tightness testing requirement as published in the 2024 *IECC*.

Conclusion

RECA's members and supporters have been involved in energy code development and adoption for decades, and we offer our assistance and experience as you work to maximize energy efficiency in residential and commercial buildings. Please contact us if you have any questions or would like to discuss how RECA can be of assistance.

Sincerely,

Eric Lacey
RECA Chairman

[9] *See* Section R402.5.1.3 of the 2024 *IECC*.

RECA is a broad coalition of energy efficiency professionals, regional efficiency organizations, product and equipment manufacturers, trade associations, and environmental organizations with expertise in the development, adoption, and implementation of building energy codes nationwide. RECA is dedicated to improving the energy efficiency of homes throughout the U.S. through greater use of energy efficient practices and building products. It is administered by the Alliance to Save Energy, a non-profit coalition of business, government, environmental and consumer leaders that supports energy efficiency as a cost-effective energy resource under existing market conditions and advocates energy-efficiency policies that minimize costs to society and individual consumers. Below is a list of RECA Members that endorse these comments.

Air Barrier Association of America

Alliance to Save Energy

American Chemistry Council

American Council for an Energy-Efficient Economy

CertainTeed LLC

EPS Industry Alliance

Extruded Polystyrene Foam Association

Institute for Market Transformation

Johns Manville Corporation

Knauf Insulation

National Fenestration Rating Council

Natural Resources Defense Council

North American Insulation Manufacturers Association

Owens Corning

Polyisocyanurate Insulation Manufacturers Association

VIRGINIA BUILDING & CODE OFFICIALS ASSOCIATION

April 6, 2026

Dear Members of the Board of Housing and Community Development,

I am writing on behalf of the Virginia Building and Code Officials Association (VBCOA) to express our strong support for the Board's ongoing code adoption process and to commend your continued commitment to ensuring a safe, resilient, and sustainable built environment across the Commonwealth.

The development and adoption of building and fire codes is a fundamental responsibility that directly impacts the health, safety, and welfare of our communities. Your deliberate and transparent approach, grounded in stakeholder input and technical expertise, ensures that Virginia's codes remain both effective and practical in their application.

We particularly appreciate the Board's continued engagement with local officials, industry professionals, and community stakeholders throughout this process. This collaborative effort strengthens the final code provisions and promotes consistency in enforcement across jurisdictions, ultimately benefiting citizens, businesses, and code officials alike.

As the built environment continues to evolve in response to emerging technologies, innovative construction methods, and increasing environmental challenges, your leadership is critical in striking the appropriate balance between safety, affordability, and innovation. Your work not only protects lives and property but also supports economic development and long-term community resilience across the Commonwealth.

VBCOA fully supports all consensus proposals as presented, as well as most non-consensus proposals. We respectfully request the Board's careful consideration of proposals B105.2.1-24 and REC-R402.1.2-24 as you finalize your decisions as VBCOA is in full support of both.

Thank you for your dedication, professionalism, and continued service to the Commonwealth of Virginia.

Respectfully,

Jason Laws, President
Virginia Building & Code Officials Association

REC-R402.1.2-24 – Staff Summary

Proponent: DeAnthony Pierce, City of Roanoke, representing Virginia Building & Code Officials Association .

Brief Description: Increases wall insulation requirements across all three Virginia Climate Zones from R-15 (or R-13+1c.i.) to R-20 (or R-13+5c.i. or R-15+4c.i.). Adjusts U-factors accordingly.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second Energy Sub-Workgroup meeting on September 29, 2025.

The proposal was also included on the agenda for the third Sub-workgroup meeting, November 14, 2025; however, the proponent informed the group that they are collaborating with stakeholders offline and would like to carry the proposal over to the General Stakeholder Workgroup meeting without additional discussion during this meeting.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members in attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

D.A. Pierce presented his proposal to increase prescriptive wall insulation values (while ceiling insulation would default to R-49 under the 2024 IECC unless separately amended).

Andrew C thanked **D.A. Pierce** and asked whether any ceiling-insulation change would require a separate proposal. **Pierce** confirmed that, absent an amendment, Virginia will automatically move to R-49 for ceilings.

Monica R voiced support.

Justin K described the measure as the sort of incremental improvement needed to phase out older weakening amendments.

Bill P and **Eric L** preferred full adoption of the 2024 IECC wall values statewide but accepted this as a partial step. **Bill P** suggested including a separate option for single-family detached dwellings; **Eric L** noted Virginia has missed two successive national upgrades and that more than 250,000 homes have been built with sub-par insulation since 2012.

Andrew G asked how the change would affect the Performance path baseline.

Florin Moldovan (DHCD staff) replied that it is premature to provide an answer given that there is still time in the process to submit code change proposals, and the Board will not take a position on any of the proposed changes and the existing amendments until later in the process.

D.A. Pierce clarified that builders must choose one of three compliance paths—Prescriptive, Total Building Performance (Performance), or ERI. His proposal alters only the Prescriptive path; ERI still references the 2006 baseline, and Total Building Performance references the current model code.

Bill P questioned whether the ERI and Performance paths indirectly reference the same insulation table; **Eric L** and **Dennis H** answered that ERI does not, but the Performance (Simulated Building Performance) path does, meaning a companion proposal might be needed.

Dennis H said VPMIA fully supports the proposal.

Chelsea H appreciated the effort and, while withholding a formal position, reiterated her organization's desire for higher wall insulation overall.

Participants agreed to continue offline discussions, with **Bill P** *requesting resolution by October 3rd.*

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Justin Koscher, Polyisocyanurate Insulation Manufacturer's Association (PIMA); Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and VBCOA PMG Code Committee; Jason Vandever, North American Insulation Manufacturers Association (NAIMA); Eric Lacey, Responsible Energy Codes Alliance (RECA); Corian Carney, York County and Independent Alliance of the Electrical Industry (IAEI) - Virginia Chapter; Sydney Roberts, Southeast Energy Efficiency Alliance (SEEA).

Opposition: William "Rick" Hinson, American Council of Engineering Companies (ACEC); Mark Graver, City of Waynesboro and VBCOA Region III; Andrew Clark, Home Builders Association of Virginia (HBAV).

Discussion:

D.A. Pierce provided an overview of the proposal.

Jeff Brown (DHCD staff) announced that there was a floor modification to this proposal, which was shared on the screen.

a. **Justin K** spoke in support of the floor modification and raised the concern that the existing requirement for R-13+1 does not provide enough exterior continuous insulation to avoid condensation issues in a wall cavity. Related to the cost of construction, he noted that using continuous insulation offers builders the opportunity to optimize their design, whether it be using continuous insulation that can also function as the air and water barrier, using

that continuous insulation to offset the need for wood sheathing, or employing other wall bracing techniques. He acknowledged that the proposal would increase the cost of construction but offered that there are ways to address the increase. He further noted that, from a consumer standpoint, the proposal is cost effective for Virginia climate zones.

b. **Eric L** commented that the current wall insulation requirements have been in place since the 2012 code cycle. Single family home permits in Virginia since the 2012 code cycle are around a quarter million. Meaning that many homes have been built to a standard that is well behind the model codes and will cost more to heat and cool. Wall insulation is also unlikely to be upgraded at any point during home's useful life.
c. **Rick H** responded that this increases costs and that nobody has died due to homes having less stringent insulation requirements than the current model codes.
d. **Mark G** added that this would have a huge impact on the cost of a home because it would force builders to use 2x6 construction.
e. **D.A Pierce**, speaking for himself, acknowledges that the proposal would increase the cost of construction, but the cost of energy would decrease over the life of the house.

DHCD Staff Notes:

- This proposal was originally included on the agenda for the second General Stakeholder Workgroup (GSW) meeting. The proponent requested that it be carried over to the third GSW meeting to allow for additional collaboration with interested stakeholders.
- This proposal conflicts with proposals REC-R402.1.2(2)-24, REC-R402.1.2(4)-24, and EC-1301-24, all of which delete the Virginia amendment to the wall insulation requirement and revert to the 2024 IECC requirements.

REC-R402.4.1.2(1)-24

VCC: 1301.1.1.1

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2021 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the *International Energy Conservation Code* (IECC). (Portions of code section not shown remain unchanged.) The following changes shall be made to the IECC :

19. ~~Change Section R402.4.1.2 of the IECC to read:~~

    R402.4.1.2 Testing. ~~The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be conducted by a Virginia licensed general contractor, a Virginia licensed HVAC contractor, a Virginia licensed home inspector, a Virginia *registered design professional*, a certified BPI Envelope Professional, a certified HERS rater, or a certified duct and envelope tightness rater. The party conducting the test shall have been trained on the equipment used to perform the test. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.~~

    Note: ~~Should additional sealing be required as a result of the test, consideration may be given to the issuance of a temporary certificate of occupancy in accordance with Section 116.1.1 .~~

    ~~**During testing:**~~

    1. ~~Exterior windows and doors and fireplace and stove doors shall be closed, but not sealed beyond the intended weatherstripping or other infiltration control measures.~~
    2. ~~Dampers, including exhaust, intake, makeup air, backdraft and flue dampers, shall be closed, but not sealed beyond intended infiltration control measures.~~
    3. ~~Interior doors, if installed at the time of the test, shall be open.~~
    4. ~~Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.~~
    5. ~~Heating and cooling systems, if installed at the time of the test, shall be turned off.~~
    6. ~~Supply and return registers, if installed at the time of the test, shall be fully open.~~

20. ~~Change Section R402.4.1.3 of the IECC to read:~~

    R402.4.1.3 Leakage rate. ~~When complying with Section R401.2.1 , the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 3 through 5, when tested in accordance with Section R402.4.1.2 .~~

Reason Statement: The purpose of this proposal is to bring Virginia's standards for air leakage rates into compliance with the 2024 IECC.

Virginia needs to adopt the IECC's 3.0 ACH (or 3 ACH50) air leakage standard, which has been in the national code since the 2012 IECC update. There is no valid reason for Virginia to continue a prescriptive air leakage standard that dates back to 2009.

The 2024 IECC is the fifth consecutive IECC to set the prescriptive standard for Virginia's climate zones at a maximum of 3.0 ACH. The IECC would not have repeatedly prescribed a 3.0 ACH maximum if actual experience had demonstrated that

compliance was either impractical or raised costs or burdens that outweighed the benefits. The IECC has had four cycles, since 2012, to raise the ACH from 3.0 to 5.0, but it has not done so.

Tightening building air sealing to 3.0 ACH is important to residents—both owners and tenants--, since it would help them save money, and experience greater comfort and a healthier home for decades after the dwelling is built. Virginia's 5.0 ACH standard allows 67% more air changes per hour than the IECC's 3.0 ACH standard.

Tightening prescriptive construction standards to 3.0 ACH will help to

(a) reduce occupancy costs, including for heating and conditioning of air in the dwelling,
(b) reduce exposure to mold that can build up in walls,
(c) increase residents' comfort,
(d) increase physical and economic resiliency to power outages, climate change and rising energy prices,
(e) reduce gaps for pests to enter the dwelling,
(f) reduce pressure on utilities to raise rates in order to build and operate more energy delivery capabilities, and
(g) reduce the air pollution that drives climate impacts and other harms to Virginia's health, property and economy.

It is noteworthy that, while the 2024 IECC retains the 3.0 ACH prescriptive standard, It also **offers builders some flexibility to trade efficiency measures, including to allow up to 4.0 ACH of air leakage, when implementing Simulated Building Performance and ERI implementation methods. However, the 2024 IECC's addition of trading flexibility is premised on full adoption of the IECC's prescriptive baseline code, including 3.0 ACH.**

Legal Standards. Remaining at 5.0 ACH level would leave Virginia's building code out of compliance with statutory standards. **Sections 36-99A and 36-99B of the Virginia Code make clear that building codes are required to "protect the health, safety and welfare of the residents of the Commonwealth" and that adjustments to reduce construction costs must nevertheless be "consistent with recognized standards of health, safety, energy efficiency and water efficiency."** **H2227**, which was enacted in 2021, calls for adoption of energy efficiency standards that are **"at least as stringent" as the latest IECC considering factors such as consumer costs "over time" and air pollution.** VIRGINIA ACTS OF ASSEMBLY – 2021 SPECIAL SESSION I, CHAPTER 425, Section 1 (referred to herein as "H2227"). Thus, like energy costs over time, pollution is a named factor to be considered in connection with building code efficiency standards.

Broad Consensus. There is a broad consensus among recognized standards that tighter sealing of walls protects the health, safety and welfare of residents, and some recognized programs have stricter standards, which is part of why the IECC has incorporated the 3.0 ACH prescriptive standard in five consecutive IECC cycles from 2012-2024.

In its commentary on its 2024 ACH levels for new residential construction, the ICC explains the importance of its air leakage standards: "**Insulation alone is not enough to moderate indoor temperatures. Sealing the building envelope is critical to good thermal performance of the building.** Insulation is important because it traps pockets of air creating stagnant air resistant to temperature change, but the air barrier is needed to stop the movement of air from scrubbing away those pockets of air. **Regardless of the compliance option chosen in Section R401.2, air leakage limits apply, and all air leakage requirements of this section must be met**." Citing EPA, the IECC commentary states that air leakage "can account for 25 to 40 percent of the energy used for heating and cooling in a typical residence." (ICC, 2024 IECC Code and Commentary.)

In EnergyStar: A complete Thermal Enclosure System (2017), EPA advised: "The energy savings from comprehensive air sealing can quickly add up when you consider all the places hot or cool air can enter or escape from your home. Having a well-sealed home also means better air quality because dirt, pollen, pests, and moisture can't get in as easily. In addition, good sealing practices help protect your home against mold and moisture damage that can be caused by condensation."

Even the NAHB has advised builders of the importance of air sealing and strategies to go below 3.0 ACH. See NAHB, et al., "TechNote – Building Tightness Code Compliance & Air Sealing Overview", which (a) states "Air leakage in a building should be minimized;" (b) identifies benefits to residents including ""Heating & cooling energy savings; Reduced potential for moisture movement through the building thermal enclosure; Improved insulation effectiveness and reduced risk of ice dams; Reduced peak heating and cooling loads resulting in smaller HVAC equipment; Improved comfort (reduces drafts and noise); Improved indoor air quality (limits contaminants from garages, crawl spaces, attics, and adjacent units)" and (c) suggests a possible construction strategy with a goal of 2.5 ACH – stricter than the IECC.

The feasibility of meeting a 3.0 ACH standard is underscored by the IECC's repeated adoption of 3.0 ACH for Virginia's climate zones; by its adoption of a 2.5 ACH standard for Climate Zones north of Virginia's; by use of 3.0 in the EnergyStar program; by

DOE's use of tighter standards in its net-zero ready program (2.5 ACH for CZ3-4 and 2.0 for CZ 5); and by the PassiveHouse standard of 0.6 ACH for its program.[1]

Cost and energy savings. Beginning with its review of the 2012 IECC, in which the 3.0 ACH standard was first adopted, the U.S. Department of Energy and the Pacific Northwest National Laboratories (collectively DOE) has found that residents would save money from full implementation of each IECC update from 2012-2024 even after considering incremental purchase and mortgage costs. Focusing on the three most significant IECC updates containing the 3.0 ACH standard, DOE found that, over 30 years, lifecycle savings (i.e., net of additional purchase and mortgage costs): **full implementation of the 2012 IECC** (which introduced the 3.0 ACH requirement for Virginia's climate zone) would have saved average Virginia residents **$5,836**; **full implementation of the 2021 IECC** would have save Virginia residents **$8,376**; and full implementation of the 2024 IECC would save Virginia residents of Virginia's Climate Zone 4 **$3,790 and Zones 2 and 5 an average of $2,502 compared to 2021 IECC**. Savings would have been achieved year in and year out, with rapid payback and lasting for decades. [2]

Collectively, Virginians would save billions of dollars in energy costs from full implementation of the IECC, greatly benefiting residents and Virginia's economy. In its July 2021 report on "Cost-Effectiveness of the 2021 IECC for Residential Buildings in Virginia" (PNNL-31627), PNNL found that aggregate energy cost savings for Virginia residents from adopting the full 2021 IECC would be $7,192,000 in the first year and $2,487,000,000 over 30 years. Virginia would achieve substantial pollution reductions and add jobs.

Pollution Reductions. DOE has also repeatedly found that full compliance with the IECC's updates will reduce energy use and air pollution, including greenhouse gas pollution, which is critical to Virginians' future. Energy use in buildings is one of the largest drivers of CO2 emissions in Virginia. By cutting energy usage, **full implementation of the IECC's efficiency standards without weakening amendments would reduce air pollution, including greenhouse gas pollution that is driving climate change**. DOE found that full implementation of the 2024 IECC alone would reduce carbon emissions by 6.5% compared to the 2021 IECC, and the 2021 IECC would reduce carbon emissions by 8.7% compared to the prior IECC. (Full implementation of just the 2021 IECC "**will reduce statewide CO2 emissions over 30 years by 28,420,000 metric tons,** equivalent to the annual CO2 emissions of 6,181,000 cars on the road (1 MMT CO2 = 217,480 cars driven/year).") Applying the social cost of carbon to the CO2 reductions recognizes huge economic savings from to Virginia and the U.S. [3]

The accumulation of more efficient buildings over years will have significant impacts on reducing future climate and other pollution. Conversely, allowing less efficient new building to be constructed under weaker building code standards will have the opposite effect: driving up pollution and climate driven harms to all Virginians.

Climate change is already harming Virginia, and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO2 and methane). Growing climate dangers include harms to communities, infrastructure, people, property and the economy from rising seas, worsening storms and more severe rainfall events. Growing dangers also include rising atmospheric and water temperatures that threaten worsening heat-related illnesses, limits on economic activity, agriculture, fisheries, and our natural heritage. The likelihood of mitigating and recovering from those harms declines the longer we delay maximizing energy efficiency and minimizing GHG pollution.

--[1] See IECC; https://basc.pnnl.gov/information/infiltration-meets-ach50-requirements ; http://passivehousebuildings.com/books/phc-2019/five-principles-of-passive-house-design-and-construction/ .

--[2] The U.S. Department of Energy found that full compliance with the 2012 IECC would save money and benefit residents compared to earlier standards. DOE/PNNL, National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf DOE found that the 2024 and 2021 IECC updates would reduce energy use and save money over the life of the dwelling, even after considering mortgage costs. U.S. Department of Energy, **Energy Savings Analysis: 2024 IECC for Residential Buildings** (Dec. 2024); DOE/PNNL, **Cost-Effectiveness of the 2021 IECC for Residential Buildings in Virginia** (July 2021), https://www.energycodes.gov/national-and-state-analysis. Following promulgation of the 2012 IECC, DOE found that the 2012 IECC changes improved efficiency and were cost effective for occupants because they saved money year after year for decades, more than recouping the cost of construction. DOE/PNNL, **National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC**, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf See also https://www.energycodes.gov/determinations

--[3] PNNL, Impacts of Model Building Energy Codes (Nov. 2023) (estimating climate and health benefits in excess of $40,000,000,000 2010-2040 from residential energy building codes). See Notes [1][2] and PNNL report cited above.

Cost Impact: The code change proposal will increase the cost

Bringing Virginia in line with the IECC's 3.0 ACH air leakage standards may modestly increase the cost of construction, but those costs will be outweighed by reduced occupancy costs and improved health, comfort and resiliency for residents. The excess of benefits over

costs is why the IECC has required 3.0 ACH for Virginia's Climate Zones for 5 consecutive updates: 2012-2024. (See Reason Statement, above.)

The costs of additional caulking, weather-stripping, gaskets, taping and other sealing measures are very limited, since workers will be on site, and the quantity of additional material is small. Planning, care and attention by builders during the framing, insulating and sealing processes is mainly what is needed to achieve the 3.0 ACH standard.

According to GreenBuildingAdvisor, "Once builders get their crews trained, 3 ACH50 should cost them the same as 5 or 7 ACH50." https://www.greenbuildingadvisor.com/article/how-much-air-leakage-in-your-home-is-too-much

Having had more than a decade to train their crews to seal gaps and to meet blower door tests, Virginia builders should be fully capable of meeting the 3.0 ACH prescriptive standard. In addition to the time since the IECC's 2012 adoption of 3.0 ACH, Virginia builders will have a year from the effective date of Virginia's 2024 update to adjust their construction practices to meet the long-recognized model standard.

Under the 2024 IECC, cost impacts can also mitigated by the 2024 IECC's permitting builders to go to 4.0 ACH with trading options for Simulated Performance and ERI compliance paths. However, that flexibility was premised upon full implementation of the IECC's prescriptive standards.

Achieving 3.0 ACH or better during initial construction is critical. Leaving buyers to retrofit after a house has been purchased would be very expensive since it would require the owner to reopen, close and refinish walls, replace windows and doors, etc. In addition to energy cost saving, comfort and health benefits from achieving 3.0 ACH, minimizing the need for future retrofits and repairs should be recognized as a cost benefit to residents.

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How Much Air Leakage in Your Home Is Too Much?

Whatever your air tightness goal, ACH50 isn't the best unit to measure it



By Allison A. Bailes III, PhD | April 10, 2012

Whether you want to build a new home or fix an old one, the way to ensure that you get the best performance is to do the building envelope right. That means installing the right amount of insulation and installing it well, and it means having an air barrier with minimal leakage. But how do you know when you've done enough air sealing? How tight is tight enough?

I get asked this question every once in a while, and I love to talk about the measures for air leakage anyway, so let's dive in. First, of course, you have to be able to measure how much air leakage the house has. That's what a blower door is for.

About air leakage units

First, you have to choose how you want to specify the air leakage. The most common unit used by blower door operators is ACH50, which stands for Air Changes per Hour at 50 Pascals. I prefer cfm50 per square foot of building envelope, or better, cfm50 per hundred square feet of building envelope (sfbe). (One cfm50 is a cubic foot per minute with a pressure difference of 50 Pascals between inside and outside.)

RELATED ARTICLES

Blower Door Basics

The two reasons for that choice are that (i) air leakage happens at the surface, not in the volume, and (ii) it's the best

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unit, in my opinion, to express what a Blower Door is really good at — measuring the amount of air moving across the building envelope at elevated pressure.

Please don't talk to me about ACHnat ('Natural' Air Changes per Hour). I loathe that measure! If you're using a blower door, you can't measure it; the only ones who can are researchers using tracer gas analysis.

Now we're ready to discuss the actual question: How much air leakage should you aim for? OK, we're not really there yet. I lied. First, we have to know about your house. Are you building new or fixing an existing home? If the latter, what's your budget and how complex is the building envelope?

New homes

Let's start with the easier one: new construction. The first rule here is that a house can never be too tight. The Passive House program takes houses about as far as you can go with air tightness, and their threshold is 0.6 ACH50. I tested a net-zero house a couple of weeks ago that had less than 200 cfm50 of air leakage, or about 0.5 ACH50. That's really tight!

A target that's more achievable for anyone — and which the 2012 International Energy Conservation Code (IECC) will require for most climate zones (CZ 3 and higher) — is 3 ACH50. That's also the level that Joe Lstiburek identified as a good target in his great article on blower door testing new homes, *Just Right and Airtight*.

That number — **3 ACH50** — translates to about 0.25 cfm50 per square foot of envelope, or 25 cfm50 per hundred square feet of envelope. Since roofers have already abbreviated 100 square feet as 1 square, I like the latter form the best. It gets it into a whole number form and is easy to remember. Get your blower

door number down to **25 cfm50 per square** (or below), and you've got a tight house. The house I built ten years ago came in at 14 cfm50 per square (1.7 ACH50).

But wait. I can hear you wondering, "Is he saying that this one number, 25 cfm50 per square, is good for every climate zone?" My friend David Butler says that we should consider cost effectiveness and not just apply a "one-size-fits-all" threshold. "We should always ask ourselves which combination of efficiency measures will provide the lowest energy usage within a given budget," he wrote recently. "The cost-benefit of achieving 3.0 ACH50 would look very different in Buffalo than in Tucson, on multiple levels."

He does have a point, He went on to explain that "in hot climates, I'd rather fight to bring ducts inside (always challenge in non-basement homes) than to arbitrarily specify a 3-ACH50, especially in dry climates where latent loads are negligible."

Lstiburek, a Canadian who lives in New England, thinks the roughly equivalent 3 ACH50 is good because it's achievable, and it solves a lot of comfort and efficiency problems associated with air leakage. I understand David's point, but here in Georgia, home builders now have to pass a blower-door test and get their houses 7 ACH50 or below. What we're finding is that a significant number of builders are getting down to 3 ACH50 in their attempt to meet the code target. Once builders get their crews trained, 3 ACH50 should cost them about the same as 5 or 7 ACH50. Now, if we can just get them to change the target to 25 cfm50 per square!

Existing homes

This can of worms is really too big for the little article I'm writing here, but let me try to shed at least a little light on it. The amount of air sealing you're going to be able to do in an existing home is limited — unless your budget isn't. Generally, with a good attack on the holes, you can get about a **20% to 30% reduction** in your Blower Door number (whether you specify it in cfm50, ACH50, or cfm50/sfbe). Sometimes you can get much more when you add surface area or volume by moving the building envelope.

The first thing you want to know here, though, is: How leaky is your home to start with? If you're already at 25 cfm50 per square, it's going to be really hard to get a 20% reduction. If you're at 100 cfm50 per square, it should be a snap to reduce it to 75 cfm50 per square or even lower. The higher that starting number is, the more big holes you probably have in your building envelope.

If you're starting at 100 cfm50 per square, however, don't count on getting down to 25 cfm50 per square unless you're doing a deep-energy retrofit. Sometimes deep-energy retrofits are called deep pockets retrofits, for obvious reasons. They cost a fortune! Check out Martin Holladay's recent post called The High Cost of Deep Energy Retrofits here at GBA.

I've done a number of air-sealing jobs when I was in the contracting business, and the results varied. Sometimes it was a frustrating 5-10% reduction, and other times it was an easy 20%. The most reduction I ever achieved was about 40% in a house that started with about 120 cfm50 per square. We encapsulated the crawl space and did a lot of work on the kneewalls and can lights on the upper floor.

Summary

If you're looking to make your home tight and you really want some numbers to go after, here are my recommendations:

New Homes: 25 cfm50 per hundred square feet of building envelope (or 3 ACH50)

Existing Homes: Get a blower door test, and try to reduce the number by 20% or more.

Allison Bailes of Decatur, Georgia, is a RESNET-accredited energy consultant, trainer, and the author of the Energy Vanguard blog.

21 Comments

D **davidmeiland** | Apr 10, 2012 11:50pm | #1

Not a bad plan

but of course it calls for measuring completely enough to determine surface area. That can be a bit time consuming in houses with lots of cathedral ceilings or other detail. The Washington State Energy Code is using a formula based on square footage that roughly equates to 5ACH50 (houses with high ceilings are penalized by this approach), and I assume it's to avoid making testers measure surface area. It's quick to go through most houses and get square footage, and then get an average ceiling height so that you have approximate volume. In an average house I think that a number that's somewhat under 1CFM50 per square foot is pretty good.

E **ewoodhouse** | Apr 11, 2012 08:46pm | #2

Maybe I'm missing something...

but it seems like measuring based on surface area (or volume, for that matter) makes less sense than measuring based on living area. A building with a large surface-area to floor-area ratio is going to use more energy than one with a simpler shape and an equal cfm50 per square, won't it? I guess that's fine if what you're aiming to measure is quality of construction alone - but it seems like the design certainly has an impact.

D **davidmeiland** | Apr 11, 2012 11:42pm | #3

Depends what you're measuring

A test result based on surface area tends to measure construction quality, both that of the builder on site, and of the manufactured products like doors and windows, dampers, etc. A test based on square footage is a dumbed-down version of the same thing. A test based on volume is useful if you want to estimate air changes for determining ventilation requirements, or heat loss via air leakage.

 **albertrooks** | Apr 12, 2012 02:24am | #4

It's really not that hard to get well below 3ACH 50

And I mean for new construction. Retrofit is a "whole 'nother kettle of fish"

After countless (seriously) new construction passive house projects that we've helped with (in a small way). It can be done without question.

The first (of yours at less than 0.6ach) is the hardest.

The third (of yours at less than 0.6ach) passes by without notice or fanfare: It has become a matter of course.

To be fair, those projects go at it from a different design perspective: A really good lid, no can lights, Floor connected to wall, wall connected to lid: The unbroken line (air barrier wise). The term "obsessiveness" might come up in some circles, but it's really just a "goal" and good workmanship towards the goal.

If these excessive Passive House folks can do it, it can't be that tough. Often it's really not. It's in the design & planning stage that you can get rid of most of the big "holes" and "disconnections". After that, it's just seeking out and keeping the small "holes" filled and making sure that new holes aren't created down stream.

There are a lot of good materials available to accomplish this with: Foams, Tapes, Gaskets, Sheet Goods, Membranes, Sealants. They are all reasonable ways to accomplish the goal.

Beating 3 ACH 50 is about as easy as reaching it. If you really care to...



GBA Editor

Allison A. Bailes III, PhD | Apr 12, 2012 08:33am | #5

Response to David Mieland

Yes, calculating the surface area is difficult in more complex houses, but so is volume when you have insulated rooflines. If you're doing energy modeling on the home for a load calculation or HERS rating anyway, then you'll have all the info. For existing homes where you just want to get in and out as quickly as possible, ACH50 is adequate.

In your response to Eric, you wrote:

A test based on volume is useful if you want to estimate air changes for determining ventilation requirements...

See the article by Joe Lstiburek that I mentioned in the section on New Homes or my linked article on what a Blower Door is good at. The amount of air moving through the Blower Door at elevated pressure doesn't extrapolate very well to "natural" pressures, so a Blower Door doesn't help a whole lot with determining ventilation requirements, in my opinion.



GBA Editor

Allison A. Bailes III, PhD | Apr 12, 2012 08:41am | #6

Response to Eric Woodhouse

We're talking about air leakage here, not general energy usage, and a Blower Door is only good at telling us how much air leakage a house has. The reason for bringing the size of the house into it is so you can compare different sizes houses to each other and to a standard that's independent of size (*e.g.*, a code requirement for 3 ACH50). I'm not sure exactly what you mean about the design being important, but a Blower Door test is all about measuring the quality of construction in new homes.

Am I missing your point?



Allison A. Bailes III, PhD | Apr 12, 2012 08:49am | #7

GBA Editor

Response to albert rooks

I'm with you, Albert, but the only house I ever built was a custom home that took me two years. I hit 14 cfm50 per square (1.7 ACH50) without ever having seen a Blower Door test. I think any custom builder who takes the time to figure it out can easily do better than 3 ACH50. Joe Lstiburek, who's been doing this work for decades and has worked with production builders, makes a pretty convincing case that 3 ACH50 is a good target, however, and that's why I settled on that number.

---

michael anschel | Apr 12, 2012 09:24am | #8

Nice job

Nice job with this post. A good 101 for foks just getting their feet wet with the subject. It would be great if the folks at BPI and ResNet would heed your advice and make the switch over to CFM per SF. (I get the idea behind the 'square' but I'm not sure if representing the home in numbers like 23.578 is really valuable. Anyone not involved with roofing or carpet is much more comfortable with SF.)

HOWEVER, I think that what is missing in this whole discussion is a conversation about where that leaking takes place. A buiding forensics expert (the work that provides Joe with enough dough for that Porche) will quickly find the point where air is leaking into the enclosure and causing damage. Without being specific about location we need to be cautious about making blanket statements about the acceptable volume of air that passes through the enclosure (not connected to mechanical or intentional passive components)

One additional point to consider. The push for air tightness in the South creates a building environment that demands the use of AC. Promoting a policy that relies entirely on mechanical delivery of conditioned air in lieu of smart building architecture that can effectively keep a home in the hotest of climates comfortable seems slightly irresponsible.

I think the incesent desire to oversimplify a structure and set of systems for the border line literate trades needs to stop. Keep it complicated and variable.

Rock on-
M



Allison A. Bailes III, PhD | Apr 12, 2012 09:44am | #9

GBA Editor

Response to Michael Anschel

Good points, Michael! Yes, the location of leakage is critical, and a wall between the house and an attached garage, for example, needs to be as tight as a vacuum chamber. But Blower Door operators are measuring the leakage from the whole house. That tool can't separate out the various components.

Regarding the South, I'd say you're ascribing the demand for air conditioning to the wrong cause. People here want AC in leaky houses, too, and comfort is the driver, not how tight the house is. I do agree that we should build houses so they can be comfortable without AC, but that's a design issue, getting windows in place for cross ventilation and ceiling fans and porches.

It'd be great if every budget included enough money so we **could** engineer houses the way we do commercial buildings and cars and computers. Then we'd have to "keep it complicated and variable."

---

michael anschel | Apr 12, 2012 09:56am | #10

Keeping it Complex

I think at GBA you should take up that challenge to go beyond simple measurements. You are in a great position (and have enough brain power) to take up the challenge. (You also have enough perspective, I think, to understand and explain the nuanced complexities involved)

I hear what you are saying about the leaky v non leaky home demand for AC. My point was that point to to 3 ACH as the metric we are not doing the home design justice, and that when we are discussing appropriate levels of tightness there is an argument to be made for spending $$ on smart design in lieu of mechnical systems. (the $12-15K spent on mechanicals will more than cover the design and modeling fees for smart ventilation and cooling systems)

Funny that we will pay hundreds of thousands of dollars for a poorly engineered product, but will spend hours pouring over the details of a $800 computer or $30K car. Sad sad sad.



Allison A. Bailes III, PhD | Apr 12, 2012 10:04am | #11

GBA Editor

Nuanced complexities - Yes!

You're right, Michael. (Wow, did I just say that?) I'll take up this challenge and see if maybe we can get the subject of air leakage in homes up to where it needs to be. And yes, it is sad, sad, sad about misplaced priorities. Since we do design (both architecture & HVAC), we deal with this issue all the time. Some people do really get it, but they're in the minority.

ewoodhouse | Apr 12, 2012 02:08pm | #12

Response to Allison A. Bailes III, PhD

We may be missing each other's point, Allison. Part of the issue, I guess, is what you call "size" when you're comparing one house to another. If I have a 2,000 s.f. house with 9' ceilings, and another house of identical design but with 15' ceilings, the latter house will obviously have far more surface area, and more volume. But the two houses will appear equally tight when looking at ACH or cfm per square... and to my way of thinking, the 9' ceiling house is the "tighter" of the two.



Allison A. Bailes III, PhD | Apr 12, 2012 03:40pm | #13

GBA Editor

Yes, size matters.

Eric, I think I see what you're getting at now, and it's basically the difference between absolute and normalized leakage. Yes, in the example you gave, the house with 9' ceilings will have less absolute leakage (cfm50) if they have equal normalized leakages (cfm50/sf).

Energy codes and green building programs, though, specify normalized leakage to take the size of the house out of the equation (though LEED for Homes and now ENERGY STAR Version 3 add it back in somewhere else). If they specified absolute leakage thresholds, say 1000 cfm50 (to make up a number), builders of larger houses would have to do much more air-sealing to hit the target, and the small homes might not have to do much at all.

So, yes, size matters.

user-1005777 | Apr 12, 2012 04:13pm | #14

Did we do the right things?

We have a mini home just over 1000 square feet. We had a blower door test done in November of 2007. It showed 6.9 ACH50. We have taken all the trim off the inside of the house and foamed or caulked every joint in the structure that we can get to and even sealed light fixtures. The blower door test done this last December showed 3.1 ACH50. Should we have attacked the envelope from the outside? That probably would have been much more difficult, and costly. Does it matter?

Wouldn't the energy auditor have to know the volume of the house to figure the ACH figure?



Allison A. Bailes III, PhD | Apr 13, 2012 08:33am | #15

GBA Editor

Response to Roger Williams

If you cut the infiltration rate by more than half on an existing home, I'd say that you did the right things. That kind of reduction isn't easy for existing homes. And getting down to 3.1 ACH50 is also good, so be happy with where you're at.

Yes, the volume figures into the ACH50 result. It's the cfm50 (the amount of air flowing through the Blower Door fan while the house is depressurized to 50 Pa) times 60 (to convert minutes to hours) and then divided by the volume (to convert cubic feet to air changes).

D

davidmeiland | Apr 13, 2012 11:34am | #16

Agreed

On an existing home, you do what you can. It would be more effective to remove all your siding and trim and seal leaks at the sheathing, but in most cases you aren't going to do that. I agree with Allison that getting to 3ACH50 with interior retrofit measures is quite an accomplishment. I assume you had some very large holes that you were able to seal.

HhsHwZFSCs | May 02, 2012 06:39pm | #17

1984 Blower Door Test results

I have about 3100 sq feet and completed my first blower door test. The result was 3300CFM50 or 8 ACH50 so I was told by the vendor. This test was completed in 2011. I have sealed all the kneewalls and floor baseboard areas. Also sealed the attic, Garage, resided two outside walls and resheathed. In 2012 the test result was 2864cfm50 (estimated number) This equates to 6.8 ACH50 I thought the numbers would be lower than these. Any other areas to focus to lower this number. I have addressed the fireplace with rigid foam and sealed all the sill plate areas in the basement. Any thoughts would be greatly appreciated.

USEuG9CHFL | May 02, 2012 07:55pm | #18

nobody mentioned this

One of the most important things you can use a blower door for is "zonals". Using the manometer, you can isolate rooms, light fixtures, the wall between the garage and the living space, the attic(the most important). I work on older homes and making sure the attic is as unattached to the home as possible is our main goal. Older homes usually don't have enough insulation in the attic or venting. This tends to keep the attic warm enough to inhibit mold growth. Throw down insulation without air sealing enough and during the Fall

or Spring when you have some humidity in the air compared to the dead of Winter and now those air leaks are producing mold. This winter was the worst here in PA because it never got cold enough out to really dry out the attics. I have to throw this out there because a little bit of knowledge can get you in a lot of trouble.
Anyway the manometer will tell you how connected the attic is to the house and you shouldn't be done airsealing until that manometer reads the attic at +49 to +50pascals with relation to the house.

D

heidner | May 02, 2012 08:04pm | #19

RE:1984 Blower Door Test results.
GBA has a number of articles and blog postings on how to find and go after the air leaks. If you are having a blower test done, make sure you have a thermograph imaging done while the testing is ongoing... and have some smoke pens handy. You should be able to find large leaks quickly.

You didn't mention if you have recessed lights. If so, you may wish to consider alternative lights and/or verify the recessed cans can be sealed up. (NOT ALL recessed lights are certified for insulation and air sealing)!!

Check behind sinks, toilets, dishwashers, and appliances. Sometimes there are gaping holes where the plumbing enters the wall.

Look for leaks in sofits, between floor wire/pipe chases, etc. If you have forced air -- is the ducting outside of the heated space and is it leaking?

If you are doing this your self and trying to tighten the house -- I would consider buying a simple dwyer 460 air meter, some used furnace blowers and build a crude blowr assembly to depressurize the house while you use a smoke pen. Then when you've found and sealed more leaks -- have it retested by a certified blower/energy audit professional.

D

user-648002 | Aug 09, 2012 05:40pm | #20

Skin Calculations
We have always looked at skin tightness this way. The size of the hole per 100 sqft of wall = leakage ratio or LR. We would get results down in the 2" per 100 sqft of wall or an LR of 2. I think this is the best way to talk about how tight your building is.

---

user-1135248 | Sep 27, 2012 09:17am | #21

alphabet soup

[Is it better to follow up on an older thread, or start a new Q&A for this? Let's try this first...]

Before my retrofit I did a quick-n-dirty volume and surface area calculation on my relatively simple Cape, and have just redone it a bit more accurately. I'm now reading up on blower-door testing because I expect that eventually the place will get one, and the confusion over which numbers are which, better, meaningful, BS, etc is *profoundly* irritating. Anybody who comes along talking about CFM leakage per square foot of *living area* needs to be shown the door and by that I mean as a prompt exit assisted by my foot, not the door to mount the blower frame in ... then you've got the problem of Equivalent Leakage Area over the entire envelope vs. MLR which only considers above-grade envelope surface, and for the latter I probably want to add in the below-grade area of my basement bulkhead door to make things more realistically accurate.

By breaking the house into sections -- attic, living floors, basement -- I know all my volumes and areas, and derived an easy reference point that 1 ACH for the whole enclosed space, just shy of 15,000 cubic feet, would be 248 CFM. That's regardless of pressure, of course, and that volume includes interior walls, closets, the volume of the remaining part of the chimney inside, etc. But what is the "geek with the blower door" going to say about what any CFM reading actually means in terms of CFM/sf? How many "square feet" should be considered, and where are they located?? How does anyone know how much "living" I'd do in my unfinished basement before deciding whether to include that in any such figures?

And then in a heavily-insulated house one has to consider where the measurements were taken -- inside or out? I started with my interior dimensions because that's effectively the volume where air will be changed, measuring heights floor-surface to floor-surface to include all of those thicknesses. But if I did the same measurement outside now, with the exterior bulked up 5 or 6 inches more with polyiso and furring and siding, everything would be different.

So really, "CFM50/sf" has to be *thoroughly* qualified and explained in any test results if it's going to mean jack. And it likely won't account for *where* leakage sites actually exist, i.e. would they contribute to stack effect more or less. At least "ACH50" makes more sense because it keeps everything in terms of volume, as long as you know how that volume was determined.

The poor sod who eventually shows up here to test the place is probably going to get a real earful about this, as he's given an envelope with *no* penetrations to test. I mean, why should I leave my HRV vents open if we're testing the *envelope*?? I know how many CFM that is already.

_H*

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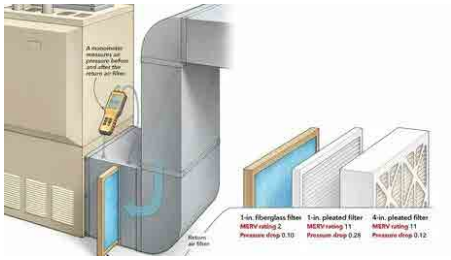
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Infiltration meets ACH50 requirements

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DOE Zero Energy Ready Home (Revision 07) (https://basc.pnnl.gov/library/doe-challenge-home-national-program-requirements)

Exhibit 2 DOE Zero Energy Ready Home Target Home.
The U.S. Department of Energy's Zero Energy Ready Home program allows builders to choose a prescriptive or performance path. The DOE Zero Energy Ready Home prescriptive path requires builders to meet or exceed the minimum HVAC efficiencies listed in Exhibit 2 of the National Program Requirements (Rev 07), as shown below. The DOE Zero Energy Ready Home performance path allows builders to select a custom combination of measures for each home that is equivalent in performance to the minimum HERS index of a modeled target home that meets the requirements of Exhibit 2 as well as the mandatory requirements of Zero Energy Ready Home Exhibit 1.

Exhibit 2, Insulation and Infiltration) Whole house leakage must be tested and meet the following infiltration limits:

- Zones 1-2: ≤ 3 ACH50;
- Zones 3-4: ≤ 2.5 ACH50;
- Zones 5-7: ≤ 2 ACH50;
- Zone 8: ≤ 1.5 ACH50;
- Attached dwellings: ≤ 3 ACH50.

Footnote 23) Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.

How to Determine Infiltration

Building envelope leakage should be determined by an approved verifier using a testing protocol approved by the Residential Energy Services Network (RESNET). Whole-house air leakage testing is conducted with a blower door test.

Climate zones are based on the Climate Zone Map, which can be found in the 2015 International Energy Conservation Code (2015 IECC Figure R301.1):

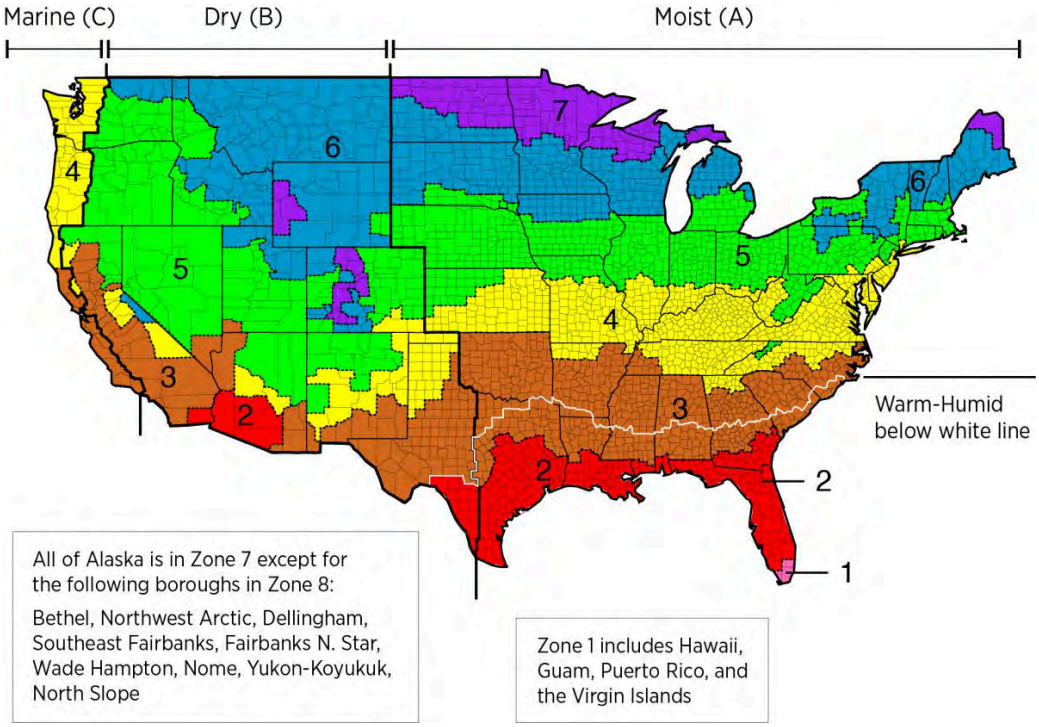


Figure 1. *IECC climate zone map.*

More Info

References and Resources*

DOE Zero Energy Ready Home National Program Requirements (https://www.energy.gov/eere/buildings/doe-zero-energy-ready-home-zerh-program-requirements)

Author(s): *U.S. Department of Energy*
Organization(s): *DOE*
Publication Date: *December, 2022*

Website listing implementation timelines and links to various versions of the DOE Zero Energy Ready Home national program requirements.

**For non-dated media, such as websites, the date listed is the date accessed.*

Last Updated: 2019-07-29

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Model Energy Code Determinations

DOE is required by the Energy Conservation and Production Act (ECPA), as amended, to review published editions of the national model energy codes—ANSI/ASHRAE/IES Standard 90.1 and the International Energy Conservation Code (IECC)—and issue a *determination* as to whether the updated edition will improve energy efficiency in commercial and residential buildings, respectively. DOE is provided 12 months to conduct its review and publish its determination in the Federal Register after the updated model code is published. ECPA also requires States to review and/or update their energy codes following the publication of an affirmative DOE determination.

Latest Versions

COMMERCIAL: ANSI/ASHRAE/IES STANDARD 90.1-2022

DOE issued a determination (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001) that Standard 90.1-2022 will achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in commercial buildings of approximately:

- 9.8 percent *site* energy
- 9.4 percent *source* energy

- 8.9 percent *energy cost*

Additional information related to this action, including the official *Federal Register* publication, is available at Regulations.gov (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001).

State Certification

Upon publication of an affirmative determination, ECPA requires States to certify that they have reviewed the provisions of their commercial building code regarding energy efficiency, and, as necessary, updated their codes to meet or exceed the updated edition of Standard 90.1. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. The **State Certification** (/state-status/state-certifications) **deadline for Standard 90.1-2022 is March 06, 2026.**

Supporting Analysis

DOE conducted a technical analysis in support of its determination. This analysis assesses Standard 90.1 compared to the previous edition and estimates the associated savings impacts.

Federal Statute for Commercial Buildings

With each new edition of ANSI/ASHRAE/IES Standard 90.1, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in commercial buildings (42 U.S.C. 6833):

> *(2)(A) Whenever the provisions of ASHRAE Standard 90.1-1989 (or any successor standard) regarding energy efficiency in commercial buildings are revised, the [DOE] Secretary shall, not later than 12 months after the date of such revision, determine whether such revision will improve energy efficiency in commercial buildings. The [DOE] Secretary shall publish a notice of such determination in the Federal Register.*
>
> *(B)(i) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed and updated the provisions of its commercial building code regarding energy efficiency in accordance with the revised standard for which such determination was made. Such certification shall include a demonstration that the provisions of such State's commercial building code regarding energy efficiency meet or exceed such revised standard.*
>
> *(ii) If the [DOE] Secretary makes a determination under subparagraph (A) that such revised standard will not improve energy efficiency in commercial buildings, State commercial building code provisions regarding energy efficiency shall meet or exceed ASHRAE Standard 90.1-1989, or if such standard has been revised, the last revised standard for which the [DOE] Secretary has made an affirmative determination under subparagraph (A).*

RESIDENTIAL: 2024 INTERNATIONAL ENERGY CONSERVATION CODE

On December 20, 2024, DOE issued a determination (https://www.regulations.gov/document/EERE-2024-BT-DET-0007-0001) that the 2024 International Energy Conservation

Code (IECC) will improve energy efficiency in residential buildings. In support of this determination, DOE conducted a technical analysis evaluating the impacts of the updated code (relative to the previous 2021 IECC edition). DOE estimates national savings of approximately:

- 7.8 percent *site* energy savings
- 6.8 percent *source* energy savings
- 6.6 percent *energy cost* savings

Additional information related to this action, including the official Federal Register publication and docket containing public comments received, is available at Regulations.gov (https://www.regulations.gov/docket/EERE-2024-BT-DET-0007).

State Certification

Upon publication of an affirmative determination, States are required to certify that they have reviewed the provisions of their residential building code regarding energy efficiency, and made a determination as to whether it is appropriate for them to revise their code to meet or exceed the updated edition of the IECC. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. **State certifications** (/state-status/state-certifications) **for the 2024 IECC must be submitted by December 30, 2026.**

Supporting Analysis

DOE published a technical analysis in support of its determination. This analysis assesses the 2024 IECC compared to the previous edition and estimates the associated savings impact.

Federal Statute for Residential Buildings

With each new edition of the IECC, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in residential buildings. (42 U.S.C. 6833):

> *(5)(A) Whenever the CABO Model Energy Code*, 1992, (or any successor of such code) is revised, the [DOE] Secretary shall, not later than 12 months after such revision, determine whether such revision would improve energy efficiency in residential buildings. The [DOE] Secretary shall publish notice of such determination in the Federal Register.*
>
> *(B) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed the provisions of its residential building code regarding energy efficiency and made a determination as to whether it is appropriate for such State to revise such residential building code provisions to meet or exceed the revised code for which the [DOE] Secretary made such determination.*
>
> **As a predecessor to the ICC, the Council of American Building Officials (CABO) was responsible for development of the Model Energy Code (MEC). Contemporary energy codes are referred to and published as the International Energy Conservation Code (IECC)®.*

Previous Determinations

Previous DOE determinations (https://www.energycodes.gov/previous-determinations) surrounding building energy codes are available for reference by states and local governments, as well as other interested stakeholders.

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ASSESSING MODEL CODE IMPACTS (/IMPACT-ANALYSIS)

PREVIOUS DETERMINATIONS (/PREVIOUS-DETERMINATIONS)

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National and State Analysis

National Analysis

Pacific Northwest National Laboratory (PNNL) assesses recent editions of the model codes to quantify the associated energy & cost savings. This analysis confirms the cost-effectiveness of updated editions of the model codes across U.S. climate zones, providing critical information during state and local adoption processes. The following national analyses are currently available:

Commercial

- National Cost Effectiveness of Standard 90.1-2022
- National Cost Effectiveness of Standard 90.1-2022 Workbook
- National Cost Effectiveness of Standard 90.1-2019
- National Cost Effectiveness of Standard 90.1-2019 Workbook
- National Cost Effectiveness of Standard 90.1-2016
- National Cost Effectiveness of Standard 90.1-2016 Workbook
- Energy and Energy Cost Savings Analysis of the 2021 IECC for Commercial Buildings
- Energy and Energy Cost Savings Analysis of the 2018 IECC for Commercial Buildings

Residential

- National Cost Effectiveness of the 2024 IECC
- National Cost Effectiveness of the 2021 IECC
- National Cost Effectiveness of the 2018 IECC
- HERS Index Values Corresponding to the IECC

State Analysis

Pacific Northwest National Laboratory (PNNL) assesses recent editions of the model codes to quantify the associated energy & cost savings. These analyses take into account varying state-level conditions, such as incremental costs, utility rates, climatic conditions and construction trends. The residential analyses are customized based on current state energy codes. The following state analyses are currently available:

State Cost-effectiveness Analysis Reports

State	Commercial	Re
Alabama	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Alaska	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Arizona	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Arkansas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
California*		

State	Commercial	R
Colorado	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Connecticut	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Delaware	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
District of Columbia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Florida	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Georgia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Hawaii	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2
Idaho	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Illinois	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2

State	Commercial	R
Indiana	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Iowa	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Kansas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Kentucky	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Louisiana	ASHRAE 90.1-2019 ASHRAE 90.1-2013	2 2 2
Maine	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Maryland	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2
Massachusetts	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2

State	Commercial	R
Michigan	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	M 20 20 20
Minnesota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Mississippi	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Missouri	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Montana	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Nebraska	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Nevada	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20
New Hampshire	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20

State	Commercial	Re
New Jersey	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
New Mexico	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
New York	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
North Carolina	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
North Dakota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Ohio	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20
Oklahoma	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Oregon	ASHRAE 90.1-2019	20
Pennsylvania	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20

State	Commercial	R
Rhode Island	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
South Carolina	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
South Dakota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Tennessee	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Texas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Utah	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Vermont	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Virginia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Washington*		

State	Commercial	R
West Virginia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Wisconsin	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013*	2 2 2
Wyoming	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2

**Deviates from model codes*

State Fact Sheets

Adopting the 2021 IECC for residential buildings and ASHRAE Standard 90.1-2019 for commercial buildings will save energy and money. These state fact sheets provide an overview of the expected benefits to homeowners and building owners.

Alabama	Louisiana	Ohio
Alaska	Maine	Oklahoma
Arizona	Maryland	Oregon
Arkansas	Massachusetts	Pennsylvania
California*	Michigan	Rhode Island
Colorado	Minnesota	South Carolina
Connecticut	Mississippi	South Dakota
Delaware	Missouri	Tennessee

Florida	Montana	Texas
Georgia	Nebraska	Utah
Hawaii	Nevada	Vermont
Idaho	New Hampshire	Virginia
Illinois	New Jersey	Washington*
Indiana	New Mexico	Washington, DC
Iowa	New York	West Virginia
Kansas	North Carolina	Wisconsin
Kentucky	North Dakota	Wyoming

**Deviates from model codes*

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Adopting the 2021 IECC for residential buildings and ASHRAE Standard 90.1-2019 for commercial buildings will save energy and money. These local fact sheets provide an overview of the expected benefits to homeowners and building owners.

Atlanta	Des Moines	Miami
Baltimore	Grand Rapids	Minneapolis
Baton Rouge	Houston	Oklahoma City
Birmingham	Las Vegas	Pittsburgh
Boise	Lexington	Richmond
Columbia	Little Rock	Salt Lake City

Columbus	Madison	

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Passive House Design

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Passive house design is a construction concept that focuses on energy efficiency, comfort, and affordability. This method of building incorporates a holistic approach, emphasizing the importance of a comfortable and healthy living environment that consumes minimal energy. The passive house, or "*passivhaus*" in German, has become a strict global standard for sustainable architecture, gaining popularity among homeowners and builders alike.

One of the core aspects of passive house design is the integration of prefabricated components, which helps to streamline the construction process while maintaining a high level of quality control. Prefabricated elements contribute to the overall efficiency and performance of the building by ensuring airtight construction, continuous insulation, and optimized windows for maximum energy savings.

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Adhering to passive house principles ensures that buildings are designed in a way that maximizes their energy efficiency and minimizes their environmental impact. This approach not only offers long-term financial benefits for homeowners through lower energy bills, but also contributes to a greener and more sustainable future.

What Is Passive House?



Defining Passive House

Passive House, or Passivhaus, is a design and construction concept that aims to create highly energy-efficient, comfortable, and sustainable buildings. The passive house movement originated in Germany, when a German physicist developed the concept based on principles of passive solar design. Passive House design has now spread to North America and other parts of the world, gaining popularity among those who value energy efficiency and sustainable living.

The Passive House certification is a strict set of standards designed to ensure that buildings meet the requirements for energy efficiency, thermal comfort, and indoor air quality. Some key principles of this approach include super-insulated building envelopes, airtight construction, and optimized window orientation for solar gain. By implementing these design strategies, passive houses can significantly reduce their energy consumption, paving the way towards net zero energy buildings.

Passive House vs Traditional House

The primary difference between passive houses and traditional houses lies in their approach to energy management. While traditional homes typically depend on active heating and cooling systems to maintain comfortable interior environments, passive houses rely on a combination of passive design strategies and mechanical ventilation with heat recovery systems to both minimize energy use and ensure a consistent indoor temperature.

In a passive building, the focus lies on smart design and construction techniques to reduce the need for additional heating or cooling, ultimately leading to a lower overall energy demand. This results in reduced greenhouse gas emissions, lower energy bills, and a healthier living environment for occupants.

Additionally, passive houses tend to have a longer lifespan due to the high-quality, durable materials and construction methods used in their design. This contributes to the sustainability aspect of the passive house movement, as buildings designed to last longer can help reduce the overall environmental impact of construction.

In summary, passive house design is an innovative approach to creating sustainable, energy-efficient buildings that prioritize occupant comfort and environmental responsibility. By incorporating passive design principles, such as super-insulation, airtight construction, and solar optimization, passive

houses can offer significant advantages in terms of energy use, durability, and long-term cost savings.

Design Factors for Passive Houses

Orientation and Shading

In passive house design, proper **orientation** of the building is crucial for optimizing daylighting and controlling solar radiation. Windows should be strategically placed to maximize natural light and maintain a comfortable temperature indoors. South-facing windows capture abundant sunlight during the winter months, while north-facing windows minimize direct sunlight during hot summer days. Overhangs, awnings, and other shading strategies should also be incorporated into the design to prevent overheating in the summer and allow passive solar heating in the winter.

Building Envelope

A high-performance building envelope is essential in passive house design. It consists of continuous insulation, airtight construction, and thermal bridge-free design. Continuous insulation helps maintain a consistent temperature inside the building by minimizing heat transfer through the walls, roof, and floor. Airtight construction prevents unwanted drafts and air leaks, leading to improved indoor air quality and reduced energy consumption. Thermal bridge-free design eliminates heat loss at connection points between building components, further enhancing energy efficiency.

In addition to the insulation and airtightness, passive houses often use high-performance windows and doors to minimize energy losses. These windows and doors provide superior insulation, air tightness, and solar heat gain control, ensuring a comfortable interior environment throughout the year.

By focusing on these key design factors, passive houses can achieve improved energy efficiency, comfort, and overall sustainability.

Heating, Cooling, and Ventilation

Mechanical Systems

In a passive house design, the mechanical systems play a crucial role in maintaining a comfortable and energy-efficient environment. Heating and cooling in such designs primarily come from passive sources such as solar gain or internal sources like appliances and occupants.

For heating, the use of high-efficiency boilers and radiators is common. A good option is the integration of a Mitsubishi VRF Heat Pump, a variable-refrigerant flow heat pump that modulates the amount of refrigerant sent through the system, saving energy by circulating the minimum refrigerant needed for each individual zone.

Ventilation Systems

One of the key aspects of passive house design is providing fresh air while maintaining energy efficiency. Balanced mechanical ventilation systems are essential to achieve this. These systems consist of separate supply and exhaust airflows, delivering fresh air to living areas and removing stale air from kitchens, bathrooms, and utility spaces.

There are two types of mechanical ventilation systems commonly used in passive house designs – Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV). Both systems work by exchanging heat between incoming and outgoing air, minimizing the energy required for heating or cooling the fresh air.

Heat Recovery

Heat recovery is a crucial feature in passive house design, and it plays a significant role in reducing energy consumption. It can be achieved through different techniques, but two of the most common ones are Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV).

ERV systems not only exchange heat but also manage humidity, transferring moisture between the incoming and outgoing air to maintain a comfortable humidity level. On the other hand, HRV systems focus solely on heat exchange.

Both ERV and HRV systems minimize the need for additional heating and cooling, making them an essential component in achieving high energy efficiency in a passive house design.

Prefab passive house designs often include these mechanical and ventilation systems pre-installed to ensure a professional and efficient implementation of these critical elements, maintaining the required energy efficiency and high indoor air quality standards.

Key Construction Aspects in Passive Houses

Airtightness

One of the primary components in passive house design is airtightness. Ensuring airtight construction reduces air infiltration and prevents drafts. This is essential for maintaining optimal temperature and humidity levels, providing a comfortable indoor environment. Airtight construction also helps

to prevent condensation and mold growth, which can lead to health issues for occupants.

Proper sealing of doors, windows, and other potential air leaks is crucial for maintaining airtightness. This can be achieved through the use of high-quality tapes, seals, and caulking materials. Additionally, attention to detail during the design and construction process can help to minimize thermal bridges, ensuring a more comfortable and energy-efficient living space.

Insulation

In passive house design, emphasis is placed on providing well-insulated building envelopes. This includes continuous insulation throughout the walls, roofs, and floors, which prevents heat transfer and minimizes energy consumption. Insulation materials vary, but they generally have a high R-value, indicating the effectiveness of the material in reducing heat flow.

Prefab passive house construction often utilizes panels with pre-installed high-performance insulation, ensuring a higher degree of precision and efficiency during the construction process. By incorporating prefabrication, passive houses can be erected quickly and with a higher level of quality control.

Windows and Doors

Windows and doors in passive houses are designed to minimize heat loss and maximize natural light. High-performance windows and skylights are essential components for achieving these goals. These windows must meet specific performance standards, with stringent requirements for insulation, airtightness, and solar heat gain properties.

Additionally, passive house windows and doors are strategically placed to take advantage of passive solar design principles, capturing sunlight and heat during the winter months while reducing overheating during the summer. To further enhance energy efficiency, windows are often triple-glazed, and frames

are designed to minimize thermal bridges. This attention to detail is necessary to meet the strict criteria required to achieve passive house certification.

Indoor Air Quality

Air Quality and Ventilation

In a passive house design, indoor air quality is a critical consideration, especially in airtight buildings which rely on mechanical ventilation. To maintain a healthy environment, passive house designs often incorporate highly efficient ventilation systems that work continuously to circulate and filter air. These systems draw in fresh outdoor air and expel contaminated indoor air, thereby improving indoor air quality[1].

A common misconception about passive house designs is that their airtight nature would lead to poor air quality. However, the airtight design helps reduce air leakages and provides greater air control[2]. This is particularly beneficial for occupants who may be sensitive to outdoor air pollution or odors.

Moisture and Condensation Control

To provide adequate moisture control, passive house designs also focus on preventing condensation and managing indoor humidity levels. A combination of strategies, such as using materials with low vapor permeability in the building envelope, installing high-performance windows, and promoting good air circulation, help to minimize this issue.

In addition to exterior moisture control measures, mechanical ventilation systems equipped with heat recovery features help remove excess moisture and maintain balanced indoor humidity levels[3]. This reduces the risk of condensation and the potential growth of mold or other moisture-related issues inside the home.

By prioritizing indoor air quality, moisture control, and ventilation, passive house designs create a comfortable and healthy living environment while significantly reducing overall energy consumption.

Footnotes

1. Indoor Air Quality in Passivhaus Dwellings: A Literature Review ↩
2. Air Control in Passive House Architecture ↩
3. Designing an HVAC System for a Passive House ↩

Passive Houses and Climate Change

Passive house design is an innovative approach to building residential and commercial structures that prioritize energy efficiency and minimize their carbon footprint. The primary goal is to reduce the overall environmental impact of buildings and help mitigate the effects of climate change.

One significant aspect of passive houses is their focus on prefabricated construction methods. This method not only saves time and resources during the process but also ensures that the design and insulation systems are

accurately implemented, minimizing any loss of energy during the construction phase [Phius Zero is the goal].

By employing the five fundamental principles of passive house design – continuous insulation, airtight construction, optimized windows, balanced ventilation, and minimal mechanical systems – these buildings can achieve a significant reduction in carbon emissions and energy consumption. This results in a lower operational carbon footprint and a positive contribution to mitigating climate change.

An added benefit of incorporating passive house design is the potential for significant financial savings on energy bills. The high level of insulation and airtightness minimizes the need for heating and cooling systems, leading to lower energy consumption and reduced costs. This energy efficiency also translates into a decreased demand for fossil fuels, which in turn helps reduce greenhouse gas emissions.

In conclusion, passive houses play an essential role in the fight against climate change by promoting energy-efficient and environmentally friendly construction practices. Their focus on prefabricated design, coupled with their low energy consumption and reduced carbon emissions, makes them a critical component in the move toward a more sustainable built environment.

Types of Passive Houses

Single-Family Homes

Prefabricated passive single-family homes are becoming increasingly popular due to their energy efficiency and sustainable features. These homes are built using high-quality insulation, airtight construction, and carefully designed ventilation systems to minimize heat loss and maintain a comfortable indoor environment. New construction for single-family homes offers the opportunity

to incorporate passive house principles from the start, while retrofit projects can help improve energy efficiency in existing homes as well.

Residential Apartment Buildings

Multifamily apartment buildings can also benefit from passive house design principles. These structures focus on providing comfortable living spaces for multiple families while minimizing energy consumption and reducing operating costs. Prefabricated passive apartment buildings use continuous insulation, efficient windows, and well-designed ventilation systems to optimize energy usage. Both new construction and retrofit projects can incorporate these principles to help create sustainable and comfortable living conditions for apartment residents.

Schools

Schools are another area where passive house design can play a significant role in creating efficient and healthy learning environments. Through the use of continuous insulation, superior windows, and efficient mechanical ventilation systems, schools can greatly reduce their energy consumption and improve indoor air quality. In addition to new construction projects, existing schools can also benefit from retrofits that implement passive house principles, creating a significantly more sustainable and comfortable learning environment for students and staff alike.

Testing and Quality Assurance

In passive house design, ensuring a high level of energy efficiency and comfort is crucial. One of the essential aspects to achieving this goal is conducting rigorous testing and quality assurance procedures throughout the design and construction process. A focus on prefab construction adds another layer of complexity to the process, making quality assurance even more vital.

One of the most critical tests conducted in passive house design is the **airtightness test**. This test is essential for verifying the effectiveness of the building's insulation and minimizing heat loss. During a prefab construction project, airtightness is a vital component since it ensures that all elements of the building are effectively sealed and any thermal bridges are minimized.

To measure a building's airtightness, a **blower door test** is typically conducted. This test involves mounting a large fan onto an exterior door and depressurizing the building. While the fan is operating, professionals can identify any air leaks or breaches in airtightness, allowing them to address these issues before they become more significant problems. By conducting blower door tests during the construction of a prefab passive house, builders can ensure that airtightness is achieved, and the building functions as a true passive design.

In addition to airtightness testing, passive house projects can benefit from a stringent Quality Assurance and Quality Control (QA/QC) program conducted on site. For example, the Passive House Institute of the U.S. PHIUS+ Certification program includes a thorough passive house design verification protocol combined with rigorous QA/QC inspections. These inspections are performed by highly skilled and specialized PHIUS+ Raters and Verifiers, helping to maintain the building's high-performance standards.

In summary, a successful passive house design not only relies on effective energy-saving principles but also on rigorous testing and quality assurance

processes. By conducting thorough airtightness tests such as blower door tests and implementing on-site QA/QC inspections, prefab passive house projects can achieve energy efficiency and maintain high-performance standards.

Frequently Asked Questions

What are the key principles in a passive house design?

A passive house design focuses on energy efficiency, comfort, and affordability. The key principles include airtightness, high-quality insulation, thermal bridge-free construction, and efficient HVAC systems, to create a building that consumes minimal energy while maintaining a comfortable indoor environment. Passive houses rely on prefabricated components to maintain consistency and precision in the building process.

How does climate influence passive house design?

Climate plays a significant role in passive house design, as the building envelope and systems need to be tailored to the specific climatic conditions of the building's location. Passive houses in colder climates require thicker insulation, while those in warmer climates need features like overhangs and shading devices to keep the interior cool. Designing a passive house requires climate-specific optimization to ensure the greatest possible energy efficiency and comfort.

What are the main benefits of a passive house?

The main benefits of a passive house include reduced energy consumption, lower utility bills, healthier indoor air quality, and minimized carbon emissions. Passive houses are designed to be energy-conscious and provide superior comfort to their occupants through excellent insulation, airtightness, and an advanced HVAC system.

How does passive house design reduce energy consumption?

Through a combination of airtight construction, highly efficient insulation, and a design that takes advantage of solar gains and natural ventilation, passive houses can significantly reduce energy consumption. The advanced HVAC systems used in passive houses also contribute to energy reduction by recovering heat from exhaust air and using it to pre-heat incoming fresh air.

What challenges are faced during the passive house certification process?

The passive house certification process is rigorous and requires meeting strict energy efficiency and comfort standards. One challenge faced during the certification process is ensuring that the building is designed and constructed to meet these standards, including eliminating thermal bridges and providing airtightness. Another challenge is accurately modeling the building's energy performance and verifying the performance through on-site testing and inspections.

Do passive houses have a higher construction cost?

While the construction cost of passive houses can be higher initially due to the need for high-quality materials, advanced systems, and skilled labor, the long-term energy savings often offset these expenses. The reduced energy consumption associated with passive houses leads to lower utility bills and a reduced carbon footprint, making them an attractive investment for homeowners concerned with both financial savings and environmental impact.

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Public Comments (PCH) for: REC-R402.4.1.2(1)-24

Discussion by Mark Graver

Dec 23, 2025 20:34 UTC

While not impossible, significant challenges are encountered when trying to improve the air leakage rate of conventionally framed buildings. Changing the standard from 5 ACH to 3 ACH is mission creep. This is because building technology has not appreciably evolved for wood-framed construction, and it likely never will without adding significant cost in the way of joint treatments. Conventionally framed buildings have many series of joints from the top to the bottom that all allow for air infiltration. Such buildings require joint treatments that are extremely prone to failure. Additionally, some joints in floor, wall and roof systems must permit the passage of air to protect against rot and decay. Sealing such joints to achieve an irrational metric can cause structural problems. With the introduction of fresh air into the building being a requirement due to building leakage requirements anyway, it is difficult to see where the justification for adopting more stringent requirements lies.

Ultimately, the cost for this change is passed onto consumers who are already finding it increasingly difficult to purchase new homes. Many Virginians, even now, are priced way outside of the housing market. The increase in cost is not justifiable, and considering that Virginia already has a standard, 5 ACH, there is no reason to pursue this requirement any further at this time. All of the areas already prone to infiltration are already being targeted and treated with sealants and other products to comply with the current requirement. The result of increasing the requirement would thus be more troubleshooting, more callbacks, more testing, more fraudulent reports, and more band-aid repairs that don't last. The troubling thing about the troubleshooting and the callbacks is that it may take several technicians and repeated trial and error until a contractor finally identifies the root of the problem. Increasing the requirement will only exacerbate the problem. All of this adds up to construction delays and a major increase in cost to every contractor involved in the project. This increase in cost is passed on to all of the citizens that we serve.

Proposal # 1351

REC-R402.4.1.2(1)-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Deletes the existing Virginia amendment related to air leakage testing and the allowable leakage rate, and defaults to the 2024 IECC requirements.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second and third Energy Sub-Workgroup meetings on September 29, 2025, and November 14, 2025, respectively.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce

- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

DHCD Staff Note: This proposal is substantially identical to proposal REC-R402.4.1.2-24. Stakeholders stood on the statements they made regarding REC-R402.4.1.2-24. The excerpt from the September 29, 2025, Energy SWG meeting summary pertaining to proposal REC-R402.4.1.2-24 is provided below.

> **Eric L** presented proposal REC-R402.4.1.2-24, which adjusts blower-door testing targets for small dwelling units and addresses tester qualifications.
>
> **Steve S** said his groups have no position on this proposal and asks whether this code change, which references attached multi-family developments, belongs in the Residential provisions of the VECC.
>
> > **Eric L** responded that his proposal would include dwelling and sleeping units detached or are located in R-2 occupancies, so it could be 3-story, garden style apartments.
> >
> > **Steve S** states that those occupancies are outside of the scope of the Residential provisions of the VECC.
> >
> > **Florin Moldovan** (DHCD staff) clarified that the amendment falls under the Residential portion of the IECC and therefore applies to all residential occupancies up to three stories, including both R-2 multifamily and single-family homes. If this proposal were to be approved by the Board for inclusion in the USBC, there would be provisions that fall within Chapter 4 of the VECC and Chapter 11 of the Virginia Residential Code (VRC), as there are provisions that would impact single-family dwellings.

Andrew G endorsed the change, noting that small units often struggle to meet the current air-leakage target because the requirement is scaled to building volume, favoring large homes. Notes that Virginia needs to provide flexibility for smaller dwelling units to achieve this standard.

Monica R agreed, stating that tighter targets are harder for small enclosures.

Dennis H said the most pressing issue is who performs the tests; qualifications should be defined. Noted that, compared to the model code language, Virginia's language is more stringent and should be maintained.

Eric L responded that he is open to specifying tester credentials.

Andrew G added that some referenced certifications are being phased out.

Monica R warned against allowing installers (e.g., insulation or mechanical contractors) to test their own work, citing conflict-of-interest concerns.

Eric L noted a similar compromise was reached on duct-leakage testing and is willing to pursue one here.

Bill P indicated support for this and a related proposal submitted by himself on behalf of Sierra Club - VA Chapter, suggesting possible consolidation.

Florin M asked **Eric L a**nd **Bill P** to consider merging or withdrawing duplicative submissions to reach a single consensus proposal.

Justin K inquired whether jurisdictions keep approved lists of third-party testers.

> **D.A. Pierce** said Roanoke requires testers to complete a registration form before testing.
>
> **Steve S** explained that "approved" simply means accepted by the local building department; the code mandates a third-party policy in general, but not a formal roster or list of approved third-party testers.
>
> **Andrew G** noted that some localities do maintain such lists.

Florin M notes that the next proposal, REC-R402.4.1.2(1)-24, authored by **Bill P** and which was not officially announced, is similar to **Eric L's** proposal, REC-R402.4.1.2-24, both in content and in scope.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble

- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Bill P stated that this proposal is similar to **Eric L's** proposal, so no additional discussion was needed.

DHCD Staff Note: The excerpt from the November 14, 2025, Energy SWG meeting summary pertaining to proposal REC-R402.4.1.2-24 is provided below.

Eric L provided an overview of the proposal which deletes Virginia specific amendments to the air leakage requirements with the intent to incorporate the 2024 IECC testing requirements.

D.A. Pierce expanded that this proposal is for R-5 use occupancies, which in Virginia are single-family and two-family dwelling homes including townhouses, and R-3 in Virginia for residencies in a mixed occupancy building. VBCOA supports this for R-5 occupancies only and requested that the proposal is amended.

Jeff Brown (DHCD staff) clarified that as written, the proposal is eliminating the requirements in this section in the Virginia Energy Conservation Code (VECC) which applies to anything under the International Residential Code (IRC), as well as low-rise residential under the VECC. The testing requirements would apply in the Virginia Residential Code (VRC) to R-5 and the VECC to other R-use groups that fall within the low-rise residential guidelines.

Florin M suggested that it could be beneficial for the Board if **D.A.** could clarify why this proposal is acceptable for a single-family home but not an R-3.

Bill P asked what is an R-3 that is not an R-5.

Florin M provided townhouses over three stories in height, as an example, which are commonly classified as R-3.

Sydney R supported the proposal and stressed that smaller units are at a disadvantage in the 2021 Virginia codes because the ratio of volume per square footage changes as the unit gets smaller and would be at an advantage if the 2024 IECC language were adopted.

Scott P was opposed and preferred the Virginia amendments.

Eric L pointed out that the primary cost of blower door testing is the test itself and that is already in Virginia's code. Going from 5 to 3 air changes per hour are not going to require extra or new materials and Virginia builders are probably already achieving this. Trading off the air leakage in the performance path would be allowed with the 2024 IECC language.

Andrew G concluded that this proposal gives flexibility that would be good for the industry moving forward. The real cost for a tighter home is installing the ventilation system and testing.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Steve Shapiro, AOBA and VAMA; and Andrew Clark, HBAV.

Discussion:

Bob S provided that this proposal was similar to proposal REC-R402.4.1.2 and there was no need to discuss.

DHCD Staff Note:

This proposal is substantially identical to proposal REC-R402.4.1.2-24, which was reviewed by stakeholders at the third GSW meeting, on January 5, 2026, and received a Non-Consensus recommendation. The excerpt from the January 5, 2026, meeting summary pertaining to REC-R402.4.1.2-24 is provided below.

January 5, 2026, GSW Meeting Summary Excerpt

Support: Bob Shippee, Sierra Club; Sydney Roberts, SEEA; and D.A. Pierce, VBCOA Energy Committee.

Opposition: Steve Shapiro, AOBA and VAMA; Andrew Clark, HBAV; Mark Graver, City of Waynesboro and VBCOA Region III; and Rick Hinson, American Council of Engineering Companies (ACEC).

Discussion:

Eric L provided an overview of the proposal.

a. **Sydney R** stressed that for the durability advantages to a tighter building envelope as insulation is increased, there also needs to be an increase in air tightness to keep the humid air out of building cavities. This is a risk mitigation measure for home builders.
b. **Steve S** stated that he has been collaborating with **Eric L** on some things that might be able to be worked out. He noted that he will continue to work with **Eric L** prior to the Board meeting

and remove their opposition if they are able to work out the issues. **Andrew C** echoed **Steve S's** comments.

c. **D.A. Pierce** inquired if the proponent was open to adding an allowance for four air changes per hour for climate zones three through five for single- and two-family dwellings as an exception.

d. **Mark G** commented that rarely are blower door test results below three air changes, and to achieve that would require a significant number of callbacks to contractors to discover where the source of the leak is coming from.

REC-R402.1.2(2)-24

VRC: TABLE N1102.1.2 (R402.1.2), TABLE N1102.1.3 (R402.1.3); VCC: 1301.1.1.1

Proponents: Eric Lacey, representing Responsible Energy Codes Alliance (eric@reca-codes.com)

2021 Virginia Residential Code

Revise as follows:

TABLE N1102.1.2 (R402.1.2) MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
3	0.30	0.55	0.25	0.026	0.060 ~~0.079~~	0.098	0.047	0.091c	0.136
4 except Marine	0.30	0.55	0.40	0.024	0.045 ~~0.079~~	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.40	0.024	0.045 ~~0.079~~	0.082	0.033	0.050	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In Warm Humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

   Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum U-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

   1. Above 4,000 feet in elevation above sea level, or

   2. In windborne debris regions where protection of openings is required by Section R301.2.1.2.

TABLE N1102.1.3 (R402.1.3) INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c,g] WALL *R*-VALUE
3	0.30	0.55	0.25	49	20 or 13&5ci or 0&15ci ~~15 or 13+1~~[g]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	0.30	0.55	0.40	60	30 or 20&5ci or 13&10ci or 0&20ci ~~15 or 13+1~~[g]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30	0.55	0.40	60	30 or 20&5ci or 13&10ci or 0&20ci ~~15 or 13+1~~[g]	13/17	30	15ci or 19 or 13&5ci	10ci, 4 ft	15ci or 19 or 13&5ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.

ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13&5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab-edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation shall not be required in Warm Humid locations as defined by Figure N1101.7 and Table N1101.7.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13&5" means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section N1102.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2.

2021 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the *International Energy Conservation Code* (IECC). The following changes shall be made to the IECC :

~~14. Change the wood frame wall *R*-value categories for Climate Zones 3A, 4A and 5A in Table R402.1.3 to read:~~

		~~Wood Frame Wall *R*-Value~~
		~~15 or 13+1[h]~~

~~15. Change the frame wall *U*-factor categories for Climate Zones 3A, 4A and 5A in Table R402.1.2 to read:~~

		~~Frame Wall *U*-Factor~~
		~~0.079~~

Reason Statement: This proposal will reduce energy costs for homeowners and improve comfort and passive survivability in new homes by adopting the wall insulation requirements as they appear in the 2021 and 2024 IECC. Virginia is now several cycles behind the model energy code in requirements that apply to wall insulation.

	IECC Wall Insulation R-Value (CZ4)	VA UCC Wall Insulation R-Value (CZ4)
2009	13	13
2012	20 or 13+5	15 or 13+1
2015	20 or 13+5	15 or 13+1
2018	20 or 13+5	15 or 13+1
2021	30 or 20+5 or 13+10 or 0+20	15 or 13+1
2024	30 or 20+5 or 13+10 or 0+20	

Virginia currently allows 75% higher wall U-factors (less stringent) than the 2021/24 IECC. That means Virginia homes allow 75% more heat transfer through the opaque walls than a home built to the 2021 or 2024 IECC. While we understand that initial construction costs are higher with increased insulation requirements, the long-term benefits in lower energy bills and increased comfort for the building owners/occupants are well-documented. Wall insulation is most cost-effectively installed at construction and is likely to remain unchanged over the useful life of the building. The homes constructed today will generate roughly 1200 utility bills (100 years x 12 months), and the amount of wall insulation will directly impact what the homeowner pays every month. It is critical to build new homes to reduce energy use wherever feasible, particularly in the systems and components that will last the longest. Because the IECC provides a wide range of compliance options -- prescriptive, Total UA, simulated performance, Energy Rating Index -- an increase in wall insulation requirements may not require a complete redesign of the proposed home, as long as the home achieves the same overall level of energy savings.

Cost Impact: The code change proposal will increase the cost In its analysis for the efficiency improvements in the 2021 IECC, the U.S. Department of Energy estimated that the increased construction cost of an additional R-5 continuous insulation would be $0.98/ft2 wall area, or $374.96 for the multifamily prototype/$1,961.96 for the single-family prototype. This improvement was part of a 30-year life-cycle energy cost savings of $2,243 in climate zone 4, with an estimated payback period of 12.4 years. *See* U.S. Department of Energy, *National Cost-Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021).

Public Comments (PCH) for: REC-R402.1.2(2)-24

Discussion by Mark Graver

Dec 23, 2025 21:17 UTC

Building technology continues to result in creative and intelligent solutions to the core challenges related to construction. New technologies and materials are created to move the industry forward. One of these core challenges is insulation and related to this, environmental effects related to moisture, air flow, and heat loss/gain. Despite the many methods of construction, conventional framing is generally where "cavity" insulation occurs. Voids have to be filled to address heat loss/gain, moisture has to remain on the outside and expelled from the building interior. Industrial processes have brought us a wide range of insulation types, constantly being refined to create better thermal resistance. The industry has adapted for 100 years from the times of filling these voids with newspaper, straw, and other flammable and inefficient materials. Those days are well behind us, and insulation products continue to advance in new and unexpected ways. However, the basics have not changed for decades. Rigid insulation panels have been in use for over 40 years. Fiberglass batts have been in use for even longer.

Because this proposal does not seek to incorporate a new and affordable technology, and because this proposal is not based on better production standards, leading to more thermally resistant products, the proposal is mission creep. There is a core duty that code professionals must uphold: regulation must be rational, measured, and calculated. A standard that continues to change due to mission creep is not a standard at all, it's a moving target based on ever changing passions of regulators. Regulations exist for the benefit of the persons served. As such, a regulation such as this, with such a high initial cost for conventionally framed structures, would increase the cost of a home to a degree that would not serve the average citizens of the Commonwealth of VA. Regulations are most effectively administered and accepted when they represent minimum standards. If the initial cost of construction is too high, the industry and the citizens of the Commonwealth will be harmed. As a counterweight, the building industry could be subsidized to temporarily stabilize a market in the event that a regulation creates too much pressure, but creating a need for subsidies is not proper stewardship. Retaining a standard that has been in place since the 2012 edition should not be seen as a problem, but should be seen as a sign of stability. Though the building industry is forced to adapt to other irrational standards, stability, where it can be maintained, is preferred. The amended VA code that is in effect is the correct, most rational standard that meets the intended and stated purpose of the VA USBC for minimum standards. At this time, adopting a different standard is nothing more than mission creep.

Proposal # 1325

Submitted Via Email to codedevelopment@dhcd.virginia.gov

April 3, 2026

Louie Berbert, Chair
Virginia Board of Housing and Community Development
600 East Main Street, Suite #300
Richmond, VA 23219

RE: RECA Comments Supporting the Adoption of the 2024 *IECC* for Residential and Commercial Construction in Virginia and Recommending Additional Improvements

Dear Chairman Berbert,

The Responsible Energy Codes Alliance[1] submits these comments in support of the proposed incorporation of the 2024 International Energy Conservation Code (*IECC*) into Virginia's Uniform Statewide Building Code (USBC) for residential and commercial construction. We have been active participants in the current and previous USBC updates and we support the important work of the Department of Housing and Community Development (DHCD) to help ensure safe, affordable, and efficient construction and renovation in the Commonwealth. **As with the 2021 update, the 2024 *IECC* provides cost-effective, energy saving improvements that will benefit Virginians for generations.**

In addition to our general support for the improvements approved through the stakeholder process, we write specifically to recommend two additional changes that have been part of the model energy code for several cycles, but which Virginia has never adopted: (1) We recommend adopting the full wall insulation requirements of the 2024 *IECC*, or at a minimum, the proposed compromise advanced by the Virginia Building Code Officials Association (VBCOA); and (2) we recommend an incremental improvement to envelope air tightness requirements to bring long-term energy saving and comfort benefits to homeowners.

Energy and Cost Savings of the 2024 *IECC*

Adopting the 2024 *IECC* residential provisions will make homes more affordable and comfortable for Virginians, and adopting the *IECC* commercial provisions (including the

[1] RECA is a national coalition of building products manufacturers, trade associations, environmental groups, regional efficiency advocates and other organizations that support the adoption of the latest model energy codes across the country.

alternative to comply with *ASHRAE* Standard 90.1-2022) will help protect businesses against unprecedented increases in energy costs. For the last two decades, the *IECC* has improved in efficiency with every new edition. According to the U.S. Department of Energy, the 2024 *IECC* will reduce energy bills by an average of 6.6% over the 2021 *IECC*.[2] Likewise, buildings constructed to *ASHRAE* Standard 90.1-2022 will cost an average of 8.9% less to operate than buildings constructed to *ASHRAE* Standard 90.1-2019.[3] (Standard 90.1 is incorporated as a compliance option in the commercial chapter of the *IECC*, and the energy savings figures for the *IECC*-Commercial Provisions and Standard 90.1 are typically similar.) As indicated in the summary table of DOE findings below, the owners and occupants of both residential and commercial buildings in Virginia stand to benefit from substantial cost savings with the adoption of the most recent editions of the model codes.

Comparison of Unamended Model Code Energy Cost Savings					
Residential (2024 *IECC*)[4]			**Commercial (*ASHRAE* 90.1-2022)[5]**		
Climate Zone	Energy Cost Savings over 2021 *IECC*	30-year Cost Savings over 2021 *IECC*	Climate Zone	Energy Cost Savings over 90.1-2019	30-year Cost Savings over 90.1-2019
3	**6.08%**	**$2,509**	**3**	**8.9%**	**$1.35/sq.ft.**
4	**6.79%**	**$3,790**	**4**	**9.8%**	**$1.32/sq.ft.**
5	**5.53%**	**$2,496**	**5**	**10.1%**	**$1.38/sq.ft.**

Efficient Homes are Affordable Homes. Home affordability is an important consideration in any code update process, and it is well-documented that homes constructed to the full 2021/24 *IECC* requirements—including the insulation and air sealing requirements—will provide more comfort and lower energy bills for occupants, and these codes have been repeatedly demonstrated to be cost-effective to the consumer.[6] Unlike some

[2] *See* U.S. Dep't of Energy, *Energy Savings Analysis: 2024 IECC for Residential Buildings*, at iv (Dec. 2024).
[3] *See* U.S. Dep't of Energy, *ANSI/ASHRAE/IES Standard 90.1-2022: Energy Savings Analysis,* at vii (Feb. 2024), available at https://energycodes.gov/sites/default/files/2024-02/Standard_90.1-2022_Final_Determination_TSD.pdf.
[4] *See* U.S. Dep't of Energy, *Energy Savings Analysis: 2024 IECC for Residential Buildings*, at iv (Dec. 2024), available at https://energycodes.gov/sites/default/files/2024-12/2024_*IECC*_Determination_TSD.pdf.
[5] *See* U.S. Dep't of Energy, *ANSI/ASHRAE/IES Standard 90.1-2022: Energy Savings Analysis,* at 24, 27 (Feb. 2024), available at https://energycodes.gov/sites/default/files/2024-02/Standard_90.1-2022_Final_Determination_TSD.pdf.
[6] *See, e.g.*, U.S. Dep't of Energy, *National Cost-Effectiveness of the Residential Provisions of the 2024 IECC* (Jan. 2025) (finding an average of $2,954 in savings over 30 years in new residential homes constructed to the 2024 IECC, with an average simple payback period of 2.5 years).

equipment and other components of the building that must be replaced on a regular basis, elements of the thermal envelope such as insulation will last many decades, providing long-term benefits for homeowners. Although we acknowledge the interest of homebuilders and developers in keeping costs low during construction, that interest must be balanced against the owner/occupant's interest in keeping operating costs low over the next 100 years. The most cost-effective time to insulate homes and commercial buildings is at construction, and it is crucially important that Virginia set efficiency requirements that make sense over the expected lifetime of each new home, and not just at the construction phase.

RECA Recommendation 1: Update Residential Wall Insulation Requirements Consistent with the *IECC*.

Virginia currently allows 75% less efficient walls than the 2021/24 *IECC*. In the 2012 USBC update cycle, Virginia elected to not adopt the wall insulation requirements of the 2012 *IECC*, and has not made any improvements in wall insulation requirements since then. Based on U.S. Census data, we estimate that over 250,000 single family homes have been constructed in Virginia since 2012,[7] and all of these homes were not subject to the insulation requirements set through the consensus-based national model code development process. Wall insulation efficiency improved in both the 2012 and 2021 *IECC* updates—neither of which has been adopted by Virginia, despite proposals submitted by RECA and other stakeholders in every code update cycle to meet the national standard.

We recommend that the Board approve Proposal REC-R402.1.2(2)-24 to incorporate the full wall insulation requirements of the 2024 *IECC*. If the Board would prefer to phase in these requirements over multiple code cycles, we recommend adopting Proposal **REC-R402.1.2-24 (as modified)**, which was submitted by VBCOA and is supported by a wide range of stakeholders. This proposal would allow Virginia to catch up to the 2012 *IECC* insulation requirements and would also correct a technical flaw in Virginia's current wall insulation requirement that could lead to durability issues over time.[8] It is important that Virginia act now to improve the thermal envelope of new homes before another 250,000 homes are built to a lesser standard.

RECA Recommendation 2: Update Residential Envelope Air Tightness Requirements Consistent with the *IECC*.

In the 2018 USBC update, Virginia adopted a requirement that each new home receive a blower door test ≤5 ACH50, which had not been required in previous editions of the USBC.

[7] *See* https://www.census.gov/construction/bps/index.html.

[8] Virginia's current prescriptive wall insulation requirement includes an option for an R-13+1c.i. wall assembly, which could increase the risk for condensation within the wall cavity. We believe either the 2024 IECC wall insulation R-value options or the modified proposal REC-R402.1.2-24 would adequately address this technical problem.

While this was a substantial improvement, it was still weaker than the full *IECC* requirement of ≤3 ACH50. Every edition of the *IECC* since 2012 has required new homes to be tested to ≤3 ACH50, but the 2024 *IECC* provides a number of exceptions and workarounds for smaller dwelling units and multifamily buildings that we believe will allow additional flexibility to help homebuilders achieve the improved efficiency. We recommend that the Board approve Proposal **REC-R402.4.1.2-24 to incorporate the full air leakage testing requirements of the 2024 *IECC*.**

In reality, the only significant cost of meeting the envelope air leakage target has already been incorporated into Virginia's USBC—the cost of the test itself. As code users have become more experienced with air sealing techniques and best practices, we have observed improvements in envelope tightness across the country. We are confident that Virginia code users will have no problem achieving ≤3 ACH50 at little to no extra cost, and for smaller dwelling units or complicated designs, the 2024 *IECC* provides several alternatives.[9] We recommend that Virginia adopt the air tightness testing requirement as published in the 2024 *IECC*.

Conclusion

RECA's members and supporters have been involved in energy code development and adoption for decades, and we offer our assistance and experience as you work to maximize energy efficiency in residential and commercial buildings. Please contact us if you have any questions or would like to discuss how RECA can be of assistance.

Sincerely,

Eric Lacey
RECA Chairman

[9] *See* Section R402.5.1.3 of the 2024 *IECC*.

RECA is a broad coalition of energy efficiency professionals, regional efficiency organizations, product and equipment manufacturers, trade associations, and environmental organizations with expertise in the development, adoption, and implementation of building energy codes nationwide. RECA is dedicated to improving the energy efficiency of homes throughout the U.S. through greater use of energy efficient practices and building products. It is administered by the Alliance to Save Energy, a non-profit coalition of business, government, environmental and consumer leaders that supports energy efficiency as a cost-effective energy resource under existing market conditions and advocates energy-efficiency policies that minimize costs to society and individual consumers. Below is a list of RECA Members that endorse these comments.

Air Barrier Association of America

Alliance to Save Energy

American Chemistry Council

American Council for an Energy-Efficient Economy

CertainTeed LLC

EPS Industry Alliance

Extruded Polystyrene Foam Association

Institute for Market Transformation

Johns Manville Corporation

Knauf Insulation

National Fenestration Rating Council

Natural Resources Defense Council

North American Insulation Manufacturers Association

Owens Corning

Polyisocyanurate Insulation Manufacturers Association

REC-R402.1.2(2)-24 – Staff Summary

Proponent: Eric Lacey, representing Responsible Energy Codes Alliance

Brief Description: Deletes the existing Virginia amendment to the wall insulation requirement and defaults to the 2024 IECC requirements (R-20 or R-13+5c.i. or R-15c.i. in CZ 3; and R-30 or R-20+5c.i. or R-13+10c.i. or R-20c.i. in CZs 4 & 5).

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at each one of the three Energy Sub-Workgroup meetings on July 9, 2025, September 29, 2025, and November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — July 9, 2025:

- Steve Shapiro
- Sydney Roberts
- Mike O'Connor

- Corian Carney
- Dennis Hart
- D.A. Pierce
- Chelsea Harnish
- Stuart Nuckols
- Mason Trimble
- Bill Penniman
- Mike Rhodes
- Eric Lacey
- William Drumeller
- Hana Nguyenky
- Sarah Thomas
- Andrew Clark

Other stakeholders in attendance — July 9, 2025:

- Nicholas Bowles – Building Official, Nottoway County
- Kyle Kratzer – Virginia Building and Code Officials Association
- Mike Hamilton – Arlington County
- Bill Riggs – Viridiant
- Bob Shippee – Virginia Citizen
- Susan Stillman – Virginia Citizen
- Jason Vandever – North American Insulation Manufacturers Association
- Monica Rokicki – Better Building Works

Discussion:

- **Eric** – Provides an overview of the proposal. Currently, we allow 75 % more heat flow through an opaque wall. Looking to eliminate that.
- **Steve** - What's the effect on framing members, particularly in Climate Zone (CZ) 4?
- **Eric** - You can still use 2 × 4 framing; continuous insulation (ci) is an option.
- **William D** - Love more efficiency but ci isn't a simple install. Strikes me the simplest way is larger framing members.
- **Monica** - If there's ci it really needs to be R-5 minimum; otherwise, you get thermal bridging… Mixed-humid climates need vapor-open walls.

Support roll-call – Sydney, Chelsea, Naima indicated "support," Steve "not in favor," Andrew reserving judgment pending full package, Monica "not in favor due to R-30 wall insulation requirement."

- **Andrew** – (Standing comment for all energy proposals) Our goal is to look at all of these proposals in totality and run them against our members' interests, not only considering the upfront cost impact. With regard to the upfront cost impact, the General Assembly has emphasized that we cannot put up barriers to folks even being able to "get to the dance floor" when it comes to housing. When builders and developers go before the Board of Supervisors, they don't care what the payoff is for

seven homeowners over 100 years. They are focused on getting people into houses now. We need to consider that local electors want that lower initial cost. It's not opposition to increased efficiency; it's that we're getting hit on both sides. We're not vehemently opposed unless something unexpected pops up.

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Eric L outlined his insulation-upgrade proposal but said he is inclined to withdraw it and instead support **D.A. Pierce's** more incremental wall-insulation amendment, even though he would still prefer larger gains in both wall and ceiling R-values.

Bill P endorsed **Eric L's** proposal in principle but recommended deferring this and the following two proposals from the October 3rd General Stakeholder Workgroup agenda.

Monica R said she supports the idea of R-60 attic insulation, "in theory," yet finds it impractical: thicker insulation can make HVAC equipment harder and riskier to service while offering only marginal energy savings. She believes R-49 is the optimal level and that greater efficiency gains can be achieved by focusing on other parts of the code.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Eric L informed the group that no discussion was necessary as the success of this proposal depends on **D.A. Pierce's** proposal [REC-R402.1.2-24].

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Bob Shippee, Sierra Club; Justin Koscher, PIMA; Sydney Roberts, SEEA; and Jason Vandever, NAIMA.

Opposition: Andrew Clark, HBAV; Mark Graver, City of Waynesboro and VBCOA Region III; Kyle Kratzer, Fairfax County and VBCOA; and Rick Hinson, American Council of Engineering Companies (ACEC).

Discussion:

Eric L provided an overview of the proposal.

a. **Bob S** commented that upfront costs exist, but the payback is quick and is a huge net positive.
b. **Justin K** raised the concern that Virginia is several code cycles behind the current model codes, and these changes are real savings to homeowners. **Justin K** also expressed that it is not realistic to believe that homeowners have the power to influence insulation requirements when purchasing a new home because those decisions are made well in advance of the buyer taking possession of the home and it is disingenuous to suggest that home buyers can just go out and buy efficiency.
c. **Sydney R** pointed out that the payback period is only nine years.
d. **Jason V** stated that a better building envelope makes the house more comfortable which could allow an owner to adjust the thermostat to a degree or two.
e. **Andrew C** reiterated his stance that the upfront costs of homeownership outweigh energy efficiency cost increases that payoff in the future. Market demand is surging at price points that these proposals collectively are making infeasible to build.
f. **Kyle K** representing himself, expressed support for proposal REC-R402.1.2-24 as opposed to this proposal because of where Virginia is regarding construction prices.

DHCD Staff Notes:

- This proposal conflicts with proposal REC-R402.1.2-24, which was reviewed by stakeholders at the third GSW meeting, on January 5, 2026, where it received a Non-Consensus recommendation.
- This proposal is substantively identical to proposal REC-R402.1.2(4)-24, which was also reviewed by stakeholders at the third GSW meeting on January 5, 2026, where it received a Non-Consensus recommendation. Discussion around proposal REC-R402.1.2(4)-24 was limited given its similarity with REC-R402.1.2(2)-24, which was discussed immediately prior. Stakeholders deferred to their prior statements.

REC-R402.1.2(4)-24

VCC: 1301.1.1.1 (New)

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2021 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the IECC. The following changes shall be made to the IECC:. (Portions of code section not shown remain unchanged.)

~~15. Change the frame wall U-factor categories for Climate Zones 3A, 4A and 5A in Table R402.1.2 to read:~~

	~~Frame Wall U-Factor~~
	~~0.079~~

~~16. Change the wood frame wall R-Value categories for Climate Zones 3A, 4A, and 5A in Table R402.1.3 to read:~~

	~~Wood Frame Wall R-Value Wood Frame Wall R-Value~~
	~~15 or 13+1~~

Reason Statement: The purpose of this proposal is to bring Virginia's standards for wall insulation into compliance with the 2024 IECC.

Virginia's residential building code has been behind the IECC's wall energy efficiency standards for over a decade -- since the 2012 IECC update. **Virginia is even farther behind today since it failed to strengthen code standards for wall insulation to adopt the 2021 IECC standards, which strengthened wall insulation standards beyond the IECC's 2012 level**, **and which remain in the 2024 IECC standards.**

Despite a decade of actual experience, IECC never weakened the wall insulation standards to levels below the 2012 IECC standards. Instead, as noted, the IECC strengthened the wall insulation standards in 2021.

Tightening wall insulation standards is important to residents —whether owners or tenants--, since it would help them save money, and experience greater comfort and a healthier home for decades after the dwelling is built.

Tightening prescriptive construction standards for wall insulation will help to

(a) reduce occupancy costs, including for heating and conditioning of air in the dwelling,
(b) reduce exposure to mold that can build up in walls,
(c) increase residents' comfort,
(d) increase physical and economic resiliency to power outages, climate change and rising energy prices,
(e) reduce gaps for pests to enter the dwelling,
(f) reduce pressure on utilities to raise rates in order to build and operate more energy delivery capabilities, and
(g) reduce the air pollution that drives climate impacts and other harms to Virginia's health, property and economy.

Legal Standards. Remaining at 5.0 ACH level would leave Virginia's building code out of compliance with statutory standards. **Sections 36-99A and 36-99B of the Virginia Code** states that building codes are required to "protect the health, safety and welfare of the residents of the Commonwealth" and that adjustments to reduce construction costs must nevertheless be **"consistent with recognized standards of health, safety, energy efficiency and water efficiency."** VIRGINIA ACTS OF ASSEMBLY – 2021 SPECIAL SESSION I, CHAPTER 425, Section 1 (referred to herein as "**H2227")**, which was enacted in 2021, calls for adoption of energy efficiency standards that are "at least as stringent" as the latest IECC considering factors such as consumer costs "over time" and air pollution.

Cost and energy savings. Beginning with its review of the 2012 IECC, in which the 3.0 ACH standard was first adopted, the U.S. Department of Energy and the Pacific Northwest National Laboratories (collectively DOE) has found that residents would save money from full implementation of each IECC update from 2012-2024 even after considering incremental purchase and mortgage costs. Focusing on the three most significant IECC updates containing the 3.0 ACH standard, DOE found that, over 30 years, lifecycle savings (i.e., net of additional purchase and mortgage costs): **full implementation of the 2012 IECC** (which introduced the 3.0 ACH requirement for Virginia's climate zone) would save average Virginia residents **$5,836, if adopted**; **full implementation of the 2021 IECC** would save Virginia residents **$8,376, if adopted**; and **full implementation of the 2024 IECC** would save residents of Virginia's Climate Zone 4 **$3,790 and Zones 2 and 5 an average of $2,502 compared to 2021 IECC**. Savings would have been achieved year in and year out, with rapid payback and lasting for decades. [2]

Collectively, Virginians would save billions of dollars in energy costs from full implementation of the IECC, greatly benefiting residents and Virginia's economy. In its July 2021 report on "Cost-Effectiveness of the 2021 IECC for Residential Buildings in Virginia" (PNNL-31627), PNNL found that aggregate energy cost savings for Virginia residents from adopting the full 2021 IECC would be $7,192,000 in the first year and $2,487,000,000 over 30 years. Virginia would achieve substantial pollution reductions and add jobs.

Significantly, even as it preserved the 2021 IECC's prescriptive wall insulation standards, the 2024 IECC offered 's builders greater flexibility to achieve total efficiency targets through Simulated Building Performance and ERI compliance paths. These performance-based paths permit builders to trade some efficiency measures for other efficiency measures, provided they meet the code's overall efficiency goals. Importantly, however, the 2024 IECC's compliance flexibility are expressly tied to the 2024 Prescriptive Path's standards for envelope efficiency, including wall insulation. **The added flexibility was not intended to permit builders to reduce efficiency from a state-weakened baseline below the 2024 IECC's prescriptive standards for walls or otherwise**. Such double-dipping would be anything but "consistent with" or "at least as stringent as" the 2024 IECC.

Pollution Reductions. DOE has also repeatedly found that full compliance with the IECC's updates will reduce energy use and air pollution, including greenhouse gas pollution, which is critical to Virginians' future. Energy use in buildings is one of the largest drivers of CO2 emissions in Virginia. By cutting energy usage, **full implementation of the IECC's efficiency standards without weakening amendments would reduce air pollution, including greenhouse gas pollution that is driving climate change**. DOE found that full implementation of the 2024 IECC alone would reduce carbon emissions by 6.5% compared to the 2021 IECC, and the 2021 IECC would reduce carbon emissions by 8.7% compared to the prior IECC. (Full implementation of just the 2021 IECC "**will reduce statewide CO2 emissions over 30 years by 28,420,000 metric tons,** equivalent to the annual CO2 emissions of 6,181,000 cars on the road (1 MMT CO2 = 217,480 cars driven/year).") Applying the social cost of carbon to the CO2 reductions recognizes huge economic savings from to Virginia and the U.S. [3]

Given the 50-100 lifespans of new buildings, the accumulation of more efficient buildings over years will have significant impacts on reducing future climate and other pollution. Conversely, permitting less efficient new building to be constructed under weaker building code standards will have the opposite effect: driving up pollution and climate driven harms to all Virginians.

Climate change is already harming Virginia, and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO2 and methane). Growing climate dangers include harms to communities, infrastructure, people, property and the economy from rising seas, worsening storms and more severe rainfall events. Growing dangers also include rising atmospheric and water temperatures that threaten worsening heat-related illnesses, limits on economic activity, agriculture, fisheries, and our natural heritage. The likelihood of mitigating and recovering from those harms declines the longer we delay maximizing energy efficiency and minimizing GHG pollution.

--[1] See IECC; https://basc.pnnl.gov/information/infiltration-meets-ach50-requirements ; http://passivehousebuildings.com/books/phc-2019/five-principles-of-passive-house-design-and-construction/ .

--[2] The U.S. Department of Energy and Pacific Northwest National Laboratories found that **full compliance with the 2012 IECC, including its stronger standards for wall insulation,** would save money even after considering purchase and mortgages costs and otherwise benefit residents compared to earlier standards. DOE/PNNL, National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf Subsequently, DOE found that the 2021 IECC update, which strengthened wall insulation standards again, would reduce energy use and save money over the life of the dwelling, even after considering purchase and mortgage costs. DOE/PNNL, **Cost-Effectiveness of the 2021 IECC for Residential Buildings in Virginia** (July 2021). And, DOE/PNNL found that the 2024 IECC would save money for residents even after considering purchase and mortgage costs, **Energy Savings Analysis: 2024 IECC for Residential Buildings** (Dec. 2024); https://www.energycodes.gov/national-and-state-analysis. PNNL, **National Cost-Effectiveness of the Residential Provisions of the 2024 IECC** (January 2025). See also https://www.energycodes.gov/determinations

--[3] PNNL, Impacts of Model Building Energy Codes (Nov. 2023) (estimating climate and health benefits in excess of $40,000,000,000 2010-2040 from residential energy building code). See also Notes [1][2] and PNNL report cited above.

Cost Impact: The code change proposal will increase the cost

Increasing the amount of wall insulation will somewhat increase construction costs. However, many choices affect the incremental costs, and the flexibility afforded by the Simulated Performance and ERI paths will enable builders to reduce costs.

Moreover, as discussed in the Reason Statement, **repeated findings by DOE and PNNL have shown that there is a net reduction of**

costs to residents when the IECC is fully implemented: (a) the cost increases are more than offset by the resulting energy cost savings; (b) the cost savings will last for decades and be accompanied by other important benefits, including more comfortable and healthier dwellings and greater resiliency to power outages and energy cost increases.

As found by DOE/PNNL (see notes in Reason Statement), residents will save money by keeping up with the IECC. Looking at the three IECC updates relevant to wall insulation, the savings are substantial.

Savings from Full Adoption of 2024, 2021 and 2012 IECC

National or Virginia Average	Life-cycle Cost Savings
Nat'l – Full 2024 IECC Savings CZ 4, 3 & 5	CZ4 -$3,790 CZ3 - $2,509 CZ5 - $2,496
VA - Full 2021 IECC Savings	$8,376
VA- Full 2012 IECC Savings	$5,836

Energy cost savings over time are critical to defining "affordability" of housing.

- By reducing residents' occupancy costs (including utilities) and making dwellings more resilient, the 2024 IECC's energy efficiency requirements will make housing more affordable for owner-occupants and tenants for decades, not just at a buyer's closing date.
- H2227 which requires a decision based on savings and other benefits over time compared to construction costs, not by just looking at construction costs.
- State and federal laws and policies define "affordability" in terms of occupancy costs, including mortgages, rents and utility costs.
- Insulation represents only a small component of total construction costs. Insulation represents 0.017 of the cost of construction, according to a published survey. *"How Much Does It Cost To Build A House In 2023?"* https://www.forbes.com/home-improvement/contractor/cost-to-build-a-house/ Yet, unlike other housing construction costs, energy efficiency saves money for residents during many years of occupancy, making housing more affordable.
- There are programs in Virginia to assist low-income residents with costs of downpayments, mortgages and rents and to subsidize builders' construction of low-income housing. *See* JLARC, *Report to the Governor and the General Assembly, Affordable Housing in Virginia 2021.*

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HOME IMPROVEMENT CONTRACTOR HOW MUCH DOES IT COST TO BUILD A HOUSE?

How Much Does It Cost To Build A House?

Audited & Verified: Dec 22, 2023, 7:55am

Written By **Nick Cellucci**
Contributor
& 2 others



Sunnye Paris / Forbes Home

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Many house hunters grapple with whether to buy or build a home. The national average cost to build a house is about **$329,000**, not including land. That can range from as little as **$42,000** to more than **$900,000** depending on factors including house type and size, where you build, the current demand for labor and materials and how you choose to customize your home.

Let's break down those costs and how to budget for a home build so you can decide the best route for you.

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Lot costs range between $3,000 to $150,000, with wide variation due to size and location.

To save money on a new home consider purchasing an already developed lot, a prefabricated home, building upward instead of outward, pay for a stock home plan or be your general contractor.

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AVERAGE COST TO BUILD A HOUSE

Lowest Cost	$42,000
Highest Cost	$900,000
Average Cost	$329,000

New House Cost Per Square Foot

Building a new house costs an average of **$150 per square foot**. The price per square foot to build a house varies by ZIP code, so your location will cause that number to fluctuate. You can use an online building cost estimator to help you predict the average cost to build a house per square foot for the area you want to build in.

However, it's worth noting that the cost per square foot only covers the house itself. There are other costs associated with house building to plan for, such as purchasing and finishing a lot.

New House Cost Per Bedroom

When determining how much it would cost to build a house, consider the number of bedrooms you want to include. Every additional room in your floor plan will add to the home's square footage, increasing the total price. The table below breaks down the typical square footage and average building cost of homes based on the number of bedrooms they have.

NUMBER OF BEDROOMS	TYPICAL HOME SIZE	AVERAGE COST
2	800 - 1,500 square feet	$122,000
3	1,000 - 2,500 square feet	$147,000
4	1,900 - 2,600 square feet	$285,000
5	2,500 - 3,500 square feet	$375,000

Home Building Cost Breakdown

If you use an online cost-to-build-a-house calculator, you'll notice that construction materials and labor combined account for about **90%** of the typical budget. These broad categories can be broken down into many distinct categories to give you a better sense of where your money will go in a project.

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HOME BUILDING TASK	AVERAGE COST
Plot price	$3,000 - $150,000
Water and sewer inspections	$8,400
House plans	$500 - $20,000
Construction project management fees	$3,000 - $52,000
Building permits	$1,200 - $2,000
Off-site living accommodations (1 - 2 years' rent)	$20,500 - $41,000
Impact fee or local charges	$3,000
Excavation	$1,400 - $5,400
Foundation	$8,900
Framing	$20,000 - $50,000

See More

Pre-Construction Costs

There are several costs to account for before construction even begins. An entire team of professionals is involved in preparing, testing and inspecting the lot and the utilities the home will need to connect to. Plans and designs need to be drawn up and permits obtained. All these costs will add up, so let's break them down so you know what to expect.

Plot Price

To start your project, you'll likely work with a realtor to find and purchase a lot. Costs typically range anywhere from **$3,000 to $150,000**, with wide variation due to size and location. The cost to build a house if you already own the land may be significantly lower.

Water, Sewage and Other Inspections

If you purchase an unfinished lot, it will need to be connected to sewers and water lines, as well as the electrical grid, cable lines and other utilities. These connections will need to be professionally inspected, which costs about **$8,400**.

House Plans or Architectural Fees

With a lot secured, you'll need to buy or create plans for your house. You can hire an architect to design your home's floor plan for roughly 10% of the total cost of your new house. This typically amounts to between **$2,000 and $20,000**. You can also save by working on your house plans with a draftsperson instead for an average of only **$1,700**.

Alternatively, you can purchase a stock blueprint online for as little as **$500**. While more affordable, this route comes with its own challenges. Your house may not feel unique, and customizing stock plans to suit your needs can be difficult and will increase your overall costs.

Construction Management Fees

Hiring a general contractor and construction manager to oversee your project and the various professional laborers involved will account for a combined **15% to 35%** of your total project cost, typically ranging anywhere from **$3,000 to $52,000**.

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Off-Site Living Expenses

Building a house starts with finding and purchasing land and doesn't conclude until the final interior touches are done. From start to finish, expect a timeline of one to two years. During this time, you'll incur living expenses and will need to arrange for off-site accommodations once construction gets underway.

If you don't have a place to stay during construction, you'll need to plan costs for housing, which can add thousands to your total.

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House Exterior Material Costs

Exterior costs include landscaping and land preparation, plus any materials that contribute to a property's structure as well as its overall look and feel on the outside.

Excavation

Construction starts with clearing the land, which adds an average of **$2,300** to your budget if the land hasn't been prepped for building as it typically is in a housing development.

Foundation

Laying the foundation for a new home typically costs about **$8,900**. It can be as simple as a concrete slab, but if you opt to build out a basement it will come with increased costs. The cost of your new home's foundation will vary depending on its size, as foundation costs **$4 per square foot on average**.

Framing

A house's frame gives it shape to support walls, windows, doors and roofing. It is typically made of solid lumber, though homes in warmer climates often use cinder blocks. Expect to pay a house framer between **$7 and $16 per square foot** for an average total of **$20,000 to $50,000**.

Roofing

The total cost of the roof for a home depends mostly on the type of roofing material you choose. The typical roof is made of asphalt shingles and costs an average of **$8,500, or $1.50 to $5.50 per square foot**, including installation.

Siding

Exterior siding provides an attractive and durable way to weatherproof a home's walls. The total cost to install siding on a newly built home ranges from about **$2 to $9 per square foot**. Luxury materials like stone and brick can more than triple the square foot cost, though.

Driveway

It costs about **$4,400** on average to add a paved driveway connecting your new house to the road. You can save by opting for a gravel driveway instead, which averages about **$1,500 for labor and materials**.

Landscaping

You can hire a landscape architect for **$70 to $150 per hour** to transform the construction zone around your new home into an outdoor space with real curb appeal. This can include sod grass or landscaping stones, trees, gardens and other features. Most people spend around **$8,200** on the cost of landscaping a totally new property or revamping an existing one.

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Home Interior Material Costs

All the materials used to cover the interior of a house's frame and furnish its rooms will add to your total project cost as well. Each of these costs will ultimately depend on the size of the home you build, your personal style and whether you opt for high-end or budget products.

HVAC

A home HVAC system costs anywhere from **$5,000 to $34,000**. This includes central AC, a furnace and all associated ductwork. The larger your home, the more expensive your system is likely to be.

Plumbing

The cost to install plumbing throughout the entirety of an average-sized new home ranges from **$1,500 to $17,500**. Costs will vary depending on the plumbing materials used, with PVC pipes costing much less than copper, for example.

Electrical

Expect to pay between **$7,000 and $13,000** for the cost to hire an electrician to install wiring, outlets, switches and electrical panels throughout a newly built home.

Insulation

Insulation will help maintain your home's indoor temperature year-round, keeping it comfortable. It will also regulate the home's energy efficiency to save you money over time, though you'll first have to spend **$3,000 to $10,000** on the upfront cost to have insulation installed during a new build.

Drywall

It costs about **$2.25 per square foot** or **$15,550** on average to have various types of drywall installed throughout a newly built home. The cost of drywall is calculated per square foot or per panel, so expect to pay more the larger your home.

Doors and Windows

For every window you install in your home, expect to spend as low as **$150** or up to **$1,500 each** depending on the style and type of window you prefer to use for each space. Meanwhile, interior doors will cost **$250 each** while exterior doors range from **$400 to $3,500 each**.

Cabinets and Countertops

The cost to install cabinets in your home's kitchen and bathrooms can range from **$100 to $1,230 per linear foot** and will largely depend on whether you choose a stock or custom product. The same goes for the cost of countertop installation, where the price can range anywhere from **$10 to $150 per square foot** depending on the type of material you choose.

Trim

Installing trim throughout a house will cost about **$1,500 on average**. To strike the best balance between pricing and quality of workmanship, research several local finishing carpenters to compare quotes and reviews.

Flooring

New flooring installation costs range from **$1 per square foot** for synthetic materials like laminate up to **$10 per square foot** or more for natural solid hardwood plank. You'll likely use a mixture of different flooring materials throughout your home, such as carpeting in bedrooms and ceramic tile in kitchens and bathrooms, so your total cost will vary dramatically depending on the choices you make and the size of each area.

Paint

How much you spend on the cost of interior house painting depends not just on the size of your home, but on whether you have the patience to do it yourself. You can keep costs as low as **$300** if you paint everything yourself, while professional costs can escalate to **$28,000** for particularly large homes with lots of painted trim and molding.

Fixtures

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Unless you're bringing them with you from a previous home, your new home will also need a new refrigerator, dishwasher, laundry washer and dryer and other appliances. Expect purchase and installation for these to cost **$3,000 to $15,000** total depending on the features you want for each machine.

Furniture

The final step in designing your new home is furnishing each room with stylish, comfortable chairs, tables, dressers, beds, couches and more. Depending on the size of your home, you should budget **$20,000 to $80,000** for all the furniture you'll need.

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Price to Build a House by State

The state you build in has a huge impact on the cost of a new home, as does the specific region within that state. Metropolitan areas tend to have higher local labor costs, while more rural areas often come with the cost of installing a private septic system or a long driveway. Average costs to build a home in each state are listed in the table below, but treat these as simply a starting point.

STATE	AMOUNT	STATE	AMOUNT
Alabama	$267,620	Montana	$298,960
Alaska	$421,080	Nebraska	$210,900
Arizona	$295,580	Nevada	$334,140
Arkansas	$251,800	New Hampshire	$299,900
California	$405,440	New Jersey	$376,900
Colorado	$299,300	New Mexico	$290,940
Connecticut	$345,440	New York	$360,180
Delaware	$327,060	North Carolina	$301,500
Florida	$263,640	North Dakota	$212,500
Georgia	$273,860	Ohio	$222,480

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Payment Options for Building a New House

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Explore Options

How to Save Money on Building a House

When you decide to build your own house, your budget dictates what you can get done. If you're working with limited funds to create your dream home, use the following tips to save without sacrificing your vision or quality.

Purchase an already developed lot. Developed lots come with all utility hookups and are generally clean and ready to build without extra preparation.

Pay for a stock home plan. Rather than hire an architect and incur another professional's fees, you can find a stock plan online that matches your vision.

Stick to prefabricated homes. Modular properties with prefabricated components are assembled mostly off-site in a factory, reducing on-site labor costs.

Build upward instead of outward. Adding another story to your design can decrease your home's footprint and reduce certain costs such as that of laying the foundation.

Budget for the unexpected. Whatever your budget, make sure about 20% of it is a buffer to account for unforeseen expenses.

Be your own general contractor. This tip only applies to highly experienced individuals who understand construction, building codes, timelines and hiring.

Frequently Asked Questions (FAQs)

Is it cheaper to buy a house or build it?

Is $300,000 enough to build a house?

How much money should I have saved to build a house?

What are the disadvantages of building a house?

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DOE Zero Energy Ready Home (Revision 07) (https://basc.pnnl.gov/library/doe-challenge-home-national-program-requirements)

Exhibit 2 DOE Zero Energy Ready Home Target Home.
The U.S. Department of Energy's Zero Energy Ready Home program allows builders to choose a prescriptive or performance path. The DOE Zero Energy Ready Home prescriptive path requires builders to meet or exceed the minimum HVAC efficiencies listed in Exhibit 2 of the National Program Requirements (Rev 07), as shown below. The DOE Zero Energy Ready Home performance path allows builders to select a custom combination of measures for each home that is equivalent in performance to the minimum HERS index of a modeled target home that meets the requirements of Exhibit 2 as well as the mandatory requirements of Zero Energy Ready Home Exhibit 1.

Exhibit 2, Insulation and Infiltration) Whole house leakage must be tested and meet the following infiltration limits:

- Zones 1-2: ≤ 3 ACH50;
- Zones 3-4: ≤ 2.5 ACH50;
- Zones 5-7: ≤ 2 ACH50;
- Zone 8: ≤ 1.5 ACH50;
- Attached dwellings: ≤ 3 ACH50.

Footnote 23) Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.

How to Determine Infiltration

Building envelope leakage should be determined by an approved verifier using a testing protocol approved by the Residential Energy Services Network (RESNET). Whole-house air leakage testing is conducted with a blower door test.

Climate zones are based on the Climate Zone Map, which can be found in the 2015 International Energy Conservation Code (2015 IECC Figure R301.1):

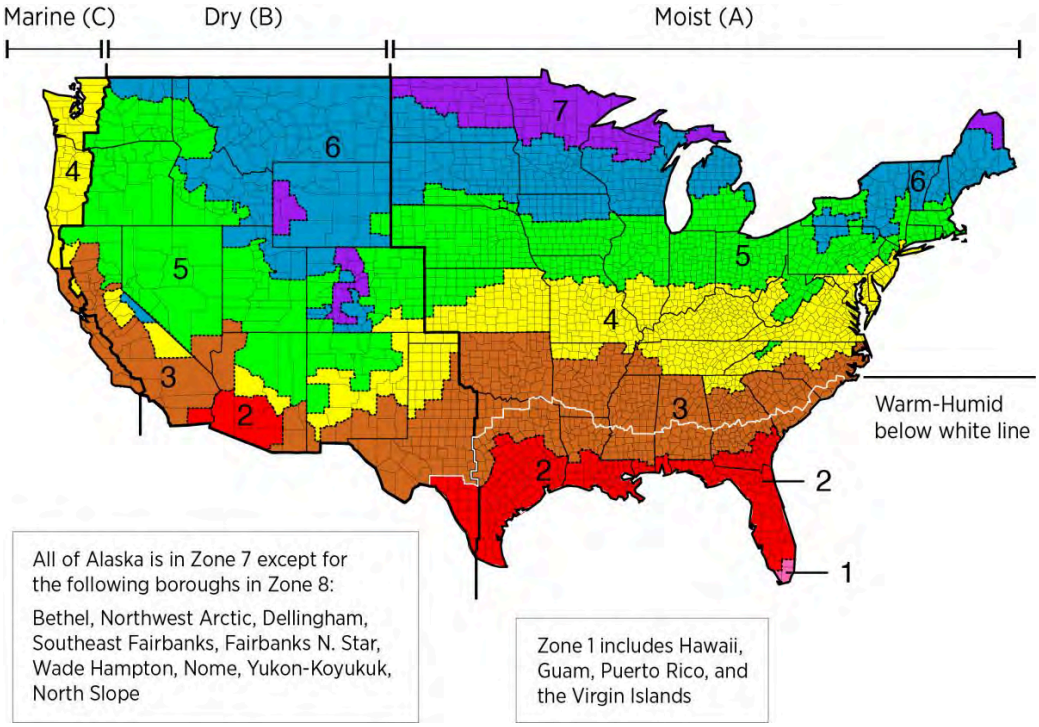


Figure 1. *IECC climate zone map.*

More Info

References and Resources*

DOE Zero Energy Ready Home National Program Requirements (https://www.energy.gov/eere/buildings/doe-zero-energy-ready-home-zerh-program-requirements)

Author(s): *U.S. Department of Energy*
Organization(s): *DOE*
Publication Date: *December, 2022*

Website listing implementation timelines and links to various versions of the DOE Zero Energy Ready Home national program requirements.

**For non-dated media, such as websites, the date listed is the date accessed.*

Last Updated: 2019-07-29

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Model Energy Code Determinations

DOE is required by the Energy Conservation and Production Act (ECPA), as amended, to review published editions of the national model energy codes—ANSI/ASHRAE/IES Standard 90.1 and the International Energy Conservation Code (IECC)—and issue a *determination* as to whether the updated edition will improve energy efficiency in commercial and residential buildings, respectively. DOE is provided 12 months to conduct its review and publish its determination in the Federal Register after the updated model code is published. ECPA also requires States to review and/or update their energy codes following the publication of an affirmative DOE determination.

Latest Versions

COMMERCIAL: ANSI/ASHRAE/IES STANDARD 90.1-2022

DOE issued a determination (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001) that Standard 90.1-2022 will achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in commercial buildings of approximately:

- 9.8 percent *site* energy
- 9.4 percent *source* energy

- 8.9 percent *energy cost*

Additional information related to this action, including the official *Federal Register* publication, is available at Regulations.gov (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001).

State Certification

Upon publication of an affirmative determination, ECPA requires States to certify that they have reviewed the provisions of their commercial building code regarding energy efficiency, and, as necessary, updated their codes to meet or exceed the updated edition of Standard 90.1. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. The **State Certification** (/state-status/state-certifications) **deadline for Standard 90.1-2022 is March 06, 2026.**

Supporting Analysis

DOE conducted a technical analysis in support of its determination. This analysis assesses Standard 90.1 compared to the previous edition and estimates the associated savings impacts.

Federal Statute for Commercial Buildings

With each new edition of ANSI/ASHRAE/IES Standard 90.1, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in commercial buildings (42 U.S.C. 6833):

> *(2)(A) Whenever the provisions of ASHRAE Standard 90.1-1989 (or any successor standard) regarding energy efficiency in commercial buildings are revised, the [DOE] Secretary shall, not later than 12 months after the date of such revision, determine whether such revision will improve energy efficiency in commercial buildings. The [DOE] Secretary shall publish a notice of such determination in the Federal Register.*
>
> *(B)(i) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed and updated the provisions of its commercial building code regarding energy efficiency in accordance with the revised standard for which such determination was made. Such certification shall include a demonstration that the provisions of such State's commercial building code regarding energy efficiency meet or exceed such revised standard.*
>
> *(ii) If the [DOE] Secretary makes a determination under subparagraph (A) that such revised standard will not improve energy efficiency in commercial buildings, State commercial building code provisions regarding energy efficiency shall meet or exceed ASHRAE Standard 90.1-1989, or if such standard has been revised, the last revised standard for which the [DOE] Secretary has made an affirmative determination under subparagraph (A).*

RESIDENTIAL: 2024 INTERNATIONAL ENERGY CONSERVATION CODE

On December 20, 2024, DOE issued a determination (https://www.regulations.gov/document/EERE-2024-BT-DET-0007-0001) that the 2024 International Energy Conservation

Code (IECC) will improve energy efficiency in residential buildings. In support of this determination, DOE conducted a technical analysis evaluating the impacts of the updated code (relative to the previous 2021 IECC edition). DOE estimates national savings of approximately:

- 7.8 percent *site* energy savings
- 6.8 percent *source* energy savings
- 6.6 percent *energy cost* savings

Additional information related to this action, including the official Federal Register publication and docket containing public comments received, is available at Regulations.gov (https://www.regulations.gov/docket/EERE-2024-BT-DET-0007).

State Certification

Upon publication of an affirmative determination, States are required to certify that they have reviewed the provisions of their residential building code regarding energy efficiency, and made a determination as to whether it is appropriate for them to revise their code to meet or exceed the updated edition of the IECC. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. **State certifications** (/state-status/state-certifications) **for the 2024 IECC must be submitted by December 30, 2026.**

Supporting Analysis

DOE published a technical analysis in support of its determination. This analysis assesses the 2024 IECC compared to the previous edition and estimates the associated savings impact.

Federal Statute for Residential Buildings

With each new edition of the IECC, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in residential buildings. (42 U.S.C. 6833):

> *(5)(A) Whenever the CABO Model Energy Code*, 1992, (or any successor of such code) is revised, the [DOE] Secretary shall, not later than 12 months after such revision, determine whether such revision would improve energy efficiency in residential buildings. The [DOE] Secretary shall publish notice of such determination in the Federal Register.*
>
> *(B) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed the provisions of its residential building code regarding energy efficiency and made a determination as to whether it is appropriate for such State to revise such residential building code provisions to meet or exceed the revised code for which the [DOE] Secretary made such determination.*
>
> **As a predecessor to the ICC, the Council of American Building Officials (CABO) was responsible for development of the Model Energy Code (MEC). Contemporary energy codes are referred to and published as the International Energy Conservation Code (IECC)®.*

Previous Determinations

Previous DOE determinations (https://www.energycodes.gov/previous-determinations) surrounding building energy codes are available for reference by states and local governments, as well as other interested stakeholders.

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National and State Analysis

National Analysis

Pacific Northwest National Laboratory (PNNL) assesses recent editions of the model codes to quantify the associated energy & cost savings. This analysis confirms the cost-effectiveness of updated editions of the model codes across U.S. climate zones, providing critical information during state and local adoption processes. The following national analyses are currently available:

Commercial

- National Cost Effectiveness of Standard 90.1-2022
- National Cost Effectiveness of Standard 90.1-2022 Workbook
- National Cost Effectiveness of Standard 90.1-2019
- National Cost Effectiveness of Standard 90.1-2019 Workbook
- National Cost Effectiveness of Standard 90.1-2016
- National Cost Effectiveness of Standard 90.1-2016 Workbook
- Energy and Energy Cost Savings Analysis of the 2021 IECC for Commercial Buildings
- Energy and Energy Cost Savings Analysis of the 2018 IECC for Commercial Buildings

Residential

- National Cost Effectiveness of the 2024 IECC
- National Cost Effectiveness of the 2021 IECC
- National Cost Effectiveness of the 2018 IECC
- HERS Index Values Corresponding to the IECC

State Analysis

Pacific Northwest National Laboratory (PNNL) assesses recent editions of the model codes to quantify the associated energy & cost savings. These analyses take into account varying state-level conditions, such as incremental costs, utility rates, climatic conditions and construction trends. The residential analyses are customized based on current state energy codes. The following state analyses are currently available:

State Cost-effectiveness Analysis Reports

State	Commercial	Re
Alabama	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Alaska	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Arizona	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Arkansas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
California*		

State	Commercial	Re
Colorado	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Connecticut	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Delaware	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
District of Columbia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Florida	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Georgia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Hawaii	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20
Idaho	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Illinois	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20

State	Commercial	R
Indiana	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Iowa	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Kansas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Kentucky	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Louisiana	ASHRAE 90.1-2019 ASHRAE 90.1-2013	2 2 2
Maine	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Maryland	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2
Massachusetts	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2

State	Commercial	R
Michigan	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	M 20 20 20
Minnesota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Mississippi	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Missouri	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Montana	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Nebraska	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Nevada	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20
New Hampshire	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20

State	Commercial	Re
New Jersey	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
New Mexico	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
New York	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
North Carolina	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
North Dakota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Ohio	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20
Oklahoma	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Oregon	ASHRAE 90.1-2019	20
Pennsylvania	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20

State	Commercial	R
Rhode Island	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
South Carolina	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
South Dakota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
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Texas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Utah	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Vermont	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Virginia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Washington*		

State	Commercial	R
West Virginia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Wisconsin	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013*	2 2 2
Wyoming	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2

**Deviates from model codes*

State Fact Sheets

Adopting the 2021 IECC for residential buildings and ASHRAE Standard 90.1-2019 for commercial buildings will save energy and money. These state fact sheets provide an overview of the expected benefits to homeowners and building owners.

Alabama	Louisiana	Ohio
Alaska	Maine	Oklahoma
Arizona	Maryland	Oregon
Arkansas	Massachusetts	Pennsylvania
California*	Michigan	Rhode Island
Colorado	Minnesota	South Carolina
Connecticut	Mississippi	South Dakota
Delaware	Missouri	Tennessee

Florida	Montana	Texas
Georgia	Nebraska	Utah
Hawaii	Nevada	Vermont
Idaho	New Hampshire	Virginia
Illinois	New Jersey	Washington*
Indiana	New Mexico	Washington, DC
Iowa	New York	West Virginia
Kansas	North Carolina	Wisconsin
Kentucky	North Dakota	Wyoming

**Deviates from model codes*

Local Fact Sheets

Adopting the 2021 IECC for residential buildings and ASHRAE Standard 90.1-2019 for commercial buildings will save energy and money. These local fact sheets provide an overview of the expected benefits to homeowners and building owners.

Atlanta	Des Moines	Miami
Baltimore	Grand Rapids	Minneapolis
Baton Rouge	Houston	Oklahoma City
Birmingham	Las Vegas	Pittsburgh
Boise	Lexington	Richmond
Columbia	Little Rock	Salt Lake City

Columbus	Madison	

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The White House (https://www.whitehouse.gov/)

Open Gov (https://www.energy.gov/open-government)

Accessibility (https://www.energy.gov/cio/accessibility-standard-statement)

Privacy (https://www.energy.gov/about-us/web-policies/privacy)

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Passive House Design

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Passive house design is a construction concept that focuses on energy efficiency, comfort, and affordability. This method of building incorporates a holistic approach, emphasizing the importance of a comfortable and healthy living environment that consumes minimal energy. The passive house, or "*passivhaus*" in German, has become a strict global standard for sustainable architecture, gaining popularity among homeowners and builders alike.

One of the core aspects of passive house design is the integration of prefabricated components, which helps to streamline the construction process while maintaining a high level of quality control. Prefabricated elements contribute to the overall efficiency and performance of the building by ensuring airtight construction, continuous insulation, and optimized windows for maximum energy savings.

Adhering to passive house principles ensures that buildings are designed in a way that maximizes their energy efficiency and minimizes their environmental impact. This approach not only offers long-term financial benefits for homeowners through lower energy bills, but also contributes to a greener and more sustainable future.

What Is Passive House?



Defining Passive House

Passive House, or Passivhaus, is a design and construction concept that aims to create highly energy-efficient, comfortable, and sustainable buildings. The passive house movement originated in Germany, when a German physicist developed the concept based on principles of passive solar design. Passive House design has now spread to North America and other parts of the world, gaining popularity among those who value energy efficiency and sustainable living.

The Passive House certification is a strict set of standards designed to ensure that buildings meet the requirements for energy efficiency, thermal comfort, and indoor air quality. Some key principles of this approach include super-insulated building envelopes, airtight construction, and optimized window orientation for solar gain. By implementing these design strategies, passive houses can significantly reduce their energy consumption, paving the way towards net zero energy buildings.

Passive House vs Traditional House

The primary difference between passive houses and traditional houses lies in their approach to energy management. While traditional homes typically depend on active heating and cooling systems to maintain comfortable interior environments, passive houses rely on a combination of passive design strategies and mechanical ventilation with heat recovery systems to both minimize energy use and ensure a consistent indoor temperature.

In a passive building, the focus lies on smart design and construction techniques to reduce the need for additional heating or cooling, ultimately leading to a lower overall energy demand. This results in reduced greenhouse gas emissions, lower energy bills, and a healthier living environment for occupants.

Additionally, passive houses tend to have a longer lifespan due to the high-quality, durable materials and construction methods used in their design. This contributes to the sustainability aspect of the passive house movement, as buildings designed to last longer can help reduce the overall environmental impact of construction.

In summary, passive house design is an innovative approach to creating sustainable, energy-efficient buildings that prioritize occupant comfort and environmental responsibility. By incorporating passive design principles, such as super-insulation, airtight construction, and solar optimization, passive

houses can offer significant advantages in terms of energy use, durability, and long-term cost savings.

Design Factors for Passive Houses

Orientation and Shading

In passive house design, proper **orientation** of the building is crucial for optimizing daylighting and controlling solar radiation. Windows should be strategically placed to maximize natural light and maintain a comfortable temperature indoors. South-facing windows capture abundant sunlight during the winter months, while north-facing windows minimize direct sunlight during hot summer days. Overhangs, awnings, and other shading strategies should also be incorporated into the design to prevent overheating in the summer and allow passive solar heating in the winter.

Building Envelope

A high-performance building envelope is essential in passive house design. It consists of continuous insulation, airtight construction, and thermal bridge-free design. Continuous insulation helps maintain a consistent temperature inside the building by minimizing heat transfer through the walls, roof, and floor. Airtight construction prevents unwanted drafts and air leaks, leading to improved indoor air quality and reduced energy consumption. Thermal bridge-free design eliminates heat loss at connection points between building components, further enhancing energy efficiency.

In addition to the insulation and airtightness, passive houses often use high-performance windows and doors to minimize energy losses. These windows and doors provide superior insulation, air tightness, and solar heat gain control, ensuring a comfortable interior environment throughout the year.

By focusing on these key design factors, passive houses can achieve improved energy efficiency, comfort, and overall sustainability.

Heating, Cooling, and Ventilation

Mechanical Systems

In a passive house design, the mechanical systems play a crucial role in maintaining a comfortable and energy-efficient environment. Heating and cooling in such designs primarily come from passive sources such as solar gain or internal sources like appliances and occupants.

For heating, the use of high-efficiency boilers and radiators is common. A good option is the integration of a Mitsubishi VRF Heat Pump, a variable-refrigerant flow heat pump that modulates the amount of refrigerant sent through the system, saving energy by circulating the minimum refrigerant needed for each individual zone.

Ventilation Systems

One of the key aspects of passive house design is providing fresh air while maintaining energy efficiency. Balanced mechanical ventilation systems are essential to achieve this. These systems consist of separate supply and exhaust airflows, delivering fresh air to living areas and removing stale air from kitchens, bathrooms, and utility spaces.

There are two types of mechanical ventilation systems commonly used in passive house designs – Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV). Both systems work by exchanging heat between incoming and outgoing air, minimizing the energy required for heating or cooling the fresh air.

Heat Recovery

Heat recovery is a crucial feature in passive house design, and it plays a significant role in reducing energy consumption. It can be achieved through different techniques, but two of the most common ones are Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV).

ERV systems not only exchange heat but also manage humidity, transferring moisture between the incoming and outgoing air to maintain a comfortable humidity level. On the other hand, HRV systems focus solely on heat exchange.

Both ERV and HRV systems minimize the need for additional heating and cooling, making them an essential component in achieving high energy efficiency in a passive house design.

Prefab passive house designs often include these mechanical and ventilation systems pre-installed to ensure a professional and efficient implementation of these critical elements, maintaining the required energy efficiency and high indoor air quality standards.

Key Construction Aspects in Passive Houses

Airtightness

One of the primary components in passive house design is airtightness. Ensuring airtight construction reduces air infiltration and prevents drafts. This is essential for maintaining optimal temperature and humidity levels, providing a comfortable indoor environment. Airtight construction also helps

to prevent condensation and mold growth, which can lead to health issues for occupants.

Proper sealing of doors, windows, and other potential air leaks is crucial for maintaining airtightness. This can be achieved through the use of high-quality tapes, seals, and caulking materials. Additionally, attention to detail during the design and construction process can help to minimize thermal bridges, ensuring a more comfortable and energy-efficient living space.

Insulation

In passive house design, emphasis is placed on providing well-insulated building envelopes. This includes continuous insulation throughout the walls, roofs, and floors, which prevents heat transfer and minimizes energy consumption. Insulation materials vary, but they generally have a high R-value, indicating the effectiveness of the material in reducing heat flow.

Prefab passive house construction often utilizes panels with pre-installed high-performance insulation, ensuring a higher degree of precision and efficiency during the construction process. By incorporating prefabrication, passive houses can be erected quickly and with a higher level of quality control.

Windows and Doors

Windows and doors in passive houses are designed to minimize heat loss and maximize natural light. High-performance windows and skylights are essential components for achieving these goals. These windows must meet specific performance standards, with stringent requirements for insulation, airtightness, and solar heat gain properties.

Additionally, passive house windows and doors are strategically placed to take advantage of passive solar design principles, capturing sunlight and heat during the winter months while reducing overheating during the summer. To further enhance energy efficiency, windows are often triple-glazed, and frames

are designed to minimize thermal bridges. This attention to detail is necessary to meet the strict criteria required to achieve passive house certification.

Indoor Air Quality

Air Quality and Ventilation

In a passive house design, indoor air quality is a critical consideration, especially in airtight buildings which rely on mechanical ventilation. To maintain a healthy environment, passive house designs often incorporate highly efficient ventilation systems that work continuously to circulate and filter air. These systems draw in fresh outdoor air and expel contaminated indoor air, thereby improving indoor air quality[1].

A common misconception about passive house designs is that their airtight nature would lead to poor air quality. However, the airtight design helps reduce air leakages and provides greater air control[2]. This is particularly beneficial for occupants who may be sensitive to outdoor air pollution or odors.

Moisture and Condensation Control

To provide adequate moisture control, passive house designs also focus on preventing condensation and managing indoor humidity levels. A combination of strategies, such as using materials with low vapor permeability in the building envelope, installing high-performance windows, and promoting good air circulation, help to minimize this issue.

In addition to exterior moisture control measures, mechanical ventilation systems equipped with heat recovery features help remove excess moisture and maintain balanced indoor humidity levels[3]. This reduces the risk of condensation and the potential growth of mold or other moisture-related issues inside the home.

By prioritizing indoor air quality, moisture control, and ventilation, passive house designs create a comfortable and healthy living environment while significantly reducing overall energy consumption.

Footnotes

1. Indoor Air Quality in Passivhaus Dwellings: A Literature Review ↩
2. Air Control in Passive House Architecture ↩
3. Designing an HVAC System for a Passive House ↩

Passive Houses and Climate Change

Passive house design is an innovative approach to building residential and commercial structures that prioritize energy efficiency and minimize their carbon footprint. The primary goal is to reduce the overall environmental impact of buildings and help mitigate the effects of climate change.

One significant aspect of passive houses is their focus on prefabricated construction methods. This method not only saves time and resources during the process but also ensures that the design and insulation systems are

accurately implemented, minimizing any loss of energy during the construction phase [Phius Zero is the goal].

By employing the five fundamental principles of passive house design – continuous insulation, airtight construction, optimized windows, balanced ventilation, and minimal mechanical systems – these buildings can achieve a significant reduction in carbon emissions and energy consumption. This results in a lower operational carbon footprint and a positive contribution to mitigating climate change.

An added benefit of incorporating passive house design is the potential for significant financial savings on energy bills. The high level of insulation and airtightness minimizes the need for heating and cooling systems, leading to lower energy consumption and reduced costs. This energy efficiency also translates into a decreased demand for fossil fuels, which in turn helps reduce greenhouse gas emissions.

In conclusion, passive houses play an essential role in the fight against climate change by promoting energy-efficient and environmentally friendly construction practices. Their focus on prefabricated design, coupled with their low energy consumption and reduced carbon emissions, makes them a critical component in the move toward a more sustainable built environment.

Types of Passive Houses

Single-Family Homes

Prefabricated passive single-family homes are becoming increasingly popular due to their energy efficiency and sustainable features. These homes are built using high-quality insulation, airtight construction, and carefully designed ventilation systems to minimize heat loss and maintain a comfortable indoor environment. New construction for single-family homes offers the opportunity

to incorporate passive house principles from the start, while retrofit projects can help improve energy efficiency in existing homes as well.

Residential Apartment Buildings

Multifamily apartment buildings can also benefit from passive house design principles. These structures focus on providing comfortable living spaces for multiple families while minimizing energy consumption and reducing operating costs. Prefabricated passive apartment buildings use continuous insulation, efficient windows, and well-designed ventilation systems to optimize energy usage. Both new construction and retrofit projects can incorporate these principles to help create sustainable and comfortable living conditions for apartment residents.

Schools

Schools are another area where passive house design can play a significant role in creating efficient and healthy learning environments. Through the use of continuous insulation, superior windows, and efficient mechanical ventilation systems, schools can greatly reduce their energy consumption and improve indoor air quality. In addition to new construction projects, existing schools can also benefit from retrofits that implement passive house principles, creating a significantly more sustainable and comfortable learning environment for students and staff alike.

Testing and Quality Assurance

In passive house design, ensuring a high level of energy efficiency and comfort is crucial. One of the essential aspects to achieving this goal is conducting rigorous testing and quality assurance procedures throughout the design and construction process. A focus on prefab construction adds another layer of complexity to the process, making quality assurance even more vital.

One of the most critical tests conducted in passive house design is the **airtightness test**. This test is essential for verifying the effectiveness of the building's insulation and minimizing heat loss. During a prefab construction project, airtightness is a vital component since it ensures that all elements of the building are effectively sealed and any thermal bridges are minimized.

To measure a building's airtightness, a **blower door test** is typically conducted. This test involves mounting a large fan onto an exterior door and depressurizing the building. While the fan is operating, professionals can identify any air leaks or breaches in airtightness, allowing them to address these issues before they become more significant problems. By conducting blower door tests during the construction of a prefab passive house, builders can ensure that airtightness is achieved, and the building functions as a true passive design.

In addition to airtightness testing, passive house projects can benefit from a stringent Quality Assurance and Quality Control (QA/QC) program conducted on site. For example, the Passive House Institute of the U.S. PHIUS+ Certification program includes a thorough passive house design verification protocol combined with rigorous QA/QC inspections. These inspections are performed by highly skilled and specialized PHIUS+ Raters and Verifiers, helping to maintain the building's high-performance standards.

In summary, a successful passive house design not only relies on effective energy-saving principles but also on rigorous testing and quality assurance

processes. By conducting thorough airtightness tests such as blower door tests and implementing on-site QA/QC inspections, prefab passive house projects can achieve energy efficiency and maintain high-performance standards.

Frequently Asked Questions

What are the key principles in a passive house design?

A passive house design focuses on energy efficiency, comfort, and affordability. The key principles include airtightness, high-quality insulation, thermal bridge-free construction, and efficient HVAC systems, to create a building that consumes minimal energy while maintaining a comfortable indoor environment. Passive houses rely on prefabricated components to maintain consistency and precision in the building process.

How does climate influence passive house design?

Climate plays a significant role in passive house design, as the building envelope and systems need to be tailored to the specific climatic conditions of the building's location. Passive houses in colder climates require thicker insulation, while those in warmer climates need features like overhangs and shading devices to keep the interior cool. Designing a passive house requires climate-specific optimization to ensure the greatest possible energy efficiency and comfort.

What are the main benefits of a passive house?

The main benefits of a passive house include reduced energy consumption, lower utility bills, healthier indoor air quality, and minimized carbon emissions. Passive houses are designed to be energy-conscious and provide superior comfort to their occupants through excellent insulation, airtightness, and an advanced HVAC system.

How does passive house design reduce energy consumption?

Through a combination of airtight construction, highly efficient insulation, and a design that takes advantage of solar gains and natural ventilation, passive houses can significantly reduce energy consumption. The advanced HVAC systems used in passive houses also contribute to energy reduction by recovering heat from exhaust air and using it to pre-heat incoming fresh air.

What challenges are faced during the passive house certification process?

The passive house certification process is rigorous and requires meeting strict energy efficiency and comfort standards. One challenge faced during the certification process is ensuring that the building is designed and constructed to meet these standards, including eliminating thermal bridges and providing airtightness. Another challenge is accurately modeling the building's energy performance and verifying the performance through on-site testing and inspections.

Do passive houses have a higher construction cost?

While the construction cost of passive houses can be higher initially due to the need for high-quality materials, advanced systems, and skilled labor, the long-term energy savings often offset these expenses. The reduced energy consumption associated with passive houses leads to lower utility bills and a reduced carbon footprint, making them an attractive investment for homeowners concerned with both financial savings and environmental impact.

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Public Comments (PCH) for: REC-R402.1.2(4)-24

Discussion by Mark Graver

Dec 23, 2025 21:24 UTC

Building technology continues to result in creative and intelligent solutions to the core challenges related to construction. New technologies and materials are created to move the industry forward. One of these core challenges is insulation and related to this, environmental effects related to moisture, air flow, and heat loss/gain. Despite the many methods of construction, conventional framing is generally where "cavity" insulation occurs. Voids have to be filled to address heat loss/gain, moisture has to remain on the outside and expelled from the building interior. Industrial processes have brought us a wide range of insulation types, constantly being refined to create better thermal resistance. The industry has adapted for 100 years from the times of filling these voids with newspaper, straw, and other flammable and inefficient materials. Those days are well behind us, and insulation products continue to advance in new and unexpected ways. However, the basics have not changed for decades. Rigid insulation panels have been in use for over 40 years. Fiberglass batts have been in use for even longer.

Because this proposal does not seek to incorporate a new and affordable technology, and because this proposal is not based on better production standards, leading to more thermally resistant products, the proposal is mission creep. There is a core duty that code professionals must uphold: regulation must be rational, measured, and calculated. A standard that continues to change due to mission creep is not a standard at all, it's a moving target based on ever changing passions of regulators. Regulations exist for the benefit of the persons served. As such, a regulation such as this, with such a high initial cost for conventionally framed structures, would increase the cost of a home to a degree that would not serve the average citizens of the Commonwealth of VA. Regulations are most effectively administered and accepted when they represent minimum standards. If the initial cost of construction is too high, the industry and the citizens of the Commonwealth will be harmed. As a counterweight, the building industry could be subsidized to temporarily stabilize a market in the event that a regulation creates too much pressure, but creating a need for subsidies is not proper stewardship.

Retaining a standard that has been in place since the 2012 edition should not be seen as a problem, but should be seen as a sign of stability. Though the building industry is forced to adapt to other irrational standards, stability, where it can be maintained, is preferred. The amended VA code that is in effect is the correct, most rational standard that meets the intended and stated purpose of the VA USBC for minimum standards. At this time, adopting a different standard is nothing more than mission creep.

Proposal # 1350

REC-R402.1.2(4)-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Deletes the existing Virginia amendment to the wall insulation requirement and defaults to the 2024 IECC requirements (R-20 or R-13+5c.i. or R-15c.i. in CZ 3; and R-30 or R-20+5c.i. or R-13+10c.i. or R-20c.i. in CZs 4 & 5).

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second and third Energy Sub-Workgroup meetings on September 29, 2025, and November 14, 2025, respectively.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith

- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Bill P provides an overview of his proposal noting that it is substantively identical to **Eric Lacey's** wall-insulation proposal. He noted that since other proposals covering the same topic areas may be tabled from the October 3rd General Stakeholder Workgroup Meeting, this proposal may need to be tabled, too, while proponents work toward a consensus proposal.

> **Florin Moldovan** (DHCD staff) noted, with regard to tabling proposals from the October 3rd General Stakeholder Workgroup Meeting, that staff will table proposals at the request of the proponent and encouraged those entertaining tabling a proposal inform staff as soon as possible so stakeholders can be notified ahead of the October 3rd meeting.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor

- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Bill P informed the group that no discussion was necessary as the success of this proposal depends on other proposals already discussed.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Justin Koscher, PIMA; Sydney Roberts, SEEA; and Jason Vandever, NAIMA.

Opposition: Andrew Clark, HBAV; Mark Graver, City of Waynesboro and VBCOA Region III; Kyle Kratzer, Fairfax County and VBCOA; and Rick Hinson, American Council of Engineering Companies (ACEC).

Discussion:

Bob S declared that this proposal is very similar to the last proposal and did not see a need for discussion because the talking points would be the same.
Jeff B announced that if everyone wants to stand on their previous comments, this proposal will be marked as Non-Consensus.

DHCD Staff Notes:

- This proposal conflicts with proposal REC-R402.1.2-24, which was reviewed by stakeholders at the third GSW meeting on January 5, 2026, where it received a Non-Consensus recommendation.
- This proposal is substantively identical to proposal REC-R402.1.2(2)-24, which received a Non-Consensus recommendation at the January 5, 2026 GSW meeting. The excerpt from the January 5, 2026, meeting summary pertaining to REC-R402.1.2(2)-24 is provided below.

January 5, 2026, GSW Meeting Summary Excerpt

Support: Bob Shippee, Sierra Club; Justin Koscher, PIMA; Sydney Roberts, SEEA; and Jason Vandever, NAIMA.

Opposition: Andrew Clark, HBAV; Mark Graver, City of Waynesboro and VBCOA Region III; Kyle Kratzer, Fairfax County and VBCOA; and Rick Hinson, ACEC.

Discussion:

Eric L provided an overview of the proposal.

a. **Bob S** commented that upfront costs exist, but the payback is quick and is a huge net positive.
b. **Justin K** raised the concern that Virginia is several code cycles behind the current model codes, and these changes are real savings to homeowners. **Justin K** also expressed that it is not realistic to believe that homeowners have the power to influence insulation requirements when purchasing a new home because those decisions are made well in advance of the buyer taking possession of the home and it is disingenuous to suggest that home buyers can just go out and buy efficiency.
c. **Sydney R** pointed out that the payback period is only nine years.
d. **Jason V** stated that a better building envelope makes the house more comfortable which could allow an owner to adjust the thermostat to a degree or two.
e. **Andrew C** reiterated his stance that the upfront costs of homeownership outweigh energy efficiency cost increases that payoff in the future. Market demand is surging at price points that these proposals collectively are making infeasible to build.
f. **Kyle K** representing himself, expressed support for proposal REC-R402.1.2-24 as opposed to this proposal because of where Virginia is regarding construction prices.

REC-R402.4.1.2-24

VRC: N1102.4.1.2, N1102.4.1.3; VCC: 1301.1.1.1

Proponents: Eric Lacey, representing Responsible Energy Codes Alliance (eric@reca-codes.com)

2021 Virginia Residential Code

Delete without substitution:

N1102.4.1.2 (R402.4.1.2) Testing. The building or *dwelling unit* shall be tested and verified as having an air leakage rate not exceeding 5 air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779, or ASTM E1827 and reported at a pressure of 0.2 inches w.g. (50 Pa). A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be conducted by a Virginia licensed general contractor, a Virginia licensed HVAC contractor, a Virginia licensed home inspector, a Virginia registered design professional, a certified BPI Envelope Professional, a certified HERS rater, or a certified duct and envelope tightness rater. The party conducting the test shall have been trained on the equipment used to perform the test. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

Note: Should additional sealing be required as a result of the test, consideration may be given to the issuance of temporary certificate of occupancy in accordance with Section 116.1.1.

During testing:

1. Exterior windows and doors and fireplace and stove doors shall be closed, but not sealed beyond the intended weather stripping or other infiltration control measures;
2. Dampers, including exhaust, intake, makeup air, backdraft, and flue dampers shall be closed, but not sealed beyond intended infiltration control measures;
3. Interior doors, if installed at the time of the test, shall be open;
4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed;
5. Heating and cooling systems, if installed at the time of the test, shall be turned off; and
6. Supply and return registers, if installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the *dwelling unit* enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch water gauge (50 Pa), shall be permitted in all climate zones for:

1. Attached single- and multiple-family building *dwelling units.*
2. Buildings or *dwelling units* that are 1,500 square feet (139.4 m^2) or smaller.

Mechanical *ventilation* shall be provided in accordance with Section M1505 of this code or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of *ventilation*.

N1102.4.1.3 (R402.4.1.3) Leakage rate. When complying with Section N1101.2.1 (R401.2.1), the building or *dwelling unit* shall have an air leakage rate not exceeding 5 air changes per hour in Climate Zones 3 through 5, when tested in accordance with Section N1102.4.1.2 (R402.4.1.2).

2021 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the *International Energy Conservation Code* (IECC). The following changes shall be made to the IECC :

19. Change Section R402.4.1.2 of the IECC to read:

R402.4.1.2 Testing. The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be conducted by a Virginia licensed general contractor, a Virginia licensed HVAC contractor, a Virginia licensed home inspector, a Virginia *registered design professional*, a certified BPI Envelope Professional, a certified HERS rater, or a certified duct and envelope tightness rater. The party conducting the test shall have been trained on the equipment used to perform the test. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

Note: Should additional sealing be required as a result of the test, consideration may be given to the issuance of a temporary certificate of occupancy in accordance with Section 116.1.1 .

During testing:

1. Exterior windows and doors and fireplace and stove doors shall be closed, but not sealed beyond the intended weatherstripping or other infiltration control measures.
2. Dampers, including exhaust, intake, makeup air, backdraft and flue dampers, shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, if installed at the time of the test, shall be open.
4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open.

20. Change Section R402.4.1.3 of the IECC to read:

R402.4.1.3 Leakage rate. When complying with Section R401.2.1 , the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 3 through 5, when tested in accordance with Section R402.4.1.2 .

Reason Statement: This proposal would improve the efficiency and durability of residential buildings and help maintain healthier indoor air quality by incorporating the air leakage testing requirements of the 2024 IECC into Virginia's code. Since the 2012 edition, the IECC has required all new residential dwellings in Virginia's climate zones to be tested and to verify a maximum total envelope leakage of 3.0 ACH50. However, Virginia did not adopt a testing requirement until the 2018 edition of the VCC, and set the maximum leakage allowance at 5.0 ACH50. That requirement remained unchanged in the 2021 VCC update, even though the 2021 IECC adopted additional flexibility that allows code users several alternatives for meeting the air tightness requirements. We believe Virginia is ready to catch up with the IECC envelope air leakage requirements. A well-sealed, verified thermal envelope will provide energy savings and promote better indoor air quality over the 70- to 100-year useful life of the home.

This proposal intends to delete the VA-specific amendments in order to incorporate the 2024 IECC air leakage testing requirements as published. This would result in the following changes:

1. All new dwelling units would be required to be air leakage tested, but the maximum allowable leakage for prescriptive compliance would improve from 5.0 ACH50 to 3.0 ACH50 in all Virginia climate zones.

2. The performance path baseline (R405) would be set at 3.0 ACH50, but dwellings could test as high as 5.0 ACH50 as long as efficiency losses are accounted for in other efficiency improvements. This allows considerable flexibility for code users who still find it challenging to achieve 3.0 ACH50, while maintaining the same overall efficiency required by the code.

3. Multifamily dwelling units (of any size) and buildings with 1500 square feet or less of conditioned floor area have the option to be tested to 0.27 cfm/min/ft2 of testing unit enclosure area. This will help address the challenges of achieving low ACH in smaller dwellings.

Cost Impact: The code change proposal will increase the cost It is possible that some additional time or materials will be required to achieve the lower air leakage number; however, we note that the largest cost is typically the cost of the blower door test itself, which is already required under the VA UCC.

Public Comments (PCH) for: REC-R402.4.1.2-24

Discussion by Mark Graver

Dec 23, 2025 20:37 UTC

While not impossible, significant challenges are encountered when trying to improve the air leakage rate of conventionally framed buildings. Changing the standard from 5 ACH to 3 ACH is mission creep. This is because building technology has not appreciably evolved for wood-framed construction, and it likely never will without adding significant cost in the way of joint treatments. Conventionally framed buildings have many series of joints from the top to the bottom that all allow for air infiltration. Such buildings require joint treatments that are extremely prone to failure. Additionally, some joints in floor, wall and roof systems must permit the passage of air to protect against rot and decay. Sealing such joints to achieve an irrational metric can cause structural problems. With the introduction of fresh air into the building being a requirement due to building leakage requirements anyway, it is difficult to see where the justification for adopting more stringent requirements lies.

Ultimately, the cost for this change is passed onto consumers who are already finding it increasingly difficult to purchase new homes. Many Virginians, even now, are priced way outside of the housing market. The increase in cost is not justifiable, and considering that Virginia already has a standard, 5 ACH, there is no reason to pursue this requirement any further at this time. All of the areas already prone to infiltration are already being targeted and treated with sealants and other products to comply with the current requirement. The result of increasing the requirement would thus be more troubleshooting, more callbacks, more testing, more fraudulent reports, and more band-aid repairs that don't last. The troubling thing about the troubleshooting and the callbacks is that it may take several technicians and repeated trial and error until a contractor finally identifies the root of the problem. Increasing the requirement will only exacerbate the problem. All of this adds up to construction delays and a major increase in cost to every contractor involved in the project. This increase in cost is passed on to all of the citizens that we serve.

Proposal # 1324

Submitted Via Email to codedevelopment@dhcd.virginia.gov

April 3, 2026

Louie Berbert, Chair
Virginia Board of Housing and Community Development
600 East Main Street, Suite #300
Richmond, VA 23219

RE: RECA Comments Supporting the Adoption of the 2024 *IECC* for Residential and Commercial Construction in Virginia and Recommending Additional Improvements

Dear Chairman Berbert,

The Responsible Energy Codes Alliance[1] submits these comments in support of the proposed incorporation of the 2024 International Energy Conservation Code (*IECC*) into Virginia's Uniform Statewide Building Code (USBC) for residential and commercial construction. We have been active participants in the current and previous USBC updates and we support the important work of the Department of Housing and Community Development (DHCD) to help ensure safe, affordable, and efficient construction and renovation in the Commonwealth. **As with the 2021 update, the 2024 *IECC* provides cost-effective, energy saving improvements that will benefit Virginians for generations.**

In addition to our general support for the improvements approved through the stakeholder process, we write specifically to recommend two additional changes that have been part of the model energy code for several cycles, but which Virginia has never adopted: (1) We recommend adopting the full wall insulation requirements of the 2024 *IECC*, or at a minimum, the proposed compromise advanced by the Virginia Building Code Officials Association (VBCOA); and (2) we recommend an incremental improvement to envelope air tightness requirements to bring long-term energy saving and comfort benefits to homeowners.

Energy and Cost Savings of the 2024 *IECC*

Adopting the 2024 *IECC* residential provisions will make homes more affordable and comfortable for Virginians, and adopting the *IECC* commercial provisions (including the

[1] RECA is a national coalition of building products manufacturers, trade associations, environmental groups, regional efficiency advocates and other organizations that support the adoption of the latest model energy codes across the country.

alternative to comply with *ASHRAE* Standard 90.1-2022) will help protect businesses against unprecedented increases in energy costs. For the last two decades, the *IECC* has improved in efficiency with every new edition. According to the U.S. Department of Energy, the 2024 *IECC* will reduce energy bills by an average of 6.6% over the 2021 *IECC*.[2] Likewise, buildings constructed to *ASHRAE* Standard 90.1-2022 will cost an average of 8.9% less to operate than buildings constructed to *ASHRAE* Standard 90.1-2019.[3] (Standard 90.1 is incorporated as a compliance option in the commercial chapter of the *IECC*, and the energy savings figures for the *IECC*-Commercial Provisions and Standard 90.1 are typically similar.) As indicated in the summary table of DOE findings below, the owners and occupants of both residential and commercial buildings in Virginia stand to benefit from substantial cost savings with the adoption of the most recent editions of the model codes.

Comparison of Unamended Model Code Energy Cost Savings					
Residential (2024 *IECC*)[4]			**Commercial (*ASHRAE* 90.1-2022)[5]**		
Climate Zone	Energy Cost Savings over 2021 *IECC*	30-year Cost Savings over 2021 *IECC*	Climate Zone	Energy Cost Savings over 90.1-2019	30-year Cost Savings over 90.1-2019
3	**6.08%**	**$2,509**	**3**	**8.9%**	**$1.35/sq.ft.**
4	**6.79%**	**$3,790**	**4**	**9.8%**	**$1.32/sq.ft.**
5	**5.53%**	**$2,496**	**5**	**10.1%**	**$1.38/sq.ft.**

Efficient Homes are Affordable Homes. Home affordability is an important consideration in any code update process, and it is well-documented that homes constructed to the full 2021/24 *IECC* requirements—including the insulation and air sealing requirements—will provide more comfort and lower energy bills for occupants, and these codes have been repeatedly demonstrated to be cost-effective to the consumer.[6] Unlike some

[2] *See* U.S. Dep't of Energy, *Energy Savings Analysis: 2024 IECC for Residential Buildings*, at iv (Dec. 2024).
[3] *See* U.S. Dep't of Energy, *ANSI/ASHRAE/IES Standard 90.1-2022: Energy Savings Analysis,* at vii (Feb. 2024), available at https://energycodes.gov/sites/default/files/2024-02/Standard_90.1-2022_Final_Determination_TSD.pdf.
[4] *See* U.S. Dep't of Energy, *Energy Savings Analysis: 2024 IECC for Residential Buildings*, at iv (Dec. 2024), available at https://energycodes.gov/sites/default/files/2024-12/2024_*IECC*_Determination_TSD.pdf.
[5] *See* U.S. Dep't of Energy, *ANSI/ASHRAE/IES Standard 90.1-2022: Energy Savings Analysis,* at 24, 27 (Feb. 2024), available at https://energycodes.gov/sites/default/files/2024-02/Standard_90.1-2022_Final_Determination_TSD.pdf.
[6] *See, e.g.*, U.S. Dep't of Energy, *National Cost-Effectiveness of the Residential Provisions of the 2024 IECC* (Jan. 2025) (finding an average of $2,954 in savings over 30 years in new residential homes constructed to the 2024 IECC, with an average simple payback period of 2.5 years).

equipment and other components of the building that must be replaced on a regular basis, elements of the thermal envelope such as insulation will last many decades, providing long-term benefits for homeowners. Although we acknowledge the interest of homebuilders and developers in keeping costs low during construction, that interest must be balanced against the owner/occupant's interest in keeping operating costs low over the next 100 years. The most cost-effective time to insulate homes and commercial buildings is at construction, and it is crucially important that Virginia set efficiency requirements that make sense over the expected lifetime of each new home, and not just at the construction phase.

RECA Recommendation 1: Update Residential Wall Insulation Requirements Consistent with the *IECC*.

Virginia currently allows 75% less efficient walls than the 2021/24 *IECC*. In the 2012 USBC update cycle, Virginia elected to not adopt the wall insulation requirements of the 2012 *IECC*, and has not made any improvements in wall insulation requirements since then. Based on U.S. Census data, we estimate that over 250,000 single family homes have been constructed in Virginia since 2012,[7] and all of these homes were not subject to the insulation requirements set through the consensus-based national model code development process. Wall insulation efficiency improved in both the 2012 and 2021 *IECC* updates—neither of which has been adopted by Virginia, despite proposals submitted by RECA and other stakeholders in every code update cycle to meet the national standard.

We recommend that the Board approve Proposal REC-R402.1.2(2)-24 to incorporate the full wall insulation requirements of the 2024 *IECC*. If the Board would prefer to phase in these requirements over multiple code cycles, we recommend adopting Proposal **REC-R402.1.2-24 (as modified)**, which was submitted by VBCOA and is supported by a wide range of stakeholders. This proposal would allow Virginia to catch up to the 2012 *IECC* insulation requirements and would also correct a technical flaw in Virginia's current wall insulation requirement that could lead to durability issues over time.[8] It is important that Virginia act now to improve the thermal envelope of new homes before another 250,000 homes are built to a lesser standard.

RECA Recommendation 2: Update Residential Envelope Air Tightness Requirements Consistent with the *IECC*.

In the 2018 USBC update, Virginia adopted a requirement that each new home receive a blower door test ≤5 ACH50, which had not been required in previous editions of the USBC.

[7] *See* https://www.census.gov/construction/bps/index.html.

[8] Virginia's current prescriptive wall insulation requirement includes an option for an R-13+1c.i. wall assembly, which could increase the risk for condensation within the wall cavity. We believe either the 2024 IECC wall insulation R-value options or the modified proposal REC-R402.1.2-24 would adequately address this technical problem.

While this was a substantial improvement, it was still weaker than the full *IECC* requirement of ≤3 ACH50. Every edition of the *IECC* since 2012 has required new homes to be tested to ≤3 ACH50, but the 2024 *IECC* provides a number of exceptions and workarounds for smaller dwelling units and multifamily buildings that we believe will allow additional flexibility to help homebuilders achieve the improved efficiency. We recommend that the Board approve Proposal **REC-R402.4.1.2-24 to incorporate the full air leakage testing requirements of the 2024 *IECC*.**

In reality, the only significant cost of meeting the envelope air leakage target has already been incorporated into Virginia's USBC—the cost of the test itself. As code users have become more experienced with air sealing techniques and best practices, we have observed improvements in envelope tightness across the country. We are confident that Virginia code users will have no problem achieving ≤3 ACH50 at little to no extra cost, and for smaller dwelling units or complicated designs, the 2024 *IECC* provides several alternatives.[9] We recommend that Virginia adopt the air tightness testing requirement as published in the 2024 *IECC*.

Conclusion

RECA's members and supporters have been involved in energy code development and adoption for decades, and we offer our assistance and experience as you work to maximize energy efficiency in residential and commercial buildings. Please contact us if you have any questions or would like to discuss how RECA can be of assistance.

Sincerely,

Eric Lacey
RECA Chairman

[9] *See* Section R402.5.1.3 of the 2024 *IECC*.

RECA is a broad coalition of energy efficiency professionals, regional efficiency organizations, product and equipment manufacturers, trade associations, and environmental organizations with expertise in the development, adoption, and implementation of building energy codes nationwide. RECA is dedicated to improving the energy efficiency of homes throughout the U.S. through greater use of energy efficient practices and building products. It is administered by the Alliance to Save Energy, a non-profit coalition of business, government, environmental and consumer leaders that supports energy efficiency as a cost-effective energy resource under existing market conditions and advocates energy-efficiency policies that minimize costs to society and individual consumers. Below is a list of RECA Members that endorse these comments.

Air Barrier Association of America

Alliance to Save Energy

American Chemistry Council

American Council for an Energy-Efficient Economy

CertainTeed LLC

EPS Industry Alliance

Extruded Polystyrene Foam Association

Institute for Market Transformation

Johns Manville Corporation

Knauf Insulation

National Fenestration Rating Council

Natural Resources Defense Council

North American Insulation Manufacturers Association

Owens Corning

Polyisocyanurate Insulation Manufacturers Association

REC-R402.4.1.2-24 – Staff Summary

Proponent: Eric Lacey, representing Responsible Energy Codes Alliance

Brief Description: Deletes the existing Virginia amendment related to air leakage testing and the allowable leakage rate, and defaults to the 2024 IECC requirements.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at each one of the three Energy Sub-Workgroup meetings on July 9, 2025, September 29, 2025, and November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — July 9, 2025:

- Steve Shapiro
- Sydney Roberts
- Mike O'Connor
- Corian Carney

- Dennis Hart
- D.A. Pierce
- Chelsea Harnish
- Stuart Nuckols
- Mason Trimble
- Bill Penniman
- Mike Rhodes
- Eric Lacey
- William Drumeller
- Hana Nguyenky
- Sarah Thomas
- Andrew Clark

Other stakeholders in attendance — July 9, 2025:

- Nicholas Bowles – Building Official, Nottoway County
- Kyle Kratzer – Virginia Building and Code Officials Association
- Mike Hamilton – Arlington County
- Bill Riggs – Viridiant
- Bob Shippee – Virginia Citizen
- Susan Stillman – Virginia Citizen
- Jason Vandever – North American Insulation Manufacturers Association
- Monica Rokicki – Better Building Works

Discussion:

- **Eric** - Proposal removes the VA-specific air-leakage rate amendment, moving from 5 ACH to the national 3 ACH target.
- **Monica** - Very rarely do homes we test fail 5 ACH; many are at three or lower. Supports.
- **Andrew** - Are other states seeing downsides to 3 ACH? At some point, do you over-correct?
    - **Eric** – Worked with Maryland builders two cycles ago, and they were concerned with coming down to 3 ACH. We came up with a solution using the performance path to allow them to go up to 5 ACH, which became known as the 'Maryland Compromise' that made it into the code.
    - **Sydney** – Can try to get some data on performance across states to bring to a future meeting. SEEA does energy code field studies, and the data is dated, but it might be worth looking at. Important to keep in mind that if we pull on a string here, it impacts a string over here. We just had a conversation about increasing wall insulation values. If the process leads to better insulated walls and we don't also decrease infiltration, then we're going to end up with mold, mildew, and rotten walls. They need to work on parallel paths. Spray foam is obviously one path, but there are a lot of other techniques used in the Southeast.

    - **Andrew** – The field studies would be helpful.
    - **Chelsea** – That field study was conducted prior to the requirement for blower door testing. While the code permitted a maximum air leakage allowance, we still had visual inspections and so that data was used to help us push for blower door testing for air leakage, which we now have. So that data would be outdated.
- **William D** – We test a lot of houses and I will tell you that conventional foundations with fiberglass all the way around are testing 4 ACH and into the 5's. A lot of the builders that we encounter are upset with the current code requirements. I would love to see a 3 ACH requirement because those are all spray foamed houses. Spray-foamed houses always test 2.5 ACH or less. We tested one the other day at .7 ACH. I would predict a lot of pushback from Andrew's group for this. As a practical matter, it has been very difficult for builders to get up to speed. I'm a 30-year general contractor so I sympathize with where they are coming from. I like what Eric is trying to do, but I'm telling you, from a practical matter it might be tricky.
- **Bill P** – Supports Eric's proposal. The 3 ACH requirement has been around since the 2012 IECC. They haven't adjusted it because it's too hard to meet. The IECC provides additional flexibility now, so you can get by with 4 ACH when using the Simulated Building Performance path or the ERI path. It's time for Virginia to catch up.
- **Eric** – Correcting something I said earlier, the 2024 IECC allows you to trade up to 4 ACH, not 5. The 2021 allowed 5 ACH.
- **William D** – Just based on what I see and the learning curve from these builders out there, it strikes me that 4 ACH is the next stop. The builders are happy now, they are passing, and they are learning. If you go straight to 3 ACH now, that seems like a lot.

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)

- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Eric L presented proposal REC-R402.4.1.2-24, which adjusts blower-door testing targets for small dwelling units and addresses tester qualifications.

Steve S said his groups have no position on this proposal and asks whether this code change, which references attached multi-family developments, belongs in the Residential provisions of the VECC.

> **Eric L** responded that his proposal would include dwelling and sleeping units detached or are located in R-2 occupancies, so it could be 3-story, garden style apartments.
>
> **Steve S** states that those occupancies are outside of the scope of the Residential provisions of the VECC.
>
> **Florin Moldovan** (DHCD staff) clarified that the amendment falls under the Residential portion of the IECC and therefore applies to all residential occupancies up to three stories, including both R-2 multifamily and single-family homes. If this proposal were to be approved by the Board for inclusion in the USBC, there would be provisions that fall within Chapter 4 of the VECC and Chapter 11 of the Virginia Residential Code (VRC), as there are provisions that would impact single-family dwellings.

Andrew G endorsed the change, noting that small units often struggle to meet the current air-leakage target because the requirement is scaled to building volume, favoring large homes. Notes that Virginia needs to provide flexibility for smaller dwelling units to achieve this standard.

Monica R agreed, stating that tighter targets are harder for small enclosures.

Dennis H said the most pressing issue is who performs the tests; qualifications should be defined. Noted that, compared to the model code language, Virginia's language is more stringent and should be maintained.

Eric L responded that he is open to specifying tester credentials.

Andrew G added that some referenced certifications are being phased out.

Monica R warned against allowing installers (e.g., insulation or mechanical contractors) to test their own work, citing conflict-of-interest concerns.

Eric L noted a similar compromise was reached on duct-leakage testing and is willing to pursue one here.

Bill P indicated support for this and a related proposal submitted by himself on behalf of Sierra Club - VA Chapter, suggesting possible consolidation.

Florin M asked **Eric L a**nd **Bill P** to consider merging or withdrawing duplicative submissions to reach a single consensus proposal.

Justin K inquired whether jurisdictions keep approved lists of third-party testers.

D.A. Pierce said Roanoke requires testers to complete a registration form before testing.

Steve S explained that "approved" simply means accepted by the local building department; the code mandates a third-party policy in general, but not a formal roster or list of approved third-party testers.

Andrew G noted that some localities do maintain such lists.

Florin M notes that the next proposal, REC-R402.4.1.2(1)-24, authored by **Bill P** and which was not officially announced, is similar to **Eric L's** proposal, REC-R402.4.1.2-24, both in content and in scope.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant

- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Eric L provided an overview of the proposal which deletes Virginia specific amendments to the air leakage requirements with the intent to incorporate the 2024 IECC testing requirements.

D.A. Pierce expanded that this proposal is for R-5 use occupancies, which in Virginia are single-family and two-family dwelling homes including townhouses, and R-3 in Virginia for residencies in a mixed occupancy building. VBCOA supports this for R-5 occupancies only and requested that the proposal is amended.

Jeff Brown (DHCD staff) clarified that as written, the proposal is eliminating the requirements in this section in the Virginia Energy Conservation Code (VECC) which applies to anything under the International Residential Code (IRC), as well as low-rise residential under the VECC. The testing requirements would apply in the Virginia Residential Code (VRC) to R-5 and the VECC to other R-use groups that fall within the low-rise residential guidelines.

Florin M suggested that it could be beneficial for the Board if **D.A.** could clarify why this proposal is acceptable for a single-family home but not an R-3.

Bill P asked what is an R-3 that is not an R-5.

Florin M provided townhouses over three stories in height, as an example, which are commonly classified as R-3.

Sydney R supported the proposal and stressed that smaller units are at a disadvantage in the 2021 Virginia codes because the ratio of volume per square footage changes as the unit gets smaller and would be at an advantage if the 2024 IECC language were adopted.

Scott P was opposed and preferred the Virginia amendments.

Eric L pointed out that the primary cost of blower door testing is the test itself and that is already in Virginia's code. Going from 5 to 3 air changes per hour are not going to require extra or new materials and Virginia builders are probably already achieving this. Trading off the air leakage in the performance path would be allowed with the 2024 IECC language.

Andrew G concluded that this proposal gives flexibility that would be good for the industry moving forward. The real cost for a tighter home is installing the ventilation system and testing.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Bob Shippee, Sierra Club; Sydney Roberts, SEEA; and D.A. Pierce, VBCOA Energy Committee.

Opposition: Steve Shapiro, AOBA and VAMA; Andrew Clark, HBAV; Mark Graver, City of Waynesboro and VBCOA Region III; and Rick Hinson, American Council of Engineering Companies (ACEC).

Discussion:

Eric L provided an overview of the proposal.

a. **Sydney R** stressed that for the durability advantages to a tighter building envelope as insulation is increased, there also needs to be an increase in air tightness to keep the humid air out of building cavities. This is a risk mitigation measure for home builders.
b. **Steve S** stated that he has been collaborating with **Eric L** on some things that might be able to be worked out. He noted that he will continue to work with **Eric L** prior to the Board meeting and remove their opposition if they are able to work out the issues. **Andrew C** echoed **Steve S's** comments.
c. **D.A. Pierce** inquired if the proponent was open to adding an allowance for four air changes per hour for climate zones three through five for single- and two-family dwellings as an exception.
d. **Mark G** commented that rarely are blower door test results below three air changes, and to achieve that would require a significant number of callbacks to contractors to discover where the source of the leak is coming from.

DHCD Staff Note:

This proposal is substantially identical to proposal REC-R402.4.1.2(1)-24, which was also reviewed by stakeholders at the third GSW meeting on January 5, 2026, and received a Non-Consensus recommendation. No additional discussion occurred regarding REC-R402.4.1.2(1)-24 as stakeholders stood on the statements they made regarding REC-R402.4.1.2-24.

REC-R402.4.1.2(1)-24

VCC: 1301.1.1.1

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2021 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the *International Energy Conservation Code* (IECC). (Portions of code section not shown remain unchanged.) The following changes shall be made to the IECC :

19. ~~Change Section R402.4.1.2 of the IECC to read:~~

    R402.4.1.2 Testing. ~~The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be conducted by a Virginia licensed general contractor, a Virginia licensed HVAC contractor, a Virginia licensed home inspector, a Virginia *registered design professional*, a certified BPI Envelope Professional, a certified HERS rater, or a certified duct and envelope tightness rater. The party conducting the test shall have been trained on the equipment used to perform the test. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.~~

    Note: ~~Should additional sealing be required as a result of the test, consideration may be given to the issuance of a temporary certificate of occupancy in accordance with Section 116.1.1 .~~

    ~~**During testing:**~~

    1. ~~Exterior windows and doors and fireplace and stove doors shall be closed, but not sealed beyond the intended weatherstripping or other infiltration control measures.~~
    2. ~~Dampers, including exhaust, intake, makeup air, backdraft and flue dampers, shall be closed, but not sealed beyond intended infiltration control measures.~~
    3. ~~Interior doors, if installed at the time of the test, shall be open.~~
    4. ~~Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.~~
    5. ~~Heating and cooling systems, if installed at the time of the test, shall be turned off.~~
    6. ~~Supply and return registers, if installed at the time of the test, shall be fully open.~~

20. ~~Change Section R402.4.1.3 of the IECC to read:~~

    R402.4.1.3 Leakage rate. ~~When complying with Section R401.2.1 , the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 3 through 5, when tested in accordance with Section R402.4.1.2 .~~

Reason Statement: The purpose of this proposal is to bring Virginia's standards for air leakage rates into compliance with the 2024 IECC.

Virginia needs to adopt the IECC's 3.0 ACH (or 3 ACH50) air leakage standard, which has been in the national code since the 2012 IECC update. There is no valid reason for Virginia to continue a prescriptive air leakage standard that dates back to 2009.

The 2024 IECC is the fifth consecutive IECC to set the prescriptive standard for Virginia's climate zones at a maximum of 3.0 ACH. The IECC would not have repeatedly prescribed a 3.0 ACH maximum if actual experience had demonstrated that

compliance was either impractical or raised costs or burdens that outweighed the benefits. The IECC has had four cycles, since 2012, to raise the ACH from 3.0 to 5.0, but it has not done so.

Tightening building air sealing to 3.0 ACH is important to residents—both owners and tenants--, since it would help them save money, and experience greater comfort and a healthier home for decades after the dwelling is built. Virginia's 5.0 ACH standard allows 67% more air changes per hour than the IECC's 3.0 ACH standard.

Tightening prescriptive construction standards to 3.0 ACH will help to

(a) reduce occupancy costs, including for heating and conditioning of air in the dwelling,
(b) reduce exposure to mold that can build up in walls,
(c) increase residents' comfort,
(d) increase physical and economic resiliency to power outages, climate change and rising energy prices,
(e) reduce gaps for pests to enter the dwelling,
(f) reduce pressure on utilities to raise rates in order to build and operate more energy delivery capabilities, and
(g) reduce the air pollution that drives climate impacts and other harms to Virginia's health, property and economy.

It is noteworthy that, while the 2024 IECC retains the 3.0 ACH prescriptive standard, It also **offers builders some flexibility to trade efficiency measures, including to allow up to 4.0 ACH of air leakage, when implementing Simulated Building Performance and ERI implementation methods. However, the 2024 IECC's addition of trading flexibility is premised on full adoption of the IECC's prescriptive baseline code, including 3.0 ACH.**

Legal Standards. Remaining at 5.0 ACH level would leave Virginia's building code out of compliance with statutory standards. **Sections 36-99A and 36-99B of the Virginia Code make clear that building codes are required to "protect the health, safety and welfare of the residents of the Commonwealth" and that adjustments to reduce construction costs must nevertheless be "consistent with recognized standards of health, safety, energy efficiency and water efficiency." H2227**, which was enacted in 2021, calls for adoption of energy efficiency standards that are **"at least as stringent" as the latest IECC considering factors such as consumer costs "over time" and air pollution.** VIRGINIA ACTS OF ASSEMBLY – 2021 SPECIAL SESSION I, CHAPTER 425, Section 1 (referred to herein as "H2227"). Thus, like energy costs over time, pollution is a named factor to be considered in connection with building code efficiency standards.

Broad Consensus. There is a broad consensus among recognized standards that tighter sealing of walls protects the health, safety and welfare of residents, and some recognized programs have stricter standards, which is part of why the IECC has incorporated the 3.0 ACH prescriptive standard in five consecutive IECC cycles from 2012-2024.

In its commentary on its 2024 ACH levels for new residential construction, the ICC explains the importance of its air leakage standards: "**Insulation alone is not enough to moderate indoor temperatures. Sealing the building envelope is critical to good thermal performance of the building.** Insulation is important because it traps pockets of air creating stagnant air resistant to temperature change, but the air barrier is needed to stop the movement of air from scrubbing away those pockets of air. **Regardless of the compliance option chosen in Section R401.2, air leakage limits apply, and all air leakage requirements of this section must be met**." Citing EPA, the IECC commentary states that air leakage "can account for 25 to 40 percent of the energy used for heating and cooling in a typical residence." (ICC, 2024 IECC Code and Commentary.)

In EnergyStar: A complete Thermal Enclosure System (2017), EPA advised: "The energy savings from comprehensive air sealing can quickly add up when you consider all the places hot or cool air can enter or escape from your home. Having a well-sealed home also means better air quality because dirt, pollen, pests, and moisture can't get in as easily. In addition, good sealing practices help protect your home against mold and moisture damage that can be caused by condensation."

Even the NAHB has advised builders of the importance of air sealing and strategies to go below 3.0 ACH. See NAHB, et al., "TechNote – Building Tightness Code Compliance & Air Sealing Overview", which (a) states "Air leakage in a building should be minimized;" (b) identifies benefits to residents including ""Heating & cooling energy savings; Reduced potential for moisture movement through the building thermal enclosure; Improved insulation effectiveness and reduced risk of ice dams; Reduced peak heating and cooling loads resulting in smaller HVAC equipment; Improved comfort (reduces drafts and noise); Improved indoor air quality (limits contaminants from garages, crawl spaces, attics, and adjacent units)" and (c) suggests a possible construction strategy with a goal of 2.5 ACH – stricter than the IECC.

The feasibility of meeting a 3.0 ACH standard is underscored by the IECC's repeated adoption of 3.0 ACH for Virginia's climate zones; by its adoption of a 2.5 ACH standard for Climate Zones north of Virginia's; by use of 3.0 in the EnergyStar program; by

DOE's use of tighter standards in its net-zero ready program (2.5 ACH for CZ3-4 and 2.0 for CZ 5); and by the PassiveHouse standard of 0.6 ACH for its program.[1]

Cost and energy savings. Beginning with its review of the 2012 IECC, in which the 3.0 ACH standard was first adopted, the U.S. Department of Energy and the Pacific Northwest National Laboratories (collectively DOE) has found that residents would save money from full implementation of each IECC update from 2012-2024 even after considering incremental purchase and mortgage costs. Focusing on the three most significant IECC updates containing the 3.0 ACH standard, DOE found that, over 30 years, lifecycle savings (i.e., net of additional purchase and mortgage costs): **full implementation of the 2012 IECC** (which introduced the 3.0 ACH requirement for Virginia's climate zone) would have saved average Virginia residents **$5,836**; **full implementation of the 2021 IECC** would have save Virginia residents **$8,376**; and full implementation of the 2024 IECC would save Virginia residents of Virginia's Climate Zone 4 **$3,790 and Zones 2 and 5 an average of $2,502 compared to 2021 IECC**. Savings would have been achieved year in and year out, with rapid payback and lasting for decades. [2]

Collectively, Virginians would save billions of dollars in energy costs from full implementation of the IECC, greatly benefiting residents and Virginia's economy. In its July 2021 report on "Cost-Effectiveness of the 2021 IECC for Residential Buildings in Virginia" (PNNL-31627), PNNL found that aggregate energy cost savings for Virginia residents from adopting the full 2021 IECC would be $7,192,000 in the first year and $2,487,000,000 over 30 years. Virginia would achieve substantial pollution reductions and add jobs.

Pollution Reductions. DOE has also repeatedly found that full compliance with the IECC's updates will reduce energy use and air pollution, including greenhouse gas pollution, which is critical to Virginians' future. Energy use in buildings is one of the largest drivers of CO2 emissions in Virginia. By cutting energy usage, **full implementation of the IECC's efficiency standards without weakening amendments would reduce air pollution, including greenhouse gas pollution that is driving climate change**. DOE found that full implementation of the 2024 IECC alone would reduce carbon emissions by 6.5% compared to the 2021 IECC, and the 2021 IECC would reduce carbon emissions by 8.7% compared to the prior IECC. (Full implementation of just the 2021 IECC "**will reduce statewide CO2 emissions over 30 years by 28,420,000 metric tons,** equivalent to the annual CO2 emissions of 6,181,000 cars on the road (1 MMT CO2 = 217,480 cars driven/year).") Applying the social cost of carbon to the CO2 reductions recognizes huge economic savings from to Virginia and the U.S. [3]

The accumulation of more efficient buildings over years will have significant impacts on reducing future climate and other pollution. Conversely, allowing less efficient new building to be constructed under weaker building code standards will have the opposite effect: driving up pollution and climate driven harms to all Virginians.

Climate change is already harming Virginia, and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO2 and methane). Growing climate dangers include harms to communities, infrastructure, people, property and the economy from rising seas, worsening storms and more severe rainfall events. Growing dangers also include rising atmospheric and water temperatures that threaten worsening heat-related illnesses, limits on economic activity, agriculture, fisheries, and our natural heritage. The likelihood of mitigating and recovering from those harms declines the longer we delay maximizing energy efficiency and minimizing GHG pollution.

--[1] See IECC; https://basc.pnnl.gov/information/infiltration-meets-ach50-requirements ; http://passivehousebuildings.com/books/phc-2019/five-principles-of-passive-house-design-and-construction/ .

--[2] The U.S. Department of Energy found that full compliance with the 2012 IECC would save money and benefit residents compared to earlier standards. DOE/PNNL, National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf DOE found that the 2024 and 2021 IECC updates would reduce energy use and save money over the life of the dwelling, even after considering mortgage costs. U.S. Department of Energy, **Energy Savings Analysis: 2024 IECC for Residential Buildings** (Dec. 2024); DOE/PNNL, **Cost-Effectiveness of the 2021 IECC for Residential Buildings in Virginia** (July 2021), https://www.energycodes.gov/national-and-state-analysis. Following promulgation of the 2012 IECC, DOE found that the 2012 IECC changes improved efficiency and were cost effective for occupants because they saved money year after year for decades, more than recouping the cost of construction. DOE/PNNL, **National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC**, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf See also https://www.energycodes.gov/determinations

--[3] PNNL, Impacts of Model Building Energy Codes (Nov. 2023) (estimating climate and health benefits in excess of $40,000,000,000 2010-2040 from residential energy building codes). See Notes [1][2] and PNNL report cited above.

Cost Impact: The code change proposal will increase the cost

Bringing Virginia in line with the IECC's 3.0 ACH air leakage standards may modestly increase the cost of construction, but those costs will be outweighed by reduced occupancy costs and improved health, comfort and resiliency for residents. The excess of benefits over

costs is why the IECC has required 3.0 ACH for Virginia's Climate Zones for 5 consecutive updates: 2012-2024. (See Reason Statement, above.)

The costs of additional caulking, weather-stripping, gaskets, taping and other sealing measures are very limited, since workers will be on site, and the quantity of additional material is small. Planning, care and attention by builders during the framing, insulating and sealing processes is mainly what is needed to achieve the 3.0 ACH standard.

According to GreenBuildingAdvisor, "Once builders get their crews trained, 3 ACH50 should cost them the same as 5 or 7 ACH50." https://www.greenbuildingadvisor.com/article/how-much-air-leakage-in-your-home-is-too-much

Having had more than a decade to train their crews to seal gaps and to meet blower door tests, Virginia builders should be fully capable of meeting the 3.0 ACH prescriptive standard. In addition to the time since the IECC's 2012 adoption of 3.0 ACH, Virginia builders will have a year from the effective date of Virginia's 2024 update to adjust their construction practices to meet the long-recognized model standard.

Under the 2024 IECC, cost impacts can also mitigated by the 2024 IECC's permitting builders to go to 4.0 ACH with trading options for Simulated Performance and ERI compliance paths. However, that flexibility was premised upon full implementation of the IECC's prescriptive standards.

Achieving 3.0 ACH or better during initial construction is critical. Leaving buyers to retrofit after a house has been purchased would be very expensive since it would require the owner to reopen, close and refinish walls, replace windows and doors, etc. In addition to energy cost saving, comfort and health benefits from achieving 3.0 ACH, minimizing the need for future retrofits and repairs should be recognized as a cost benefit to residents.

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How Much Air Leakage in Your Home Is Too Much?

Whatever your air tightness goal, ACH50 isn't the best unit to measure it



By Allison A. Bailes III, PhD | April 10, 2012

Whether you want to build a new home or fix an old one, the way to ensure that you get the best performance is to do the building envelope right. That means installing the right amount of insulation and installing it well, and it means having an air barrier with minimal leakage. But how do you know when you've done enough air sealing? How tight is tight enough?

I get asked this question every once in a while, and I love to talk about the measures for air leakage anyway, so let's dive in. First, of course, you have to be able to measure how much air leakage the house has. That's what a blower door is for.

About air leakage units

First, you have to choose how you want to specify the air leakage. The most common unit used by blower door operators is ACH50, which stands for Air Changes per Hour at 50 Pascals. I prefer cfm50 per square foot of building envelope, or better, cfm50 per hundred square feet of building envelope (sfbe). (One cfm50 is a cubic foot per minute with a pressure difference of 50 Pascals between inside and outside.)

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unit, in my opinion, to express what a Blower Door is really good at — measuring the amount of air moving across the building envelope at elevated pressure.

Please don't talk to me about ACHnat ('Natural' Air Changes per Hour). I loathe that measure! If you're using a blower door, you can't measure it; the only ones who can are researchers using tracer gas analysis.

Now we're ready to discuss the actual question: How much air leakage should you aim for? OK, we're not really there yet. I lied. First, we have to know about your house. Are you building new or fixing an existing home? If the latter, what's your budget and how complex is the building envelope?

New homes

Let's start with the easier one: new construction. The first rule here is that a house can never be too tight. The Passive House program takes houses about as far as you can go with air tightness, and their threshold is 0.6 ACH50. I tested a net-zero house a couple of weeks ago that had less than 200 cfm50 of air leakage, or about 0.5 ACH50. That's really tight!

A target that's more achievable for anyone — and which the 2012 International Energy Conservation Code (IECC) will require for most climate zones (CZ 3 and higher) — is 3 ACH50. That's also the level that Joe Lstiburek identified as a good target in his great article on blower door testing new homes, *Just Right and Airtight*.

That number — **3 ACH50** — translates to about 0.25 cfm50 per square foot of envelope, or 25 cfm50 per hundred square feet of envelope. Since roofers have already abbreviated 100 square feet as 1 square, I like the latter form the best. It gets it into a whole number form and is easy to remember. Get your blower

door number down to **25 cfm50 per square** (or below), and you've got a tight house. The house I built ten years ago came in at 14 cfm50 per square (1.7 ACH50).

But wait. I can hear you wondering, "Is he saying that this one number, 25 cfm50 per square, is good for every climate zone?" My friend David Butler says that we should consider cost effectiveness and not just apply a "one-size-fits-all" threshold. "We should always ask ourselves which combination of efficiency measures will provide the lowest energy usage within a given budget," he wrote recently. "The cost-benefit of achieving 3.0 ACH50 would look very different in Buffalo than in Tucson, on multiple levels."

He does have a point, He went on to explain that "in hot climates, I'd rather fight to bring ducts inside (always challenge in non-basement homes) than to arbitrarily specify a 3-ACH50, especially in dry climates where latent loads are negligible."

Lstiburek, a Canadian who lives in New England, thinks the roughly equivalent 3 ACH50 is good because it's achievable, and it solves a lot of comfort and efficiency problems associated with air leakage. I understand David's point, but here in Georgia, home builders now have to pass a blower-door test and get their houses 7 ACH50 or below. What we're finding is that a significant number of builders are getting down to 3 ACH50 in their attempt to meet the code target. Once builders get their crews trained, 3 ACH50 should cost them about the same as 5 or 7 ACH50. Now, if we can just get them to change the target to 25 cfm50 per square!

Existing homes

This can of worms is really too big for the little article I'm writing here, but let me try to shed at least a little light on it. The amount of air sealing you're going to be able to do in an existing home is limited — unless your budget isn't. Generally, with a good attack on the holes, you can get about a **20% to 30% reduction** in your Blower Door number (whether you specify it in cfm50, ACH50, or cfm50/sfbe). Sometimes you can get much more when you add surface area or volume by moving the building envelope.

The first thing you want to know here, though, is: How leaky is your home to start with? If you're already at 25 cfm50 per square, it's going to be really hard to get a 20% reduction. If you're at 100 cfm50 per square, it should be a snap to reduce it to 75 cfm50 per square or even lower. The higher that starting number is, the more big holes you probably have in your building envelope.

If you're starting at 100 cfm50 per square, however, don't count on getting down to 25 cfm50 per square unless you're doing a deep-energy retrofit. Sometimes deep-energy retrofits are called deep pockets retrofits, for obvious reasons. They cost a fortune! Check out Martin Holladay's recent post called The High Cost of Deep Energy Retrofits here at GBA.

I've done a number of air-sealing jobs when I was in the contracting business, and the results varied. Sometimes it was a frustrating 5-10% reduction, and other times it was an easy 20%. The most reduction I ever achieved was about 40% in a house that started with about 120 cfm50 per square. We encapsulated the crawl space and did a lot of work on the kneewalls and can lights on the upper floor.

Summary

If you're looking to make your home tight and you really want some numbers to go after, here are my recommendations:

New Homes: 25 cfm50 per hundred square feet of building envelope (or 3 ACH50)

Existing Homes: Get a blower door test, and try to reduce the number by 20% or more.

Allison Bailes of Decatur, Georgia, is a RESNET-accredited energy consultant, trainer, and the author of the Energy Vanguard blog.

21 Comments

D **davidmeiland** | Apr 10, 2012 11:50pm | #1

Not a bad plan

but of course it calls for measuring completely enough to determine surface area. That can be a bit time consuming in houses with lots of cathedral ceilings or other detail. The Washington State Energy Code is using a formula based on square footage that roughly equates to 5ACH50 (houses with high ceilings are penalized by this approach), and I assume it's to avoid making testers measure surface area. It's quick to go through most houses and get square footage, and then get an average ceiling height so that you have approximate volume. In an average house I think that a number that's somewhat under 1CFM50 per square foot is pretty good.

E **ewoodhouse** | Apr 11, 2012 08:46pm | #2

Maybe I'm missing something...

but it seems like measuring based on surface area (or volume, for that matter) makes less sense than measuring based on living area. A building with a large surface-area to floor-area ratio is going to use more energy than one with a simpler shape and an equal cfm50 per square, won't it? I guess that's fine if what you're aiming to measure is quality of construction alone - but it seems like the design certainly has an impact.

D **davidmeiland** | Apr 11, 2012 11:42pm | #3

Depends what you're measuring

A test result based on surface area tends to measure construction quality, both that of the builder on site, and of the manufactured products like doors and windows, dampers, etc. A test based on square footage is a dumbed-down version of the same thing. A test based on volume is useful if you want to estimate air changes for determining ventilation requirements, or heat loss via air leakage.

 **albertrooks** | Apr 12, 2012 02:24am | #4

It's really not that hard to get well below 3ACH 50

And I mean for new construction. Retrofit is a "whole 'nother kettle of fish"

After countless (seriously) new construction passive house projects that we've helped with (in a small way). It can be done without question.

The first (of yours at less than 0.6ach) is the hardest.

The third (of yours at less than 0.6ach) passes by without notice or fanfare: It has become a matter of course.

To be fair, those projects go at it from a different design perspective: A really good lid, no can lights, Floor connected to wall, wall connected to lid: The unbroken line (air barrier wise). The term "obsessiveness" might come up in some circles, but it's really just a "goal" and good workmanship towards the goal.

If these excessive Passive House folks can do it, it can't be that tough. Often it's really not. It's in the design & planning stage that you can get rid of most of the big "holes" and "disconnections". After that, it's just seeking out and keeping the small "holes" filled and making sure that new holes aren't created down stream.

There are a lot of good materials available to accomplish this with: Foams, Tapes, Gaskets, Sheet Goods, Membranes, Sealants. They are all reasonable ways to accomplish the goal.

Beating 3 ACH 50 is about as easy as reaching it. If you really care to...



GBA Editor

Allison A. Bailes III, PhD | Apr 12, 2012 08:33am | #5

Response to David Mieland

Yes, calculating the surface area is difficult in more complex houses, but so is volume when you have insulated rooflines. If you're doing energy modeling on the home for a load calculation or HERS rating anyway, then you'll have all the info. For existing homes where you just want to get in and out as quickly as possible, ACH50 is adequate.

In your response to Eric, you wrote:

A test based on volume is useful if you want to estimate air changes for determining ventilation requirements...

See the article by Joe Lstiburek that I mentioned in the section on New Homes or my linked article on what a Blower Door is good at. The amount of air moving through the Blower Door at elevated pressure doesn't extrapolate very well to "natural" pressures, so a Blower Door doesn't help a whole lot with determining ventilation requirements, in my opinion.



GBA Editor

Allison A. Bailes III, PhD | Apr 12, 2012 08:41am | #6

Response to Eric Woodhouse

We're talking about air leakage here, not general energy usage, and a Blower Door is only good at telling us how much air leakage a house has. The reason for bringing the size of the house into it is so you can compare different sizes houses to each other and to a standard that's independent of size (*e.g.*, a code requirement for 3 ACH50). I'm not sure exactly what you mean about the design being important, but a Blower Door test is all about measuring the quality of construction in new homes.

Am I missing your point?



Allison A. Bailes III, PhD | Apr 12, 2012 08:49am | #7

GBA Editor

Response to albert rooks

I'm with you, Albert, but the only house I ever built was a custom home that took me two years. I hit 14 cfm50 per square (1.7 ACH50) without ever having seen a Blower Door test. I think any custom builder who takes the time to figure it out can easily do better than 3 ACH50. Joe Lstiburek, who's been doing this work for decades and has worked with production builders, makes a pretty convincing case that 3 ACH50 is a good target, however, and that's why I settled on that number.

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michael anschel | Apr 12, 2012 09:24am | #8

Nice job

Nice job with this post. A good 101 for foks just getting their feet wet with the subject. It would be great if the folks at BPI and ResNet would heed your advice and make the switch over to CFM per SF. (I get the idea behind the 'square' but I'm not sure if representing the home in numbers like 23.578 is really valuable. Anyone not involved with roofing or carpet is much more comfortable with SF.)

HOWEVER, I think that what is missing in this whole discussion is a conversation about where that leaking takes place. A buiding forensics expert (the work that provides Joe with enough dough for that Porche) will quickly find the point where air is leaking into the enclosure and causing damage. Without being specific about location we need to be cautious about making blanket statements about the acceptable volume of air that passes through the enclosure (not connected to mechanical or intentional passive components)

One additional point to consider. The push for air tightness in the South creates a building environment that demands the use of AC. Promoting a policy that relies entirely on mechanical delivery of conditioned air in lieu of smart building architecture that can effectively keep a home in the hotest of climates comfortable seems slightly irresponsible.

I think the incesent desire to oversimplify a structure and set of systems for the border line literate trades needs to stop. Keep it complicated and variable.

Rock on-
M



Allison A. Bailes III, PhD | Apr 12, 2012 09:44am | #9

GBA Editor

Response to Michael Anschel

Good points, Michael! Yes, the location of leakage is critical, and a wall between the house and an attached garage, for example, needs to be as tight as a vacuum chamber. But Blower Door operators are measuring the leakage from the whole house. That tool can't separate out the various components.

Regarding the South, I'd say you're ascribing the demand for air conditioning to the wrong cause. People here want AC in leaky houses, too, and comfort is the driver, not how tight the house is. I do agree that we should build houses so they can be comfortable without AC, but that's a design issue, getting windows in place for cross ventilation and ceiling fans and porches.

It'd be great if every budget included enough money so we **could** engineer houses the way we do commercial buildings and cars and computers. Then we'd have to "keep it complicated and variable."

---

michael anschel | Apr 12, 2012 09:56am | #10

Keeping it Complex

I think at GBA you should take up that challenge to go beyond simple measurements. You are in a great position (and have enough brain power) to take up the challenge. (You also have enough perspective, I think, to understand and explain the nuanced complexities involved)

I hear what you are saying about the leaky v non leaky home demand for AC. My point was that point to to 3 ACH as the metric we are not doing the home design justice, and that when we are discussing appropriate levels of tightness there is an argument to be made for spending $$ on smart design in lieu of mechnical systems. (the $12-15K spent on mechanicals will more than cover the design and modeling fees for smart ventilation and cooling systems)

Funny that we will pay hundreds of thousands of dollars for a poorly engineered product, but will spend hours pouring over the details of a $800 computer or $30K car. Sad sad sad.



Allison A. Bailes III, PhD | Apr 12, 2012 10:04am | #11

GBA Editor

Nuanced complexities - Yes!

You're right, Michael. (Wow, did I just say that?) I'll take up this challenge and see if maybe we can get the subject of air leakage in homes up to where it needs to be. And yes, it is sad, sad, sad about misplaced priorities. Since we do design (both architecture & HVAC), we deal with this issue all the time. Some people do really get it, but they're in the minority.

E

ewoodhouse | Apr 12, 2012 02:08pm | #12

Response to Allison A. Bailes III, PhD

We may be missing each other's point, Allison. Part of the issue, I guess, is what you call "size" when you're comparing one house to another. If I have a 2,000 s.f. house with 9' ceilings, and another house of identical design but with 15' ceilings, the latter house will obviously have far more surface area, and more volume. But the two houses will appear equally tight when looking at ACH or cfm per square... and to my way of thinking, the 9' ceiling house is the "tighter" of the two.



GBA Editor

Allison A. Bailes III, PhD | Apr 12, 2012 03:40pm | #13

Yes, size matters.

Eric, I think I see what you're getting at now, and it's basically the difference between absolute and normalized leakage. Yes, in the example you gave, the house with 9' ceilings will have less absolute leakage (cfm50) if they have equal normalized leakages (cfm50/sf).

Energy codes and green building programs, though, specify normalized leakage to take the size of the house out of the equation (though LEED for Homes and now ENERGY STAR Version 3 add it back in somewhere else). If they specified absolute leakage thresholds, say 1000 cfm50 (to make up a number), builders of larger houses would have to do much more air-sealing to hit the target, and the small homes might not have to do much at all.

So, yes, size matters.

user-1005777 | Apr 12, 2012 04:13pm | #14

Did we do the right things?

We have a mini home just over 1000 square feet. We had a blower door test done in November of 2007. It showed 6.9 ACH50. We have taken all the trim off the inside of the house and foamed or caulked every joint in the structure that we can get to and even sealed light fixtures. The blower door test done this last December showed 3.1 ACH50. Should we have attacked the envelope from the outside? That probably would have been much more difficult, and costly. Does it matter?

Wouldn't the energy auditor have to know the volume of the house to figure the ACH figure?



Allison A. Bailes III, PhD | Apr 13, 2012 08:33am | #15

GBA Editor

Response to Roger Williams

If you cut the infiltration rate by more than half on an existing home, I'd say that you did the right things. That kind of reduction isn't easy for existing homes. And getting down to 3.1 ACH50 is also good, so be happy with where you're at.

Yes, the volume figures into the ACH50 result. It's the cfm50 (the amount of air flowing through the Blower Door fan while the house is depressurized to 50 Pa) times 60 (to convert minutes to hours) and then divided by the volume (to convert cubic feet to air changes).

D

davidmeiland | Apr 13, 2012 11:34am | #16

Agreed

On an existing home, you do what you can. It would be more effective to remove all your siding and trim and seal leaks at the sheathing, but in most cases you aren't going to do that. I agree with Allison that getting to 3ACH50 with interior retrofit measures is quite an accomplishment. I assume you had some very large holes that you were able to seal.

HhsHwZFSCs | May 02, 2012 06:39pm | #17

1984 Blower Door Test results

I have about 3100 sq feet and completed my first blower door test. The result was 3300CFM50 or 8 ACH50 so I was told by the vendor. This test was completed in 2011. I have sealed all the kneewalls and floor baseboard areas. Also sealed the attic, Garage, resided two outside walls and resheathed. In 2012 the test result was 2864cfm50 (estimated number) This equates to 6.8 ACH50 I thought the numbers would be lower than these. Any other areas to focus to lower this number. I have addressed the fireplace with rigid foam and sealed all the sill plate areas in the basement. Any thoughts would be greatly appreciated.

USEuG9CHFL | May 02, 2012 07:55pm | #18

nobody mentioned this

One of the most important things you can use a blower door for is "zonals". Using the manometer, you can isolate rooms, light fixtures, the wall between the garage and the living space, the attic(the most important). I work on older homes and making sure the attic is as unattached to the home as possible is our main goal. Older homes usually don't have enough insulation in the attic or venting. This tends to keep the attic warm enough to inhibit mold growth. Throw down insulation without air sealing enough and during the Fall

or Spring when you have some humidity in the air compared to the dead of Winter and now those air leaks are producing mold. This winter was the worst here in PA because it never got cold enough out to really dry out the attics. I have to throw this out there because a little bit of knowledge can get you in a lot of trouble.
Anyway the manometer will tell you how connected the attic is to the house and you shouldn't be done airsealing until that manometer reads the attic at +49 to +50pascals with relation to the house.

D

heidner | May 02, 2012 08:04pm | #19

RE:1984 Blower Door Test results.
GBA has a number of articles and blog postings on how to find and go after the air leaks. If you are having a blower test done, make sure you have a thermograph imaging done while the testing is ongoing... and have some smoke pens handy. You should be able to find large leaks quickly.

You didn't mention if you have recessed lights. If so, you may wish to consider alternative lights and/or verify the recessed cans can be sealed up. (NOT ALL recessed lights are certified for insulation and air sealing)!!

Check behind sinks, toilets, dishwashers, and appliances. Sometimes there are gaping holes where the plumbing enters the wall.

Look for leaks in sofits, between floor wire/pipe chases, etc. If you have forced air -- is the ducting outside of the heated space and is it leaking?

If you are doing this your self and trying to tighten the house -- I would consider buying a simple dwyer 460 air meter, some used furnace blowers and build a crude blowr assembly to depressurize the house while you use a smoke pen. Then when you've found and sealed more leaks -- have it retested by a certified blower/energy audit professional.

D

user-648002 | Aug 09, 2012 05:40pm | #20

Skin Calculations
We have always looked at skin tightness this way. The size of the hole per 100 sqft of wall = leakage ratio or LR. We would get results down in the 2" per 100 sqft of wall or an LR of 2. I think this is the best way to talk about how tight your building is.

---

user-1135248 | Sep 27, 2012 09:17am | #21

alphabet soup

[Is it better to follow up on an older thread, or start a new Q&A for this? Let's try this first...]

Before my retrofit I did a quick-n-dirty volume and surface area calculation on my relatively simple Cape, and have just redone it a bit more accurately. I'm now reading up on blower-door testing because I expect that eventually the place will get one, and the confusion over which numbers are which, better, meaningful, BS, etc is *profoundly* irritating. Anybody who comes along talking about CFM leakage per square foot of *living area* needs to be shown the door and by that I mean as a prompt exit assisted by my foot, not the door to mount the blower frame in ... then you've got the problem of Equivalent Leakage Area over the entire envelope vs. MLR which only considers above-grade envelope surface, and for the latter I probably want to add in the below-grade area of my basement bulkhead door to make things more realistically accurate.

By breaking the house into sections -- attic, living floors, basement -- I know all my volumes and areas, and derived an easy reference point that 1 ACH for the whole enclosed space, just shy of 15,000 cubic feet, would be 248 CFM. That's regardless of pressure, of course, and that volume includes interior walls, closets, the volume of the remaining part of the chimney inside, etc. But what is the "geek with the blower door" going to say about what any CFM reading actually means in terms of CFM/sf? How many "square feet" should be considered, and where are they located?? How does anyone know how much "living" I'd do in my unfinished basement before deciding whether to include that in any such figures?

And then in a heavily-insulated house one has to consider where the measurements were taken -- inside or out? I started with my interior dimensions because that's effectively the volume where air will be changed, measuring heights floor-surface to floor-surface to include all of those thicknesses. But if I did the same measurement outside now, with the exterior bulked up 5 or 6 inches more with polyiso and furring and siding, everything would be different.

So really, "CFM50/sf" has to be *thoroughly* qualified and explained in any test results if it's going to mean jack. And it likely won't account for *where* leakage sites actually exist, i.e. would they contribute to stack effect more or less. At least "ACH50" makes more sense because it keeps everything in terms of volume, as long as you know how that volume was determined.

The poor sod who eventually shows up here to test the place is probably going to get a real earful about this, as he's given an envelope with *no* penetrations to test. I mean, why should I leave my HRV vents open if we're testing the *envelope*?? I know how many CFM that is already.

_H*

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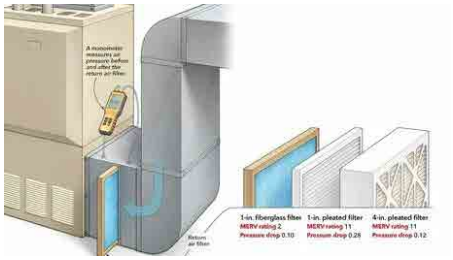
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Infiltration meets ACH50 requirements

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DOE Zero Energy Ready Home (Revision 07) (https://basc.pnnl.gov/library/doe-challenge-home-national-program-requirements)

Exhibit 2 DOE Zero Energy Ready Home Target Home.
The U.S. Department of Energy's Zero Energy Ready Home program allows builders to choose a prescriptive or performance path. The DOE Zero Energy Ready Home prescriptive path requires builders to meet or exceed the minimum HVAC efficiencies listed in Exhibit 2 of the National Program Requirements (Rev 07), as shown below. The DOE Zero Energy Ready Home performance path allows builders to select a custom combination of measures for each home that is equivalent in performance to the minimum HERS index of a modeled target home that meets the requirements of Exhibit 2 as well as the mandatory requirements of Zero Energy Ready Home Exhibit 1.

Exhibit 2, Insulation and Infiltration) Whole house leakage must be tested and meet the following infiltration limits:

- Zones 1-2: ≤ 3 ACH50;
- Zones 3-4: ≤ 2.5 ACH50;
- Zones 5-7: ≤ 2 ACH50;
- Zone 8: ≤ 1.5 ACH50;
- Attached dwellings: ≤ 3 ACH50.

Footnote 23) Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.

How to Determine Infiltration

Building envelope leakage should be determined by an approved verifier using a testing protocol approved by the Residential Energy Services Network (RESNET). Whole-house air leakage testing is conducted with a blower door test.

Climate zones are based on the Climate Zone Map, which can be found in the 2015 International Energy Conservation Code (2015 IECC Figure R301.1):

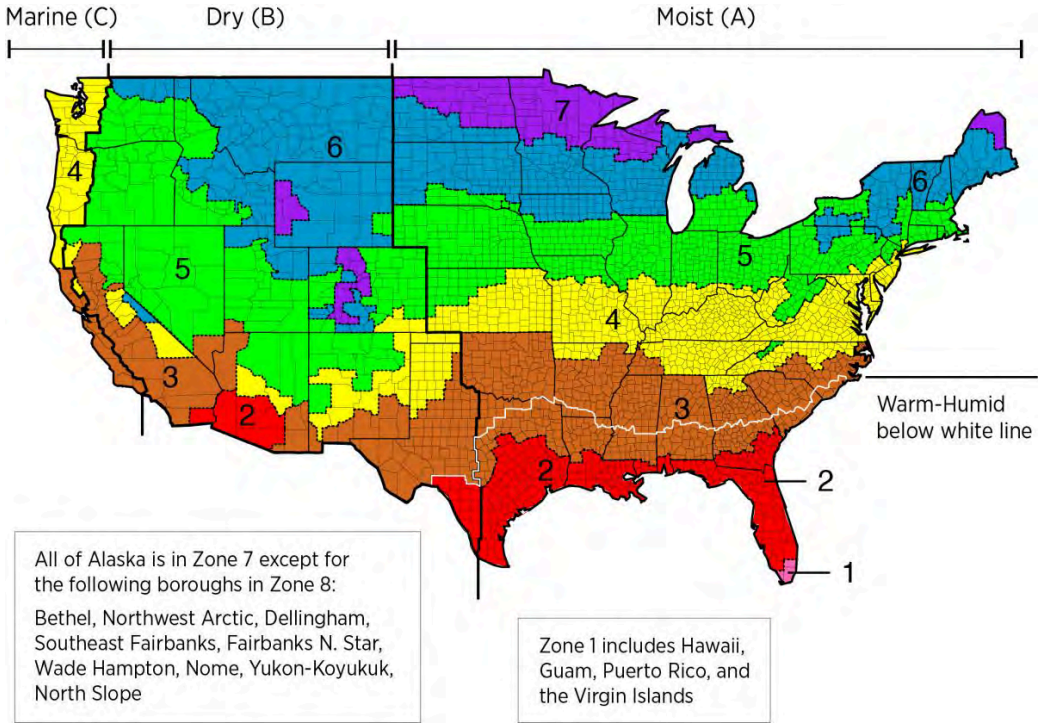


Figure 1. *IECC climate zone map.*

More Info

References and Resources*

DOE Zero Energy Ready Home National Program Requirements (https://www.energy.gov/eere/buildings/doe-zero-energy-ready-home-zerh-program-requirements)

Author(s): *U.S. Department of Energy*
Organization(s): *DOE*
Publication Date: *December, 2022*

Website listing implementation timelines and links to various versions of the DOE Zero Energy Ready Home national program requirements.

**For non-dated media, such as websites, the date listed is the date accessed.*

Last Updated: 2019-07-29

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Model Energy Code Determinations

DOE is required by the Energy Conservation and Production Act (ECPA), as amended, to review published editions of the national model energy codes—ANSI/ASHRAE/IES Standard 90.1 and the International Energy Conservation Code (IECC)—and issue a *determination* as to whether the updated edition will improve energy efficiency in commercial and residential buildings, respectively. DOE is provided 12 months to conduct its review and publish its determination in the Federal Register after the updated model code is published. ECPA also requires States to review and/or update their energy codes following the publication of an affirmative DOE determination.

Latest Versions

COMMERCIAL: ANSI/ASHRAE/IES STANDARD 90.1-2022

DOE issued a determination (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001) that Standard 90.1-2022 will achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in commercial buildings of approximately:

- 9.8 percent *site* energy
- 9.4 percent *source* energy

- 8.9 percent *energy cost*

Additional information related to this action, including the official *Federal Register* publication, is available at Regulations.gov (https://www.regulations.gov/document/EERE-2023-BT-DET-0017-0001).

State Certification

Upon publication of an affirmative determination, ECPA requires States to certify that they have reviewed the provisions of their commercial building code regarding energy efficiency, and, as necessary, updated their codes to meet or exceed the updated edition of Standard 90.1. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. The **State Certification** (/state-status/state-certifications) **deadline for Standard 90.1-2022 is March 06, 2026.**

Supporting Analysis

DOE conducted a technical analysis in support of its determination. This analysis assesses Standard 90.1 compared to the previous edition and estimates the associated savings impacts.

Federal Statute for Commercial Buildings

With each new edition of ANSI/ASHRAE/IES Standard 90.1, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in commercial buildings (42 U.S.C. 6833):

> *(2)(A) Whenever the provisions of ASHRAE Standard 90.1-1989 (or any successor standard) regarding energy efficiency in commercial buildings are revised, the [DOE] Secretary shall, not later than 12 months after the date of such revision, determine whether such revision will improve energy efficiency in commercial buildings. The [DOE] Secretary shall publish a notice of such determination in the Federal Register.*
>
> *(B)(i) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed and updated the provisions of its commercial building code regarding energy efficiency in accordance with the revised standard for which such determination was made. Such certification shall include a demonstration that the provisions of such State's commercial building code regarding energy efficiency meet or exceed such revised standard.*
>
> *(ii) If the [DOE] Secretary makes a determination under subparagraph (A) that such revised standard will not improve energy efficiency in commercial buildings, State commercial building code provisions regarding energy efficiency shall meet or exceed ASHRAE Standard 90.1-1989, or if such standard has been revised, the last revised standard for which the [DOE] Secretary has made an affirmative determination under subparagraph (A).*

RESIDENTIAL: 2024 INTERNATIONAL ENERGY CONSERVATION CODE

On December 20, 2024, DOE issued a determination (https://www.regulations.gov/document/EERE-2024-BT-DET-0007-0001) that the 2024 International Energy Conservation

Code (IECC) will improve energy efficiency in residential buildings. In support of this determination, DOE conducted a technical analysis evaluating the impacts of the updated code (relative to the previous 2021 IECC edition). DOE estimates national savings of approximately:

- 7.8 percent *site* energy savings
- 6.8 percent *source* energy savings
- 6.6 percent *energy cost* savings

Additional information related to this action, including the official Federal Register publication and docket containing public comments received, is available at Regulations.gov (https://www.regulations.gov/docket/EERE-2024-BT-DET-0007).

State Certification

Upon publication of an affirmative determination, States are required to certify that they have reviewed the provisions of their residential building code regarding energy efficiency, and made a determination as to whether it is appropriate for them to revise their code to meet or exceed the updated edition of the IECC. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. **State certifications** (/state-status/state-certifications) **for the 2024 IECC must be submitted by December 30, 2026.**

Supporting Analysis

DOE published a technical analysis in support of its determination. This analysis assesses the 2024 IECC compared to the previous edition and estimates the associated savings impact.

Federal Statute for Residential Buildings

With each new edition of the IECC, DOE is required by statute to issue a determination as to whether the updated edition will improve energy efficiency in residential buildings. (42 U.S.C. 6833):

> *(5)(A) Whenever the CABO Model Energy Code*, 1992, (or any successor of such code) is revised, the [DOE] Secretary shall, not later than 12 months after such revision, determine whether such revision would improve energy efficiency in residential buildings. The [DOE] Secretary shall publish notice of such determination in the Federal Register.*
>
> *(B) If the [DOE] Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed the provisions of its residential building code regarding energy efficiency and made a determination as to whether it is appropriate for such State to revise such residential building code provisions to meet or exceed the revised code for which the [DOE] Secretary made such determination.*
>
> **As a predecessor to the ICC, the Council of American Building Officials (CABO) was responsible for development of the Model Energy Code (MEC). Contemporary energy codes are referred to and published as the International Energy Conservation Code (IECC)®.*

Previous Determinations

Previous DOE determinations (https://www.energycodes.gov/previous-determinations) surrounding building energy codes are available for reference by states and local governments, as well as other interested stakeholders.

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National and State Analysis

National Analysis

Pacific Northwest National Laboratory (PNNL) assesses recent editions of the model codes to quantify the associated energy & cost savings. This analysis confirms the cost-effectiveness of updated editions of the model codes across U.S. climate zones, providing critical information during state and local adoption processes. The following national analyses are currently available:

Commercial

- National Cost Effectiveness of Standard 90.1-2022
- National Cost Effectiveness of Standard 90.1-2022 Workbook
- National Cost Effectiveness of Standard 90.1-2019
- National Cost Effectiveness of Standard 90.1-2019 Workbook
- National Cost Effectiveness of Standard 90.1-2016
- National Cost Effectiveness of Standard 90.1-2016 Workbook
- Energy and Energy Cost Savings Analysis of the 2021 IECC for Commercial Buildings
- Energy and Energy Cost Savings Analysis of the 2018 IECC for Commercial Buildings

Residential

- National Cost Effectiveness of the 2024 IECC
- National Cost Effectiveness of the 2021 IECC
- National Cost Effectiveness of the 2018 IECC
- HERS Index Values Corresponding to the IECC

State Analysis

Pacific Northwest National Laboratory (PNNL) assesses recent editions of the model codes to quantify the associated energy & cost savings. These analyses take into account varying state-level conditions, such as incremental costs, utility rates, climatic conditions and construction trends. The residential analyses are customized based on current state energy codes. The following state analyses are currently available:

State Cost-effectiveness Analysis Reports

State	Commercial	Re
Alabama	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Alaska	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Arizona	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Arkansas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
California*		

State	Commercial	Re
Colorado	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Connecticut	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Delaware	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
District of Columbia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Florida	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Georgia	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Hawaii	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20
Idaho	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Illinois	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20

State	Commercial	R
Indiana	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Iowa	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Kansas	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Kentucky	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Louisiana	ASHRAE 90.1-2019 ASHRAE 90.1-2013	2 2 2
Maine	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Maryland	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2
Massachusetts	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2

State	Commercial	R
Michigan	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	M 20 20 20
Minnesota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
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Nebraska	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20
Nevada	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20
New Hampshire	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	20 20 20

State	Commercial	R
New Jersey	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
New Mexico	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
New York	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
North Carolina	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
North Dakota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Ohio	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2
Oklahoma	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Oregon	ASHRAE 90.1-2019	2
Pennsylvania	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2

State	Commercial	R
Rhode Island	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
South Carolina	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
South Dakota	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
Tennessee	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2
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Washington*		

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Wisconsin	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013*	2 2 2
Wyoming	ASHRAE 90.1-2019 ASHRAE 90.1-2016 ASHRAE 90.1-2013	2 2 2

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State Fact Sheets

Adopting the 2021 IECC for residential buildings and ASHRAE Standard 90.1-2019 for commercial buildings will save energy and money. These state fact sheets provide an overview of the expected benefits to homeowners and building owners.

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Passive House Design

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Passive house design is a construction concept that focuses on energy efficiency, comfort, and affordability. This method of building incorporates a holistic approach, emphasizing the importance of a comfortable and healthy living environment that consumes minimal energy. The passive house, or "*passivhaus*" in German, has become a strict global standard for sustainable architecture, gaining popularity among homeowners and builders alike.

One of the core aspects of passive house design is the integration of prefabricated components, which helps to streamline the construction process while maintaining a high level of quality control. Prefabricated elements contribute to the overall efficiency and performance of the building by ensuring airtight construction, continuous insulation, and optimized windows for maximum energy savings.

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Adhering to passive house principles ensures that buildings are designed in a way that maximizes their energy efficiency and minimizes their environmental impact. This approach not only offers long-term financial benefits for homeowners through lower energy bills, but also contributes to a greener and more sustainable future.

What Is Passive House?



Defining Passive House

Passive House, or Passivhaus, is a design and construction concept that aims to create highly energy-efficient, comfortable, and sustainable buildings. The passive house movement originated in Germany, when a German physicist developed the concept based on principles of passive solar design. Passive House design has now spread to North America and other parts of the world, gaining popularity among those who value energy efficiency and sustainable living.

The Passive House certification is a strict set of standards designed to ensure that buildings meet the requirements for energy efficiency, thermal comfort, and indoor air quality. Some key principles of this approach include super-insulated building envelopes, airtight construction, and optimized window orientation for solar gain. By implementing these design strategies, passive houses can significantly reduce their energy consumption, paving the way towards net zero energy buildings.

Passive House vs Traditional House

The primary difference between passive houses and traditional houses lies in their approach to energy management. While traditional homes typically depend on active heating and cooling systems to maintain comfortable interior environments, passive houses rely on a combination of passive design strategies and mechanical ventilation with heat recovery systems to both minimize energy use and ensure a consistent indoor temperature.

In a passive building, the focus lies on smart design and construction techniques to reduce the need for additional heating or cooling, ultimately leading to a lower overall energy demand. This results in reduced greenhouse gas emissions, lower energy bills, and a healthier living environment for occupants.

Additionally, passive houses tend to have a longer lifespan due to the high-quality, durable materials and construction methods used in their design. This contributes to the sustainability aspect of the passive house movement, as buildings designed to last longer can help reduce the overall environmental impact of construction.

In summary, passive house design is an innovative approach to creating sustainable, energy-efficient buildings that prioritize occupant comfort and environmental responsibility. By incorporating passive design principles, such as super-insulation, airtight construction, and solar optimization, passive

houses can offer significant advantages in terms of energy use, durability, and long-term cost savings.

Design Factors for Passive Houses

Orientation and Shading

In passive house design, proper **orientation** of the building is crucial for optimizing daylighting and controlling solar radiation. Windows should be strategically placed to maximize natural light and maintain a comfortable temperature indoors. South-facing windows capture abundant sunlight during the winter months, while north-facing windows minimize direct sunlight during hot summer days. Overhangs, awnings, and other shading strategies should also be incorporated into the design to prevent overheating in the summer and allow passive solar heating in the winter.

Building Envelope

A high-performance building envelope is essential in passive house design. It consists of continuous insulation, airtight construction, and thermal bridge-free design. Continuous insulation helps maintain a consistent temperature inside the building by minimizing heat transfer through the walls, roof, and floor. Airtight construction prevents unwanted drafts and air leaks, leading to improved indoor air quality and reduced energy consumption. Thermal bridge-free design eliminates heat loss at connection points between building components, further enhancing energy efficiency.

In addition to the insulation and airtightness, passive houses often use high-performance windows and doors to minimize energy losses. These windows and doors provide superior insulation, air tightness, and solar heat gain control, ensuring a comfortable interior environment throughout the year.

By focusing on these key design factors, passive houses can achieve improved energy efficiency, comfort, and overall sustainability.

Heating, Cooling, and Ventilation

Mechanical Systems

In a passive house design, the mechanical systems play a crucial role in maintaining a comfortable and energy-efficient environment. Heating and cooling in such designs primarily come from passive sources such as solar gain or internal sources like appliances and occupants.

For heating, the use of high-efficiency boilers and radiators is common. A good option is the integration of a Mitsubishi VRF Heat Pump, a variable-refrigerant flow heat pump that modulates the amount of refrigerant sent through the system, saving energy by circulating the minimum refrigerant needed for each individual zone.

Ventilation Systems

One of the key aspects of passive house design is providing fresh air while maintaining energy efficiency. Balanced mechanical ventilation systems are essential to achieve this. These systems consist of separate supply and exhaust airflows, delivering fresh air to living areas and removing stale air from kitchens, bathrooms, and utility spaces.

There are two types of mechanical ventilation systems commonly used in passive house designs – Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV). Both systems work by exchanging heat between incoming and outgoing air, minimizing the energy required for heating or cooling the fresh air.

Heat Recovery

Heat recovery is a crucial feature in passive house design, and it plays a significant role in reducing energy consumption. It can be achieved through different techniques, but two of the most common ones are Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV).

ERV systems not only exchange heat but also manage humidity, transferring moisture between the incoming and outgoing air to maintain a comfortable humidity level. On the other hand, HRV systems focus solely on heat exchange.

Both ERV and HRV systems minimize the need for additional heating and cooling, making them an essential component in achieving high energy efficiency in a passive house design.

Prefab passive house designs often include these mechanical and ventilation systems pre-installed to ensure a professional and efficient implementation of these critical elements, maintaining the required energy efficiency and high indoor air quality standards.

Key Construction Aspects in Passive Houses

Airtightness

One of the primary components in passive house design is airtightness. Ensuring airtight construction reduces air infiltration and prevents drafts. This is essential for maintaining optimal temperature and humidity levels, providing a comfortable indoor environment. Airtight construction also helps

to prevent condensation and mold growth, which can lead to health issues for occupants.

Proper sealing of doors, windows, and other potential air leaks is crucial for maintaining airtightness. This can be achieved through the use of high-quality tapes, seals, and caulking materials. Additionally, attention to detail during the design and construction process can help to minimize thermal bridges, ensuring a more comfortable and energy-efficient living space.

Insulation

In passive house design, emphasis is placed on providing well-insulated building envelopes. This includes continuous insulation throughout the walls, roofs, and floors, which prevents heat transfer and minimizes energy consumption. Insulation materials vary, but they generally have a high R-value, indicating the effectiveness of the material in reducing heat flow.

Prefab passive house construction often utilizes panels with pre-installed high-performance insulation, ensuring a higher degree of precision and efficiency during the construction process. By incorporating prefabrication, passive houses can be erected quickly and with a higher level of quality control.

Windows and Doors

Windows and doors in passive houses are designed to minimize heat loss and maximize natural light. High-performance windows and skylights are essential components for achieving these goals. These windows must meet specific performance standards, with stringent requirements for insulation, airtightness, and solar heat gain properties.

Additionally, passive house windows and doors are strategically placed to take advantage of passive solar design principles, capturing sunlight and heat during the winter months while reducing overheating during the summer. To further enhance energy efficiency, windows are often triple-glazed, and frames

are designed to minimize thermal bridges. This attention to detail is necessary to meet the strict criteria required to achieve passive house certification.

Indoor Air Quality

Air Quality and Ventilation

In a passive house design, indoor air quality is a critical consideration, especially in airtight buildings which rely on mechanical ventilation. To maintain a healthy environment, passive house designs often incorporate highly efficient ventilation systems that work continuously to circulate and filter air. These systems draw in fresh outdoor air and expel contaminated indoor air, thereby improving indoor air quality[1].

A common misconception about passive house designs is that their airtight nature would lead to poor air quality. However, the airtight design helps reduce air leakages and provides greater air control[2]. This is particularly beneficial for occupants who may be sensitive to outdoor air pollution or odors.

Moisture and Condensation Control

To provide adequate moisture control, passive house designs also focus on preventing condensation and managing indoor humidity levels. A combination of strategies, such as using materials with low vapor permeability in the building envelope, installing high-performance windows, and promoting good air circulation, help to minimize this issue.

In addition to exterior moisture control measures, mechanical ventilation systems equipped with heat recovery features help remove excess moisture and maintain balanced indoor humidity levels[3]. This reduces the risk of condensation and the potential growth of mold or other moisture-related issues inside the home.

By prioritizing indoor air quality, moisture control, and ventilation, passive house designs create a comfortable and healthy living environment while significantly reducing overall energy consumption.

Footnotes

1. Indoor Air Quality in Passivhaus Dwellings: A Literature Review ↩
2. Air Control in Passive House Architecture ↩
3. Designing an HVAC System for a Passive House ↩

Passive Houses and Climate Change

Passive house design is an innovative approach to building residential and commercial structures that prioritize energy efficiency and minimize their carbon footprint. The primary goal is to reduce the overall environmental impact of buildings and help mitigate the effects of climate change.

One significant aspect of passive houses is their focus on prefabricated construction methods. This method not only saves time and resources during the process but also ensures that the design and insulation systems are

accurately implemented, minimizing any loss of energy during the construction phase [Phius Zero is the goal].

By employing the five fundamental principles of passive house design – continuous insulation, airtight construction, optimized windows, balanced ventilation, and minimal mechanical systems – these buildings can achieve a significant reduction in carbon emissions and energy consumption. This results in a lower operational carbon footprint and a positive contribution to mitigating climate change.

An added benefit of incorporating passive house design is the potential for significant financial savings on energy bills. The high level of insulation and airtightness minimizes the need for heating and cooling systems, leading to lower energy consumption and reduced costs. This energy efficiency also translates into a decreased demand for fossil fuels, which in turn helps reduce greenhouse gas emissions.

In conclusion, passive houses play an essential role in the fight against climate change by promoting energy-efficient and environmentally friendly construction practices. Their focus on prefabricated design, coupled with their low energy consumption and reduced carbon emissions, makes them a critical component in the move toward a more sustainable built environment.

Types of Passive Houses

Single-Family Homes

Prefabricated passive single-family homes are becoming increasingly popular due to their energy efficiency and sustainable features. These homes are built using high-quality insulation, airtight construction, and carefully designed ventilation systems to minimize heat loss and maintain a comfortable indoor environment. New construction for single-family homes offers the opportunity

to incorporate passive house principles from the start, while retrofit projects can help improve energy efficiency in existing homes as well.

Residential Apartment Buildings

Multifamily apartment buildings can also benefit from passive house design principles. These structures focus on providing comfortable living spaces for multiple families while minimizing energy consumption and reducing operating costs. Prefabricated passive apartment buildings use continuous insulation, efficient windows, and well-designed ventilation systems to optimize energy usage. Both new construction and retrofit projects can incorporate these principles to help create sustainable and comfortable living conditions for apartment residents.

Schools

Schools are another area where passive house design can play a significant role in creating efficient and healthy learning environments. Through the use of continuous insulation, superior windows, and efficient mechanical ventilation systems, schools can greatly reduce their energy consumption and improve indoor air quality. In addition to new construction projects, existing schools can also benefit from retrofits that implement passive house principles, creating a significantly more sustainable and comfortable learning environment for students and staff alike.

Testing and Quality Assurance

In passive house design, ensuring a high level of energy efficiency and comfort is crucial. One of the essential aspects to achieving this goal is conducting rigorous testing and quality assurance procedures throughout the design and construction process. A focus on prefab construction adds another layer of complexity to the process, making quality assurance even more vital.

One of the most critical tests conducted in passive house design is the **airtightness test**. This test is essential for verifying the effectiveness of the building's insulation and minimizing heat loss. During a prefab construction project, airtightness is a vital component since it ensures that all elements of the building are effectively sealed and any thermal bridges are minimized.

To measure a building's airtightness, a **blower door test** is typically conducted. This test involves mounting a large fan onto an exterior door and depressurizing the building. While the fan is operating, professionals can identify any air leaks or breaches in airtightness, allowing them to address these issues before they become more significant problems. By conducting blower door tests during the construction of a prefab passive house, builders can ensure that airtightness is achieved, and the building functions as a true passive design.

In addition to airtightness testing, passive house projects can benefit from a stringent Quality Assurance and Quality Control (QA/QC) program conducted on site. For example, the Passive House Institute of the U.S. PHIUS+ Certification program includes a thorough passive house design verification protocol combined with rigorous QA/QC inspections. These inspections are performed by highly skilled and specialized PHIUS+ Raters and Verifiers, helping to maintain the building's high-performance standards.

In summary, a successful passive house design not only relies on effective energy-saving principles but also on rigorous testing and quality assurance

processes. By conducting thorough airtightness tests such as blower door tests and implementing on-site QA/QC inspections, prefab passive house projects can achieve energy efficiency and maintain high-performance standards.

Frequently Asked Questions

What are the key principles in a passive house design?

A passive house design focuses on energy efficiency, comfort, and affordability. The key principles include airtightness, high-quality insulation, thermal bridge-free construction, and efficient HVAC systems, to create a building that consumes minimal energy while maintaining a comfortable indoor environment. Passive houses rely on prefabricated components to maintain consistency and precision in the building process.

How does climate influence passive house design?

Climate plays a significant role in passive house design, as the building envelope and systems need to be tailored to the specific climatic conditions of the building's location. Passive houses in colder climates require thicker insulation, while those in warmer climates need features like overhangs and shading devices to keep the interior cool. Designing a passive house requires climate-specific optimization to ensure the greatest possible energy efficiency and comfort.

What are the main benefits of a passive house?

The main benefits of a passive house include reduced energy consumption, lower utility bills, healthier indoor air quality, and minimized carbon emissions. Passive houses are designed to be energy-conscious and provide superior comfort to their occupants through excellent insulation, airtightness, and an advanced HVAC system.

How does passive house design reduce energy consumption?

Through a combination of airtight construction, highly efficient insulation, and a design that takes advantage of solar gains and natural ventilation, passive houses can significantly reduce energy consumption. The advanced HVAC systems used in passive houses also contribute to energy reduction by recovering heat from exhaust air and using it to pre-heat incoming fresh air.

What challenges are faced during the passive house certification process?

The passive house certification process is rigorous and requires meeting strict energy efficiency and comfort standards. One challenge faced during the certification process is ensuring that the building is designed and constructed to meet these standards, including eliminating thermal bridges and providing airtightness. Another challenge is accurately modeling the building's energy performance and verifying the performance through on-site testing and inspections.

Do passive houses have a higher construction cost?

While the construction cost of passive houses can be higher initially due to the need for high-quality materials, advanced systems, and skilled labor, the long-term energy savings often offset these expenses. The reduced energy consumption associated with passive houses leads to lower utility bills and a reduced carbon footprint, making them an attractive investment for homeowners concerned with both financial savings and environmental impact.

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Public Comments (PCH) for: REC-R402.4.1.2(1)-24

Discussion by Mark Graver

Dec 23, 2025 20:34 UTC

While not impossible, significant challenges are encountered when trying to improve the air leakage rate of conventionally framed buildings. Changing the standard from 5 ACH to 3 ACH is mission creep. This is because building technology has not appreciably evolved for wood-framed construction, and it likely never will without adding significant cost in the way of joint treatments. Conventionally framed buildings have many series of joints from the top to the bottom that all allow for air infiltration. Such buildings require joint treatments that are extremely prone to failure. Additionally, some joints in floor, wall and roof systems must permit the passage of air to protect against rot and decay. Sealing such joints to achieve an irrational metric can cause structural problems. With the introduction of fresh air into the building being a requirement due to building leakage requirements anyway, it is difficult to see where the justification for adopting more stringent requirements lies.

Ultimately, the cost for this change is passed onto consumers who are already finding it increasingly difficult to purchase new homes. Many Virginians, even now, are priced way outside of the housing market. The increase in cost is not justifiable, and considering that Virginia already has a standard, 5 ACH, there is no reason to pursue this requirement any further at this time. All of the areas already prone to infiltration are already being targeted and treated with sealants and other products to comply with the current requirement. The result of increasing the requirement would thus be more troubleshooting, more callbacks, more testing, more fraudulent reports, and more band-aid repairs that don't last. The troubling thing about the troubleshooting and the callbacks is that it may take several technicians and repeated trial and error until a contractor finally identifies the root of the problem. Increasing the requirement will only exacerbate the problem. All of this adds up to construction delays and a major increase in cost to every contractor involved in the project. This increase in cost is passed on to all of the citizens that we serve.

Proposal # 1351

REC-R402.4.1.2(1)-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Deletes the existing Virginia amendment related to air leakage testing and the allowable leakage rate, and defaults to the 2024 IECC requirements.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second and third Energy Sub-Workgroup meetings on September 29, 2025, and November 14, 2025, respectively.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce

- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

DHCD Staff Note: This proposal is substantially identical to proposal REC-R402.4.1.2-24. Stakeholders stood on the statements they made regarding REC-R402.4.1.2-24. The excerpt from the September 29, 2025, Energy SWG meeting summary pertaining to proposal REC-R402.4.1.2-24 is provided below.

> **Eric L** presented proposal REC-R402.4.1.2-24, which adjusts blower-door testing targets for small dwelling units and addresses tester qualifications.
>
> **Steve S** said his groups have no position on this proposal and asks whether this code change, which references attached multi-family developments, belongs in the Residential provisions of the VECC.
>
> > **Eric L** responded that his proposal would include dwelling and sleeping units detached or are located in R-2 occupancies, so it could be 3-story, garden style apartments.
> >
> > **Steve S** states that those occupancies are outside of the scope of the Residential provisions of the VECC.
> >
> > **Florin Moldovan** (DHCD staff) clarified that the amendment falls under the Residential portion of the IECC and therefore applies to all residential occupancies up to three stories, including both R-2 multifamily and single-family homes. If this proposal were to be approved by the Board for inclusion in the USBC, there would be provisions that fall within Chapter 4 of the VECC and Chapter 11 of the Virginia Residential Code (VRC), as there are provisions that would impact single-family dwellings.

Andrew G endorsed the change, noting that small units often struggle to meet the current air-leakage target because the requirement is scaled to building volume, favoring large homes. Notes that Virginia needs to provide flexibility for smaller dwelling units to achieve this standard.

Monica R agreed, stating that tighter targets are harder for small enclosures.

Dennis H said the most pressing issue is who performs the tests; qualifications should be defined. Noted that, compared to the model code language, Virginia's language is more stringent and should be maintained.

Eric L responded that he is open to specifying tester credentials.

Andrew G added that some referenced certifications are being phased out.

Monica R warned against allowing installers (e.g., insulation or mechanical contractors) to test their own work, citing conflict-of-interest concerns.

Eric L noted a similar compromise was reached on duct-leakage testing and is willing to pursue one here.

Bill P indicated support for this and a related proposal submitted by himself on behalf of Sierra Club - VA Chapter, suggesting possible consolidation.

Florin M asked **Eric L a**nd **Bill P** to consider merging or withdrawing duplicative submissions to reach a single consensus proposal.

Justin K inquired whether jurisdictions keep approved lists of third-party testers.

D.A. Pierce said Roanoke requires testers to complete a registration form before testing.

Steve S explained that "approved" simply means accepted by the local building department; the code mandates a third-party policy in general, but not a formal roster or list of approved third-party testers.

Andrew G noted that some localities do maintain such lists.

Florin M notes that the next proposal, REC-R402.4.1.2(1)-24, authored by **Bill P** and which was not officially announced, is similar to **Eric L's** proposal, REC-R402.4.1.2-24, both in content and in scope.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble

- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Bill P stated that this proposal is similar to **Eric L's** proposal, so no additional discussion was needed.

DHCD Staff Note: The excerpt from the November 14, 2025, Energy SWG meeting summary pertaining to proposal REC-R402.4.1.2-24 is provided below.

Eric L provided an overview of the proposal which deletes Virginia specific amendments to the air leakage requirements with the intent to incorporate the 2024 IECC testing requirements.

D.A. Pierce expanded that this proposal is for R-5 use occupancies, which in Virginia are single-family and two-family dwelling homes including townhouses, and R-3 in Virginia for residencies in a mixed occupancy building. VBCOA supports this for R-5 occupancies only and requested that the proposal is amended.

Jeff Brown (DHCD staff) clarified that as written, the proposal is eliminating the requirements in this section in the Virginia Energy Conservation Code (VECC) which applies to anything under the International Residential Code (IRC), as well as low-rise residential under the VECC. The testing requirements would apply in the Virginia Residential Code (VRC) to R-5 and the VECC to other R-use groups that fall within the low-rise residential guidelines.

Florin M suggested that it could be beneficial for the Board if **D.A.** could clarify why this proposal is acceptable for a single-family home but not an R-3.

Bill P asked what is an R-3 that is not an R-5.

Florin M provided townhouses over three stories in height, as an example, which are commonly classified as R-3.

Sydney R supported the proposal and stressed that smaller units are at a disadvantage in the 2021 Virginia codes because the ratio of volume per square footage changes as the unit gets smaller and would be at an advantage if the 2024 IECC language were adopted.

Scott P was opposed and preferred the Virginia amendments.

Eric L pointed out that the primary cost of blower door testing is the test itself and that is already in Virginia's code. Going from 5 to 3 air changes per hour are not going to require extra or new materials and Virginia builders are probably already achieving this. Trading off the air leakage in the performance path would be allowed with the 2024 IECC language.

Andrew G concluded that this proposal gives flexibility that would be good for the industry moving forward. The real cost for a tighter home is installing the ventilation system and testing.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Steve Shapiro, AOBA and VAMA; and Andrew Clark, HBAV.

Discussion:

Bob S provided that this proposal was similar to proposal REC-R402.4.1.2 and there was no need to discuss.

DHCD Staff Note:

This proposal is substantially identical to proposal REC-R402.4.1.2-24, which was reviewed by stakeholders at the third GSW meeting, on January 5, 2026, and received a Non-Consensus recommendation. The excerpt from the January 5, 2026, meeting summary pertaining to REC-R402.4.1.2-24 is provided below.

January 5, 2026, GSW Meeting Summary Excerpt

Support: Bob Shippee, Sierra Club; Sydney Roberts, SEEA; and D.A. Pierce, VBCOA Energy Committee.

Opposition: Steve Shapiro, AOBA and VAMA; Andrew Clark, HBAV; Mark Graver, City of Waynesboro and VBCOA Region III; and Rick Hinson, American Council of Engineering Companies (ACEC).

Discussion:

Eric L provided an overview of the proposal.

a. **Sydney R** stressed that for the durability advantages to a tighter building envelope as insulation is increased, there also needs to be an increase in air tightness to keep the humid air out of building cavities. This is a risk mitigation measure for home builders.
b. **Steve S** stated that he has been collaborating with **Eric L** on some things that might be able to be worked out. He noted that he will continue to work with **Eric L** prior to the Board meeting

and remove their opposition if they are able to work out the issues. **Andrew C** echoed **Steve S's** comments.

c. **D.A. Pierce** inquired if the proponent was open to adding an allowance for four air changes per hour for climate zones three through five for single- and two-family dwellings as an exception.
d. **Mark G** commented that rarely are blower door test results below three air changes, and to achieve that would require a significant number of callbacks to contractors to discover where the source of the leak is coming from.

REC-R403.14-24

IECC: R403.14 (N1103.14) (New)

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2024 International Energy Conservation Code [RE Project]

Add new text as follows:

R403.14 (N1103.14) Ceiling fans. R403.14 (N1103.14). A ceiling fan (with variable speeds and reversible direction) shall be installed in each bedroom.

Exception: such fans are not required in rooms with ceilings less than 8 feet high.

Reason Statement: Ceiling fans save energy and energy costs, while improving comfort for residents. They are an inexpensive, well-established technology. While distributing air with a ceiling fan will can improve comfort in any occupied room, this proposal is limited to bedrooms, which are occupied for sustained periods every night.

The U.S. Department of Energy (https://www.energy.gov/energysaver/fans-cooling) states:

"Ceiling fans are the most effective type of circulating fan. They help improve comfort year-round by effectively circulating air throughout a room.

- **Summer Use:** Run ceiling fans counterclockwise to create a cooling breeze.
- **Winter Use:** Reverse the direction to clockwise and set to low speed to circulate warm air from the ceiling down to living spaces.
- **Energy Savings:** Using a ceiling fan allows you to raise the thermostat setting by about 4°F without reducing comfort. In moderate climates, ceiling fans can sometimes replace air conditioning altogether."

The potential energy and energy-cost savings are very large when residents have the ability to live comfortably with temperatures set up to 4°F higher during the summer air-conditioning season. The benefits from ceiling fans will grow as climate change extends and exacerbates the annual air-conditioning season. As noted by DOE, winter demand can be reduced as well as summer demand.

Reduced demands for electricity will also reduce the driver of utilities' capital and operating costs. That will reduce rates for all customers and reduce utilities' need for intrusive and harmful construction projects to build or modify generation, transmission, distribution. Those reductions will benefit all Virginians.

Cost Impact: The code change proposal will increase the cost

Installing ceiling fans will modestly increase costs of construction but it will save money and improve comfort for residents for many years. The ability to reduce air conditioning demands by up to 4.0 F degrees will provide large savings for occupants and for utilities.

Ceiling fan with variable speeds and reversible directions can be purchased at retail for under $60 on Amazon or under $66 at Lowes, and installation is no different from (and can even replace with a fan-and-light) installing a ceiling light. https://www.amazon.com/s?k=ceiling+fans+for+bedroom&crid=7S8YNULXX7R4&sprefix=ceiling+fans%2Caps%2C189&ref=nb_sb_ss_p13n-expert-pd-ops-ranker_10_12 ; https://www.lowes.com/pl/ceiling-fans/indoor/4294395604-2003401792

Delivering to Ashburn 20149
Update location

All ceiling fans for bedroom

EN

Hello, sign in
Account & Lists

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0

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Customer Reviews

& Up

Size

36 Inches & Under
37 to 45 Inches
46 to 50 Inches
51 to 55 Inches
56 to 65 Inches
66 Inches & Up

Color & Finish

Price

OPONL

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OPONL 42 Inch Ceiling Fans with Light, Black Low Profile Ceiling
4.4 (328)
Limited time deal
-29% $49.98
List: $69.99

Results

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Best Seller



+3 other colors/patterns

Sponsored

Amico Ceiling Fans with Lights, 42 inch Low Profile Ceiling fan with Light and Remote Control, Flush Mount, Reversible, 3CCT,...

120V AC input, DC motor

Top Reviewed for Ease of installation
4.3 (2.7K)
3K+ bought in past month

$55.99 List Price: $84.99
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+2 other colors/patterns

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TCL 52" Low Profile Ceiling Fan with Light, Slim, Black, Flush Mount, DC Reversible Motor, 6 Speeds, Remote Control,...

DC

4.3 (222)
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$119.99 List: $159.99
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+3 other colors/patterns

Sponsored

TCL Ceiling Fans with Lights, 52 Inch Low Profile Ceiling Fan with Light and Remote Control, Flush Mount, DC Reversible Motor,...

dc

Top Reviewed for Ease of installation
4.4 (752)

$119.99 List: $159.99
FREE delivery **Sun, Mar 15**
Or fastest delivery **Tomorrow, Mar 11**
Matching: bedroom

Add to cart

Best Seller



+2 other colors/patterns

Sponsored

TCL 52" Ceiling Fan with Lights, Black Flush Mount Ceiling Fans with Remote Control, 6 Speeds DC Reversible, Dimmable,...

dc

Top Reviewed for Ease of installation

4.5 (798)

600+ bought in past month



Amico Ceiling Fans with Lights, 42 inch Low Profile Ceiling fan with Light and Remote Control, Flush Mount, Reversible, 3CCT,...

120V AC input, DC motor

Top Reviewed for Ease of installation

4.3 (2.7K)

3K+ bought in past month



addlon Ceiling Fans with Lights, 42 Inch Low Profile Ceiling Fan with Light and Remote Control, Flush Mount, Reversible, 3CCT,...

120V AC input, DC motor

Top Reviewed for Ease of installation

4.4 (1.5K)

3K+ bought in past month

Best Seller



Amico Ceiling Fans with Lights, 42 inch Low Profile Ceiling Fan with Light and Remote Control, Flush Mount, Reversible, 3CCT,...

120V AC input, DC motor

Top Reviewed for Ease of installation

4.3 (2.7K)

$99.99

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More Buying Choices
$39.99 (5+ used & new offers)

Overall Pick



Ohniyou Ceiling Fans with Lights, 52" Low Profile Ceiling Fan with Light and Remote/APP Control, Modern Flush Mount Ceiling Fa...

AC

Top Reviewed for Ease of installation

4.3 (775)

1K+ bought in past month

$59.99 List Price: ~~$90.99~~

Exclusive Prime price

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See options



+12

Asyko Ceiling Fans with Lights,46" Low Profile Ceiling Fan with Light and Remote Control,Flush Mount, Reversibl...

dc

4.4 (532)

500+ bought in past month

$47.99

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+7 other colors/patterns

46 Inch Ceiling Fans with Lights and Remote Control, Farmhouse Ceiling Fan for Bedroom Living Room and Patio, Black Caged…

Corded Electric



+4 other colors/patterns

52 Inch Solid Wood Ceiling Fans with Lights and Remote, 3 Blade Walnut Outdoor Ceiling Fans with Wall Control, Dimmable, 6…

4.5 (20)



+4 other colors/patterns

72 Inch Ceiling Fans with Lights and Remote, Dual Color 8 Blades, Bedroom Living Room Office Library Cafe Outdoor Industrial…

DC

More results



ZMISHIBO Ceiling Fans with Lights and Remote, 19.7'' Low Profile Ceiling Fan, 3000-6000K Dimmable Modern Flush Moun…

Options: 3 sizes

4.5 (1.8K)

2K+ bought in past month

$56.99 List Price: $74.99

Exclusive Prime price

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See options



+11 other colors/patterns

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Depuley Modern Ceiling Fan with Light: 42-Inch Black Small Fans for Bedroom Indoor Outdoor - Dimmable Low Profile Ceiling…

dc

Top Reviewed for Ease of installation

4.5 (606)

1K+ bought in past month

$49.99

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+2 other colors/patterns

Sponsored

TCL Ceiling Fans with Light and Remote: 52 inch 3 Blades Dimmable LED Fan for Room Indoor Modern Farmhouse Dec…

5.0 (20)

$249.99

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Matching: bedroom

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+4 other colors/patterns

Sponsored



+4 other colors/patterns

Sponsored



52 Inch Ceiling Fans with Lights and Remote, Modern Wood Outdoor Ceiling Fan with Light, 3 Blade Propeller Indoor Ceiling…

ac_dc

5.0 (9)

New on Amazon in past month

$179.00

Save $64.00 with coupon

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Add to cart

72 Inch Ceiling Fans with Lights and Remote, Dual Color 8 Blades, Bedroom Living Room Office Library Cafe Outdoor Industrial…

DC

4.8 (12)

$113.99 Typical price: ~~$119.99~~

Exclusive Prime price

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Or fastest delivery **Thu, Mar 12**

Matching: bedroom

See options

Ceiling Fans with Lights,42" Low Profile Ceiling Fan with Light and Remote Control,Flush Mount, Reversible, Dimmable, Noiseles…

4.5 (287)

300+ bought in past month

$49.99

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Sponsored

Modern 42 Inch Ceiling Fans with Lights and Remote, Bedroom Living Room Offic…

4.5 (216)

100+ bought in past month

$55.98 List Price: ~~$79.99~~

Save 10% at checkout

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KNUN 52inch Smart Ceiling Fans with Lights

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KNUN 52Inch Black Ceiling Fan, Low Profile Ceiling Fans with Lights and Remote/APP Control, 8 Blades, Noiseless, DC Motor,

4.4 34

$79.99

List: ~~$89.99~~

KNUN 52Inch Brown Ceiling Fan, Low Profile Ceiling Fans with Lights and Remote/APP Control, 8 Blades, Noiseless, DC Motor,

4.4 34

$85.99

List: ~~$99.99~~

KNUN 52Inch White Ceiling Fan, Low Profile Ceiling Fans with Lights and Remote/APP Control, 8 Blades, Noiseless, DC Motor,

4.4 34

$75.99

List: ~~$89.99~~

More results



+11 other colors/patterns

Depuley Modern Ceiling Fan with Light: 42-Inch Black Small Fans for Bedroom Indoor Outdoor - Dimmable Low Profile Ceiling…

dc

Top Reviewed for Ease of installation

4.5 (606)

1K+ bought in past month

$49.99

Save 5% on 5 select item(s)

FREE delivery **Sun, Mar 15**



ZMISHIBO 52 Inch Ceiling Fan with Light, App&Remote Control, Flush Mount Low Profile, Dimmable 20W LED Light, Qui…

DC Motor

4.4 (911)

1K+ bought in past month

Limited time deal

$65.99 List: $89.99

10% off promotion available

FREE delivery **Sun, Mar 15**



Ohniyou Ceiling Fans with Lights, 52" Low Profile Ceiling Fan with Light and Remote/APP Control, Modern Flush Mount Ceiling Fa…

120V AC input, DC motor

Top Reviewed for Ease of installation

4.3 (775)

400+ bought in past month

$59.99 List Price: $98.99

Exclusive Prime price

FREE delivery **Sun, Mar 15**



+2 other colors/patterns

Sponsored

Portage Bay 51442 Miller Park Ceiling Fan, 44, Bronze

Corded Electric

4.6 (847)

$119.99

FREE delivery **Fri, Mar 13**

Only 9 left in stock - order soon.

Matching: bedroom

Small Business

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+10 other colors/patterns

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Modern 72 Inch Ceiling Fans with Lights and Remote, Dual Color 8 Blades,Living Room Office Library Cafe Outdoor Industrial, 24W…

DC

4.5 (125)

100+ bought in past month

Limited time deal

$109.98 List: $169.99

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Matching: bedroom

Add to cart



+4 other colors/patterns

Sponsored

WINGBO 48 Inch DC Ceiling Fan with Lights and Remote Control, 4 Carved Solid Wood Blades, 6-Speed Noiseless Reversible DC…

DC

4.1 (49)

$229.99

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Carbon impact

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+2 other colors/patterns

Sponsored

60Inch Ceiling Fan with Lights and Remotes, Large Low Profile Flush Mount Ceiling Fans,DC Reversible Motor, 3CCT…

dc

5.0 (11)

100+ bought in past month



Ceiling Fans with Lights, 42 Inch Ceiling Fan with Light And Remote, 3CCT Flush Moun Low Profile Ceiling Fans, 6 Speed…

dc

4.4 (189)

1K+ bought in past month

$46.99 List Price: $58.99



TCL 52" Ceiling Fan with Lights, Black Flush Mount Ceiling Fans with Remote Control, 6 Speeds DC Reversible, Dimmable,…

dc

Top Reviewed for Ease of installation

4.5 (798)

600+ bought in past month

Limited time deal



addlon Ceiling Fans with Lights, 42 Inch Low Profile Ceiling Fan with Light And Remote Control, Flush Mount, Reversible, 3CCT,…

120V AC input, DC motor

Top Reviewed for Ease of installation

4.4 (1.5K)

1K+ bought in past month

$69.99 List Price: $99.99

Exclusive Prime price

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See options



ZMISHIBO Low Profile Ceiling Fans with Lights and Remote, 20 Inch Flush Mount Ceiling Fan with Light, 3000K-6000K…

DC Motor

4.5 (895)

500+ bought in past month

$59.99 List Price: $79.99

Exclusive Prime price

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See options



Ceiling Fans with Lights - 42 Inch Low Profile Ceiling Fan with Light and Remote, Reversible DC Motors, 3CCT Dimmable Timer…

DC

4.4 (231)

300+ bought in past month

$49.99

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More Buying Choices
$43.25 (2 used & new offers)







addlon Ceiling Fans with Lights and Remote, 20" Low Profile Ceiling Fans, 3000-6000K Dimmable Modern Flush Moun…

Options: 3 sizes

4.5 (1.1K)

1K+ bought in past month

$49.99 List Price: $69.99

Exclusive Prime price

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See options

+2

Passky Ceiling Fans with Lights, 52 inch Sleek Ceiling Fan with Light and Remote Control, 3CCT, Dimmable, Reversible, Noiseles…

Options: 4 sizes

4.5 (390)

1K+ bought in past month

Limited time deal

$59.98 List: $99.99

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More Buying Choices
$47.38 (2+ used & new offers)

+3

Black Ceiling Fans with Lights - 46" Flush Mount Ceiling Fan with Remote and 5 Reversible Blades, 3CCT Dimmable, 6 Wind…

Options: 3 sizes

4.5 (114)

300+ bought in past month

$45.99

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Add to cart

More Buying Choices
$43.69 (2 used & new offers)



Passky Ceiling Fans with Lights, 52 inch Flush Mount Ceiling fan with Remote Control, Low Profile Ceiling Fan for Bedroom,…

AC input, DC motor

4.5 (277)

1K+ bought in past month

$59.99 List Price: $79.99

Exclusive Prime price

FREE delivery **Sun, Mar 15**
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See options



Ceiling Fans with Lights, 52 Inch Modern Ceiling Fans with Lights and Remote Control, DC Reversible Motor, Noiseless,…

dc

4.5 (304)

1K+ bought in past month

$59.99

FREE delivery **Sun, Mar 15**
Or fastest delivery **Tomorrow, Mar 11**

Add to cart



42" Ceiling Fan with Lights and Remote, Low Profile Modern Ceiling Fan Gold, 6 Speed, Reversible, 3000k-6000k LED,…

Options: 4 sizes

4.4 (349)

400+ bought in past month

$59.99 List Price: $89.99

Exclusive Prime price

FREE delivery **Sun, Mar 15**
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See options



TALOYA 52 inch Ceiling Fans with Lights Remote Control, Modern Low Profile Ceiling Fan with Quiet Reversible DC Motor for…



42 Inch Ceiling Fans with Light, Black Low Profile Ceiling Fan with Light, Remote Control, Flush Mount, Reversible, 6CCT,…



+4 other colors/patterns

Passky 20" Farmhouse Flush Mount Ceiling Fans with Lights and Remote, Industrial Black Caged Low Profile Fandelier, 6…

Options: 2 sizes

4.3 (572)

300+ bought in past month

$109.63

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AC/DC

4.4 (328)

400+ bought in past month

Limited time deal

$49.98 List: $69.99

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More Buying Choices

ac

4.4 (199)

1K+ bought in past month

$69.99 List Price: $89.99

Exclusive Prime price

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See options



+3 other colors/patterns

72 inch Ceiling Fans with Lights,Large Ceiling Fan with Light and Remote Control, Dimmable, 3CCT, Quiet, Black…

dc

4.6 (201)

500+ bought in past month

$99.99 List Price: $119.99

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Recycled materials +2 more

See options



+8

52 Inch Gold Ceiling Fans with Lights and Remote/APP, Modern Sleek Black and Gold Ceiling Fan, ETL Listed, Indoor Outdoor…

DC

4.7 (54)

200+ bought in past month

$88.99 List: $99.99

FREE delivery **Sun, Mar 15**
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Small Business

Add to cart



+6

41" Black Low Profile Ceiling Fans with Lights and Remote, Modern Flush Mount Ceiling Fan Light with Quiet Reversible DC Motor…

4.3 (309)

400+ bought in past month

$44.99

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+2 other colors/patterns

Dreo Ceiling Fans with Lights, 52 Inch, 6 Speeds, 5 Color Tones Dimmable LED, Quiet Reversible DC Motor, Remote, 8H Timer,…

dc

Top Reviewed for Ease of installation

4.6 (543)

300+ bought in past month

Limited time deal



Ceiling Fans with Lights, 52 Inch Ceiling Fan with Light and Remote Control, Reversible DC Motor, 3CCT, Dimmable, Timer,…

ac_dc

4.5 (77)

300+ bought in past month

$79.99 List: $119.99

Save 5% on 3 select item(s)



46" Black Ceiling Fans with RGB Lights - Flush Mount Ceiling Fan Light with LED 3CCT Dimmable, Modern Low Profile Ceiling Fan…

dc

4.3 (159)

300+ bought in past month

$56.99

Save 5% on 3 select item(s)

$139.97 List: $159.99

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More Buying Choices
$117.70 (2+ used & new offers)

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More Buying Choices
$69.99 (2+ used & new offers)

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Fanbulous 2 Pack Farmhouse 42 Inch Ceiling Fans with Lights, Black Industrial Caged Ceiling Fans for Bedroom Living Room,…

Options: 3 sizes

4.2 (252)

200+ bought in past month

$139.99 ($70.00/count)

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More Buying Choices
$125.81 (2 used & new offers)



Dreo Ceiling Fans with Lights and Remote, 44 Inch Low Profile, Black Flush Mount Bedroom Ceiling Fan, Reversible Motor,…

dc

Top Reviewed for Ease of installation
4.5 (650)

300+ bought in past month

$149.99

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Add to cart

More Buying Choices
$102.31 (2+ used & new offers)



Hunter 52 inch Indoor Ceiling Fan No Light - Black Modern Ceiling Fan without Light, 3 Blades, Standard Mount, For Bedroom,…

AC

4.4 (521)

$199.99

FREE delivery **Sun, Mar 15**
Or fastest delivery **Thu, Mar 12**

Add to cart



+3

20'' Ceiling Fan with Light, Upgraded Low Profile Fan, Flush Mount Ceiling Fan, 6 Speeds, Dimmable LED, App & Remote…

Options: 2 sizes

4.5 (2.2K)

500+ bought in past month

Limited time deal

$69.87 List: $99.90

FREE delivery **Sun, Mar 15**
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Add to cart



Gold Ceiling Fans with Lights and Remote 52 Inch Crystal Chandelier Ceiling Fan for Bedroom Living Room, Modern…

4.5 (1.5K)

$148.99

FREE delivery **Mar 13 - 17**
Small Business

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Prominence Home Alvina, 42 Inch Traditional Flush Mount Indoor LED Ceiling Fan with Light, Pull Chain, Dual Finish Blades,…

Corded Electric

Top Reviewed for Ease of installation
4.6 (8.6K)

50+ bought in past month

$83.00

FREE delivery **Sun, Mar 15**
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Small Business

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addlon Ceiling Fans with Lights, 52 inch Black Ceiling fan with Light and Remote Control, Reversible, 3CCT, Dimmable,...

120V AC input, DC motor

Top Reviewed for Ease of installation

4.4 (888)

500+ bought in past month

$69.99 List Price: $99.99

Exclusive Prime price

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See options



+5 other colors/patterns

addlon Ceiling Fans with Lights and Remote, 24" Low Profile Flush Mount Ceiling Fan, 3000–6000K Dimmable LED Fandelie...

Options: 2 sizes

4.5 (153)

1K+ bought in past month

$59.99 List Price: $74.99

Exclusive Prime price

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Ceiling Fans with Lights, 48 inch Low Profile Ceiling Fan with Light and Remote Control, Flush Mount, Reversible, 3CCT,...

ac

4.6 (156)

300+ bought in past month

Limited time deal

$56.98 List: $72.99

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+3 other colors/patterns

TCL Ceiling Fans with Lights, 52 Inch Low Profile Ceiling Fan with Light and Remote Control, Flush Mount, DC Reversible Motor,...

dc

Top Reviewed for Ease of installation

4.4 (752)

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More Buying Choices
$115.19 (2 used & new offers)



Ceiling Fans with Lights, 52 Inch Low Profile Ceiling Fan with Light and Remote Control, Flush Mount, Reversible, 3CCT,...

ac

Top Reviewed for Ease of installation

4.6 (287)

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$99.99

Save 5% on 2 select item(s)

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More Buying Choices
$91.99 (2+ used & new offers)



Dreo Ceiling Fans with Lights, 12 Speeds & 3 Fan Modes, Quiet DC Motor, Low Profile Easy to Install, Flush Mount Smart Ceiling Fan...

Electric DC Motor

Top Reviewed for Ease of installation

4.6 (470)

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Works with Alexa

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More Buying Choices
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Honeywell Ceiling Fans Glen Alden, 52 Inch Classic Flush Mount Indoor LED Ceiling Fan with Light, Pull Chain, Quick-2-…

Corded Electric

4.6 (3K)

300+ bought in past month

$99.99 List: ~~$109.99~~

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Add to cart



+3 other colors/patterns

LEDIARY 20 Inch Low Profile Ceiling Fans with Lights and Remote, Fandelier Ceiling Fan Flush Mount, 3000K-6000K…

DC Motor

4.5 (1K)

700+ bought in past month

$47.99 List Price: ~~$59.99~~

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TCL 52" Low Profile Ceiling Fan with Light, Slim, White, Flush Mount, DC Reversible Motor, 6 Speeds, Remote Control,…

dc

4.3 (222)

200+ bought in past month

$119.99 List: ~~$159.99~~

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+9 other colors/patterns

Depuley 52-Inch Ceiling Fans with Lights: Black 3 Blade Flush Mount Low Profile Ceiling Fan for Bedroom - Dimmable Indoor…

dc

4.4 (408)

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52 Inch ETL Listed Indoor Outdoor Smart Ceiling Fans with Lights Remote Control, Quiet DC Motor 3 Blade Modern White…

AC/DC

4.3 (900)

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$127.45 List: ~~$149.95~~

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More Buying Choices
$107.99 (2+ used & new offers)



Dreo Smart Ceiling Fans with Lights, Low Profile Ceiling Fan with Alexa/App, 52'' Dimmable Lighting & Color Tuning, RGB…

4.6 (368)

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Limited time deal

$197.99 List: ~~$219.99~~

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Works with Alexa

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+2 other colors/patterns

TCL Ceiling Fans with Light and Remote: 52 inch 3 Blades Dimmable LED Fan for Room Indoor Modern Farmhouse Dec…

5.0 (20)

$249.99

FREE delivery **Sun, Mar 15**
Or fastest delivery **Fri, Mar 13**

Add to cart



+4 other colors/patterns

52 Inch Ceiling Fans with Lights and Remote, Modern Wood Outdoor Ceiling Fan with Light, 3 Blade Propeller Indoor Ceiling…

ac_dc

5.0 (9)

New on Amazon in past month

$179.00

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FREE delivery **Sun, Mar 15**



+9 other colors/patterns

Depuley 52-Inch Ceiling Fans with Lights: Black 3 Blade Flush Mount Low Profile Ceiling Fan for Bedroom - Dimmable Indoor…

dc

4.4 (408)

200+ bought in past month

Limited time deal

$62.99 List: ~~$69.99~~

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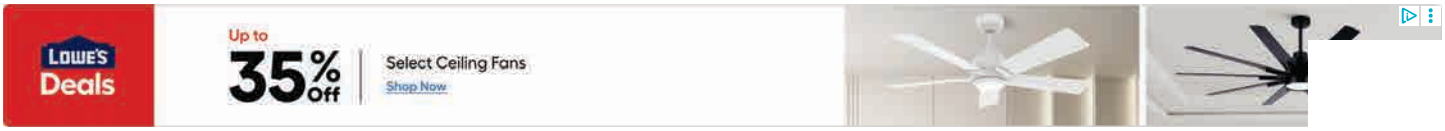
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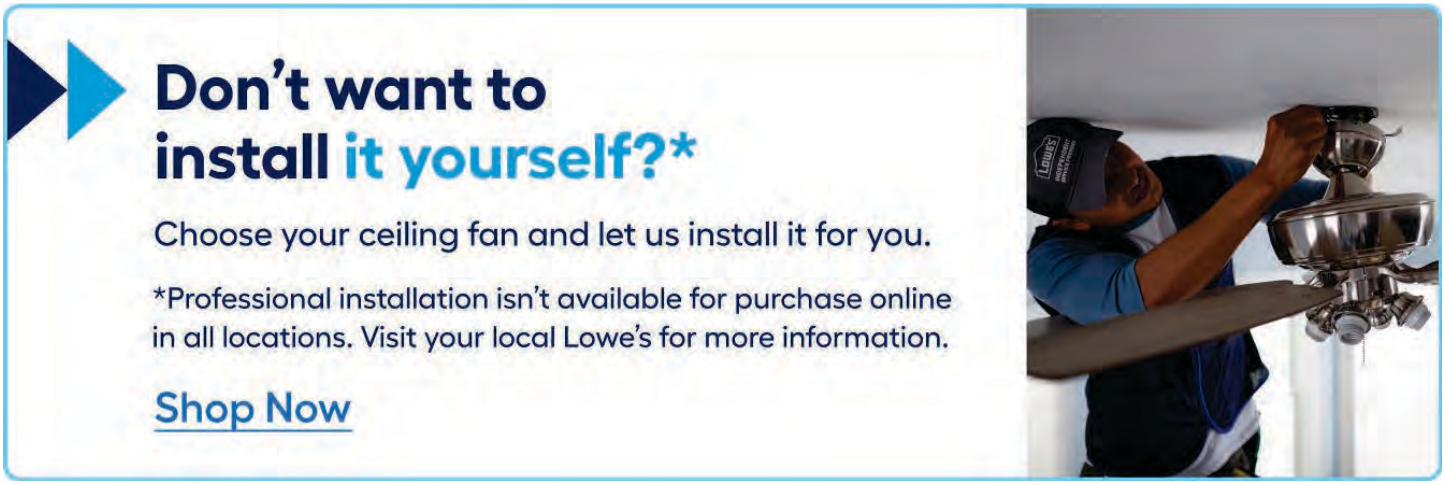
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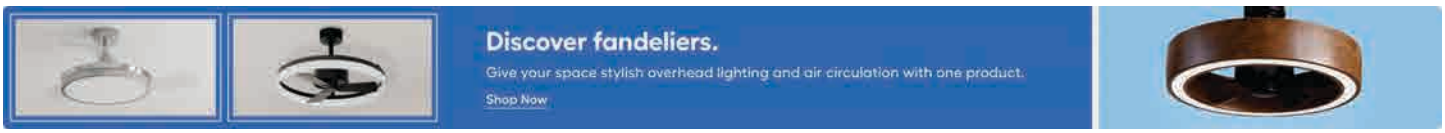


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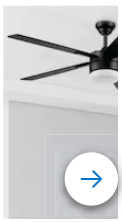
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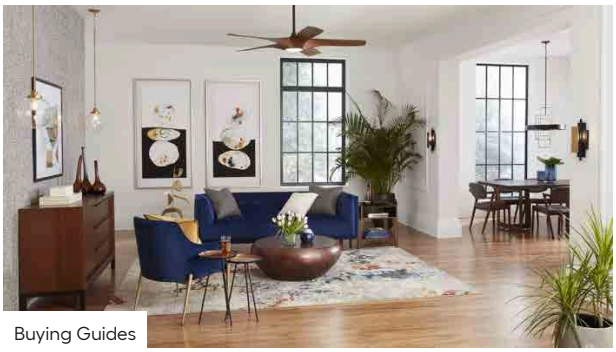
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REC-R403.14-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Requires the installation of a ceiling fan with variable speeds and reversible direction in each bedroom.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second and third Energy Sub-Workgroup meetings on September 29, 2025, and November 14, 2025, respectively.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce

- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Steve S objected, stating that the building code is intended to set minimum standards, and mandating ceiling fans goes beyond that intent.

Corian C opposed the proposal and added that the National Electrical Code (NEC) already requires the installation of ceiling fan boxes where a fan might be placed, giving occupants the choice to install a ceiling fan.

Dennis H questioned what is meant by the term “planned principal living area.”

Kyle K agreed, noting that if such a term is used, it must be clearly defined.

Bill P responded that he would be amenable to limiting the requirement to sleeping rooms only, as ceiling fans can deliver meaningful energy savings by allowing higher thermostat settings.

Eric L acknowledged the effectiveness of ceiling fans and appreciated that the NEC already addresses the necessary infrastructure.

Monica R supported the proposal from an energy perspective but expressed design concerns, mentioning that some clients have safety fears related to ceiling fans.

Corian C pointed out that such concerns are why the NEC requires appropriate ceiling fan boxes, to allow for future safe installation.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark

- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Bill P provided an overview of the proposal which adds a requirement for ceiling fans to be installed in each bedroom. This proposal has changed from originally applying to bedrooms and the principal living area to now being limited to bedrooms only.

Scott P was opposed. Stated that this is micro managerial of people's lifestyles and this proposal is legislating people's bedrooms in the code.

Eric L, speaking for himself, supported the proposal as ceiling fans are more likely to have integrated controls if installed during construction.

Andrew C asked if wiring for ceiling fans is installed in new homes currently. After confirmation from the group, **Michael R** asked if the box in the ceiling is adequate for supporting the fan or just the electrical wires for the ceiling fan.

Florin Moldovan (DHCD staff) provided that there was a change in the 2021 IRC and the National Electrical Code (NEC) that if there is an outlet box installed in the ceiling, then the box must be listed and labeled for supporting a ceiling fan, with the exception of where the box is in close proximity to a wall and a ceiling fan cannot be installed.

Andrew C questioned if requiring ceiling fans can be cost prohibitive in the future when the consumer already has a choice to install or not install a ceiling fan and the infrastructure is already there to install a fan if the consumer so chooses.

Bill P countered that hiring an electrician to do the work after the home is built is more expensive than during initial construction.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Steve Shapiro, AOBA and VAMA; Andrew Clark, HBAV; Michael Dellinger, Albemarle County and VBCOA Region IV; Rick Hinson, American Council of Engineering Companies (ACEC); and Tread Willis, Prince William County and IAEI - Virginia Chapter.

Discussion:

Bob S provided an overview of the proposal.

a. **Steve S** emphasized that the code should not be legislating what people do in their bedrooms.
b. **Andrew C** agreed that a ceiling fan should be a consumer choice.
c. **Cory C** explained that the NEC does not require an overhead box to be installed in a bedroom. If a box is installed then it should be a ceiling fan rated box, but it is still not required equipment.
d. **Michael D** added that this would increase costs.
e. **Tread W**, speaking for himself, opined that the volume of lighting is more important than air flow.

DHCD Staff Note: N/A

REC-R404.1-24

IRC: N1104.1 (R404.1); IECC: R404.1

Proponents: Andrew Clark, representing Home Builders Association of Virginia (aclark@hbav.com)

2024 International Residential Code

Revise as follows:

N1104.1 (R404.1) Lighting equipment. Not less than 90 percent of the ~~All~~ permanently installed luminaires shall be capable of operation with an efficacy of not less than 45 lumens per watt or shall contain lamps capable of operation with an efficacy of not less than 65 lumens per watt.

Exceptions:

1. Appliance lamps
2. Antimicrobial lighting used for the sole purpose of disinfecting
3. General service lamps complying with DOE 10 CFR, Part 430.32.
4. Luminaires with a rated electric input of not greater than 3.0 watts.

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R404.1 Lighting equipment. Not less than 90 percent of the ~~All~~ permanently installed luminaires shall be capable of operation with an efficacy of not less than 45 lumens per watt or shall contain lamps capable of operation with an efficacy of not less than 65 lumens per watt.

Exceptions:

1. Appliance lamps
2. Antimicrobial lighting used for the sole purpose of disinfecting.
3. General service lamps complying with DOE 10 CFR, Part 430.32.
4. Luminaires with a rated electric input of not greater than 3.0 watts.

Reason Statement: This proposal restores the 10% allowance from the 2018 Code permitting a limited number of lighting sources that do not meet the current definition of high-efficacy lighting sources. The allowance is restored to provide design flexibility.

Cost Impact: The code change proposal will not increase or decrease the cost
The proposed code change may result in a modest reduction in construction costs; however, its primary benefit is the increased design flexibility it provides.

REC-R404.1-24 – Staff Summary

Proponent: Andrew Clark, representing Home Builders Association of Virginia

Brief Description: Reduces the required percentage of high-efficacy luminaires to a minimum of 90% of all permanently installed luminaires (The 2021 VRC/VECC and the 2024 IECC require all permanently installed luminaires to be high-efficacy).

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the third Energy Sub-Workgroup meeting on November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
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- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman

- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Andrew C provided an overview of the proposal which restores the 10 percent allowance from the 2018 VECC for lighting fixtures not to contain high-efficacy lamps.

Dennis H questioned how a code official would enforce it.

Andrew C reminded the room that the requirement was in the code before, thus it would be handled in the same manner it was handled prior.

Andrew G noted that the requirement used to be 50 percent.

Eric L was opposed due to the reduction in efficiency which weakens the standard that currently applies.

Sydney R was also opposed and doesn't see a reason to reserve the 10 percent. She also questioned how this affects inspectors and plan reviewers and how this is implemented.

Dennis H responded that most localities aren't doing trade reviews on residential so it would be up to the inspector, and he would be surprised if it was being looked at in the field.

Scott P supported the proposal.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Bob Shippee, Sierra Club; Joseph Wages, NEMA; and Sydney Roberts, SEEA.

Discussion:

Andrew C provided an overview of the proposal.

a. **Bob S** pointed out that this proposal seems to be a reduction with no offsetting tradeoff.
b. **Joseph W** remarked that this section already has four exceptions.
c. **Sydney R** brought up that this proposal was discussed at the Energy Sub-Workgroup meeting and there were no strong reasons or good examples of why this would be necessary and that it would probably be more expensive to buy less efficient bulbs.

DHCD Staff Note: N/A

REC-R404.2-24

IECC: SECTION 202, R404.2, R404.2.1, R404.2.2; IRC: SECTION 202, N1104.2 (R404.2), N1104.2.1 (R404.2.1), N1104.2.2 (R404.2.2)

Proponents: Andrew Clark, representing Home Builders Association of Virginia (aclark@hbav.com)

2024 International Energy Conservation Code [RE Project]

Delete without substitution:

~~**AUTOMATIC SHUTOFF CONTROL.** A device capable of automatically turning loads off without *manual* intervention. *Automatic shutoff controls* include devices such as, but not limited to, occupancy sensors, vacancy sensors, door switches, programmable time switches (i.e., timeclocks), or count-down timers.~~

~~**R404.2 Interior lighting controls.**. All permanently installed luminaires shall be controlled as required in Sections R404.2.1 and R404.2.2.~~

~~**Exception:** Lighting controls shall not be required for safety or security lighting.~~

~~**R404.2.1 Habitable spaces.** All permanently installed luminaires in habitable spaces shall be controlled with a *manual dimmer* or with an *automatic* shutoff control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.~~

~~**R404.2.2 Specific locations.** All permanently installed luminaires in garages, unfinished basements, laundry rooms and utility rooms shall be controlled by an *automatic* shutoff control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.~~

2024 International Residential Code

Delete without substitution:

~~**[RE] AUTOMATIC SHUTOFF CONTROL.** For the definition applicable in Chapter 11, see Section N1101.6.~~

~~**N1104.2 (R404.2) Interior lighting controls.** All permanently installed luminaires shall be controlled as required in Sections N1104.2.1 and N1104.2.2.~~

~~**Exception:** Lighting controls shall not be required for safety or security lighting.~~

~~**N1104.2.1 (R404.2.1) Habitable spaces.** All permanently installed luminaires in *habitable spaces* shall be controlled with a *manual dimmer* or with an *automatic shutoff control* that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.~~

~~**N1104.2.2 (R404.2.2) Specific locations.** All permanently installed luminaires in garages, unfinished *basements*, laundry rooms and utility rooms shall be controlled by an *automatic shutoff control* that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.~~

Reason Statement: This proposal seeks to simplify the interior residential lighting provisions of the code by removing the 2021 requirements mandating interior lighting controls in the form of a “dimmer, an occupant sensor, or another control,” as well as the 2024 IRC/IECC provisions requiring dimmers or automatic shutoff controls for all permanently installed luminaires in habitable spaces and automatic shutoff controls with manual on/off options in garages, basements, laundry rooms, and utility rooms. Removing these provisions restores consumer choice and design flexibility, without jeapordizing energy savings from the expanded use of hig-efficacy lighting sources.Limited Energy Savings:

Limited Energy Savings: A report by the Washington State University Energy Program found that energy savings from increased use of residential lighting controls are significantly lower than those achieved through the high-efficacy lighting sources already required under the Virginia Residential Code (N1104.1/R404.1). As high-efficacy lamps have become standard, the marginal benefit of additional control strategies continues to decline, providing little measurable improvement in overall residential energy performance. The report also cited U.S. Department of Energy analysis showing that properly controlled exterior residential lighting offers far greater savings potential than interior controls, reducing energy use by up to 36%. (Source: Washington State University Energy Program).

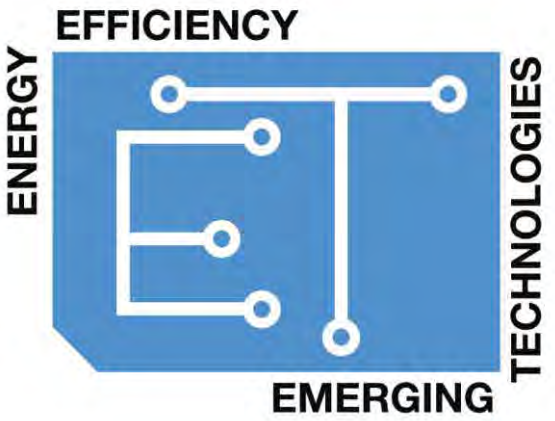
Uncertainty about compliant control types: The 2021 VRC requires all permanently installed lighting fixtures to be controlled by a dimmer or an occupant sensor control, yet also allows for the use of "another control" that is installed and built into the fixture. Without further clarification, this term can be interpreted to include a standard on/off switch, effectively negating the intended requirement.

Unclear Applicability: The 2021 VRC lists specific exceptions for certain areas—bathrooms, hallways, exterior fixtures, and safety or security lighting—but provides no clear guidance on other common spaces such as closets, laundry rooms, mudrooms, garages, pantries, and utility rooms. The revisions introduced in the 2024 IECC further build upon this lack of clarity, expanding control requirements without resolving how they apply to these common residential areas.

Cost Impact: The code change proposal will decrease the cost Proposal will decrease construction costs

Future Energy Reductions in Residential Lighting

June 2018



A Report of BPA's Emerging Technologies Initiative

Prepared for
Bonneville Power Administration

Prepared by
Washington State University Energy Program

Contract 71419

A Report for the BPA Emerging Technologies Initiative

The following report was funded by the Bonneville Power Administration (BPA) to assess emerging technology topics that have the potential to increase energy efficiency. BPA is committed to identify, assess and develop emerging technologies with significant potential for contributing to efficient use of electric power resources in the Northwest.

BPA does not endorse specific products or manufacturers. Any mention of a particular product or manufacturer should not be construed as an implied endorsement. The information, statements, representations, graphs and data presented in these reports are provided by BPA as a public service. For more reports and background on BPA's efforts to "fill the pipeline" with emerging, energy-efficient technologies, visit the ET website at http://www.bpa.gov/energy/n/emerging_technology/.

Acknowledgements

The Northwest Power Planning Council, and in particular Tina Jayaweera, provided technical assistance for this report. We recognize and give thanks for their expertise and contribution.

Abstract

Energy savings from BPA's residential lighting program currently provide the majority of savings in the residential portfolio, yet their savings' contribution will begin to decrease in 2018 as lighting program baselines increase. Improvements in LED quality and efficacy leading to saturation of energy efficient lamps, an anticipated 2020 national standard requiring greater lumens per watt, and more stringent residential lighting building codes will create fewer savings' opportunities, reducing the amount of savings that residential lighting programs may claim. Reduction in energy use continues to be realized through use of LEDs, while the next breakthrough for greatly reducing energy use with emerging lighting technologies is not expected until at least 2025. Residential energy savings from lighting controls, whether stand alone controls, integrated or part of home automation systems, are hampered by low usage and high efficacy of residential lighting, limiting effectiveness. This paper was commissioned by the BPA to identify new technologies to ensure future residential lighting energy savings for the Pacific Northwest.

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Executive Summary

Lighting energy savings play a key role in BPA's Residential Energy Efficiency Program. Between 2015 and 2017, lighting savings grew from 43% to 72% of the total residential portfolio. This contribution will fall substantially starting in 2018 when changing baselines will cut savings by up to 60%. Anticipating these changes, BPA began evaluating alternatives to replace expected losses from the residential lighting program in 2017. This research supports the resulting strategic planning initiative to redesign the residential lighting program in response to the anticipated changes.

The objectives of this report were to understand the future state of residential lighting including how the continued growth of LEDs would impact future savings, as well as identify new technologies that could potentially replace anticipated saving losses. An extensive literature search, as well as interviews with staff from utilities, manufacturers and subject matter experts provided the content. The report has been divided into two major categories including lamps and controls. Residential lighting energy savings are identified in the Northwest for both new construction and retrofit applications. Energy efficient lighting solutions are presented for both near term savings (1 – 5 years) as well as technologies which require additional research and development for future energy savings (over 5 years).

During the next five years, potential for reductions in total residential lighting energy use will be driven by further penetration of high efficacy lamps, primarily LEDs. During this time frame, the efficacy of LED lighting is expected to continue to improve with the potential for LEDs to become twice as efficient as products currently in the market. The efficacy of LEDs currently available in the Northwest ranges from 80 to 100 lumens/watt. However, state of the art products can be found with efficacies of 200 lumens/watt. The efficacy of all products is anticipated to increase to this level in the near future with DOE targeting 200 lumens per watt by the year 2025 as the standard.

While improving, concerns about cost, light quality, flicker and dimming performance have slowed adoption of LEDs. To address these barriers consumers have purchased familiar looking halogens lamps, resulting in their market share growing from 1% in 2011 to 26% in 2016. However, the upcoming Energy Independence and Security Act (EISA) 2020 will require an efficacy of greater than 45 lumens/watt which eliminates halogens from the lighting mix. As prices continue to fall and halogen lamps are eliminated from the market, customers' expectations will demand LED lamps with good lighting and dimming performance.

The EISA 2020 federal standard, along with advancing energy codes in the Northwest, have the potential to increase the market penetration of higher efficacy lamps. New codes will raise the baseline from and diminish utilities programmatic savings. As a result, utilities may look to promote lighting products with efficacies higher than the EISA minimum. Utility incentive programs could potentially accelerate the adoption of higher efficacy LED lighting, for instance through the use of tiered incentives that provide larger incentives for more efficient products.

Increased use of lighting controls in the residential sector has the potential to increase lighting energy reductions, but energy savings are small compared to the savings potential from the expanded use of high efficacy lamps. Savings from control strategies are minimized as higher and higher efficacy lamps become the norm. DOE estimates 7% of residential lighting savings can come from controls by 2035. According to DOE and CEE, proper control of exterior lighting on homes has higher potential for savings (energy use reduction of as much as 36%) than interior residential controls.

Adding controls that include connectivity to house automation systems and/or the internet increases installation costs but has not been shown to significantly increase energy savings over savings provided by independent lighting control technologies. Connectivity does however provide the potential to create a demand response resource for utilities. Further research is recommended to validate energy savings potential and cost effectiveness.

There are interesting emerging lighting technologies that may impact the residential sector in the long term, many beyond five years. These include Organic LEDs, Laser LEDs and Quantum Dots. Currently, there is limited availability of organic LED (OLED) products for the residential sector, but cost and incompatibility with current fixtures and standard lighting design are significant barriers. Laser LEDs and quantum dots may play a role in the future (beyond ten years), but with no products generally available in the market, their application to lighting remains speculative. In addition, while these new technologies could radically impact how lighting is implemented, they do not appear to offer significant, if any, improvements in efficacy. Future efforts for these new technologies will need to focus on accelerating their development through strategic partnerships to support research and development.

It will be challenging to continue the very successful reductions in residential lighting energy use achieved in the last five years at the same pace. As more sockets are filled with low wattage, high efficacy lamps such as LEDs, opportunities for further energy savings diminish. In addition, incremental savings from reduced operating hours through lighting controls shrink as the source wattage is reduced. Finally, the rated life of the high efficacy, low wattage fluorescent and LED sources are long, resulting in low replacement rates. With these lamps remaining in sockets longer, there is limited opportunity for installation of newer, more efficient lamps.

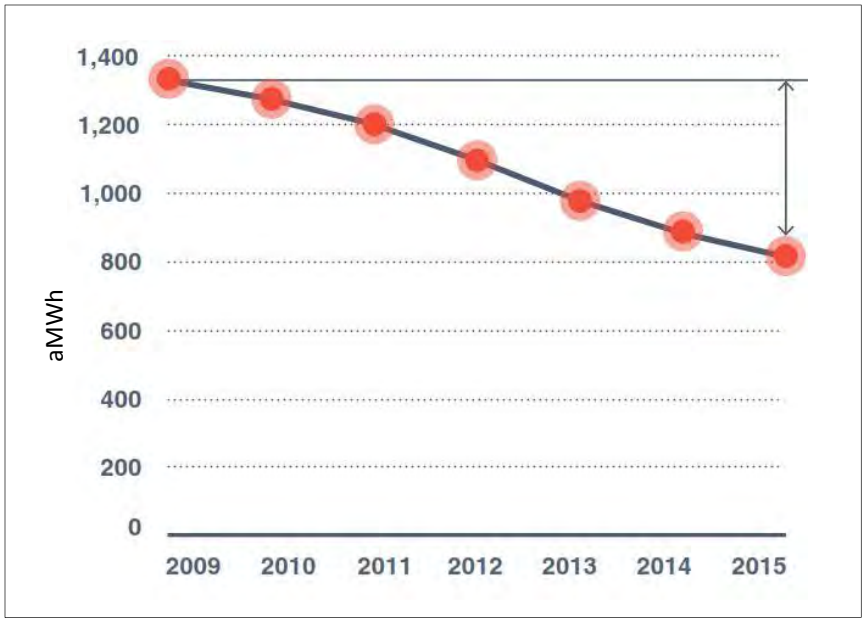
Background

Currently, there are more than 300 million lamps in Northwest homes (Navigant Consulting, Inc. 2017). Lighting is the 3rd largest residential electrical energy end use after space conditioning and domestic hot water and represents 6% of regional consumption (Northwest Power and Conservation Council).

The last ten years has been a unique period in the evolution of lighting as we have seen significant changes in the dominant lighting technologies in our homes. Almost half (46%) of all light bulbs are now either a CFL or LED compared to just 25% (all CFLs) in 2014 (RBSA, 2017). Due to the shift from inefficient incandescent bulbs to these more efficient sources, the lighting power density (watt per sq. ft.) decreased from 1.4 to 1.0 (RBSA, 2017).

These changes have been driven by three key factors: the adoption of the 2007 Energy Independence and Security Act (EISA) prohibiting the manufacture of the most common incandescent lamps between 2012 and 2014; rapid advancement in performance and decline in cost of highly efficacious light emitting diodes (LEDs); and aggressive utility programs promoting efficient lighting technologies. As a result the region has seen a large reduction in total residential lighting energy consumption from 2009 to 2015 of 39% (see Figure 1).

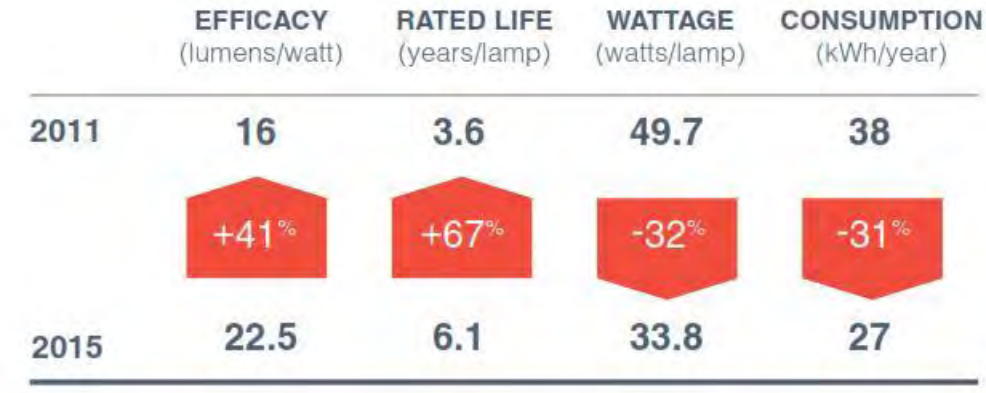
Figure 1. Residential Lighting Consumption Decrease from 2009 to 2015 in aMWh



Navigant Consulting, Inc. (2017). *Residential Lighting Market Characterization Study.* Bonneville Power Administration.

The lower annual residential lighting energy consumption is the direct result of the growing market penetration of higher efficacy lamps, both CFLs and more recently LEDs. Based on all the lamps shipped to the region for the years 2011 through 2015 for all applications and technologies, there was a significant reduction in average wattage and resulting annual energy consumption, as shown with the right two arrows in Figure 2. At the same time, the efficacy and rated life for the average lamp sold increased, as shown with the left two arrows in the figure.

Figure 2. Lighting Market Changes from 2011 to 2015



(Navigant Consulting, Inc)

Continuing to reduce residential lighting energy consumption at the same pace as the last five years will be difficult. As more low wattage, high efficacy lamps are installed in homes, opportunities for further reduction in wattage diminish. In addition, incremental savings from reduced operating hours through lighting controls shrink as the source wattage is reduced. Finally, the rated life of the high efficacy, low wattage fluorescent and LED sources are long, resulting in low replacement rates. With these lamps remaining in sockets longer, there is limited opportunity for installation of newer, even more efficient lamps.

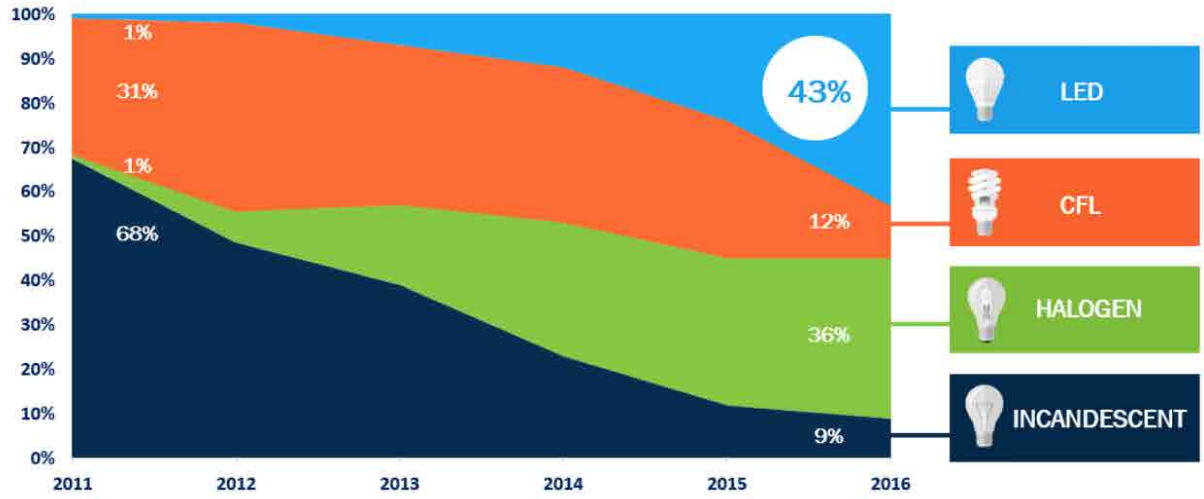
Market Characterization

BPA completed its' most recent Residential Lighting Market Study (Navigant Consulting, Inc) in May 2017. This report documents market conditions and trends in the Northwest and illustrates the magnitude of the LED revolution as these lamps have surged into the high efficacy part of the market displacing CFLs. Similar to LEDs, halogen lamps have surged into the low efficacy market displacing the once dominant standard incandescent lamps but with only minimal improvement in efficiency and no improvement in rated life. These changes have been most pronounced in general service lighting as a result of the EISA 2007 legislation.

Specialty lighting, which includes decorator, reflector, globe, 3-way, appliance and rough duty lamps among others, is currently exempt from EISA 2007 requirements. However, incandescent lamps in this category will be phased out once the 2020 EISA rulemaking goes into effect on January 1, 2020. Until recently, the availability of high efficacy LED and fluorescent lighting options for specialty lighting has been limited. However, in anticipation of the EISA 2020 the technology has advanced and specialty LED lamps are now becoming more readily available.

Figures 3 and 4 show the units sold in the Northwest region for general purpose and specialty lamps.

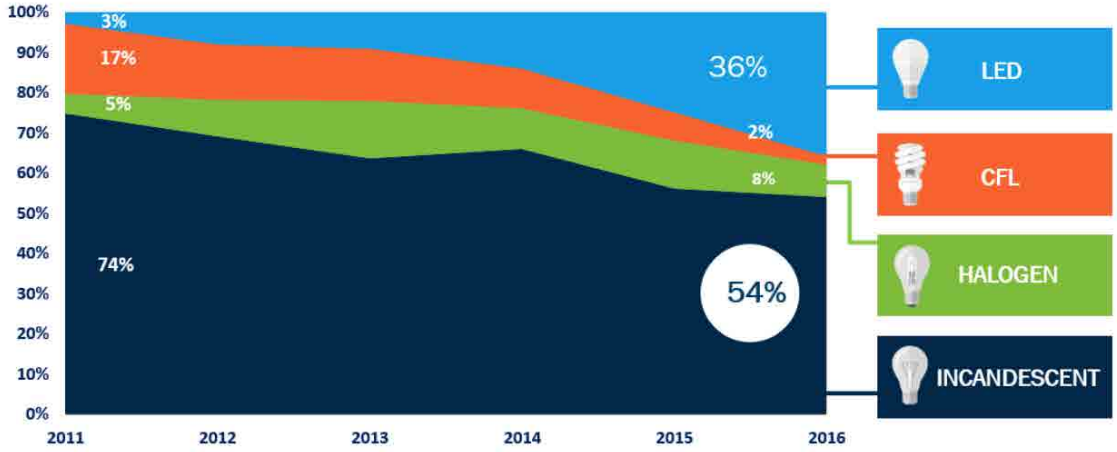
Figure 3. General Purpose Lamps - Technology Shares, 2011-2016



Data source: Weighted combination of sales data and NEEA shelf data.

Source: 2016-2017 Northwest Residential Lighting Long-Term Monitoring and Tracking Study, Oct 19, 2017 REPORT #E17-357

Figure 4. Specialty Lamps - Technology Shares, 2011-2016



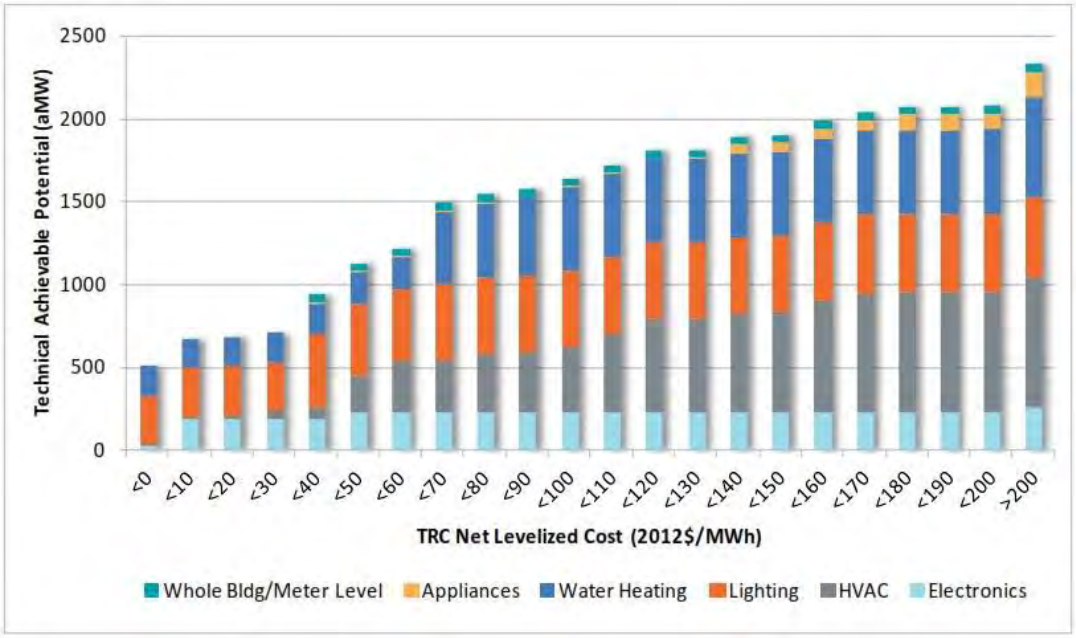
Data source: Weighted combination of sales data and NEEA shelf data.

Source: 2016-2017 Northwest Residential Lighting Long-Term Monitoring and Tracking Study, Oct 19, 2017 REPORT #E17-357

Regional Technical Potential

The 7th Northwest Power Plan (Northwest Power and Conservation Council), adopted February 10, 2016, identifies lighting as providing the second highest potential savings in the residential sector with 484 average megawatts, most of which is available at less than $0.07/kWh. The potential is identified as being driven by the advent of low cost solid state lighting (LEDs) and was based on projections from PNNL (PNNL) completed in October of 2013 and included projected improvements in costs and efficacy of LEDs through 2017 (see Figure 5). This estimate does not include additional potential savings from residential lighting controls.

Figure 5. Residential Potential by End-use and Levelized Cost by 2035



From NWPCC 7th Power Plan

Methods

The objective of this report is to provide an understanding about current and future residential lighting technologies and their impact to the BPA residential lighting program. Profiles have been created for residential lighting technologies (both current and future) using the following characteristics: future technical potential (energy savings); product features; availability; cost; and market, product and program readiness levels. This information has been divided into two categories –lamps and controls. This information will be used by BPA to revise the Residential Lighting Program to deliver future energy savings for the Pacific Northwest.

In order to complete this assignment, WSU performed an extensive literature search, as well as interviews with staff from utilities, manufacturers and subject matter experts. The list of organizations interviewed includes: Lighting Design Lab, Lighting Research Center – Rensselear Polytechnic Institute, Northwest Energy Efficiency Alliance, CLEAResults, Design Lights Consortium, Consortium of Energy Efficiency, Electric Power Research Institute (EPRI) and BPA. The complete list of experts is included in Appendix B. A complete list of reviewed sources is provided in Appendix A.

Findings

Lighting Technologies

Potential Savings

Within the next two to five years, it is anticipated that the largest savings in residential lighting energy will be realized from the continued penetration of higher efficacy lamps, specifically LEDs. The DOE September 2016 publication, Solid State Lighting Report Summary: Energy Savings Forecast of SSL in General Illumination, projects that 93% of future residential lighting sector energy savings through 2035 will be from utilization of higher efficacy lamps. DOE projects that 86% of all residential lighting will be LEDs by 2035 (Building Technologies Office).

In the Northwest, residential demand reduction from high efficacy lamps is estimated at 484 average megawatts based on Northwest Power and Conservation Council (NWPCC) projections in the 7th Power Plan.

Current studies indicate large numbers of inefficient lamps continue to be sold in the Northwest. Through 2016, lower efficacy halogens and incandescent lamps comprised 45% of general service lamp sales in the Northwest (Navigant Consulting, Inc). Halogen and incandescent sources comprised 62% of specialty lamp sales (decorative, reflector, globe, and 3-way) (Navigant Consulting, Inc). Significant energy savings could be achieved through converting these lamps sales to high efficacy sources.

It is also important to note that significant continued improvement in the efficacy of LED lamps of all types is predicted in the next few years. In 2016, the U.S. Department of Energy (DOE) (Building Technologies Office) estimated that the "highest performing LED devices can produce 160-170 lumens/watt; DOE projects that a target of 255 lumens/watt can be achieved". In 2017 Phillips started marketing the "Dubai Lamp" (Philips) in the United Arab Emirates with a reported efficacy of 200 lumens/watt in three lamp sizes (1 W, 2W, 3W) designed to replace 25W, 40W and 60W incandescent lamps respectively. The Dubai Lamp is roughly twice as efficient as the typical LED lamp sold in the US today. Focus on promoting these higher efficacy lamps would maximize potential energy savings.

The expected life of LED sources is ten years or more in residential applications. This suggests currently installed LED lamps will remain in sockets for many years providing persistent savings. Paradoxically, this could potentially slow the replacement of older less efficient LED lamps with future higher efficacy products. Because LED lamps will remain in sockets for many years, utilities should encourage the use of the most efficient products on the market, with program adjustments as the technology advances to always promote the most efficient products available including continued incentives for higher efficacy LEDs.

Barriers to LED Growth

While improving, concerns about cost, light quality, flicker and dimming performance are presumed to have at least in part slowed the adoption of LEDs. Barriers both real and perceived continue to limit LED sales and support the sale of halogen lamps, which do not exhibit the same drawbacks. Key barriers include: competitive products; higher prices; poor light quality; and flicker performance issues.

Competitive Products

Initially, LED sales were limited by high prices and consumers looked for cheaper efficient lighting alternatives. Lower cost halogen lamps which also addressed light quality and flicker performance issues entered the market. The ready availability and appeal of halogen lamps slowed the adoption of LED alternatives. Halogen lamp sales grew from 1% of the general service lamps in 2011 to 36% in 2016 (Navigant Consulting, Inc). For the typical consumer, halogen lamps looked and performed the same as the lower efficacy traditional incandescent lamps and were lower cost than CFL and LED lamps. It is expected that halogens will maintain in this position until January 1, 2020, when new standards calling for 45 lumens per watt, will make it illegal to sell most halogen and incandescent lamps in the U.S.

High Prices

LED lamps and fixtures are typically more expensive than lamps and fixtures using fluorescent and incandescent. However, the cost of LEDs has been dropping rapidly. In particular, the cost of LED general service lamps purchased in multipacks at big box stores are now much more competitive.

Poor Light Quality

Poor light quality as perceived by consumers has long been recognized as a barrier to market acceptance. Light quality is most commonly referenced in terms of CRI (Color Rendering Index). Limitations of CRI as a metric have long been recognized and the industry has struggled to develop more effective standards. In 2015 a new standard IES TM-30 was introduced (Energy Efficiency & Renewable Energy), however this standard has not been widely adopted. To help assure consumer satisfaction with LED products, it will be important to promote products with good color quality.

In addition, minimum requirements for color quality should be considered. For example, Energy Star requires a minimum CRI of 80 for LEDs. Another standard, the California Quality Lighting Specification, requires a CRI of 90.

Flicker

Concern about flicker is another barrier to widespread adoption of LEDs. The most basic definition of flicker is a modulation of light; light levels fluctuate high to low and back to high. Sometimes this modulation of light happens at a slow enough rate that it is visible. Often with LED and fluorescent sources, this modulation happens at a very high frequency, so it can only be detected when there is movement relative to the eye and the light source. This is called stroboscopic flicker. Even though

stroboscopic flicker is not directly visible, it may cause people who work under such light to experience more subtle effects of this flicker, including headaches, eye strain, and discomfort.

LED lighting sources require a driver to convert AC current to DC and flicker can result from the use of low quality drivers. . Flicker is more of an issue when LED lamps are dimmed. LED dimming performance is a function of both the quality and capability of the driver and compatibility with the dimmer. The cost of the driver is a significant part of the total cost of an LED lamp and using a quality driver that completely eliminates flicker increases product cost.

Dimming in the real world can be challenging and can be an additional barrier to acceptance. First not all LED lamps are designed to be dimmable. Therefore, it is essential that consumers choose lamps that the manufacturer describes as 'dimmable'. Secondly, there is a wide variation in the characteristics of different LED sources and different dimmers. It is important for consumers to use a dimmer designed for use with LED lighting. Most major lighting manufacturers publish lists of dimmers that are compatible with their products.

The National Electrical Manufacturers Association (NEMA) is initiating a LED Dimming Compatibility Program. This is a voluntary program through which lamp and control manufacturers can label their products as dimming compatible with the logo shown below. When the logo appears on the package, consumers know that the LED bulb or dimmer inside has been designed to be compatible with dimmers or bulbs that have the same logo on their package.

Figure 6. NEMA LED Dimming Compatibility Logo



Technology Overview

The following section of the document provides an overview of various lighting technologies. The technologies are presented across three categories depending on different development phases: currently in the market place; near term emerging technologies expected to enter the market in the next 2 – 5 years; and long term emerging technologies expected after five years.

Current (and continuing) technologies are available in the market today and are expected to continue contributing significant energy savings over the next two years. These include LED general service A-line lamps, LED specialty lamps, linear LEDs, LED exterior lighting, and dedicated fixtures.

Near term lighting technologies may have recently entered the market place, have a small adoption rate and are expected to mature over the next 2 – 5 years. In most cases energy savings and cost effectiveness for these technologies have not been validated. These technologies include OLEDs.

Long term technologies are in the Research and Development Phase of development with expected market entry defined as being five years or more. These technologies are still in the proof of concept stage and include Laser Diodes and Quantum Dots. Expected applications and energy savings are currently unknown.

Information about two additional power distribution technologies that are related to lighting, Power over Ethernet and DC Power Distribution, are provided in Appendix D. While these technologies do not provide direct lighting energy savings, their implementation may provide more efficient means of powering high efficacy lighting systems.

Technologies have been profiled using the characteristics in the following table.

Table 1. Characteristics and definitions used in report

Characteristics	Definition
Technical Potential	What are the expected savings if the technology is fully deployed within the Pacific Northwest?
Applications	Where and how are technologies utilized?
Product Features	What are the unique characteristics of the technology?
Availability	Where are the technologies offered?
Energy Savings	How much energy savings are associated with the use of this technology?
Cost	How much do the technologies costs?

The Regional Emerging Technology Advisory Committee (RETAC) made up of public and IOU utilities in the Pacific Northwest facilitates collaborative activities to identify, prioritize and assess emerging technologies. The RETAC has proposed a series of scales to identify readiness across three different levels: market or commercial readiness – how available is the technology; product readiness – has the technology been validated; and program readiness – has the cost effectiveness of the technology been assessed. Each readiness criteria has 1 – 6 different levels as defined as follows.

Table 2. Readiness Level Score Definitions

Market/ Commercial	**LEVEL 1:** Not commercially available or limited, pre-commercial availability **LEVEL 2:** Commercially available outside of NW. Requires special order in NW. **LEVEL 3:** Commercially available in NW from one manufacturer through standard channels. **LEVEL 4:** Commercially available in NW from at least two manufacturers. Stocked throughout region. **LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 1:** Concept not yet validated **LEVEL 2**: Concept validated **LEVEL 3**: Limited Assessment **LEVEL 4:** Extensive Assessment **LEVEL 5:** Comprehensive Analysis **LEVEL 6:** Approved for Implementation
Program	**LEVEL 1:** No program design. No risk assessment. **LEVEL 2:** Not cost effective, but preliminary analysis shows a pathway to CE. Limited program design and risk assessment. **LEVEL 3:** Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots. **LEVEL 4:** Marginally at cost effective levels. Program design complete, larger scale pilots underway. Well-developed risk assessment. **LEVEL 5:** Cost effective. Ready for full-scale programs. Periodic risk assessment process in place.

Technical potential estimates for the current and continuing technologies were developed by staff from the NWPPC. As part of their mission, the NWPPC prepares periodic regional power plans that include development of technical potential for energy efficiency technologies. The technical potential estimates provided for this paper are **rough** estimates, and are not intended to represent what will be in the Power Plan. However, having the NWPPC provide technical potential for this paper will provide consistency in the analysis and data sets.

The technical potential estimates account for the impacts of the 2020 EISA standard that will raise the baseline efficacy to 45 L/watt and represent long-term savings potential. For A-lamps and specialty lamps, the near term potential could be up to five times higher. However, this higher level of savings will only be available to utility programs until January 1, 2020 when the new EISA standards go into effect.

In addition, the estimates reflect recent findings from RBSA II (RBSA, 2017) that show the saturation of LED lighting in homes is approximately 20%. The savings per bulb is based on recent work by the Regional Technical Forum that developed a "current practice" bulb for use as the baseline. A current practice bulb is defined as the bulb the customer would have *purchased* in the absence of an energy efficiency program and includes a mix of all bulb types (halogen, CFL, LED).

Finally, it should be noted that the technical potential estimates for individual technologies are not mutually exclusive. For instance, a portion of the technical potential for exterior lamps will come from replacement of general service A-lamps. Therefore, these savings are included in the technical potential for both exterior lighting and general service A-lamps.

Since there is so much uncertainty regarding newly emerging and R&D technologies, no estimates of technical potential were developed for these technologies.

Current and Continuing Lighting Technologies

Efficient LED sources are currently supported in NW efficiency programs and are expected to continue contributing significant energy savings over the next two years. Continued improvement in the efficacy of LED lamps of all types is predicted in the next few years. Potential energy savings could be maximized through a utility focus on promoting these higher efficacy lamps, for instance through tiered incentives.

General Service A-Line Lamps

The most familiar and available LED lamps in the residential market are general service lamps configured to replace standard Edison base lamps. Currently available LED lamps are significantly more efficient than incandescent lamps, providing energy savings of up to 80%. LED lamps are about 25% more efficient than CFL lamps and provide superior light quality. In addition, LED lamp life can range from 10,000 to 25,000 hours, as compared to 1,200 hours for incandescent lamps and 8,000 hours for CFL lamps.





There is a variation in quality of LED lamps. Costs are higher for lamps that provide good color quality, good dimming performance and long lamp life. Filament LED lamps are a type of general service A-line lamp that are typically used in decorative settings. These lamps are becoming widely available with high efficacy and lower costs and consumer interest is strong driven by the unique look and style.

Technical Potential: 35 aMW

Applications: Residential fixtures that have an Edison base suitable for screw in lamps.

Product Features: Lamps are available with various lumen outputs and in various color temperatures. Dimming and non-dimming versions are available.

Availability: Readily available through all consumer channels: big box stores, hardware stores, online.

Energy Savings: LED lamps use about 80% less energy than standard incandescent lamps; about 30% less than CFLs.

Cost: LED lamps cost somewhat more than standard incandescent halogen lamps, but costs continue to decline and can be competitive when purchased in multi-packs. Costs are higher for LED lamps that provide good color quality, good dimming performance and long lamp life.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 6:** Approved for Implementation
Program	**LEVEL 5:** Cost effective. Ready for full-scale programs. Periodic risk assessment process in place.

LED Specialty Lamps





Specialty lamps is a broad category that generally refers to lamp types other than standard A-line Edison screw base lamps and include reflector, globe and candelabra light bulbs. Because standard A-line lamps represent the largest market share, manufacturers of LED lamps originally focused attention on development of these lamps and LED specialty lamps were not commonly available. As the A-line lamps have become readily available with good quality and low price, manufacturers have shifted attention to the introduction of LED specialty lamps. LED versions of numerous specialty lamp types are now becoming readily available and the number of Energy Star approved products is growing rapidly. As with A-line LED lamps, the efficiency of the LED specialty lamps is far superior to the efficiency of the incandescent versions, providing the opportunity for significant energy savings.

Technical Potential: 51 aMW

Applications: Residential fixtures that use replaceable lamps with other than an Edison base. These include fixtures that use reflector, globe and candelabra light bulbs with various screw base sizes, such as candelabra (E11) and medium screw (E26) and with pin bases such as GU4 and GU10.

Product Features: Lamps are available in a large variety of sizes and shapes to fit a variety of applications. Lamps come with various lumen outputs and in various color temperatures. Dimming and non-dimming versions are available.

Availability: LED specialty lamps are becoming readily available through most consumer channels: big box stores, hardware stores, online.

Energy Savings: LED lamps use about 80% less energy than standard incandescent lamps; about 30% less than CFLs.

Cost: The cost of LED specialty lamps is typically higher than the equivalent standard incandescent and halogen lamps. Costs are higher for LED lamps that provide good color quality, good dimming performance and long lamp life

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 6:** Approved for Implementation
Program	**LEVEL 5:** Cost effective. Ready for full-scale programs. Periodic risk assessment process in place.

LED Linear Lamps

Based on the Residential Building Stock Assessment (RBSA) developed by NEEA, 11% of lamps in single family homes in the Northwest are in linear fluorescent fixtures typically located in shops, garages, basements and kitchens (David Baylon). Linear fluorescent lamps are also found in multifamily facilities in common areas and garages. The majority of these linear fluorescent lamps are T8/T12 fluorescent lamps drawing 32 W to 40 W. LED linear replacement lamps currently in the market can provide energy savings of 40 – 45% at competitive prices. Current data on market penetration of linear LED replacement lamps has not been found.



However, for these it is important to confirm the compatibility of the existing T8 fluorescent ballast and the new linear LED T8 replacement lamp. LED tube replacement lamps come in a variety of configurations. Some require rewiring fixtures and installation should be done by a qualified electrician. Others are plug and play and can be installed without rewiring. Attention needs to be paid in retrofit applications to ensure proper and safe installation.

Technical Potential: 2.7 aMW

Applications: Residential fixtures that use linear fluorescent lamps. These are most often found in garages, closets and utility rooms.

Product Features: LED linear replacement lamps are available in a variety lumen outputs and in various color temperatures. Dimming and non-dimming versions are available. Lamps have different installation configurations with some requiring rewiring of fixtures and others being are plug and play.

Availability: LED linear replacement lamps are becoming readily available through most consumer channels: big box stores, hardware stores, online.

Energy Savings: LED linear replacement lamps currently in the market can provide energy savings of 40 – 45%

Cost: The cost of LED linear replacement lamps is typically higher than fluorescent versions. Costs are higher for LED lamps that provide good color quality, good dimming performance and long lamp life**.**

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 6:** Approved for Implementation
Program	**LEVEL 5:** Cost effective. Ready for full-scale programs. Periodic risk assessment process in place.

LED Exterior Lighting



Based on 2012 findings, the average exterior lighting power in a Northwest home is 227 W (Poppy Storm). Based on the RTF Residential Building Stock Assessment (2014 RBSA) metering the average hours of use for exterior lighting in Northwest homes was 3.7 hours per day (Ecotope). This is the highest average hours of use for lighting in any location in a typical home.

LED replacement lamps with built in photo sensors are readily available and are an easy upgrade for existing homes. Alternatively, outdoor lights can be replaced with new fixtures with a built in photo sensor control.

Technical Potential: 19 aMW

Applications: Exterior porch and security lighting.

Product Features: New fixtures with integrated LED sources are available in a wide variety of styles, mounting types, lumen outputs, and color temperatures. These are available with integrated photo sensors and motion sensors. Alternatively, LED replacement lamps with integrated photo sensors can be used in existing fixtures.

Availability: Readily available through all consumer channels: big box stores, hardware stores, online.

Energy Savings: Exterior fixtures with LED sources use about 80% less energy than fixtures with standard incandescent lamps; about 30% less than fixtures with CFLs.

Cost: The cost of exterior fixtures with LED lamps is comparable to the cost of exterior fixtures using incandescent and fluorescent sources. Cost varies widely and is more a function of style and housing material, rather than light source.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 6:** Approved for Implementation
Program	**LEVEL 5:** Cost effective. Ready for full-scale programs. Periodic risk assessment process in place.

Dedicated Fixtures



Dedicated fixtures that use integrated LED sources are widely available. Well-designed dedicated LED fixtures, those that have been designed from the ground up to incorporate LED sources, can provide benefits over the use of LED replacement lamps in fixtures that were designed for incandescent and fluorescent sources. For instance, dedicated LED fixtures can more effectively accommodate the directionality of LED emitters, provide improved thermal management, include higher quality drivers and incorporate integrated controls.



Dedicated LED fixtures are sometimes more expensive than fixtures using traditional sources, although this cost premium is not large and is dropping as the cost of LEDs continues to decline. In existing homes, it is still typically much less expensive to replace a lamp with an LED lamp than to replace the entire fixture. The incremental cost of dedicated LED fixtures is small, making them more suitable for new construction applications.

Technical Potential: 89 aMW

Applications: All residential lighting applications.

Product Features: New fixtures with integrated LED sources are available in a wide variety of styles, mounting types, lumen outputs, and color temperatures.

Availability: Readily available through all consumer channels: big box stores, hardware stores, online.

Energy Savings: New fixtures with LED sources use about 80% less energy than fixtures with standard incandescent lamps; about 30% less than fixtures with CFLs.

Cost: The cost of dedicated LED fixtures is sometimes higher, but often comparable to, the cost of new fixtures using incandescent and fluorescent sources. Cost varies widely and is more a function of style and materials, rather than light source.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 6**: Approved for Implementation
Program	**LEVEL 5:** Cost effective. Ready for full-scale programs. Periodic risk assessment process in place.

Future Lighting Technologies

In addition to the efficient lighting technologies that are established and available today, research and development of other efficient lighting technologies continues. These technologies are in various states of development, with technical viability and widespread availability at competitive costs not expected for at least 5 to 10 years.

Due to the anticipated initial high cost of market-available products, initial adoption will likely take place in commercial applications. If and when costs decline, these technologies may find applications in the residential market. It is recommended that utilities monitor these technologies and reassess viability for the residential market as the technologies advance. Future efforts for these new technologies will need to focus on accelerating their development through strategic partnerships to support research and development.

Near Term Two – Five Years

OLEDs

OLEDs are light emitting diodes in which the emissive electroluminescent layer is a film of organic compound that emits light when excited by an electric current. OLED lighting panels were first mass produced in 2011 and OLED lighting panels are now available from a number of manufacturers however, production volumes are small. They are a growing part of the TV and display market and a major area of research in the development of white OLED devices for use in general illumination applications.





Advantages: OLEDs offer advantages over regular LEDs primarily in relation to lighting quality and new alternatives for lighting design. They can uniquely produce large area panels as light sources.

Potential Barriers: Current efficacies (50 lumens/watt) are comparable to CFLs far behind current LEDs. In addition, OLEDs require dedicated fixtures and don't provide a one for one screw-in replacement that can be used in existing fixtures.

Outlook: With the current high cost, it is likely that OLEDs will first be adopted in commercial applications, with early residential applications limited to high-end residential new construction. The potential to drive significant near term energy savings in the residential sector seems low.

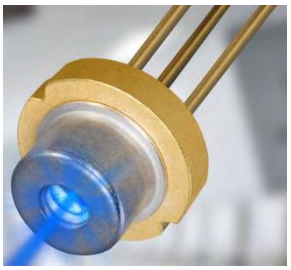
Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 1:** Not commercially available or limited, pre-commercial availability
Product	**LEVEL 2:** Concept validated
Program	**LEVEL 1:** No program design. No risk assessment.

Long Term Over Five Years

Lighting technologies with significant uncertainty regarding technical viability and application in the residential market include laser diodes and quantum dots. Widespread availability is not expected for at least 5 to 10 years.

Laser Diodes



Shuji Nakamura, Nobel Laureate for his contributions to the invention of blue LEDs, says, "The laser, we believe, is the next generation of lighting, even for general applications such as homes, businesses, and a variety of displays". Laser diodes do not fit a marketing model of a transition to a new replacement A-Lamp but rather offer a powerful, high density, efficient light source that could revolutionize lighting design. Laser diodes are currently the most common type of laser with wide applications in telecommunications, measuring devices, scanners and many other applications. Lighting applications have been very limited to specialty applications.

Advantages: The best laser diodes have similar efficiencies to current LEDs. The advantage of the laser diode is that it can function with much higher power inputs literally producing a 1000 times as much light from a single diode. Steven DenBaars, a research scientist at UC Santa Barbara, envisions using small numbers of powerful lasers and redirecting the light into fiber optic cables and other waveguides that would evenly distribute the light as a warm diffuse glow. A single intense source of light could be used in this way to create a diffuse glow that could appear to emanate from entire surfaces of rooms or light fixtures of any conceivable shape (Mims).

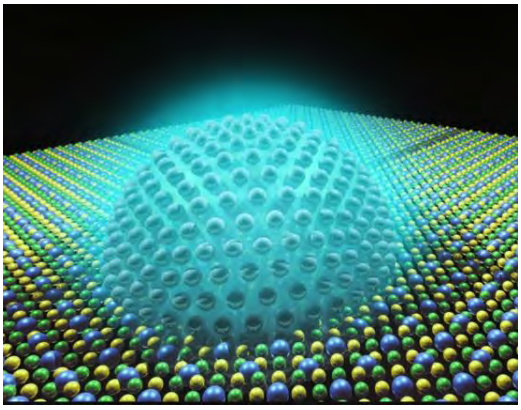
Potential Barriers: Barriers to market introduction are high and utilization would almost certainly begin with commercial application before residential. Efficiency is high but on a lumen to lumen basis only comparable to existing LEDs and the potential for additional reductions in residential lighting energy use probably low.

Outlook: Competitive products appear to be at least 5-10 years in the future and their acceptance will be based on possible advantages to lighting quality and design.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 1:** Not commercially available or limited, pre-commercial availability
Product	**LEVEL 1:** Concept not yet validated
Program	**LEVEL 1:** No program design. No risk assessment.

Quantum Dots



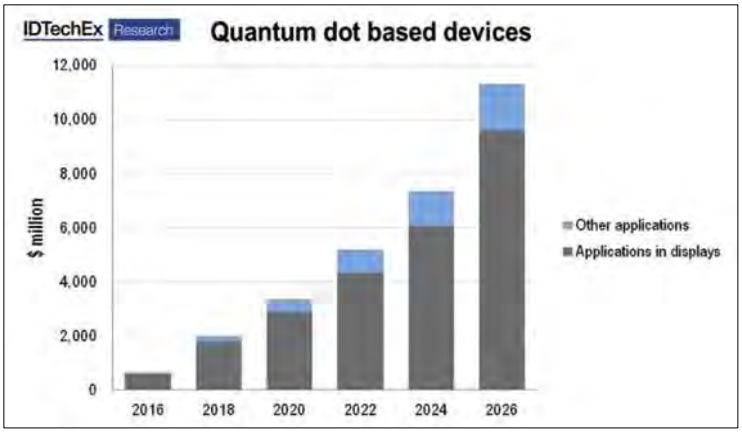
Quantum dots are very small (typically 2-10 nanometers) semiconductor particles many of which will emit light of specific frequencies if electricity or light is applied to them. They are a central component in the expanding world of nanotechnology first identified in 1986. Research underway is exploring applications in quantum computing, studying intercellular biological processes, improved photovoltaic devices, photodetectors, photo catalysts, and light emitting devices.

Advantages: Potential advantages to using quantum dots in lighting systems are unclear at this point in the technology development**.**

Potential Barriers: Potential barriers to using quantum dots in lighting systems are unclear at this point in the technology development**.**

Outlook: Quantum dots represent the newest of emerging technology but could produce improvements in LEDs and/or laser diodes in the next 5-10 years. The potential impact on general lighting remains undetermined but should be monitored.

Figure 7. Projected sales of different quantum dot based devices



Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 1:** Not commercially available or limited, pre-commercial availability
Product	**LEVEL 1:** Concept not yet validated
Program	**LEVEL 1:** No program design. No risk assessment.

Residential Lighting Controls

Lighting savings from the use of controls comes from either a reduction in the hours of use or a reduction in power. Lighting controls generally fall into two categories: traditional stand alone controls and connected controls. Savings for residential lighting controls have traditionally been provided by stand-alone controls, such as vacancy/occupancy sensors, dimmers, timers and photo sensors.

With the introduction of the Internet of Things (IoT), consumers have new capabilities to control their environment and access conveniences considered unimaginable just a decade ago. Connected lighting controls offer solutions for improved security, convenience and comfort. Today consumers can turn lights on and off, dim them and change the color of the lighting all through smart phones or tablets. With technology advancements, connected "smart" lighting controls are becoming more widely available including being incorporated into Home Energy Management Systems (HEMS) that provide users with information, feedback and/or control of household energy usage.

For the purpose of this paper, the market for residential lighting controls and the rapidly evolving connected control technologies has been broken down into two categories:

1. Traditional standalone controls including vacancy and occupancy sensors, dimmers, timers, and photo sensors
2. Connected controls both
    a. lighting specific for lamps, fixtures and switches; and
    b. implemented as part of a complete HEMS as part of the larger Internet of Things.

Potential Savings

In September 2016, DOE estimated 7% of future savings in the residential sector would come from controls through 2035 (Building Technologies Office). While the study identified much larger savings from controls in the commercial, outdoor and industrial sectors, savings from lighting controls in the residential sector is limited because of the relatively low baseline average hours of use.

As with the lamp technologies, staff at the NWPCC developed a technical potential estimate for residential lighting controls. Given the lack of specific data for the NW, the estimate was developed using the DOE estimate of 7% savings from controls, which results in a technical potential of 18.5 aMW for all residential controls combined.

Average residential hours of use by lamp location shown in Table 3 were documented in the Northwest Regional Technical Forum's Residential Building Stock Assessment (RBSA 2014). Interior residential lighting averages less than two hours of use per lamp per day while exterior residential lighting averages 3.7 average hours of use per lamp per day.

Increased penetration of high efficacy, low wattage lamps further reduces the potential energy savings from lighting controls that reduce hours of use.

Table 3. Residential Lighting Hours of Use (HOU) by Room Type

Room	Hours/day
Bedroom	1.4
Master Bedroom	1.1
Bathroom	1.2
Closet	0.08
Dining Room	1.9
Exterior	3.7
Family Room	3.3
Garage	1.1
Hall	2.0
Kitchen	3.6
Laundry Room	1.5
Living Room	2.8
Office	1.8

Barriers to Adoption of Controls

While traditional standalone and connected lighting controls have the potential to provide energy savings, issues such as cost, compatibility and complexity, and standby loads are barriers to widespread adoption.

Cost

The cost of traditional standalone controls, such as occupancy sensors and dimmers, is relatively low. However, if a homeowner is not comfortable installing these devices on their own, hiring an electrician could add significant cost.

The cost of connected lighting controls is currently high. Even the simpler smart devices, such as smart lamps and smart switches, cost significantly more than similar devices that do not include connectivity. When considering a larger, whole home energy management system to control lighting, costs can range from several hundred to several thousand dollars.

Compatibility and Complexity of Connected Controls

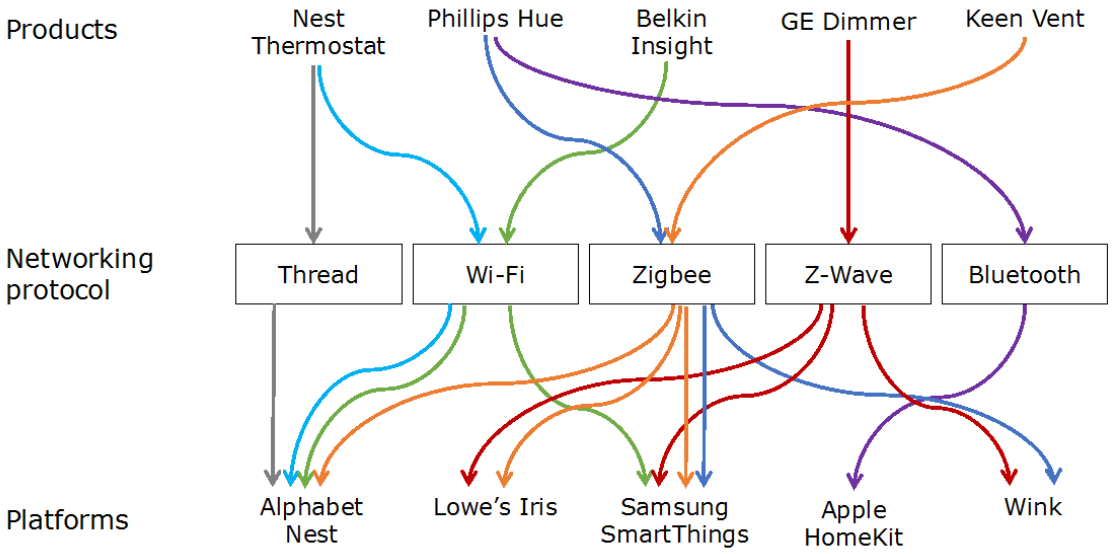
A recent report completed by PG&E's Emerging Technologies Program (Ford, 2016) provided a comprehensive review of home energy management systems (HEMS), including a discussion of compatibility and complexity issues. A brief excerpt from the report is provided here, and readers are encouraged to read the full report for more detail.

Understanding which products work together, how exactly they can work together is a moving target as the HEMS, smart home, and IoT industries are rapidly evolving. For example, is their interaction limited to simply being accessed via the same energy portal? Or are users able to set integrated schedules or rule-based control so events or data from one Home Energy Management (HEM) technology can be used to control another? Compatibility and complexity of connected controls are challenges to be resolved over the next five years.

Further confusion arises due to the lack of standardization of smart home network protocols (e.g., ZigBee vs. Z-Wave vs. Wi-Fi). Also, consumer media often confuses protocols (e.g., Bluetooth) with smart home platforms (e.g., Wink). The former strictly describes the type of network protocol the device uses, whereas multiple network protocols can still be integrated into a smart home platform, either using a hub to translate between them or via a system than can communicate across all of these protocols.

At the same time, two HEM technologies that speak the same network protocol could still be non-interoperable because the higher software layers are not compatible. This is illustrated in Figure 8, showing how HEM technologies (on top) use different wireless protocols (the middle) and are compatible with different smart home platforms (bottom).

Figure 8. Integration and Interoperability within HEMS Technologies



Standby Loads of Connected Controls

Another potential barrier is the "hidden" energy cost to provide connectivity generally referred to as standby loads. In order to respond to remote control, smart devices must remain powered in standby mode and are never completely off, increasing the total energy usage of the lamp. The stand-by load can significantly impact the potential energy savings provided by the control functions of a connected smart lamp. This is because the standby load is consumed 24 hr/day, while average lighting operation in residential applications is around two hr/day.

For Energy Star certification of Smart Lamps, the maximum allowable standby power is 0.5 W. There are products in the market that easily meet this requirement with standby power draws as low as 0.1 W. However, when additional sensors are included to sense motion or light levels the standby loads increase and many products have standby loads closer to the 0.5 W level. For example, consider the case of a typical 10 W LED residential lamp operating two hours/day, compared to a smart lamp with 0.5 W standby load and total 10.5 W consumption when on. The total energy use for three situations is calculated below with the results shown graphically in Figure 9 below.

Baseline Energy Use

10 W/hr * 2 hr/dy = **20 W-hr/dy**

Smart Lamp with No Reduction in Hours of Use

10.5 W/hr* 2 hr/dy + 0.5 W/hr * 22 hr/dy = **32 W-hr/dy**

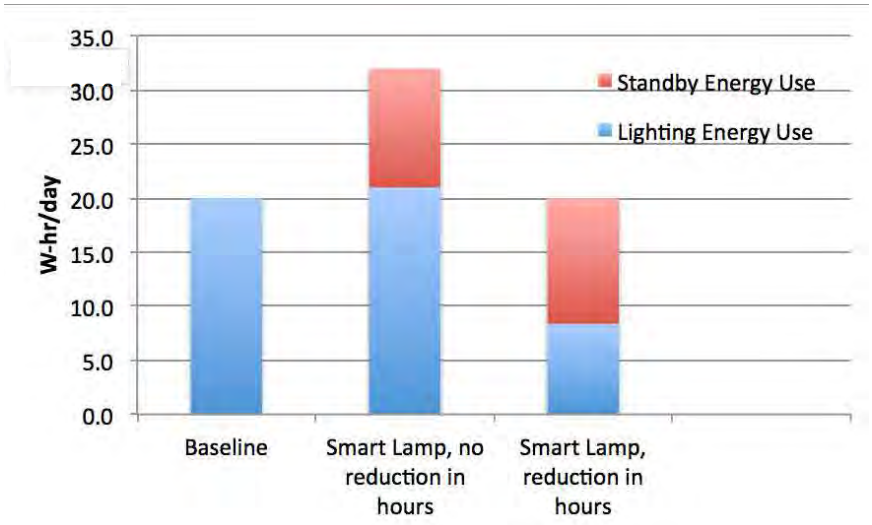
Smart Lamp with Reduction in Hours of Use

Assume lighting hours of operation are reduced to 48 min/day (0.8 hr/day)

10.5 W/hr* 0.8 hr/dy + 0.5 W/hr * 23.2 hr/dy = **20 W-hr/dy**

For the smart lamp to consume the same energy as the standard LED, the hours of operation would have to be reduced by 60% to 0.8 hr/day. To deliver savings, the hours would have to be reduced even further.

Figure 9. Standard LED compared to Smart LED

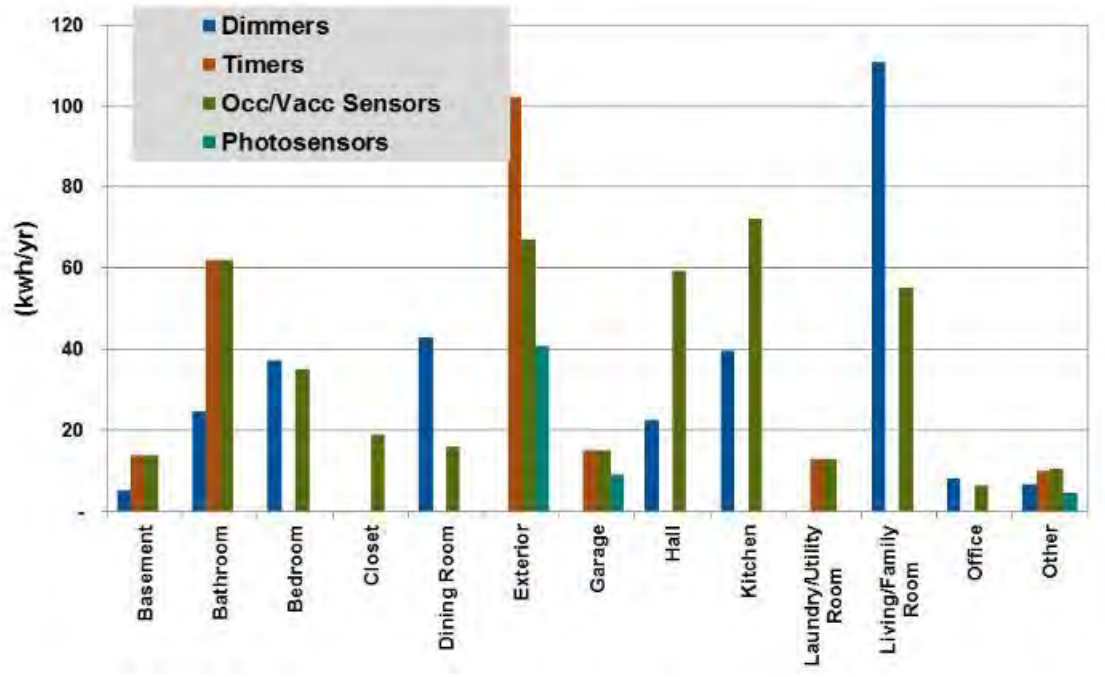


Traditional Lighting Controls

In January of 2014, CEE published *Residential Lighting Controls Market Characterization* (CEE), which was found to be the most up to date and thorough characterization of residential lighting controls available. The data represents a national characterization although at the time of this report, most of the data is more than five years old. Changes in product costs over time (LED prices have fallen significantly) and regional differences in electrical rates (Northwest rates are below national averages) will certainly effect the reported payback times but the overall trends should remain significant.

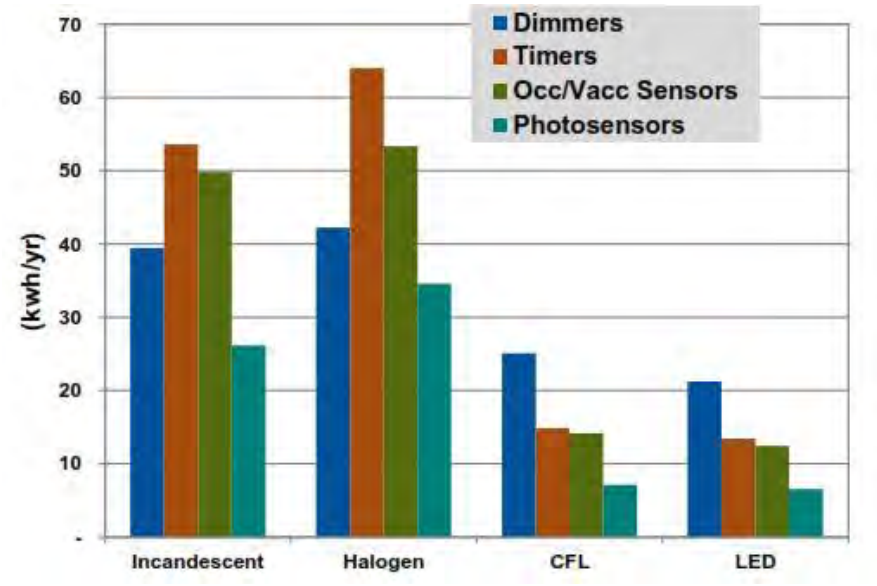
The report focuses on vacancy/occupancy sensors, dimmers, timers, and photo sensors characterizing their use, energy savings and simple payback period by location in the home (room type) and lamp type (incandescent, halogen, CFL or LED). Figure 10 and Figure 11 show estimated savings for each type of control by room type and by lamp type, respectively.

Figure 10. Average Annual Energy Savings per Control, by Room Type



CEE, Navigant Consulting

Figure 11. Average Annual Energy Savings per Control, by Lamp Type



CEE, Navigant Consulting

When controls are coupled with less efficient incandescent and halogen sources, the simple payback period in some room types is less than 2-3 years while the average payback period across all room types is about six years. The simple payback period for controls used with efficient CFL and LED sources is typically longer than ten years.

Dimming controls have the best overall cost to benefit ratio for all lamp types. Dimming control of an LED source in living rooms has a simple payback period of 4.3 years, while the average payback period for dimming control in all room types is 12 years. With low baseline operating hours and high efficacy, the annual average energy savings from dimming control of residential LED sources is low, about 20 kWh/year. Other controls on average save much less.

The CEE report provides information for retrofit situations, where the cost includes the entire cost of new controls and installation labor cost.[1] Given the limited energy savings predicted from lighting controls, they are likely to be much more appropriate for new construction where incremental equipment cost is minimal and there is no incremental labor cost.

Demand for advanced lighting controls in the residential market has been low but Navigant Research projects that total revenue associated with the installation of residential lighting controls will grow at a compound annual growth rate of 4.6% between 2016 and 2025. (Navigant Research)

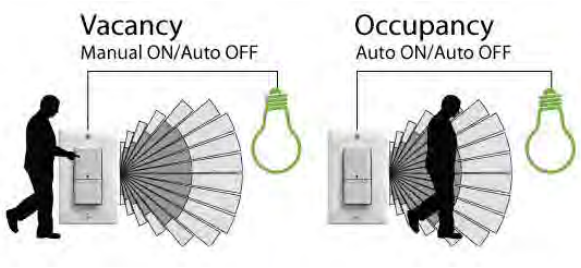
An extensive list of available products for three major manufacturers (Legrand, Leviton and Lutron) is contained in Appendix C of the CEE report.

[1] The CEE report calculates an average installation cost for each type of control assuming some percentage is installed by an electrician and the rest by the homeowner.

Vacancy/Occupancy Sensors

These sensors save energy by turning lights off when they sense that the room is no longer occupied. They can be sensitive to motion or heat (infrared) or both. Both types are limited to the occupant being within line of site of the sensor. Motion sensors may leave you in the dark if you are inactive for an extended period. Vacancy sensors are generally used more indoors and require a manual on. Occupancy sensors are used more outdoors and automatically turn the light on as well as off.

Figure 12. Comparison of Vacancy and Occupancy Sensors



Outdoor applications have greater potential savings because of the generally longer run times. Where security is a primary concern for using exterior lighting, homeowners often resist the idea of motion or infrared control preferring to leave lights on all night. An alternative, bi-level control is now available in the market where the sensor switches the lighting to 30-50% rather than completely off. Significant savings are achieved with bi-level systems (50% or more) while gaining broader market acceptance by addressing security concerns.

The costs of vacancy/occupancy sensors are relatively low. A quick internet search has product starting at $13.25 for a line voltage wall mounted sensor. In new construction, controls will be more cost effective, as the incremental cost of an occupancy/vacancy sensor compared to a standard wall switch is low. (David Douglass-Jaimes) A CEE Residential Lighting Controls Market Characterization study indicates an average payback period for occupancy sensors is 8.6 years, with the shortest payback period of 4.3 years when used with kitchen lights. (CEE) Additional details from the CEE study are provided in Appendix C.

Applications: Any residential light in a home, but most often used in rooms where lights may be left on when unoccupied, such as bedrooms and bathrooms.

Product Features: Typically installed as a wall control and turn lights off when the room is vacant. Can be used with both indoor and outdoor lights.

Availability: Readily available through all consumer outlets: big box stores, hardware stores, online.

Energy Savings: Savings can vary depending on occupancy patterns with studies showing estimated savings from 25% - 60%.

Cost: Occupancy sensor wall controls typically cost slightly more than a standard wall switch.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 6:** Approved for Implementation
Program	**LEVEL 5:** Cost effective. Ready for full-scale programs. Periodic risk assessment process in place.

Dimmers

Currently, approximately 5% of residential lighting in Northwest homes has a dimmer control (David Baylon). A recent small study (less than 15 sites) by Efficiency Vermont reported that occupants dimmed 38% of the lighting fixtures in the home operated by dimmer switches. Also in another small study, PG&E reported that lights with dimmers were dimmed 18.5% of the time. If confirmed with a statistically significant sample, this suggests potential saving from a wider use of controls consistent with DOE estimates for the residential sector.



With the increased use of CFLs and LEDs, compatibility between dimmers and lamps is a potential issue. Even CFLs and LEDs designed to be dimmable will not work with all dimmers. Dimming LEDs and CFLs may also result in flicker depending on the lamp and the dimmer. This is more of an issue in existing homes than in new construction where approved dimmers can be pared with high efficacy lamps.

Compatibility issues between dimmers and LEDs is addressed by NEMA standard SSL 7A and 7B. Part A addresses interoperability and basic compatibility and product labeling for compliance will go into effect in 2018. Part B is designed to set performance standards establishing minimum acceptable functionality but has been delayed because of a lack of industry consensus about what should be required and how it should be tested. Establishing standards of functionality for SSL dimmers remains a barrier to wider deployment of dimmer controls.

As with occupancy/vacancy sensors, the costs of dimming switches are relatively low. A quick internet search has product starting at $12.00 with numerous options below $25.00. In new construction, dimmers will be more cost effective, as the incremental cost of a dimmer compared to a standard wall switch is low. (David Douglass-Jaimes). A CEE Residential Lighting Controls Market Characterization indicates an average payback period for dimmers is 7.7 years, with the shortest payback period of 2.3 years when used with living rooms lights. (CEE) Additional details from the CEE study are provided in Appendix C.

Applications: Any residential light in a home, but most often used in rooms that are frequently occupied and adjustable light levels are desired, such as kitchens, living rooms, bedrooms and bathrooms.

Product Features: Typically installed as a wall control to allow occupants to dim lights as desired. Dimmers specifically designed to be compatible with LED and CFL lamps should be used with these sources.

Availability: Readily available through all consumer outlets: big box stores, hardware stores, online.

Energy Savings: Savings can vary depending on occupancy patterns with studies showing estimated savings from 25% - 60%.

Cost: Dimming wall controls typically cost slightly more than a standard wall switch.

Dimmers - Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 3:** Limited Assessment
Program	**LEVEL 4:** Marginally at cost effective levels. Program design complete, larger scale pilots underway. Well-developed risk assessment.

Timers

Residential timers are found most often on exterior lighting; however the CEE report also found them in garages, basement, laundry/utility rooms and bathrooms where they may be used to control lights that are installed in ventilation fan units. A CEE Residential Lighting Controls Market Characterization indicates an average payback period for timers is 10.2 years, with the shortest payback period of 3.9 years when used with exterior lights. (CEE) Additional details from the CEE study are provided in Appendix C.



Applications: Most often used with exterior lighting, but also in garages, basement, laundry/utility rooms and bathrooms.

Product Features: Typically installed as a wall control to allow occupants to turn lights on for a specified period of time.

Availability: Readily available through all consumer outlets: big box stores, hardware stores, online.

Energy Savings: Savings can vary depending on occupancy patterns with studies showing estimated savings from 25% - 60%.

Cost: Timer wall controls typically cost slightly more than a standard wall switch.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 3:** Limited Assessment
Program	**LEVEL 4:** Marginally at cost effective levels. Program design complete, larger scale pilots underway. Well-developed risk assessment.

Photo sensors

Photo sensors are most commonly used to control exterior lighting. The photo sensor is typically an integral part of the fixture and controls operation to only nighttime hours. The photo sensor will turn on the light at dusk and turn off the light at dawn. Where outdoor lights need to operate all night for security reasons, photo sensors can ensure that lights are not left on during the day.



Since photo sensors are typically an integral part of the fixture, replacement of the entire existing fixture is most common in retrofit situations. Most Northwest Codes require photo sensors on exterior residential lighting on new homes. A CEE Residential Lighting Controls Market Characterization indicates an average payback period for photo sensors is 17.2 years, with the shortest payback period of 7.6 years when used with exterior lights. (CEE) Additional details from the CEE study are provided in Appendix C.

Applications: Residential exterior fixtures.

Product Features: Typically included as an integral part of the fixture and controls operation to only nighttime hours.

Availability: Readily available through all consumer outlets: big box stores, hardware stores, online.

Energy Savings: Savings can vary depending on the baseline operation of the fixture. For fixtures consistently left on during the day, converting to photo control can reduce operating hours by about 50%, with the same level of energy savings. For fixtures only intermittently left on during the day, savings will be lower.

Cost: Exterior fixtures with integral photo controls typically cost somewhat more than a similar fixture without photo control.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 3:** Limited Assessment
Program	**LEVEL 4:** Marginally at cost effective levels. Program design complete, larger scale pilots underway. Well-developed risk assessment.

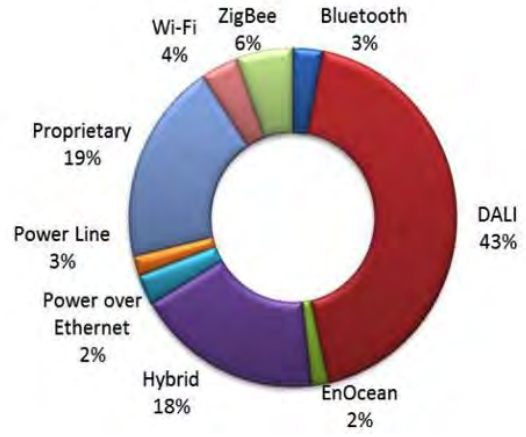
Connected Controls

Connected controls refer to lighting equipment that has an element of intelligence or connectivity. According to DOE's LED Adoption Report: "Realizing the greatest possible benefit from LED lighting will depend on connected lighting controls that respond dynamically to changing conditions and demands" (LED Adoption Report). Controls connect multiple lamps, fixtures, and switches to allow intelligent operation. Connected lighting controls can operate independently within a home without an internet connection; however, most will be connected to the internet through a bridge with control through an app.

Options for implementing connected lighting controls include "smart" lamps, switches, plugs and in-wall dimmers. These can all include various sensors to determine occupancy, lighting levels, timing etc. integrated into a platform that allows remote control and possible monitoring.

As shown in Figure 13 below, the market is segmented, ranging from plug and play smart lamps with built in Wi-Fi (4% of market) that can talk directly to your smart phone to complete automation systems from a couple of dozen manufacturers using both open and proprietary (19% of market) communications protocols (Smallwood).

Figure 13. 2014 Connected Indoor Lighting Market



(Smallwood)

According to DOE, connected controls were installed in less than 0.1% of both commercial and residential lighting systems in 2016 (Building Technologies Office). In the residential sector, the anticipated potential savings for lighting controls is low, given low baseline operating hours and continued penetration of high efficacy sources.

While it has been suggested that this new level of connectivity could provide enhanced control to drive additional savings in the residential lighting sector beyond the savings associated with traditional (unconnected) controls, this remains substantially unproven for wide application. With the current high cost of connected lighting controls, these systems are not likely to be cost effective based on energy savings alone and are dependent on non-energy benefits to drive their market acceptance.

Connectivity could provide a pathway for utilities to acquire a demand response (DR) resource but the fragmentation of the market and lack of standards for compatibility pose significant barriers.

Connected controls fall into two categories,

a) lighting specific for lamps, fixtures and switches; and
b) implemented as part of a complete HEMS as part of the larger Internet of Things.

Both of these options are explored in the next sections.

Smart Lamps

Smart lamps provide a relative low cost path to connected lighting control. These lamps pair LED lighting sources with the ability for remote dimming, color changing, color tuning (CCT) and on/off control. There is a broad range of lighting options (color temp, color tuning, dimming) as well as access to voice control and audio speakers with appropriate hardware. The features of some of the best rated "smart" lamps as reviewed by http://smarthome.reviewed.com are located in Appendix B.

In retrofit applications, installation of a smart lamp with or without a gateway is basically "plug and play" and shouldn't require professional installation. Because the homeowner can generally install these lamps, their cost will be lower than hard-wired controls installed by a contracted professional. However, smart lamps are not cost effective based on energy savings alone. Non-energy related benefits, such as color changing capability, integrated audio speakers and other control features are driving early adoption versus cost effectiveness.



Smart lamps fall into 2 categories: lamps that require a hub or gateway to communicate with other devices and lamps that can communicate directly by WIFI, Bluetooth or proprietary protocols. ZigBee is currently the dominant communication protocol for smart lamps that require a hub or gateway. Gateways are an added cost that becomes less significant if a large number of lamps are being installed. There is a wide variation in the approach used for connecting lamps and devices and some set-up and programing features are awkward especially across different platforms. The PG&E Market Analysis for HEMS published in November of 2016 (B. K. Rebecca Ford) found the following for smart lamps:

> "The main difference between the products is around how they connect to the home area network. Of the 15 manufacturers, whose products were reviewed, four distinct communication approaches emerged. Most developed proprietary hubs (5); others produced bulbs that were compatible with a slew of platforms developed by other manufacturers (4). Two manufacturers produced bulbs that connect to the Wi-Fi router directly. Nine additional products did not need a hub and were directly controlled via Bluetooth using smartphones and tablets, but can only communicate in close proximity, prohibiting remote control from outside the home."

Also, a word of caution, in a small PG&E study in 2014 looking at smart lamps, the hours of use per lamp actually increased for smart lamps compared to standard lamps partially offsetting savings gained from added control. (Price)

Applications: Residential fixtures that have an Edison base suitable for screw in lamps.

Product Features: Remote control for dimming, on/off, color changing, color tuning, audio typically through smart phone apps.

Availability: Becoming more readily available through major consumer outlets, mainly big box stores and online.

Energy Savings: Given the early stage of technology development and adoption, energy savings are generally unproven and anticipated to be low, given low baseline operating hours and the high efficacy of the lamp.

Cost: Smart lamps typically cost significantly more than an LED lamp without integrated control functionality.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 2:** Concept validated
Program	**LEVEL 3:** Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.

Smart switches

Like smart lamps, smart switches provide connected lighting control. Smart switches replace the normal wall switches in a house and provide connectivity which enables the ability to turn lights on and off, dim regular bulbs, and provide connected control of switched devices other than lighting. Another feature of the smart wall switch, as compared to the standard wall dimmer, is the remote control capability. An advantage for smart switches is that standard LED bulbs can be controlled. This can be especially useful if the application requires a particular size, shape or style that isn't available as a smart bulb.



However, these switches do not provide the additional features, such as color changing, available with smart lamps unless the bulbs are also replaced.

Most smart switches use either WIFI or ZigBee. WIFI models like the Belkin WeBo Light Switch can pair directly with your home network or smart phone while models that use ZigBee will require some sort of hub or control device. Lutron has an extensive line of higher-end lighting controls for smart lighting based on their own proprietary signal.

Installation is more complicated than a smart lamp, requiring wall switches to be replaced at an average cost, around $50, which is fairly high impacting the cost effectiveness of smart switches. Like smart lamps, market adoption is currently driven by non-energy benefits.

While smart lamps can lose connectivity if they are turned off by a regular wall or fixture switch, smart switches are always connected directly to house power and remain connected as long as the power is on. Because smart switches are always powered even when they are turned off, this results in standby energy use similar to a smart lamp.

Applications: Any residential lighting controlled by a wall switch.

Product Features: Remote control typically through phone apps for dimming, on/off.

Availability: Becoming more readily available through major consumer outlets, mainly big box stores and online.

Energy Savings: Given the early stage of technology development and adoption, energy savings are generally unproven and anticipated to be low, given low baseline operating hours and the continued penetration of high efficacy lamps.

Cost: Smart switches typically cost significantly more than a standard wall switch.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 2:** Concept validated
Program	**LEVEL 3:** Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.

Smart plug-in and hardwired outlets

Smart outlets provide connected intelligent control to any device. Most, smart outlets are designed to work with whatever is plugged into them to turn devices on and off and for lamps provide dimming controls. However, some outlets are lamp specific, with built in dimming control. Many devices now have or are developing compatibility with various platforms such as Apple HomeKit for iOS, Amazon Echo or Google Home. With the right hardware you can have voice control of your lighting and other devices.



These devices can either be plug-in or hard wired. Plug-in options are basically plug and play and adapt an existing outlet they can automate other devices including small applications and provide connectivity for fixtures using standard bulbs. Smart plug-in outlets are simple to set up and like smart lamps can be easily relocated. Other smart outlets are hard wired and offer a more seamless and fully integrated feel for a fully automated home but require more labor to install.

Many smart outlets also provide data on power consumption, which could become a valuable resource in tracking use and verifying potential savings.

Similar to smart switches, unless the smart outlet is turned off, it will have standby energy consumption in order to maintain connectivity even when not in use.

Applications: Any residential lighting plugged into an electrical outlet.

Product Features: Remote control typically through phone apps for dimming, on/off.

Availability: Becoming more readily available through major consumer outlets, mainly big box stores and online.

Energy Savings: Given the early stage of technology development and adoption, energy savings are generally unproven and anticipated to be low, given low baseline operating hours and the continued penetration of high efficacy lamps.

Cost: Smart outlets typically cost significantly more than a standard electrical outlet.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 5:** Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available.
Product	**LEVEL 2:** Concept validated
Program	**LEVEL 3:** Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.

Connected Homes

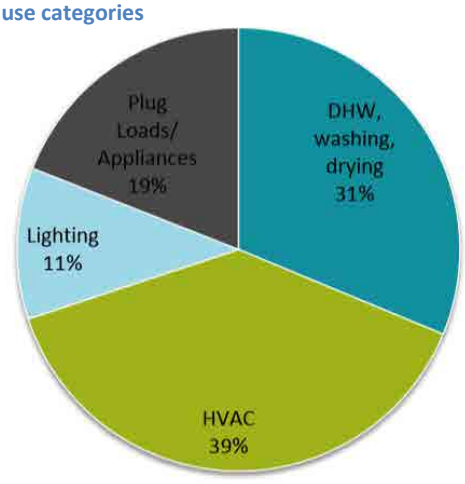
Home automation systems have been on the horizon for decades but applications have generally been found in higher end residences. With a growing "internet of things" and dropping prices for connectivity, the last five years have seen increased adoption for these systems. Home energy management systems provide a host of services including: home security; controls for lighting levels, color and/or daylighting; controls for HVAC using artificial Intelligence algorithms; and smart appliances including refrigerators that send shopping lists to smart phones or ones that have cameras which show the contents. The landscape of possibilities appears to be limitless.

While connected homes offer the potential for delivery of energy savings, energy management is typically not a feature highlighted in marketing these systems. Rather, the connected home is offered to the public as a path to convenience, control, security and information. In addition, the integration of a Home Energy Management System (HEMS) or stand-alone connected lighting systems into this larger Internet of things (IoT) is expensive relative to the savings potential. However, these costs may be mitigated by non-energy benefits and the service supplier's interest in gaining access to data about homeowners for additional marketing purposes.

As part of home automation, Home Energy Management Systems (HEMS) have been in the market for a number of years. Significant market characterizations and assessments have been published by NEEP (2015), PG&E (2016) and others. Energy savings associated with the use of HEMS are attributed to both changes in behavior of occupants and the growing ability of systems to interact with automated home controls and directly modify operational characteristics that have the potential to reduce overall energy use while maintaining or even enhancing comfort and performance.

Studies designed to quantify energy savings for HEM systems has been limited. Two sources which did develop these estimates are highlighted here. A 2010 ACEEE report began to quantify the potential savings from HEMS technologies reporting 4% to 12% average reduced household electrical consumption (Ehrhardt-Martinez). A Northeast Energy Efficiency Partnership (NEEP) study in 2015 estimated potential savings that is achievable with HEMS for all combined end uses as shown by percentage in Figure 14. As shown in this chart, lighting provides only a small part (11%) of the potential energy savings anticipated from using a HEMS.

Figure 14. Estimated HEMS Savings Potential by major end use categories



NEEP also estimated potential savings by end use for both control-based systems (Table 4) and information-based (feedback only) systems (Table 5). Savings are shown as a percentage of whole home energy use. Again, these tables show relatively low potential savings for control of lighting energy use through a HEMS.

Details about lighting controls via HEM systems are on the next page.

Table 4. Whole Home Savings Estimates for Control-Based HEMS

Control-Based HEMS Savings Estimates by End-Use							
Products	**End-Use**	**Savings Range (whole home energy usage as baseline)**			**Cost Range**		
		Low	Avg.	High	Low	Avg.	High
Smart Hardware / Smart Home Platforms	Space Heating	1%	7%	13%	$46.00	$247.13	$615.00
	Space Cooling	1%	9%	17%	$46.00	$247.13	$615.00
	Water Heating	1%	8%	15%	$799.99	$1350.00	$1,900.00
	Appliances	<1%	3%	6%	$54.00	$1,503.50	$4,000.00
	Plug Loads	<1%	3%	5%	$11.00	$208.41	$1,300.00
	Lighting	1%	2%	3%	$15.00	$46.89	$150.00

Table 5. Whole Home Savings Estimates for Information-Based HEMS

Information-Based HEMS Savings Estimates by End-Use							
Products	**End-Use**	**Savings Range (whole home energy usage as baseline)**			**Cost Range**		
		Low	Avg.	High	Low	Avg.	High
Customer-Facing Energy Portal / In-home Display / Load Monitor	Space Heating	1%	8%	15%	$20.00	$197.00	$4000.00
	Space Cooling	1%	5%	9%			
	Water Heating	1%	8%	15%			
	Appliances	<1%	1%	1%			
	Plug Loads	<1%	2%	3%			
	Lighting	<1%	2%	3%			

Applications: Theoretically any home, but given cost and complexity will most likely be adopted first in high-end homes.

Product Features: Remote control of lighting and other home appliances typically through phone apps. Can provide additional non-energy benefits such as security, entertainment, usage tracking, and other information.

Availability: Becoming more readily from major manufacturers.

Energy Savings: Given the early stage of technology development and adoption, energy savings are generally unproven. Energy savings for lighting controlled through HEMS are anticipated to be low, given low baseline operating hours and the continued penetration of high efficacy lamps.

Cost: Installing a home energy management system is costly, ranging from several hundred to several thousand dollars, if new smart appliances are included.

Readiness Levels:

Category	**Scores**
Market/Commercial	**LEVEL 4:** Commercially available in NW from at least two manufacturers. Stocked throughout region.
Product	**LEVEL 2:** Concept validated
Program	**LEVEL 3:** Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.

Codes and Standards

Codes and Standards have been instrumental in the evolution of energy efficient residential lighting. The Energy Independence and Security Act (EISA) of 2007 raised efficacy standards for general service lighting, effectively phasing out incandescent lighting from the market and accelerating the transition to efficient light sources. In addition, current building codes, particularly in California and the Northwest, require widespread use of high efficacy lighting in residential applications and address lighting controls. Lamp quality certification programs, such as Energy Star, have also helped expand the market for efficient lighting.

EISA 2020 rule making

Over the years since its passage in 2007, EISA standards have been implemented through a periodic rule making process. The latest rule making, scheduled to take effect January 1, 2020, requires a minimum 45 lumens/watt for almost all general service lamps (GSL) and previously exempt specialty lighting. This will effectively make only LED and CFL lamps available in the market, since no currently available halogen or incandescent lamps are able to meet the efficacy requirement.

From the article Impacts of the 2020 Federal Light Bulb Efficiency Standard By Chris Granda, February 2018 issue of Strategies:

"While the federal standard is technology neutral and allows the sale of any kind of General Service Lamp (GSL) that can meet the 45 LPW efficiency requirement, most light bulbs of all types for sale in the U.S. will probably be LEDs after the standard comes into effect. LEDs mostly run above 70 LPW, consumers like the technology and LED market share has recently increased rapidly. Halogen bulbs for sale today only run at about 20 LPW and several years ago manufacturers abandoned efforts to commercialize a new generation of more efficient halogens. Most compact fluorescent lamps (CFL) can meet the 45 LPW requirement, but are losing market share to LEDs based on light quality, reliability and price. CFLs dropped from 50 percent of all A-line light bulb sales in 2014 to less than 10 percent today and some manufacturers are discontinuing their CFL product lines. The federal backstop GSL standard does not cover linear fluorescent lamps, which are subject to their own federal standards.

This transition will eventually make most residential lighting efficiency programs no longer cost-effective. A couple of factors point to a closing window for residential lighting efficiency programs. Since 2010, first CFLs and then LEDs have claimed significant shares of the U.S. light bulb market. As a result, the energy efficiency of the average new light bulb sold in the U.S. has increased significantly. That

means the savings that energy efficiency programs can claim for helping to install an efficient LED has decreased, compared to the average new light bulb that consumers would have installed anyway. Because LEDs and CFLs last much longer than halogen light bulbs, consumers also need to buy replacement bulbs less frequently and annual sales of light bulbs in the U.S. are dropping."

Energy Star

The EPA Energy Star program maintains quality and efficiency standards for light bulbs. The standard is technology neutral and applies to any lighting technology. Light bulbs that earn an Energy Star label meet these efficiency standards and are tested by accredited labs. The standards require light bulbs to use about 70-90% less energy than traditional incandescent bulb and last at least 15 times longer. Many utility programs provide incentives for only Energy Star certified lamps in order to ensure quality products are offered to consumers. Energy Star also provides educational materials to inform consumers about LED lighting in general, and how choosing an Energy Star lamp can provide assurance of quality in various lamp characteristics.

California Quality LED Lamp Specification

California has developed a separate standard for LED lamps. This specification is intended to set a high performance standard to create a positive public perception of LED lamps, especially in residential applications. California investor owned utilities can only provide rebates for screw-based LEDs products that meet the quality specification. The specification includes enhanced criteria for numerous customer metrics related to customer satisfaction. These include color rendering (CRI), light distribution, dimming performance and flicker. The specification also includes a minimum efficacy requirement of 80 lumens/watt, well above the federal minimum standard of 45 lumens/watt.

Building Codes

California's Title 24 Building Energy Code, effective January 1, 2017, includes comprehensive requirements for energy efficient lighting and controls, including the following

- All lighting must be high-efficacy. Screw-based high-efficacy lighting is allowed, except in recessed ceiling downlights.
- A vacancy sensor must be installed to control lights in bathrooms, garages, laundry rooms, and utility rooms.
- A dimmer or vacancy sensor must be used to control all permanently installed indoor recessed ceiling downlights, screw-based light fixtures, and LED light fixtures.
- Outdoor lighting connected to a building must be controlled with a manual on/off switch plus an astronomical timeclock, or photocell and motion sensor, or photocell and time switch.

Northwest lighting codes vary based on jurisdiction. For example,

- Washington State lighting codes are based on the 2015 IECC with amendments.
- Montana State lighting codes are based on the 2012 IECC.
- Oregon has developed its own set of lighting codes that are mainly prescriptive.
- Idaho State lighting codes are based on the 2012 IECC with amendments.

Conclusions

Increased adoption of LED light sources will continue to be the dominant driver of residential lighting energy savings for at least the next decade. While LED products currently in the market are very efficient, with efficacies of 80 – 110 lumens/watt, continued improvement in the efficacy of LED lamps and luminaires is predicted in the next few years. The DOE estimates that the highest performing LED devices currently have efficacies of 160-170 lumens/watt and 255 lumens/watt is possible.

Stringent federal standards for lighting source efficacy and building codes with requirements for widespread use of high efficacy lighting in residential applications will negatively impact utility residential lighting programs. As these codes and standards go into effect, the baseline for calculating energy savings will be more efficient, reducing the rate of savings efficiency programs can claim. In addition, dropping prices will impact the cost effectiveness impacting the ability to provide incentives.

EISA 2020 will bring significant changes to the residential lighting market when it imposes a 45 lumens per watt standard for lamps including most specialty lamps which are currently exempt. This new standard will eliminate all options currently in the market except for LEDs. Utility lighting programs have a limited amount of time to incent specialty lamps for lighting energy savings before the January 1, 2020 implementation date.

Controls could provide additional incremental energy savings. However, potential savings from residential controls are limited by the successful penetration of the general market by both high efficacy lights and low baseline hours of operation of residential lighting. DOE estimates that residential lighting controls will drive 7% savings by 2035. Traditional controls with the greatest potential savings are dimmers followed by vacancy sensors.

Savings and cost effectiveness for connected controls have not been validated. With higher penetrations of high efficacy lamps and low hours of usage justification to include these technologies in utility lighting programs may be limited. Additional research will be needed to explore if and how to incorporate these technologies into future lighting programs.

Home automation in its various forms will help increase the penetration of lighting controls into more homes. While these technologies offer the potential for lighting energy savings, energy savings are not typically the main driver for adoption. Currently, consumers cite non-energy benefits of these systems, such as safety and security, convenience and entertainment, as higher priorities than energy savings for adoption of home automation.

As more houses become “connected”, home automation offers an opportunity to support demand side management. However, currently most products do not focus on this potential or provide a way to integrate utility signals such as time-of-use or critical-peak pricing into lighting solutions.

Emerging technologies are not expected to impact the residential lighting programs before 2025. These technologies should be monitored and opportunities to accelerate research and adoption with strategic partnerships should be explored.

Overview of Technologies

Table 6. Summary of Report Findings for Lamp Technologies

Lamps	Technical Potential	Energy Savings	Applications	Readiness Scores
Currently Available				
LED General Service A-Line Lamps are available with various lumen outputs and in various color temperatures. Dimming and non-dimming available.	35 aMWs	LED lamps use about 80% less energy than standard incandescent lamps; about 30% less than CFLs	Residential Fixtures	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.
LED Specialty Lamps Lamps are available in a large variety of sizes and shapes to fit a variety of applications. Available in various lumen outputs and color temperatures. Dimming and non-dimming available	51 aMWs	LED lamps use about 80% less energy than standard incandescent lamps; about 30% less than CFLs	Residential fixtures other than an Edison base including reflector, globe, and candelabra light bulbs with various screw base sizes and pin bases	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.
LED Linear LED Linear lamps are available in a variety of lumen outputs and color temperatures. Dimming and non-dimming available. Lamps have different configurations with some requiring rewiring and others plug and play	2.7 aMWs	LED Linear replacement lamps currently in the market can provide energy savings of 40 - 45%	Residential fixtures that use linear fluorescent lamps. Most often found in Single Family in garages, closets, and utility rooms; and in Multifamily common areas and parking garages.	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.

Lamps	Technical Potential	Energy Savings	Applications	Readiness Scores
LED Exterior Lighting New fixtures with integrated LED sources are available in wide variety of styles, mounting types, lumen outputs, and color temperatures. Available with integrated photo and motion sensors.	19 aMWs	Exterior fixtures with LED sources use about 80% less energy than fixtures with standard incandescent lamps; and 30% less than CFLs	Exterior porch and security lighting	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.
Dedicated Fixtures New fixtures with integrated LED sources are available in a wide variety of styles, mounting types, lumen outputs and color temperatures	89 aMWs	Exterior fixtures with LED sources use about 80% less energy than fixtures with standard incandescent lamps; and 30% less than CFLs	All residential lighting applications	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.

Emerging Technologies Near Term				
Organic LEDs (OLEDS) Light emitting diodes in which emissive electroluminescent layer is a film of organic compound.	TBD	Current efficacies (50 lumens/watt) are comparable to CFLS.	OLED panels are growing part of TV and display market and research is underway for general illumination applications	**Market Readiness:** Level 1: Not commercially available or limited, pre-commercial availability **Product Readiness:** Level 2: Concept validated **Program Readiness:** Level 1: No program design. No risk assessment.
Lamps	**Technical Potential**	**Energy Savings**	**Applications**	**Readiness Scores**
Future Technology Over 5 years				
Laser Diodes May offer a powerful, high density, efficient light source that could revolutionize lighting design.	TBD	Similar efficiencies to current LEDs in the market now.	Currently commonly used in telecommunications, measuring devices, scanners and other applications. Limited to specialty applications	**Market Readiness:** Level 1: Not commercially available or limited, pre-commercial availability **Product Readiness:** Level 1: Concept not yet validated **Program Readiness:** Level 1: No program design. No risk assessment.
Quantum Dots Very small , typically 2-10 nanometers, semiconductor particles which will emit light if electricity is applied to them. First identified in 1986, these are anticipated to be a central component in the expanding world of nanotechnology.	TBD	Potential savings would come from possible improvements in efficacy through the use of quantum dots in LEDs.	Research is underway exploring applications in quantum computing; studying intercellular biological processes; improved photovoltaic devices; photodetectors; photo catalysts and light emitting diodes (LEDs)	**Market Readiness:** Level 1: Not commercially available or limited, pre-commercial availability **Product Readiness:** Level 1: Concept not yet validated **Program Readiness:** Level 1: No program design. No risk assessment.

Table 7. Summary of Report Findings for Lighting Controls Technologies

Lighting Controls	Technical Potential	Energy Savings	Applications	Readiness Scores
Currently Available Standalone Controls including sensors, timers, dimmers and photo sensors				
Vacancy/Occupancy Sensors Sensors save energy in indoor and outdoor applications by turning lights off after a period of time with no activity. They can be sensitive to motion or heat (infrared) or both.		Savings can vary depending on occupancy patterns with studies showing estimated savings from 25 – 60%. Outdoor applications provide more savings because of longer hours of use.	Can be used with lamps or fixtures. Typically installed as a wall control and turn lights off when the room is vacant. Can be used with indoor and outdoor lamps.	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.
Dimmers Wall controls that allow light levels to be lowered to save energy and/or create ambiance. Approximately 5% of NW homes have dimmer controls. Compatibility between dimmers and lamps is a potential issue.		Savings can vary depending on occupancy patterns with studies showing estimated savings from 25 – 60%. Establishing standards functionality for SSL remains a barrier to adoption.	Any residential lights but are most often used in rooms that are frequently occupied where adjustable light levels are desired such as kitchens, living rooms, dining rooms, bedrooms and bathrooms	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.
Timers Typically installed as a wall control to allow occupants to turn lights on for a specified period of time.		Savings can vary depending on occupancy patterns with studies showing estimated savings from 25 – 60%	Most often used with exterior lighting but also found in garages, basements, laundry/utility rooms, and bathrooms	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.

Lighting Controls	Technical Potential	Energy Savings	Applications	Readiness Scores
Currently Available Standalone Controls including sensors, timers, dimmers and photo sensors-Cont'd				
Photo Sensors Typically included as an integral part of exterior fixtures to control operation to only nighttime hours.		Savings can vary depending on the baseline operation of the fixture. For fixtures consistently left on during the day, converting to photo controls can reduce operating hours by about 50% with the same level of energy savings.	Residential exterior fixtures.	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 6 – Approved for implementation **Program Readiness:** Level 5 – Cost Effective. Ready for full-scale programs. Periodic risk assessment in place.

Lighting Controls	Technical Potential	Energy Savings	Applications	Readiness Scores
Connected Controls – Multiple Lamps, Fixtures and Switches				
Smart Lamps Replacement LED lamps that provide remote control capabilities for dimming; on/off; color changing; color tuning; and audio typically through smart phone apps.		Given low baseline operating hours and the high efficacy of the lamps as well as the early stage of development and adoption, energy savings are generally unproven and anticipated to be low.	Residential fixtures with an Edison base suitable for screw in lamps.	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 2 – Concept validated **Program Readiness:** Level 3 – Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.
Smart Switches Smart switches replace the normal wall switches to provide remote control for dimming and on/off for lighting through phone apps.		Given low baseline operating hours and the high efficacy of the lamps as well as the early stage of development and adoption, energy savings are generally unproven and anticipated to be low. Standby loads may impact savings.	Residential wall switches that control lights.	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 2 – Concept validated **Program Readiness:** Level 3 – Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.
Smart Plug-in and Hardwired Outlets Provides connected intelligent control to any device plugged into the outlet. Controls support dimming and on/off capability.		Given low baseline operating hours and the high efficacy of the lamps as well as the early stage of development and adoption, energy savings are generally unproven and anticipated to be low. Standby loads may impact savings.	Residential lighting plugged into the electrical outlet.	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 2 – Concept validated **Program Readiness:** Level 3 – Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.

Lighting Controls	Technical Potential	Energy Savings	Applications	Readiness Scores
Connected controls integrated into a complete Home Energy Management System (HEMS)				
Connected Homes Offer the potential to deliver energy savings through energy management systems by providing remote control of lighting and other home appliances typically through phone apps. Can provide non-energy benefits such as security, entertainment and information.		Given low baseline operating hours and the high efficacy of the lamps as well as the early stage of development and adoption, energy savings are generally unproven. Energy savings for lighting controls through HEMS are anticipated to be low. Other non-energy benefits may drive adoption.	Can be used in any home but will most likely be adopted first in high end homes. **Are we sure about this given Alexa and other products?**	**Market Readiness:** Level 5 – Commercially available from 2+ manufacturers, well developed supply chain. Widely and easily available. **Product Readiness:** Level 2 – Concept validated **Program Readiness:** Level 3 – Not cost effective but shows pathway to CE with higher volumes, more competition, improved technology. Small scale pilots.

Recommendations

Opportunities for utility programs to deliver energy savings in residential lighting are changing as technology and codes and standards evolve. Based on the findings in this paper, the following recommendations for utility residential lighting programs are offered.

Short-term: Next 2 years

- Support adoption of high efficacy, high quality sources.
- Utilities might consider a tiered incentive with higher incentives for higher efficacy lamps to encourage consumers to purchase the most efficient lamps available.
- Continue to require quality metrics, such as Energy Star or the CA Quality LED Lamp specification to ensure customer satisfaction.
- Identify specialty lamps that could be targeted for new incentives before the implementation of EISA 2020 where penetration of high efficacy lamps is currently limited.
- Support retrofit of linear fluorescent fixtures with TLEDs, particularly in multifamily applications where hours of operation are longer. Consider supporting only plug and play type TLEDs to minimize retrofit cost and safety concerns.
- Identify pilots and assessments of residential connected lighting controls in order to quantify energy savings and cost effectiveness. Evaluate customer experience issues and demand control opportunities.
- Support lighting controls for exterior fixtures, both in single family and multifamily applications. Exterior lighting has relatively longer hours of operation providing greater potential for savings through use of lighting controls

Mid-term: 2 – 5 years

- Explore a tiered incentive approach to encourage consumers to purchase the highest efficacy lamps to replace failing lamps including early LEDs which were installed beginning in 2010.
- Continue with pilots and assessments of residential connected lighting controls as the technology advances. Evaluate customer experience issues and demand control opportunities and gather additional data to quantify energy savings and cost effectiveness.
- Identify and develop strategic partnerships to support research and development of future lighting technologies to accelerate their development.

Long-term: Over 5 years

- Monitor advances in future lighting technologies and look for opportunities to accelerate development.

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Appendix B: Interviews

Jessica Aiona: presentation on BPA Residential Lighting Market Study May 2017

Eric Strandberg; Lighting Design Lab

Jeremy Snyder; Lighting Research Center; Director of Energy Programs/Director of Lighting Energy Alliance, Rensselear Polytechnic Institute

Ken Nichols; ACS Professional Staffing, BPA

Mary Matteson Bryan; Consultant

Chris Wolgamott; Senior Project Mgr. Technology & Product Management, NEEA

Heather Gates; Operations Mgr., Clear Results

Levin Nock; Design Lights

Michael Jouaneh; ASHRAE 90.2, Lutron

Eileen Eaton; CEE

Appendix C: Smart Lamps

Table 8. Smart Lamps Available for Purchase, Winter 2017/18

Lamp	HUB	Cost	Max W	Standby W	Efficacy L/W	Dim	Color Change	Color Temp Adjust	Programmable	Compatible
Phillips HUE White & Color Starter Kit (GEN 3)	Y	$160/hub + 3 lamps $50 each extra bulb	10W	0.2 W	80 @ 4000K	Y To 5%	Y 16M Colors	Y 2000K to 6500K	Y	Alexa Google Home Siri
C-Sleep by GE	N	$35 each	11w	?	66	N	N	Y	Sleep cycle	Waiting for smart bridge
TP Link LB 100	N	$20 each	7W	0.5 W	86	Y	N	N 2700K	Y	Android 4.1 iOS 8
Phillips Hue White Ambiance Kit	Y	$100 /hub + 3 lamps $28 each extra bulb	10W	0.1 W	80.6 @4000 k	Y	N	Y 2200K to 6500K	Y	Alexa Google Home Siri
Sengled Element Classic Kit	Y	$40/hub + 3 lamps $9 each extra bulb	9W	?	72	Y	N	N 2700K	N	Alexa only
Ikea Tradfri Gateway kit	Y	$80/hub + 3 lamps $18 Extra Tunable lamps	12W	0.5 W	81.7	Y	N	Y 2200K 2700K 4000K	?	Planned for: Alexa Google Home Siri
LIFX A19	N	$60	13W	0.5 W	84.6	Y To 1%	Y 16M Colors	Y 2500K to 9000K	Y	Alexa Google Home Siri
CREE 60W soft white replacement	Y	$20 Lamp only	11.5 W	?	71	Y	N	2700K	Y	ZigBee hub Wink Smart Things WEMO
OSRAM A19 White Tunable	Y	$24	9.5W	?	85	Y	N	Y 2700K to 6500K	Y	ZigBee hub Alexa Google Home

Appendix D: Annual Energy Savings Per Control Unit

The following tables demonstrate the elative payback of different controls in various rooms controlling various lamp types. This information is from the CEE 2014 Residential Lighting Controls Market Characterization (CEE).

Table 9. Occupancy/Vacancy Sensor Results

	Annual Energy Savings Per Control Unit (kWh/yr)					Payback Period (years)				
Room Type	Inc	Halogen	CFL	LED	Average	Inc	Halogen	CFL	LED	Average
Basement	28.2	22.7	7.6	7	14	11	13.6	40.9	44	22.2
Bathroom	75.9	86.8	21.7	19	62	4.1	3.6	14.3	16.3	5
Bedroom	44.9	50.2	12.9	11.2	35	6.9	6.2	24	27.6	8.8
Closet	28.5	20.7	7.8	7.1	19.2	10.9	15	39.6	43.4	16.1
Dining Room	18.3	19.7	6	4.6	16.1	17	15.7	52	67.9	19.2
Exterior	79.4	111.5	21.8	19.9	67.2	3.9	2.8	14.2	15.6	4.6
Garage*	38.1	48.1	10	9.5	15.1	8.1	6.4	30.8	32.5	20.6
Hall	72.2	78.8	21	18.1	59.4	4.3	3.9	14.7	17.2	5.2
Kitchen	126	100.8	35.7	31.5	72.3	2.5	3.1	8.7	9.8	4.3
Laundry/Utility Room	22.8	21.3	6.1	5.7	13	13.6	14.5	50.4	54.4	23.8
Living/Family Room	72.4	81.9	21.4	18.1	55.1	4.3	3.8	14.5	17.1	5.6
Office	8.8	9.7	2.6	2.2	6.4	35	31.9	120.6	140.1	48.2
Other	16.9	16.4	4.8	4.2	10.8	18.3	18.9	64.1	73.3	28.8
Average	49.8	53.4	14.2	12.5	36	6.2	5.8	21.9	24.9	8.6

Table 10. Timer Results

	Annual Energy Savings Per Control Unit (kWh/yr)					Payback Period (years)				
Room Type	Inc	Halogen	CFL	LED	Average	Inc	Halogen	CFL	LED	Average
Basement	28.2	22.7	7.6	7	14	14.3	17.7	53.2	57.1	28.8
Bathroom	75.9	86.8	21.7	19	62	5.3	4.6	18.6	21.2	6.5
Bedroom	-	-	-	-	-	-	-	-	-	-
Closet	-	-	-	-	-	-	-	-	-	-
Dining Room	-	-	-	-	-	-	-	-	-	-
Exterior	120.6	169.3	33.1	30.2	102	3.3	2.4	12.2	13.3	3.9
Garage*	38.1	48.1	10	9.5	15.1	10.6	8.4	40.1	42.3	26.7
Hall	-	-	-	-	-	-	-	-	-	-
Kitchen	-	-	-	-	-	-	-	-	-	-
Laundry/Utility Room	22.8	21.3	6.1	5.7	13	17.7	18.9	65.5	70.7	30.9
Living/Family Room	-	-	-	-	-	-	-	-	-	-
Office	-	-	-	-	-	-	-	-	-	-
Other	15.7	15.2	4.5	3.9	10	25.7	26.5	89.8	102.7	40.3
Average	53.6	64	14.9	13.4	39.5	7.5	6.3	27.1	30	10.2

Table 11. Dimmer Results

	Annual Energy Savings Per Control Unit (kWh/yr)					Payback Period (years)				
Room Type	Inc	Halogen	CFL	LED	Average	Inc	Halogen	CFL	LED	Average
Basement	8.3	6.7	6.2	5.8	5.3	30.5	37.8	40.9	44.1	47.6
Bathroom	27	30.8	21.4	18.6	24.8	9.4	8.3	11.9	13.6	10.3
Bedroom	43.9	49.1	23.9	20.4	37.4	5.8	5.2	10.6	12.5	6.8
Closet	-	-	-	-	-	-	-	-	-	-
Dining Room	46	49.8	29.9	22.3	42.9	5.5	5.1	8.5	11.4	5.9
Exterior	-	-	-	-	-	-	-	-	-	-
Garage*	-	-	-	-	-	-	-	-	-	-
Hall	24.1	26.3	19.5	16.6	22.5	10.6	9.7	13.1	15.3	11.3
Kitchen	57.3	45.8	45.1	39.6	39.7	4.4	5.6	5.6	6.4	6.4
Laundry/Utility Room	-	-	-	-	-	-	-	-	-	-
Living/Family Room	133.1	150.6	70.8	59.6	110.7	1.9	1.7	3.6	4.3	2.3
Office	9.4	10.3	7.6	6.5	8.2	27	24.7	33.5	39.1	31.2
Other	9.6	9.3	6.6	5.5	6.8	26.6	27.4	38.7	46	37.5
Average	39.4	42.2	25.1	21.2	33.1	6.4	6	10.1	12	7.7

Table 12. Photosensor Results

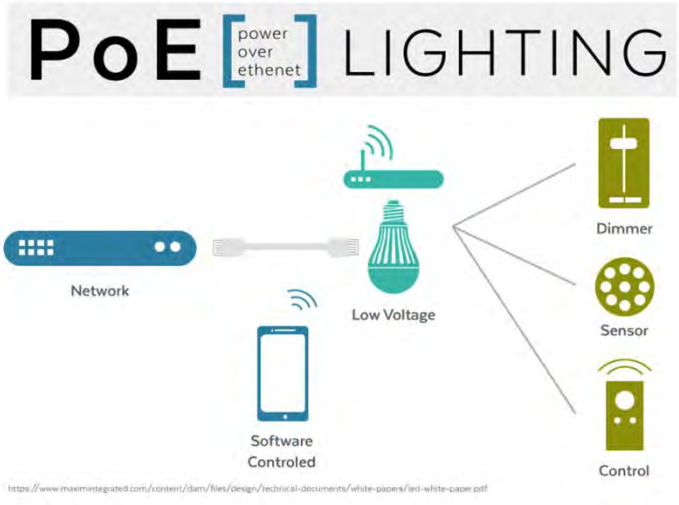
	Annual Energy Savings Per Control Unit (kWh/yr)					Payback Period (years)				
Room Type	Inc	Halogen	CFL	LED	Average	Inc	Halogen	CFL	LED	Average
Basement	-	-	-	-	-	-	-	-	-	-
Bathroom	-	-	-	-	-	-	-	-	-	-
Bedroom	-	-	-	-	-	-	-	-	-	-
Closet	-	-	-	-	-	-	-	-	-	-
Dining Room	-	-	-	-	-	-	-	-	-	-
Exterior	48.2	67.7	13.2	12.1	40.8	6.5	4.6	23.6	25.9	7.6
Garage*	22.9	28.9	6	5.7	9	13.6	10.8	51.7	54.6	34.5
Hall	-	-	-	-	-	-	-	-	-	-
Kitchen	-	-	-	-	-	-	-	-	-	-
Laundry/Utility Room	-	-	-	-	-	-	-	-	-	-
Living/Family Room	-	-	-	-	-	-	-	-	-	-
Office	-	-	-	-	-	-	-	-	-	-
Other	7.4	7.1	2.1	1.8	4.7	42.4	43.8	148.4	169.6	66.6
Average	26.2	34.6	7.1	6.5	18.2	11.9	9	43.8	47.7	17.2

Appendix E – Power Distribution

Power over Ethernet (PoE)

Technology Description: With the success of LEDs and their extremely low power requirements some vendors have started offering lighting integrated with Ethernet networks which draw their power from the low voltage wiring of the network and are directly controlled on the network. These have been primarily commercial installations.

Advantages: Potential savings comes from increased control and any increased penetration of high efficacy lighting into the market.



Potential Barriers: Wire gauge and potential DC voltage drops over the networks are barriers to more widespread application. Final cost per circuit is high when compared to basic, traditional AC lighting installations.

Outlook: Power over Ethernet systems are not currently applied in the residential sector. Retrofit of existing homes would be cost prohibitive. With the current high cost, it is likely that PoE systems will first be adopted in commercial applications, with early residential applications limited to high-end residential new construction. The potential to drive significant near term energy savings in the residential sector seems low.

Readiness Levels:

Category	Scores
Market/Commercial	**LEVEL 1:** Not commercially available or limited, pre-commercial availability
Product	**LEVEL 2:** Concept validated
Program	**LEVEL 1:** No program design. No risk assessment.

DC Power Distribution

Technology Description: Many electrical power uses in the home require direct current (DC) including computers, electronics and LED and fluorescent lighting. Since utilities supply AC power to the home, a driver or ballast is required to convert power from AC to DC. This conversion is not 100% efficient and the additional ballast or driver adds cost to the lighting.

If DC power was available at the outlet, it could reduce the cost to manufacture many types of lamps and fixtures by eliminating ballasts and drivers. As we see an increasing number of homes with photovoltaic (PV) generation of DC power and/or electric vehicles with battery storage for DC power, it may become advantageous to consider at what point the cost of independent distribution of DC power in the home alongside of AC power would be offset by the lower cost of lighting systems without drivers and ballasts.

Advantages: Reduced cost lamps and ballasts without drivers and ballasts.

Potential Barriers: Voltage drop can be an issue with DC distribution. In DC circuits, voltage gradually drops as it travels along through a length of wire. So, with every foot of wire, the available voltage gradually decreases along the length of wire.

Outlook: It will be difficult to change a major infrastructure such as AC distribution systems and retrofit of existing homes would be cost prohibitive. It is likely that DC systems will first be adopted in commercial applications, with early residential applications limited to high-end residential new construction where PV solar is also installed. The potential to drive significant near term energy savings in the residential sector seems low.

Readiness Levels:

Market/Commercial	**LEVEL 1:** Not commercially available or limited, pre-commercial availability
Product	**LEVEL 2:** Concept validated
Program	**LEVEL 2:** Not cost effective, but preliminary analysis shows a pathway to CE. Limited program design and risk assessment.

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REC-R404.2-24 – Staff Summary

Proponent: Andrew Clark, representing Home Builders Association of Virginia

Brief Description: Deletes the interior lighting control provisions that require the installation of automatic shutoff controls, such as occupancy sensors, vacancy sensors, door switches, programmable time switches, or countdown timers.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the third Energy Sub-Workgroup meeting on November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman

- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Andrew C provided an overview of the proposal which deletes the automatic shutoff control requirements for lighting.

Andrew C also introduced possibly removing exterior lighting controls into his proposal as a floor modification at the final General Stakeholder Workgroup Meeting.

Mike H, speaking for himself, stated that electricians seem to have a challenge selecting and installing the correct sensors and will cause a lot of frustrated homeowners.

Eric L was opposed to any roll back in efficiency in any current Virginia requirements.

Scott P supported the proposal.

Andrew C asked **Eric L** what the driver of his opposition was.

Eric L responded that these things save energy and that is why they are in the code.

Bill P also opposed and expressed that 20 minutes for a light to automatically turn off after an occupant has left a room is a long time.

Michael R, speaking for himself, stated opposition to this proposal as written, but is open to a minor tweak, if possible, instead of eliminating the entire proposal.

Sydney R was also opposed and noted that there may be a relationship between this proposal and proposal REC-R404.1-24. **Sydney R** highlighted that they should make sure that the code requires controls on non-high-efficacy luminaires if there are exceptions that may get adopted.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Steve Shapiro, AOBA and VAMA; Cory Carney, York County and IAEI - Virginia Chapter; Ryan Celestino, City of Newport News and IAEI - Virginia Chapter; and Rick Hinson, American Council of Engineering Companies (ACEC).

Opposition: Bob Shippee, Sierra Club; and Joseph Wages, NEMA.

Discussion:

Andrew C provided an overview of the proposal.

a. **Steve S** supported the proposal in the name of individual choice.
b. **Cory C** explained that energy savings are negligible.
c. **Bob S** declared that he did not see any justification for further eroding the standards.

DHCD Staff Note: N/A

REC-R404.5-24

IECC: 404.5 (N1104.5) (New), 404.5.1 (N1104.5.1) (New), 404.5.2 (N1104.5.2) (New), 404.5.2.1 (N1104.5.2.1) (New), 404.5.2.2 (N1104.5.2.2) (New), 404.5.2.3 (N1104.5.2.3) (New), 404.5.2.4 (N1104.5.2.4) (New), 404.5.2.5 (N1104.5.2.5) (New)

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2024 International Energy Conservation Code [RE Project]

Add new text as follows:

404.5 (N1104.5) ELECTRIC VEHICLE POWER TRANSFER.

404.5.1 (N1104.5.1) Definitions.

AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, electric vehicle supply equipment (EVSE), a rechargeable storage battery, a fuel cell, a photovoltaic array or another source of electric current.

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). A designated automobile parking space that is provided with electrical infrastructure such as, but not limited to, raceways, cables, electrical capacity, a panelboard or other electrical distribution equipment space necessary for the future installation of an EVSE.

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An automobile parking space that is provided with a branch circuit and an outlet, junction box or receptacle that will support an installed EVSE.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer, including ungrounded, grounded and equipment grounding conductors; electric vehicle connectors; attached plugs; any personal protection system; and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE SPACE). An automobile parking space that is provided with a dedicated EVSE connection.

404.5.2 (N1104.5.2) Electric vehicle power transfer infrastructure. New residential automobile parking spaces for residential buildings shall be provided with electric vehicle power transfer infrastructure in accordance with Sections R404.5.2.1 through R404.5.2.5.

404.5.2.1 (N1104.5.2.1) Quantity. New one- and two-family dwellings and townhouses with a designated attached or detached garage or other on-site private parking provided adjacent to the dwelling unit shall be provided with one EV capable, EV ready or EVSE space per dwelling unit. R-2 occupancies or allocated parking for R-2 occupancies in mixed-use buildings shall be provided with an EV capable space, EV ready space or EVSE space for 40 percent of the dwelling units or automobile parking spaces, whichever is less; provided that

the required number of served spaces shall be reduced to the extent that shared charging facilities are planned and designed to serve vehicles owned by occupants of multiple dwelling units.
Exceptions:

1. Where the local electric distribution entity certifies in writing that it is not able to provide 100 percent of the necessary distribution capacity within 2 years after the estimated certificate of occupancy date, the required EV charging infrastructure shall be reduced based on the available existing electric distribution capacity.

2. Where substantiation is approved that meeting the requirements of Section R404.5.2.5 will alter the local utility infrastructure design requirements on the utility side of the meter so as to increase the utility side cost to the builder or developer by more than $450 per dwelling unit.

3. To the extent the number of EVSE charging spaces must be reduced to comply with applicable fire safety codes.

404.5.2.2 (N1104.5.2.2) EV Capable Spaces. R404.5.2.2 (N1104.5.2.2)EV capable spaces.
Each EV capable space used to meet the requirements of Section R404.5.2.1 shall comply withall of the following:

1. A continuous raceway or cable assembly shall be installed between a suitable panelboard or other on-site electrical distribution equipment and an enclosure or outlet located within 6 feet (1828 mm) of the EV capable space.

2. The installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with Section R404.5.2.5.

3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a two-pole circuit breaker or set of fuses.

4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: “For future electric vehicle supply equipment (EVSE).”

404.5.2.3 (N1104.5.2.3) EV Ready Spaces. Each branch circuit serving EV ready spaces shall comply withall of the following:
1. Termination at an outlet or enclosure, located within 6 feet (1828 mm) of each EV ready space it serves and marked “For electric vehicle supply equipment (EVSE).”

2. Service by an electrical distribution system and circuit capacity in accordance with Section R404.5.2.5.

3. Designation on the panelboard or other electrical distribution equipment directory as “For electric vehicle supply equipment (EVSE).”

404.5.2.4 (N1104.5.2.4) EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE serving either a single EVSE space or multiple EVSE spaces shall comply with the following:
1. Be served by an electrical distribution system in accordance with Section R404.5.2.5.

2. Have a nameplate charging capacity of not less than 6.2 kVA (or 30A at 208/240V) per EVSE space served. Where an EVSE serves three or more EVSE spaces and is controlled by an energy management system in accordance with Section R404.5.2.5, the nameplate charging capacity shall be not less than 2.1 kVA per EVSE space served.

3. Be located within 6 feet (1828 mm) of each EVSE space it serves.

4. Be installed in accordance with NFPA 70 and be listed and labeled in accordance with UL 2202 (Electric Vehicle (EV) Charging System Equipment—with revisions through February 2018) or UL 2594 (Standard for Electric Vehicle Supply Equipment Standard for Electric Vehicle Supply Equipment.)

404.5.2.5 (N1104.5.2.5) Electrical distribution system capacity. The branch circuits and electrical distribution system serving each EV capable space, EV ready space and EVSE space used to comply with Section R404.5.2.1 shall comply with one of the following:
1. Sized for a calculated EV charging load of not less than 6.2 kVA per EVSE, EV ready or EV capable space. Where a circuit is shared or managed, it shall be in accordance with NFPA 70.

2. The capacity of the electrical distribution system and each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system in accordance with NFPA 70 shall be sized for a calculated EV charging load of not less than 2.1 kVA per space. Where an energy management system is used to control EV charging loads for the purposes of this section, it shall not be configured to turn off electrical power to EVSE or EV used to comply with Section R404.5.2.1.

Reason Statement: The purpose of this proposal is to incorporate into Virginia's residential building code the substance of 2024 IECC's Appendix RE which spells out requirements to install electric vehicle charging infrastructure in connection with new residential construction. Appendix RE comes with the 2024 IECC, but activation of Appendix RE requires inserting language into the Virginia Construction Code for residential construction, which this proposal would do by adding a new Section R404.5 and N1104.5.

The terms of Appendix RE are modified by (a) allowing the number of served spaces for R2 occupancies to be reduced by use of shared charging spaces and (b) the number of charging spaces shall be reduced to the extent required by any restrictions imposed by fire safety regulations.

Adoption of this proposal would benefit residents of new buildings by facilitating convenient electric vehicle charging, which can readily be expanded as the need grows. Implementation would benefit residents and the public with cost savings, pollution reduction (including greenhouse gases, ozone and carbon monoxide) and more equitable access to EVs and EV charging for residents. It would avoid the much higher costs of having to retrofit parking areas and building electrical systems.

Under Section 405, builders would be able to choose among three levels of EV charging readiness: EV Capable Space (raceway and basic infrastructure for future installation of a branch circuit and charger); or EV Ready Space (basic infrastructure plus a branch circuit, outlet, junction box or receptacle); or EVSE Space (includes actual charging).

The optionality allows builders to minimize construction costs while still making easier and much less costly for the owner to add an EV charger in the future. As explained in the IECC Commentary, "EV capable spaces are the first step towards the preparation of future electric vehicle charging infrastructure. The raceways, electrical capacity, and panelboard placed and sized accordingly will ease future installations and reduce future costs."

By agreement among members of the ICC's committee to develop the 2024 IECC, these EV charging requirements were to have been included in the main body of the 2024 IECC (as proposed here). It was shifted to an appendix on appeal but activating an appendix requires text in the code itself.

It would serve Virginians' near and long-term interest to require minimum levels of EV charging infrastructure in new construction. Given the savings to vehicle users and the pollution reduction benefits to the community, requiring installation of EV charging infrastructure is just as appropriate as it is for the building code to require lighting and other electric infrastructure for lighting and future equipment (HVAC, appliances, etc.), as well as safety measures like carbon monoxide alarms needed for houses with garages for traditional gas/diesel fired vehicles.

EVs have many economic and health benefits for vehicle users, and assuring installation of basic electric infrastructure to serve EVs as their usage grows will best serve Virginia and its residents. EVs are cheaper to use and maintain compared to vehicles with internal

combustion engines (ICE).

At-home charging is important for EV owners. It accounts for approximately 80% EV charging today and is much more convenient than searching for public chargers. However, many EV owners and potential buyers do not have EV infrastructure at their dwellings or even the potential to install charging in the future. That is a barrier to EV adoption and the inherent benefits of EVs for residents.

Growing EV usage is very important to Virginia. As explained in the ICC commentary accompanying the 2024 IECC, "The U.S. transportation sector accounted for 29 percent of the nation's greenhouse gas (GHG) emissions in 2019." That is specifically due to the traditional predominance of vehicles with internal combustion engines (ICE). Greenhouse gases from charging and operating EVs are less than 30% of GHG emissions from fueling and operating ICE vehicles. https://theicct.org/why-evs-are-already-much-greener-than-combustion-engine-vehicles-jul25/ Emissions will go down further as the electric system adopts more to zero-carbon energy sources. EVs are also far more energy efficient than burning fuels in vehicle engines.

Reducing GHG emissions is a stated policy goal in Virginia law because climate change is a current and growing danger for Virginians. (See., e.g., § 45.2-1706.1. Commonwealth Clean Energy Policy. "A. The Commonwealth recognizes that effectively addressing climate change and enhancing resilience will advance the health, welfare, and safety of the residents of the Commonwealth. The Commonwealth further recognizes that addressing climate change requires reducing greenhouse gas emissions across the Commonwealth's economy sufficient to reach net-zero emission by 2045 in all sectors, including the electric power, transportation, industrial, agricultural, building, and infrastructure sectors….") Virginia faces growing threats, including more heat-illnesses, disruption of outdoor work, worsening storms, flooding, sea level rise, supply-chain disruption, damage to crops, trees and natural resources, arrival of diseases and pests, etc.

Bringing on EVs will also reduce other air pollutants that also threaten Virginian's health and welfare. ICE vehicles are a major source of ozone and other pollutants, including carbon monoxide risks in homes with garages.

Providing EV electric infrastructure as part of new construction is no different from the building code's requiring electrical infrastructure for HVAC and other appliances likely to be used in the future or from its requiring more efficient equipment in homes (heat pumps, high-efficiency appliances and lighting). (The infrastructure for future EV charging could be used for other purposes if a resident were to choose to do so.)

Facilitating adoption of EVs requires that drivers have access to convenient, cost-effective EV charging. That can most easily be provided as part of new construction. It is very costly and complicated to renovate EV charging infrastructure into existing buildings. In the absence of a raceway from the electric panel to the garage, retrofitting would require reopening and repairing walls, which is very expensive and disruptive. Expanding EV charging at home is important and cannot be replicated by the slow process of trying to grow a highway-based charging system. That is why so much charging occurs at home.

The importance of incorporating into new construction is particularly great in the case of buildings whose parking is governed by condominium or common-interest-area boards. The high costs of retrofitting is a particularly large and a common barrier in apartment buildings where residents' choices are restricted by the need for third-party approvals and possible financial interests.

Cost Impact: The code change proposal will increase the cost

The cost of installing infrastructure would depend on the builder's choice among the three levels of EV charging readiness, which are provided by this proposal. The costs would be minimal for an EV Capable Space and not much more for the EV Ready Space option if the panel box is in or near a garage or outdoor parking space and low regardless of the location. The costs could be under $100 per garage. Upstream costs would also provide an exception to the requirements. Since electricity will be installed anyway (e.g. for garage or parking lighting at a minimum), it would not be difficult or costly to go the extra steps during building construction—far less than undertaking to install EV charging capabilities as a retrofit.

BLOG

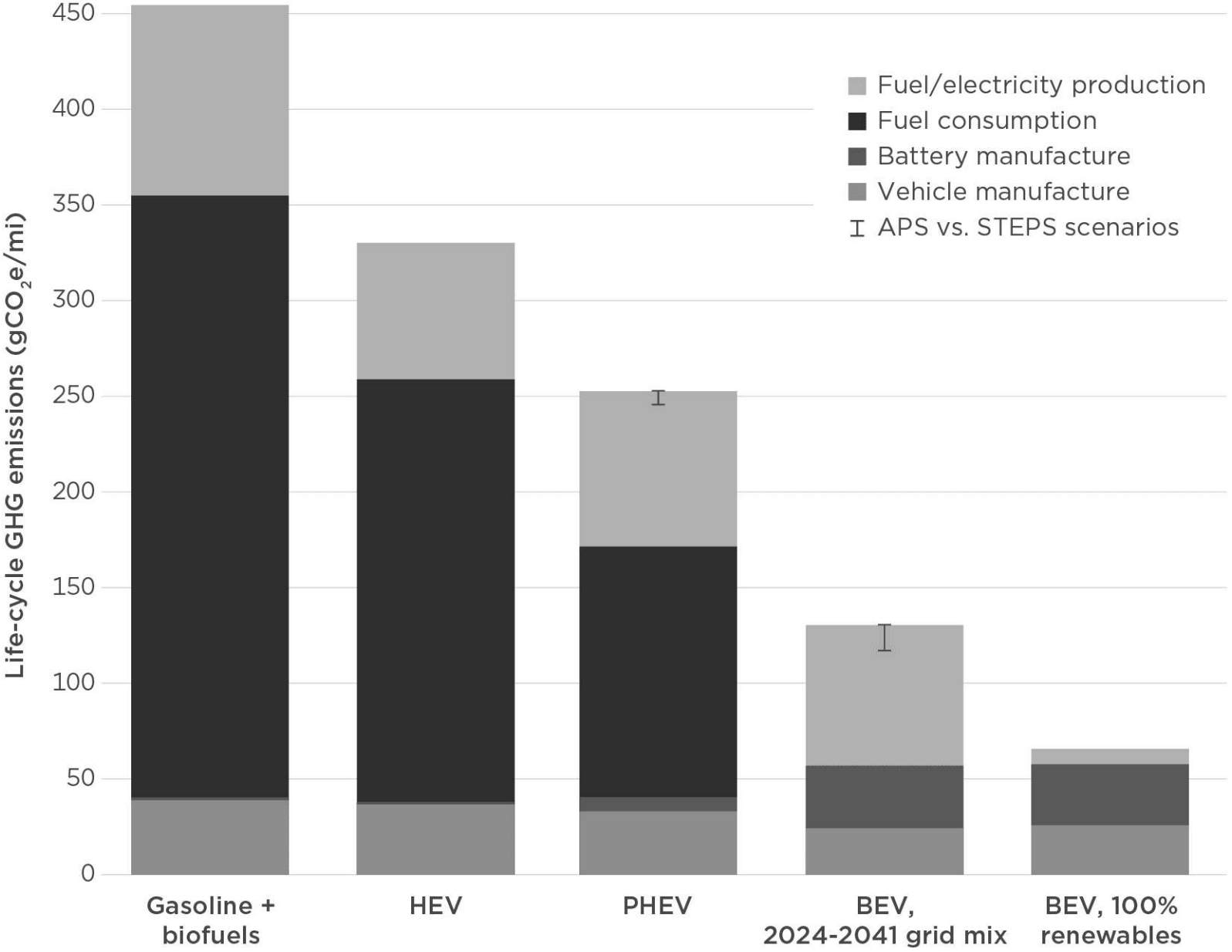
WHY ELECTRIC VEHICLES ARE ALREADY MUCH GREENER THAN COMBUSTION ENGINE VEHICLES

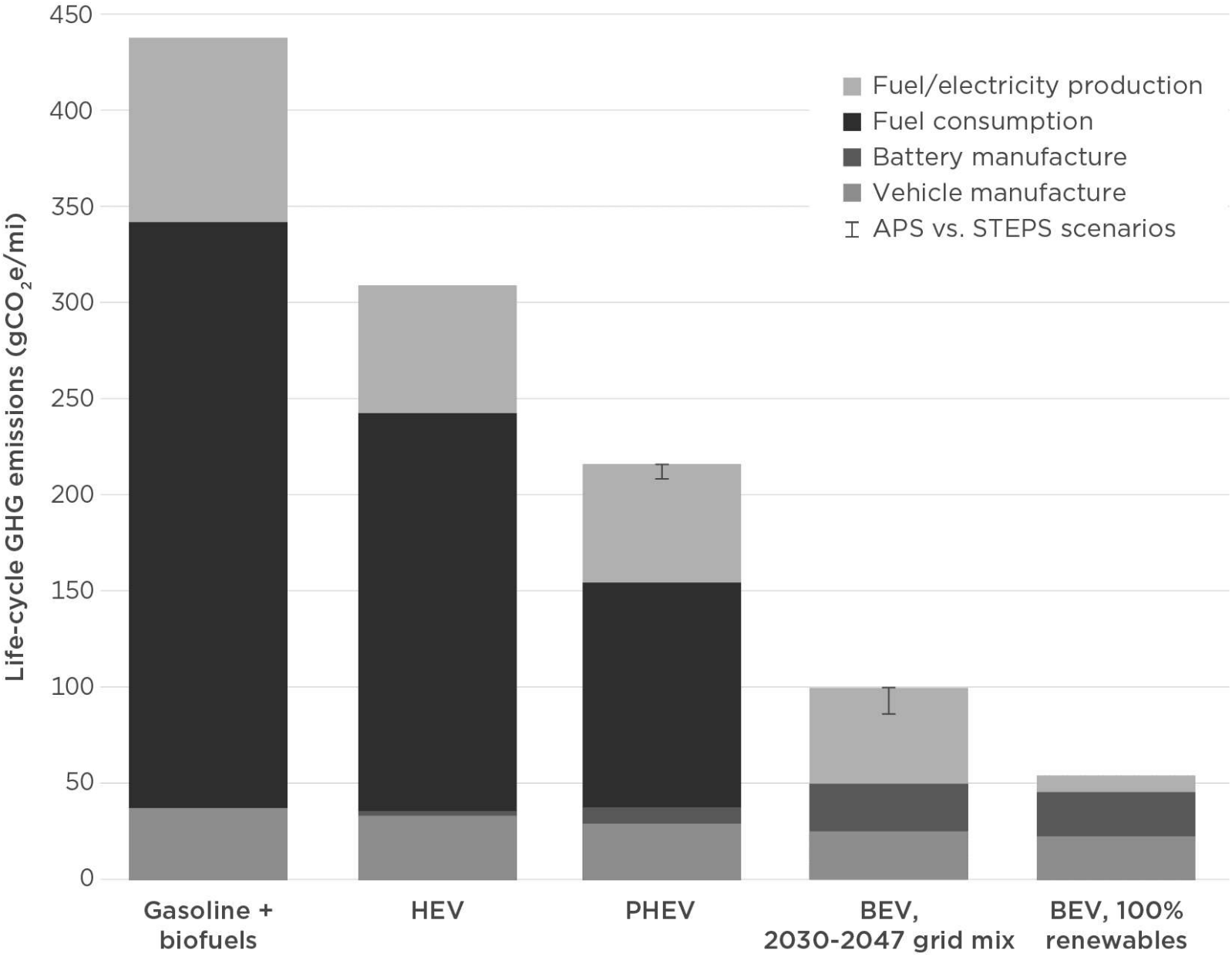
July 24, 2025 | By: Anh Bui

The research is clear: In major markets that make up 70% of global new passenger car sales, today's battery electric vehicles (BEVs) are associated with far fewer greenhouse gas (GHG) emissions than internal combustion engine vehicles (ICEVs) over their lifetimes. More than that, ICEV tailpipe emissions during their operation can exceed the full life-cycle emissions of a BEV, from initial manufacturing to operation to end-of-life. As there are narratives out there—some recent—that may confuse things, allow me to guide you through the climate benefits one at a time.

Let's start with some numbers for the U.S. market. Figure 1, from our paper from last year, shows the estimated life-cycle GHG emissions for a representative ICEV and BEV sport utility vehicle (SUV) built in 2024 (left panel) and in 2030 (right panel). When comparing the climate pollution emitted over the lifetime of SUVs built in 2024, the GHG emissions of the BEV SUV with a 300-mile range are 71% lower than the ICEV (the BEV is powered by the average grid mix in the United States from 2024–2041). Looking ahead to the 2030–2047 U.S. average grid mix, BEVs are associated with 77% fewer GHG emissions than ICEVs. As the electricity grid becomes still cleaner after 2047, the emissions advantage of BEVs will only grow. Indeed, several states and cities are approaching their goal of a fully renewable electricity grid.

Figure 1. Estimated life-cycle GHG emissions for model year 2024 and 2030 SUV


Life-cycle GHG emissions (gCO_2e/mi)
450
400
350
300
250
200
150
100
50
0
Fuel/electricity production
Fuel consumption
Battery manufacture
Vehicle manufacture
APS vs. STEPS scenarios
Gasoline + biofuels
HEV
PHEV
BEV, 2024-2041 grid mix
BEV, 100% renewables


Life-cycle GHG emissions (gCO_2e/mi)
450
400
350
300
250
200
150
100
50
0
Fuel/electricity production
Fuel consumption
Battery manufacture
Vehicle manufacture
APS vs. STEPS scenarios
Gasoline + biofuels
HEV
PHEV
BEV, 2030-2047 grid mix
BEV, 100% renewables

Source: O'Malley and Slowik (2024)

Our analysis comports with other studies (here's one from 2015 that was updated in 2020) which found that driving a 300-mile-range BEV with an average efficiency of 0.31 kWh per mile in every U.S. state had significantly lower life-cycle GHG emissions than the average ICEV. As you can see in Figure 1, BEVs outperform all vehicle types, including plug-in hybrid electric vehicles (PHEVs) and hybrid electric vehicles (HEVs).

According to news reports, though, some Americans remain skeptical of the green credentials. Headlines such as this one are no doubt contributing, but this article refers to a study by Emission Analytics that considered tire emissions and not any other emissions, including GHGs. And the article is refuted by the researcher himself: "They conflate and blur and obfuscate and play fast and loose with the definitions. And that's completely wrong."

Understanding manufacturing phase emissions

Because of the emissions from battery manufacturing, electric vehicles start their life with an "emissions debt" compared with ICEVs. The emissions from battery production, which are about 25% of a BEV's life-cycle emissions today, arise from the mining and processing of battery minerals such as lithium, nickel, and cobalt, and the manufacturing of other battery components. At the end of the manufacturing phase of the same 2024 SUVs analyzed above, BEVs were associated with slightly more than 12 tonnes of CO_2e (including battery manufacturing) and ICEVs about 8 tonnes of CO_2e. However, as BEVs have zero tailpipe emissions when they operate, this debt is typically offset within 1–2 years of driving and then the gap widens more and more in later years, as shown in Figure 2.

Figure 2. Estimated tonnes of CO_2e emissions from three 2024 vehicle types

Source: Based on analysis in O'Malley and Slowik (2024)

Operation phase emissions: BEVs are without peer

To get a sense of just how much greener BEVs are, it's important to understand that BEVs are also more energy efficient than ICEVs. They convert a greater share of energy into wheels and motion and BEVs require only about one-fourth (or less) the energy needed to power a comparable ICEV. Meanwhile, the gasoline needed to power ICEVs requires continuous extraction and refining of fossil fuels for as long as the vehicles remain on the road. As I mentioned above, **ICEV tailpipe**

emissions alone can exceed the full life-cycle emissions of a BEV. By the end of the typical operation phase of a 2024 SUV, we estimated that BEVs have emitted about 130 g CO_2e/mile and ICEVs have emitted more than 450 g CO_2e/mile.

As electric grids continue to shift toward cleaner, renewable sources of energy, the emissions benefits of the electric vehicles already on the road will become even more pronounced. Moreover, while the environmental impact of BEVs can be further reduced by recycling their mineral content, deploying new battery chemistries, and extending battery lifetime, similar improvements are not expected from fossil fuels.

Recycling plays a critical role in reducing the need for new mining because it recovers battery materials and cuts down on emissions associated with producing a new battery. Each electric vehicle requires only a relatively small quantity of battery minerals over its entire lifetime. In the United States, we estimate that the operational and announced recycling capacity should be sufficient to process end-of-life batteries from BEVs and PHEVs up until 2044. At the same time, advances in battery chemistry are helping to reduce dependence on battery materials. Battery lifetimes can also be extended through reuse and repurposing.

It's just no contest. When you look at the complete picture—including production and operation—BEVs already produce about 70% fewer emissions than gasoline cars. That is a three-fold advantage of BEVs over ICEVs and it will grow to four-fold or more in the future as the grid gets cleaner and battery technologies and recycling operations improve. Quite simply, BEVs are a significantly greener transportation option than gasoline cars now and in the long term.

AUTHOR



Anh Bui

Researcher

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RESEARCH BRIEF

JULY 2024

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Life-cycle greenhouse gas emissions of U.S. sedans and SUVs with different powertrains and fuel sources

Jane O'Malley and Peter Slowik

The ability of battery electric vehicles (BEVs) to greatly reduce energy consumption and emissions is among the factors driving widespread government interest in them in the United States and globally. While these vehicles emit no pollution during operation, a detailed assessment of their life-cycle emissions is critical for understanding their net greenhouse gas (GHG) advantages relative to other technologies. This brief updates a 2021 analysis by the International Council on Clean Transportation (ICCT) that estimated the life-cycle emissions of passenger vehicles, including sedans and sport utility vehicles (SUVs), in major global vehicle markets.[1] In this brief, we focus on the United States and expand the analysis to include "strong" hybrid electric vehicles that can temporarily power a vehicle without the engine; these have increased to more than 5% of new light-duty vehicle sales in the United States since 2021.[2] This work considers model year 2024 vehicles and projected model year 2030 vehicles.

The earlier ICCT study found that the life-cycle GHG emissions of average battery electric mid-size cars sold in the United States in 2021 were 57%–68% lower than

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1 Georg Bieker, *A Global Comparison of the Life-Cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars* (International Council on Clean Transportation, 2021), https://theicct.org/publication/a-global-comparison-of-the-life-cycle-greenhouse-gas-emissions-of-combustion-engine-and-electric-passenger-cars/.



Life-cycle greenhouse gas emissions of U.S. sedans and SUVs with different powertrains and fuel sources

This brief updates a 2021 ICCT analysis and estimates the life-cycle emissions of four common passenger vehicle powertrains in the United States: internal combustion engine (ICE) vehicles, hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and BEVs. It considers average model year 2024 vehicles and projected model year 2030 vehicles.

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A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars

July 20, 2021

REC-R404.5-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Requires one- and two-family dwellings and townhouses with designated parking to be provided with a minimum of one EV space, EV capable space or EV ready space; and R-2 occupancies with one space for 40 percent of the dwelling units or automobile parking spaces, whichever is less.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second and third Energy Sub-Workgroup meetings on September 29, 2025, and November 14, 2025, respectively.

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- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith

- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

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- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

Florin Moldovan (DHCD staff) announced that the two similar proposals—REC-R404.5-24 from **Bill Penniman** and REC-R404.5(1)-24 from **Joseph Wages**—would be discussed together. **Bill P** then provided an overview of the proposals.

- **Ross S** shared research on the differences between 110V and 220V charging noting a 10% loss when charging on 220V compared to 15-17% on 110V, with the reason being the length of time it takes to charge on 110V.
- **Florin M** shares on the screen proposed new Section 404.5.2.4, which addresses the charging capacity for these installations and requires a 30amp or 208/240V circuit.
    - **Ross S** confirms that the Section shared by **Florin M** on the screen answers his question.
- **Kyle K** asked whether the requirement applies to onsite private parking in multi-family developments and if 50% of those spaces would need to be EV ready.
    - **Bill P** confirmed that was the intent.
- **Kyle K** asked if, in a multi-bay residential garage, only one bay would need to be equipped with EV charging readiness.
    - **Bill P** confirmed that was the intent.
- **Corian C** noted that the NEC is working on EV charging standards for future code editions and stated that IAEI does not support this proposal in its current form. **Kyle K** asked if **Corian C**

had a copy of the proposed NEC language and **Corian C** indicated that proposed NEC language is not yet available.

- **Ron C** raised concerns that the proposal may be outside the statutory scope of the building code and stressed that cost impact statements should include actual, concrete compliance costs.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Bill P provided an overview of the proposal which introduces new definitions and requirements for electrical vehicle charging spaces and equipment near new residential developments. The original proposal has been modified by adding language to the exceptions.

Dennis H brought up that newly added Exception 4 to proposed new Section R404.5.2.4, is adding UL 2202 and UL 2594. These appear to be new standards as they are not referenced in the commercial or residential provisions of the 2021 code. Typically, new standards are

submitted with proposals so that they can be vetted by the stakeholders and ensure that they do not contain non-enforceable language.

Bill P commented that he did not have copies of UL2202 and UL2594 to share and would remove the standards from the exception if he could not get access to them and that was a concern.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Sydney Roberts, SEEA; and Joseph Wages, National Electrical Manufacturers Association (NEMA).

Opposition: Steve Shapiro, AOBA and VAMA; Rick Hinson, American Council of Engineering Companies (ACEC); Cory Carney, IAEI-Virginia Chapter; Tread Willis, Prince William County and IAEI - Virginia Chapter; and Andrew Clark, HBAV.

Discussion:

Bob S provided an overview of the proposal.

a. **Sydney R** mentioned that several municipalities are starting to incorporate this into their local ordinances, so it makes sense to have a statewide code for consistency.
b. **Steve S** reminded the group that the codes are supposed to be the minimum codes to protect health, safety, and welfare and now we are going to tell everybody they must supply electric vehicle spaces and equipment. **Steve S** also added that electric vehicle language is in Appendix RE, and the whole purpose of the appendices is for people to adopt them if they want and not make the appendices part of the code.

DHCD Staff Notes:

1. The VECC companion proposal EC-C405.17(1)-24 was also reviewed by stakeholders at the second and third Sub-Workgroup meetings, and the third GSW, on January 5, 2026, where it received a Non-Consensus recommendation.
2. This proposal is substantially identical to proposal REC-R404.5(1)-24, which was reviewed by stakeholders at the second GSW on October 3, 2025, and received a Non-Consensus recommendation. The excerpt from the October 3, 2025, meeting summary pertaining to proposal REC-R404.5(1)-24 is provided below.

October 3, 2025, GSW Meeting Summary Excerpt

Support: Bill Penniman, Sierra Club – Virginia Chapter.

Opposition: Steve Shapiro, AOBA and VAMA; Ron Clements, Chesterfield County and VBCOA Admin and Existing Building Code Committees; Andrew Clark, HBAV; Mike O'Connor, VPCMA and VAPGA; Andrew Milliken, Stafford County Fire Marshal's Office, Virginia Fire Services Board (VFSB) Codes and Standards Committee; Shahriar Amiri, Arlington County.

Discussion:

I. **Brian Holland** (NEMA) provided an overview of the proposal on behalf of the proponent.
   a. **Steve S** opposed, stating it goes beyond the "minimum code" and should be in appendices.
   b. **Ron C** opposed, questioning if it's within the state code's scope and citing an inadequate cost impact statement.
   c. **Andrew C** strongly opposed, citing unstudied impacts on utilities, land planning, and development costs.
   d. **Mike O'** opposed, noting federal EV tax incentives have been repealed.
   e. **Andrew M** opposed, raising safety concerns for parking garages, particularly with regard to ventilation and adequate sprinkler systems.
   f. **Shahriar A** opposed, noting safety concerns about EV fires and fumes.

II. **Brian H** responded to opposition by stating that other states have successfully implemented similar requirements and that guidance exists to avoid the raised concerns. **Brian** further moved to have companion proposal REC-R404.5(1)-24 go forward as non-consensus, as it deals with the same topics but on the residential side.

REC-R404.5(1)-24

VECC: R404.5 (New), R404.5.1 (New), R404.5.2 (New), R404.5.3 (New), R404.5.4 (New), R404.5.5 (New)

Proponents: Joseph Wages, representing National Electrical Manufacturers Association (NEMA) (joseph.wages@nema.org)

2021 Virginia Energy Code

Add new text as follows:

R404.5 Electric Vehicle Power Transfer Infrastructure. Residential automobile parking spaces for residential buildings shall be provided with electric vehicle power transfer infrastructure in accordance with Sections R404.5.1 through R404.5.5

R404.5.1 Quantity. One- and two-family dwellings and townhouses with a designated attached or detached garage or other onsite private parking provided adjacent to the dwelling unit shall be provided with one EV-capable, EV-ready, or EVSE space per dwelling unit. R-2 occupancies or allocated parking for R-2 occupancies in mixed-use buildings shall be provided with an EV capable space, EV ready space, or EVSE space for 40 percent of dwelling units or automobile parking spaces, whichever is less.

R404.5.2 EV Capable Spaces. Each EV capable space used to meet the requirements of Section R404.5.1 shall comply with all of the following:

- 1.A continuous raceway or cable assembly shall be installed between a suitable panelboard or other onsite electrical distribution equipment and an enclosure or outlet located within 6 feet (1828mm) of the EV capable space.
- 2.Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with Section R404.5.5.
- 3.The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
- 4.The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."

R404.5.3 EV Ready Spaces. Each branch circuit serving EV ready spaces shall comply with all of the following:

- 1.Terminate at an outlet or enclosure, located within 6 feet (1828 mm) of each EV ready space it serves and marked "For electric vehicle supply equipment (EVSE)".
- 2.Be served by an electrical distribution system and circuit capacity in accordance with Section R404.5.5.
- 3.Be designated on the panelboard or other electrical distribution equipment directory as "For electric vehicle supply equipment (EVSE)."

R404.5.4 EVSE spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE serving either a single EVSE space or multiple EVSE spaces shall comply with the following:

- 1.Be served by an electrical distribution system in accordance with Section R404.5.5
- 2.Have a nameplate charging capacity of not less than 6.2 kVA (or 30A at 208/240V) per EVSE space served. Where an EVSE serves three or more EVSE spaces and is controlled by an energy management system in accordance with Section R404.5.5, the nameplate charging capacity shall be not less than 2.1 kVA per EVSE space served.
- 3.Be located within 6 feet (1828 mm) of each EVSE space it serves.
- 4.Be installed in accordance with NFPA 70 and be listed and labeled in accordance with UL 2202 or UL 2594.

R404.5.5 Electrical distribution system capacity.. The branch circuits and electrical distribution system used to comply with Section R404.7.1 shall comply with one of the following:

- 1.Sized for a calculated EV charging load of not less than 7.2 kVA per EVSE, EV ready, or EV capable space. Where a circuit is

shared or managed it shall be in accordance with NFPA 70.

- 2.The capacity of the electrical distribution system and each branch circuit serving multiple EVSE spaces, EV ready spaces, or EV capable spaces designed to be controlled by an energy management system in accordance with NFPA 70, shall be sized for a calculated EV charging load of not less than 2.1 kVA per space. Where an energy management system is used to control EV charging loads for the purposes of this section, it shall not be configured to turn off electrical power to EVSE or EV ready spaces used to comply with Section R404.5.1.

Reason Statement: This proposal adds a new section covering Electric Vehicle Power Transfer Infrastructure as a mandatory requirement in Chapter 4 similar to Appendix RE in the 2024 IECC. These requirements were approved by the ICC appointed residential energy code consensus committee by a two-thirds majority vote during the 2024 IECC development cycle. Adding EV ready requirements to the 2024 VECC-R ensures new residential parking facilities have the electrical infrastructure necessary for the installation of EV charging equipment at time of construction or any time in the future. This will provide a significant cost and labor savings.

Cost Impact: The code change proposal will increase the cost The code change proposal will increase the cost of premises-wiring systems and parking facilities for residential projects. However, the initial cost of EV ready infrastructure is considerably less expensive compared to retrofitting and altering the electrical system and parking facility in the future. The actual cost associated with this proposal is heavily dependent on the scale and scope of the residential project.

It should be noted NEMA proposals are developed by a member consensus process where both our bylaws and federal regulations prohibit us from discussing prices, costs, and other financial details of electrical products.

Public Comments (PCH) for: REC-R404.5(1)-24

Discussion by Mal Skowron

Oct 2, 2025 23:43 UTC

Tesla supports this proposal to increase EV readiness for residential buildings. This language is consistent with Section R404.7 of the 2024 IECC-residential (IECC-R) code, which requires that new one- and two-family dwellings and townhouses with designated parking provide one EV capable, EV ready, or EVSE space per dwelling unit. Multifamily buildings with three stories or less must provide an EV capable space, EV ready space, or EVSE space for 40 percent of dwelling units or automobile parking spaces, whichever is less. These requirements give building owners flexibility in establishing the level of EV readiness that will fit their current and future needs, while still providing the necessary minimum EV charging load that the distribution system needs to be sized for.

EV readiness at residential properties is a significant opportunity for cost avoidance, especially for residents of multifamily buildings. Apartment dwellers often face the highest barriers to installing charging infrastructure retroactively in existing buildings. Residential EV readiness requirements will address the availability of charging infrastructure at least cost to residents, homeowners, and building managers. Even in single-family homes, the cost of installing electrical infrastructure with simple 240-volt service in a garage after construction can exceed thousands of dollars, costs which are easily avoidable if capacity is made available during construction.

Moreover, the language in Section R404.7 was developed as a consensus proposal with input from a diverse group of stakeholders including representatives from the home builders, electrical manufacturers, EV charging providers, and utilities. It went through several rounds of public comment and editorial changes to ensure clarity, consistency, enforceability, and technical soundness. It is worth noting that the appeals process moved Section R404.7 to the appendix of the 2024 IECC against the recommendation of the IECC consensus committee.

REC-R404.5(1)-24 – Staff Summary

Proponent: Joseph Wages, representing National Electrical Manufacturers Association (NEMA)

Brief Description: Requires one- and two-family dwellings and townhouses with designated parking to be provided with a minimum of one EV space, EV capable space or EV ready space; and R-2 occupancies with one space for 40 percent of the dwelling units or automobile parking spaces, whichever is less.

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- **Kyle K** asked if, in a multi-bay residential garage, only one bay would need to be equipped with EV charging readiness.
    - **Bill P** confirmed that was the intent.
- **Corian C** noted that the NEC is working on EV charging standards for future code editions and stated that IAEI does not support this proposal in its current form. **Kyle K** asked if **Corian C**

had a copy of the proposed NEC language and **Corian C** indicated that proposed NEC language is not yet available.

- **Ron C** raised concerns that the proposal may be outside the statutory scope of the building code and stressed that cost impact statements should include actual, concrete compliance costs.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Second GSW Meeting — 10/03/2025

Support: Bill Penniman, Sierra Club – Virginia Chapter.

Opposition: Steve Shapiro, AOBA and VAMA; Ron Clements, Chesterfield County and VBCOA Admin and Existing Building Code Committees; Andrew Clark, HBAV; Mike O'Connor, VPCMA and VAPGA; Andrew Milliken, Stafford County Fire Marshal's Office, Virginia Fire Services Board (VFSB) Codes and Standards Committee; Shahriar Amiri, Arlington County.

Discussion:

I. **Brian H** provided an overview of the proposal on behalf of the proponent.
   a. **Steve S** opposed, stating it goes beyond the "minimum code" and should be in appendices.
   b. **Ron C** opposed, questioning if it's within the state code's scope and citing an inadequate cost impact statement.
   c. **Andrew C** strongly opposed, citing unstudied impacts on utilities, land planning, and development costs.
   d. **Mike O'** opposed, noting federal EV tax incentives have been repealed.
   e. **Andrew M** opposed, raising safety concerns for parking garages, particularly with regard to ventilation and adequate sprinkler systems.
   f. **Shahriar A** opposed, noting safety concerns about EV fires and fumes.

II. **Brian H** responded to opposition by stating that other states have successfully implemented similar requirements and that guidance exists to avoid the raised concerns. **Brian** further moved to have companion proposal REC-R404.5(1)-24 go forward as non-consensus, as it deals with the same topics but on the residential side.

DHCD Staff Notes:

1. The VECC companion proposal EC-C405.17-24 was also reviewed by stakeholders at the second Sub-Workgroup meeting, and at the second GSW, on October 3, 2025, where it received a Non-Consensus recommendation.
2. This proposal is substantially identical to proposal REC-R404.5-24, which was reviewed by stakeholders at the third GSW on January 5, 2026, and received a Non-Consensus recommendation. The excerpt from the January 5, 2026, meeting summary pertaining to proposal REC-R404.5-24 is provided below.

January 5, 2026, GSW Meeting Summary Excerpt

Support: Sydney Roberts, SEEA; and Joseph Wages, National Electrical Manufacturers Association (NEMA).

Opposition: Steve Shapiro, AOBA and VAMA; Rick Hinson, American Council of Engineering Companies (ACEC); Cory Carney, IAEI-Virginia Chapter; Tread Willis, Prince William County and IAEI - Virginia Chapter; and Andrew Clark, HBAV.

Discussion:

Bob S provided an overview of the proposal.

a. **Sydney R** mentioned that several municipalities are starting to incorporate this into their local ordinances, so it makes sense to have a statewide code for consistency.
b. **Steve S** reminded the group that the codes are supposed to be the minimum codes to protect health, safety, and welfare and now we are going to tell everybody they must supply electric vehicle spaces and equipment. **Steve S** also added that electric vehicle language is in Appendix RE, and the whole purpose of the appendices is for people to adopt them if they want and not make the appendices part of the code.

REC-R404.6-24

IECC: R404.6 (N1104.6) (New), R404.6.1 (N1104.6.1) (New), R404.6.2 (N1104.6.2) (New), R404.6.3 (N1104.6.3) (New), R404.6.4 (N1104.6.4) (New), R404.6.5 (N1104.6.5) (New), R404.6.6 (N1104.6.6) (New), R404.6.7 (N1104.6.7) (New), R404.6.8 (N1104.6.8) (New), R404.6.9 (N1104.6.9) (New)

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2024 International Energy Conservation Code [RE Project]

Add new text as follows:

R404.6 (N1104.6) Solar Ready Provisions - Detached One- and Two Story-Dwellings and Townhouses.

R404.6.1 (N1104.6.1) General. New detached one- and two-family dwellings, and townhouses with not less than 600 square feet (55.74 m2) of roof area oriented between 110 degrees and 270 degrees of true north shall comply with Sections R404.6.2 (N1104.6.2) through R404.6.9 (N1104.6.9).

Exceptions:

1. New residential buildings with a permanently installed on-site renewable energy system.

2. A building where all areas of the roof that would otherwise meet the requirements of this Section and Section R404.6.3 (N1104.6.3) are in full or partial shade for more than 70 percent of daylight hours annually.

R404.6.2 (N1104.6.2) General Definitions. -
SOLAR-READY ZONE. A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.

R404.6.3 (N1104.6.3) Solar-ready zone area. The total solar-ready zone area shall be not less than 300 square feet (27.87 m2) exclusive of mandatory access or setback areas as required by the International Fire Code. New townhouses three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 square feet (185.8 m2) per dwelling shall have a solar-ready zone area of not less than 150 square feet (13.94 m2). The solar-ready zone shall be composed of areas not less than 5 feet (1524 mm) in width and not less than 80 square feet (7.44 m2) exclusive of access or setback areas as required by the International Fire Code.

R404.6.4 (N1104.6.4) Obstructions. Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof mounted equipment.

R404.6.5 (N1104.6.5) Shading. The solar-ready zone shall be set back from any existing or new permanently affixed object on the building or site that is located south, east or west of the solar zone a distance not less than two times the object's height above the nearest point on the roof surface. Such objects include, but are not limited to, taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees and roof plantings.

R404.6.6 (N1104.6.6) Capped roof penetration sleeve. A capped roof penetration sleeve shall be provided adjacent to a solar-ready zone located on a roof slope of not greater than 1 unit vertical in 12 units horizontal (8 percent slope). The capped roof penetration sleeve shall be sized to accommodate the installed or future photovoltaic system conduit, but shall have an inside diameter of not less than 11/4 inches (32 mm).

R404.6.7 (N1104.6.7) Construction document requirements. Construction documents shall clearly indicate

1.the solar-ready zone;

2.the structural design loads for roof dead load and roof live load;

3.pathways for routing of conduit or plumbing from the solar-ready zone to the electrical service panel or service hot water system.

R404.6.8 (N1104.6.8) Electrical service reserved space. The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled “For Future Solar Electric.” The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.

R404.6.9 (N1104.6.9) Construction documentation certificate. A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional.

Reason Statement: This proposal adopts the provisions contained in IECC APPENDIX RB. The provisions of APPENDIX RB have been reorganized for greater clarity, but no substantive changes were made to the appendix. Adoption of this proposed section is needed since IECC appendices are not mandatory unless specifically referenced or otherwise incorporated in a state’s building code. This proposed section is intended to support future potential improvements for detached one- and two-family dwellings and townhouses for solar electric and solar thermal systems. This provision requires a capped roof penetration sleeve in a solar-ready zone area, but does not require:

- The installation of conduit, prewiring or pre-plumbing.
- Any specific physical orientation of a residential building.
- Any increased load capacities for residential roofing systems.

Having important information and documentation available to the building department, solar contractor and homeowner will assist in supporting the accelerated working environment many municipalities have mandated.

This proposed section is intended to identify the areas of a residential building roof, called the solar-ready zone, for potential future installation of renewable energy systems. The ability to plan for possible future solar equipment starts with documenting necessary solar-ready zone information on the plans, some of which may already be required in permit construction documents. This proposal also requires the builder to post specific information about the home for use by the homeowner.

This definition clarifies the term “solar-ready zone” as an area of the roof or building where photovoltaic or thermal may be installed in the future.

The proposal does not apply to low-rise residential with more than two units or dwellings less than 600 square feet of roof area. For solar equipment to be effective, it must be adequately oriented to the sun. This section clarifies that the appendix only applies to roof area oriented between 110 degrees and 270 degrees of true north. Note that this is the orientation for the northern hemisphere; if the appendix were applied in the southern hemisphere, the equipment would need to be on a roof oriented between 110 degrees and 270 degrees of true south.

Exceptions are provided for buildings that already have permanently installed systems or are too shaded for the equipment to be viable.

To be solar-ready requires that the existing structure is capable of providing the required support for the future installation of a solar system. The benefit of the solar-ready provisions is to avoid the potential exponential costs of having to structurally retrofit a building for a future solar installation. Therefore, the design criteria provided within the construction documents for the proposed structure must indicate the structure is designed and will be built to the loading conditions necessary for a future solar installation.

This section establishes minimum dimensions and square footage for the solar-ready zones while balancing the need for a minimum area of solar access, fire safety and roof area.

For photovoltaics or thermal storage to be effective, unobstructed sun is important. This section simply clarifies that the solar access zone must not be located in an area where other rooftop obstructions will shade the equipment.

This section provides clarification for the term “shade” as used in Section RB103.1, Exception 2. The section also specifies how far the designated solar-ready zone should be set back from permanently affixed objects.

As with other readiness requirements, the installation of roof penetration elements during initial construction is more cost effective than

retrofitting existing construction. Due to other considerations, for roofs with a pitch over one unit vertical in 12 units horizontal this section is not applicable.

Planning ahead for electrical connections avoids retrofitting to accommodate the equipment. This section identifies the routing pathways for electrical and plumbing connections.

This section specifies the requirements for labeling on the electrical service panel, ensuring adequate capacity for a dualpole circuit breaker.

The certificate requirements complement those of Chapter 4 (see commentary, Section R401.3). The required certificate provides easy-to-reference information to building owners and contractors for future installation of solar equipment. The builder or other approved party must complete the certificate and place it in an approved location in the building, preferably near the electrical box. The permanent certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels.

The documentation of solar-ready zones and roof load calculations (already performed during the design phase) will assist building departments as well as any future solar contractors seeking to install renewable energy systems on a roof. The builder/designer is knowledgeable on the intricacies of each model and plan and can easily identify unobstructed roof areas as well as spaces where conduit, wiring and plumbing can be routed from the roof to the respective utility areas. This will save building departments and solar designers time and effort when installing future solar systems. If a homeowner wishes to install a solar energy system later, this documentation can save thousands of dollars in labor, installation, design and integration of the solar system into the house or townhouse.

Cost Impact: The code change proposal will not increase or decrease the cost

Like the IECC Appendix RB whose terms it incorporates, this proposed section does not require any specific construction cost changes, except the minimal cost of a roof-penetration sleeve which could be offset by simplification of the roof design. It mainly defines and requires documents describing areas of solar readiness and future pathways to connect to the electrical service panel.

REC-R404.6-24 – Staff Summary

Proponent: Bill Penniman, representing Sierra Club Virginia Chapter

Brief Description: Incorporates the non-mandatory 2024 IECC Appendix NB (RB) Solar-Ready Provisions—Detached One- and Two-Family Dwellings and Townhouses, making the provisions mandatory in Virginia.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second Energy Sub-Workgroup meeting on September 29, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith

- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

- **Steve S** noted that there is a reason these solar panel provisions are included in the appendix. They are optional because they are above code requirements. AOBA is in opposition. Further, these provisions are in the appendix to provide guidance to those who choose to have these systems installed.

    - **Bill P** states that since most houses are built as projects, the choice won't be available unless they are a retrofit.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Second GSW Meeting — 10/03/2025

Support: Brian Holland, NEMA.

Opposition: Tread Willis, Prince William County and IAEI - Virginia Chapter; Mark Graver, representing self; Matthew Robinson, representing self; and David Beahm, Warren County and VBCOA.

Discussion:

Bill P provided an overview of the proposal.

a. **Andrew C** asked for clarification about Section 404.6.5, specifically what is meant by a "permanently affixed object on site."

    i. **Bill P** responded that the intent is for the reserved area to be free from obstructions like chimneys or anything that would shade the area where solar panels are to be installed.

b. **Andrew C** asked if the provision would require developers to cut down trees that shade the roof or otherwise "obstruct" solar readiness.
    i. **Bill P** clarified that the proposal would not require trees to be cut down and expressed willingness to further modify the language to clarify intent.

c. **Andrew C** voiced opposition: As written, the proposal could impose additional upfront costs on homeowners for a feature they may never use, while future owners could easily add solar readiness features during resale if desired. He does not see the benefit in mandating this for every home and believes it should be left to the homeowner's discretion.
    i. **Bill P** responded that if no roof area is reserved for solar panels at construction, the option for future homeowners to install solar is lost, emphasizing the importance of thinking ahead for future needs.

d. **Brian H** strongly supported the proposal, arguing that over the next decade, three systems - onsite renewable energy, energy storage, and electrified transportation - will become as fundamental in homes as circuits and branch feeders. Urged the group to be forward-looking and anticipate future trends in code development.

e. **Tread W** felt the provisions should remain in the appendix as an option rather than being mandatory.

f. **Mark G** representing himself, believes solar readiness is best left to the free market. Noted some owners may simply not want roof-mounted systems due to concerns (e.g., fear of roof leaks).

g. **Matthew R** representing himself, opposed, arguing that the proposal would create more requirements at plan review and inspection, possibly incurring costs that may not provide real benefit in the long run.

h. **David B** opposed for the reasons already mentioned by other opponents.

DHCD Staff Note: N/A

REC-R404.7-24

IECC: R404.7 (N1104.7) (New), R404.7.1 (N1104.7.1) (New), R404.7.2 (N1104.7.2) (New), R404.7.3 (N1104.7.3) (New), R404.7.4 (N1104.7.4) (New)

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2024 International Energy Conservation Code [RE Project]

Add new text as follows:

R404.7 (N1104.7) Electric Readiness. Water heaters, household clothes dryers and cooking appliances that use fuel gas or liquid fuel shall comply with Sections R404.7.1 through R404.7.4.

R404.7.1 (N1104.7.1) Cooking appliances. A dedicated branch circuit outlet with a rating not less than 240 volts and not less than 40 amperes shall be installed and terminate within 3 feet (914 mm) of conventional cooking tops, conventional ovens or cooking appliances combining both.

Exception: Cooking appliances not installed in an individual dwelling unit.

R404.7.2 (N1104.7.2) Household clothes dryers. A dedicated branch circuit with a rating not less than 240 volts and not less than 30 amperes shall be installed and terminate within 3 feet (914 mm) of each household clothes dryer.

Exception: Clothes dryers not installed in an individual dwelling unit.

R404.7.3 (N1104.7.3) Water heaters. A dedicated branch circuit with a rating either not less than 240 volts and not less than 30 amperes, or not less than 120 volts and not less than 20 amperes, shall be installed and terminate within 3 feet (914 mm) of each water heater.

Exception: Water heaters serving multiple dwelling units in a R-2 occupancy.

R404.7.4 (N1104.7.4) Electrification-ready circuits. The unused conductors required by Sections R404.7.1 through R404.7.3 shall be labeled with the word “spare.” Space shall be reserved in the electrical panel in which the branch circuit originates for the installation of an overcurrent device. Capacity for the circuits required by Sections R404.7.1 through R404.7.3shall be included in the load calculations of the original installation.

Reason Statement: This section incorporates into Virginia’s code the text of Appendix RK in the 2024 IECC. It was originally agreed upon by participants as part of a package of measures for inclusion in the 2024 IECC but was shifted to an appendix on appeal.

Adoption of the proposed language would enhance customer choices by making it easy for homeowners to choose either electric or gas appliances and water heating equipment. It is a low-cost measure to improve residents’ health and safety by reducing a much larger cost barrier of requiring retrofitting new branch circuits into a dwelling after walls have been enclosed and initial construction has been completed. In addition to the health and safety benefits from shifting to electricity discussed below, large amounts of energy can be saved, particularly by replacing combustion appliances with far more efficient electric-heat-pump water heaters and dryers and with induction cook tops. Availability of these options is growing, and consumer awareness will grow more in the future.

By helping insulate customers from potential high retrofit costs from gas to electric appliances, this “readiness” requirement also recognizes residents’ and the public’s long-term interest in shifting to electric appliances in order to reduce air pollution both indoors and outdoors and to reduce climate risks from CO2 and methane emissions. Virginia’s building code already recognizes the dangers of indoor carbon-monoxide air pollution from gas appliances and thus requires CO monitors be installed and interconnected in dwellings with fuel burning appliances. (See N311.2 and N311.3.)

Indoor air pollution from gas-fired appliances has been increasingly recognized as a health and safety hazard for residents, as well as for

the public. In addition to fire hazards, onsite fuel combustion also poses dangers from indoor air pollution from leakage of methane (CH4), as well as combustion byproducts, such as CO and CO2. See, e.g., https://rmi.org/insight/gasstoves-pollution-health Gas stoves are a particularly large source of indoor air pollution. https://rmi.org/insight/gas-stoves-pollution-health .

Electrification of appliances is one critical component of decarbonization strategies to reduce climate-pollution, especially CO2 and methane that result from producing, transmitting and combusting fossil fuels. Reducing CO2 and methane is essential to stabilizing and eventually reducing global warming. See, e.g., https://www.vox.com/2016/9/19/12938086/electrify-everything; https://rmi.org/eight-benefits-of-building-electrification-for-households-communities-and-climate/ ; https://www.rff.org/publications/explainers/electrification-101/ . While CO2 has gotten greater attention, methane is a much more powerful greenhouse gas than carbon dioxide per unit emitted--approximately 86 times more potent than carbon dioxide as a heat-trapping gas, over 20 years. UCS, *The Natural Gas Gamble: A Risky Bet on America's Clean Energy Future* (March 2015). Substituting electric energy for on-site combustion is a necessary step to mitigating harms from climate change and meeting internationally recognized goals. Electricity is much cleaner and will become more so as Virginia utilities move toward zero-carbon renewable energy.

Increasingly, customers are concerned about health and climate impacts from fossil fuel combustion, in addition to energy efficiency and bills. Harmful indoor fumes that they may have ignored initially are getting greater attention. As a result, they may want to transition from fossil fuels to electric appliances to take advantage of the climate and efficiency benefits.

Cost Impact: The code change proposal will increase the cost

The proposal will modestly raise costs by requiring installation of branch circuits from the electrical panel to the vicinity of certain combustion driven appliances if such appliances are installed. The precise costs would depend on the appliances installed and their location. During construction, the additional line for future use could easily be installed along with the basic conductor going to the appliance resulting in little cost beyond the future conductors themselves. The cost impact would be much less than if the wiring were to be added in a retrofit after walls are closed and construction is completed.

Residents switching to newer, more efficient electric appliances will save money as well as energy. They can also save money by not having to replace CO alarms as the initial ones wear out. The cost, health, safety and environmental benefits from facilitating future appliance changes outweigh the modest initial costs.

Why a diverse mix of energy sources helps reliability and affordability. >>

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fits of Building ion for Households, Communities, and Climate

March 29, 2021

By Sherri Billimoria, Mina Lee

Buildings account for **28 percent** of the

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more than half of American homes rely on gas or other fossil fuels as their primary heating or cooking fuel, which produces carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x), methane, and many other harmful compounds.

Building electrification is the movement to shift away from fossil fuels—like gas—toward clean electricity for heating and cooking. All-electric homes deliver climate, health, and economic benefits to Americans and are a crucial component of the clean energy future that should not be overlooked.

Below are eight facts about building electrification that can help move cities, states, and the country away from burning fossil fuels in buildings:

1. Building Electrification Is a Key Part of the Solution for Climate Change and Reducing Emissions

Seventy million American homes and businesses burn gas, oil, and propane for heating space and water and cooking food, generating 600 million tons of CO_2

1550 Embodied Carbon Standard

From Roadmap to Reality: A New Interactive Hub for Tracking Global Progress on Carbon Dioxide Removal

Why Communities Can and Must Consider Electricity Affordability and Risk Together

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Building Electrification

Buildings

Carbon

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of climate change and for US states and cities to meet their "deep decarbonization" climate goals, we must eliminate carbon pollution from gas furnaces, water heaters, and other fossil fuel-powered appliances in homes. Electrification is the only established way to accomplish this.

2. Building Electrification Creates Healthy Homes and Living Environments

More than half of all US households have gas appliances, which emit a wide range of air pollutants. As a result, the air indoors—where people spend nearly 90 percent of their time—is often **more polluted** than outdoor air. In fact, homes with gas stoves have nitrogen dioxide (NO_2) concentrations that are 50 percent to over 400 percent higher than in homes with electric stoves.

Additional pollutants such as CO, particulate matter, and formaldehyde from gas appliances can all cause negative health effects, often exacerbating respiratory conditions like asthma and allergies. Children living in homes with gas stoves are **42 percent**

Climate Finance

Commercial Buildings

e-Lab: Electricity Innovation Lab

Electricity

Energy Efficiency

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South East Asia

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health incidents, like the current COVID-19 pandemic.

3. Building All-Electric Homes Is Less Expensive Than Building Homes with Fossil Fuel Appliances

RMI research has shown that building a new all-electric, single-family home is less expensive than a new mixed-fuel home that relies on gas, regardless of location. This is because mixed-fuel homes have gas furnaces, water heaters, air conditioning, and new gas connections (which carry a median price tag of nearly $9,000). The all-electric home, by comparison, uses a single heat pump system for both heating and cooling, as well as a heat pump water heater. Heat pumps also provide significant carbon and energy savings over gas appliances, resulting in a lower annual utility cost for the all-electric home.

4. Electrifying Buildings Can Create Thousands of Good, Family-Supporting Middle Class Jobs

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double the number of jobs supported by today's energy industry.

A report released by UCLA's Luskin Center for Innovation found that building electrification in California alone will boost employment in the construction, energy, and manufacturing industries, supporting more than **100,000 jobs**—eight times as many jobs as would be lost in the gas sector as it is phased out. The right electrification policies can build a just transition for these gas workers as well. Furthermore, three out of every five jobs required to meet building electrification goals would be in "high-road" sectors, where firms compete on the basis of skill, experience, and qualifications, and where worker pay tends to be higher.

5. Building Electrification Can Be a Transformative, Positive Force for Low-Income Residents and Communities of Color

Air pollution **disproportionately impacts** low-income communities and communities of color. Because buildings contribute to this dangerous air

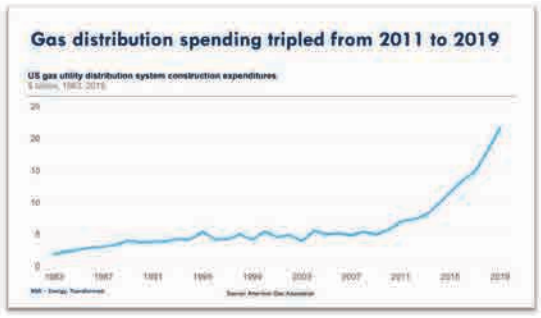
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three times as high as other homes. Equitable building electrification—through programs that offer electric appliances at low or no cost, energy efficiency programs, and building upgrades—can reduce this energy burden.

Building electrification will bring cleaner air, healthier homes, good jobs, and empowered workers. It also expands access to affordable clean energy and energy efficiency to reduce monthly energy bills for pollution-burdened communities—all while helping states meet their climate goals.

6. Gas Infrastructure Costs Are Soaring



While the cost of highly efficient electric

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pay them off over the next 50-plus years—long past the point at which we know we need to have eliminated emissions. It's not only that heat pumps are cheaper—continuing to invest in gas creates a big financial and equity problem down the road. By phasing out gas, states can invest more financial resources into expanding their electricity grid and renewable energy sources, rather than pouring billions into maintaining gas pipelines.

Additionally, many states are rethinking the role of gas in their energy mix—especially gas that is burned on-site for heating and cooling in homes. **Last year**, states representing roughly **a quarter** of the nation's direct gas usage began processes to manage a transition off of their gas systems, and even major utilities and financial institutions have announced that they no longer view gas as a long-term part of the energy mix.

7. Gas Alternatives Are Not Sufficient

"Renewable" natural gas (RNG) usually refers to biomethane that is created

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shows that RNG is likely to remain too limited and costly to decarbonize the buildings sector. It could only replace **3 to 12 percent** of the existing demand for gas and is **4 to 17 times** more expensive than fossil gas. Furthermore, because RNG supplies are limited, the best use of RNG will likely be in hard-to-decarbonize sectors such as industrial processes that cannot be easily electrified.

Other alternatives, like hydrogen or synthetic methane, have also been touted by the gas industry as alternatives for decarbonizing buildings. These technologies face steep cost and infrastructure challenges to scale up, and they would ultimately require more electricity generation to produce than would be needed for an all-electric buildings sector.

8. Building Electrification Is Gaining Momentum across the United States

In less than two years, 40 cities and counties across California have passed local building electrification policies to phase out gas and ensure that new

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Jersey, and California—feature electrification as a key component of their decarbonization plans.

All-electric construction is already the standard in many US states. Nearly **60 percent** of new homes nationwide are built all-electric, and more new homes use heat pumps than any other technology. Moreover, the latest polls show that Americans **strongly support** transitioning the United States to clean sources of energy, and they believe that moving away from natural gas will benefit their communities.

As these facts show, building electrification is the most cost-effective and lowest-risk solution to phase fossil fuels out of buildings. Electrifying homes and businesses eliminates emissions—a crucial step toward a 1.5°C future—and brings an array of additional health and economic benefits. With electrification gaining momentum across the United States and cost-effective, efficient technologies like heat pumps already widely available, the future of all-electric buildings looks increasingly bright.

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RESOURCES *for the* FUTURE

Electrification 101

An overview of how electrification can reduce emissions, from the feasibility of electrifying different technologies to the policy options for encouraging economy-wide electrification.

Date

Dec. 5, 2019
(Updated March 24, 2022)

Authors

Kathryne Cleary

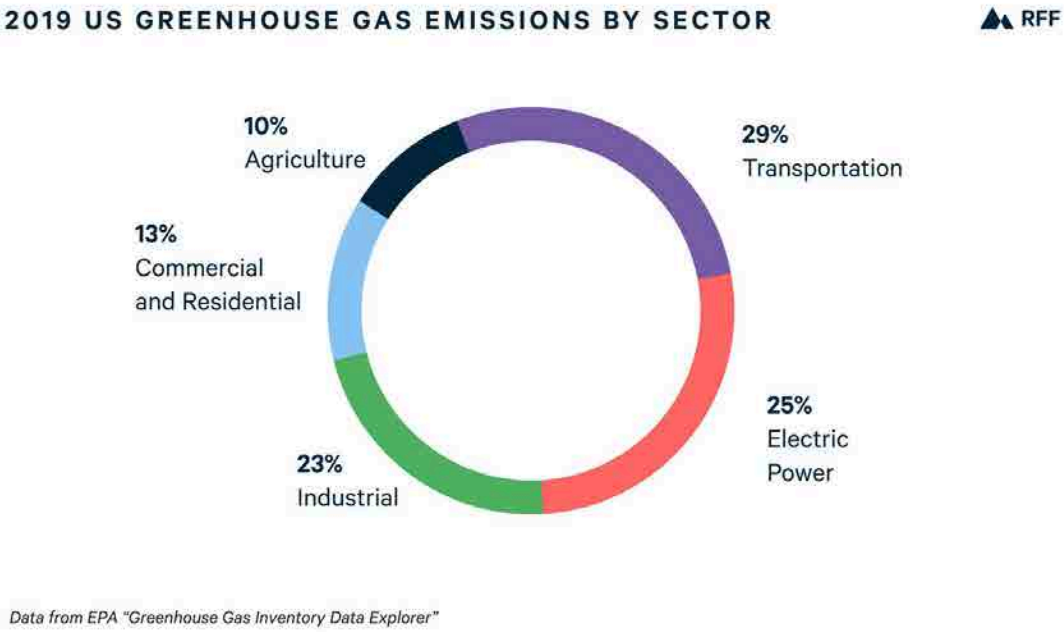
Publication

Explainer

Reading time

8 minutes

Electrification refers to the process of replacing technologies that use fossil fuels (coal, oil, and natural gas) with technologies that use electricity as a source of energy. Depending on the resources used to generate electricity, electrification can potentially reduce carbon dioxide (CO_2) emissions from the transportation, building, and industrial sectors, which account for **65 percent** of all US greenhouse gas emissions. Addressing emissions from these sectors is critical to decarbonizing the economy and, ultimately, mitigating the impacts of climate change. This explainer reviews how electrification can reduce emissions; possibilities and potential challenges of electrification in the transportation, building, and industrial sectors; and policy options for encouraging electrification.



(This webpage contained embedded content here that cannot be printed)

How Can Electrification Reduce Emissions?

In the United States, over **40 percent** of electricity is currently generated using zero-carbon fuels such as nuclear energy and renewables, and 35 percent is generated from natural gas, which emits the **least carbon dioxide** of any fossil fuel when burned. Consequently, technologies that use electricity as a fuel source result in lower carbon dioxide emissions on average than those that use fossil fuels directly. Additionally, the electricity grid is expected to become even cleaner over time as many state policies (such as **Renewable Portfolio Standards**) aim to increase the amount of electricity generated by zero-carbon sources. Therefore, the benefits associated with electrification will likely grow in the future as electricity generation becomes less carbon intensive.

If policymakers seek to decarbonize the transportation, building, and industrial sectors, replacing fossil fuels with electricity may also be one of the only technologically viable options. Several methods are available for decarbonizing the electricity sector, but other sectors have far fewer options available for significantly reducing emissions aside from electrification (read about different options for reducing emissions in each sector **here**). For example, many alternative transportation fuels (such as biodiesel and ethanol) are cleaner than gasoline, but they still emit carbon dioxide and other conventional air pollutants when burned. **Hydrogen**, another alternative fuel, does not produce emissions but is very expensive and requires electricity to make. Transitioning to electric technologies, which emit no emissions at the point of use, would transfer most emissions to the power sector. This would allow policymakers to focus on decarbonizing the electrical grid to reduce emissions, rather than focusing on myriad pathways like vehicle fuel efficiency requirements. Focusing on electrical grid decarbonization may be far more feasible than attempting to decarbonize each sector separately.

Notably, the benefits of electrification today vary depending on the resources used to generate electricity. Within the United States, emissions from electricity generation vary significantly. Some areas have a higher proportion of zero-carbon resources in their electricity generation portfolios and are much cleaner than regions that rely more on fossil fuels like coal. For example, the state of **Washington** relies on hydropower for most electricity generation and stands to benefit greatly from electrification. **Wyoming**, on the other hand, has a resource mix comprised almost entirely of coal with a small amount of renewables and natural gas. Consequently, the benefits from electrification in Wyoming today could be negligible, or even negative for some technologies if generating the electricity to run them creates more emissions than using fossil fuel technologies would. However, these benefits could change in the future as the grid resource mix evolves.

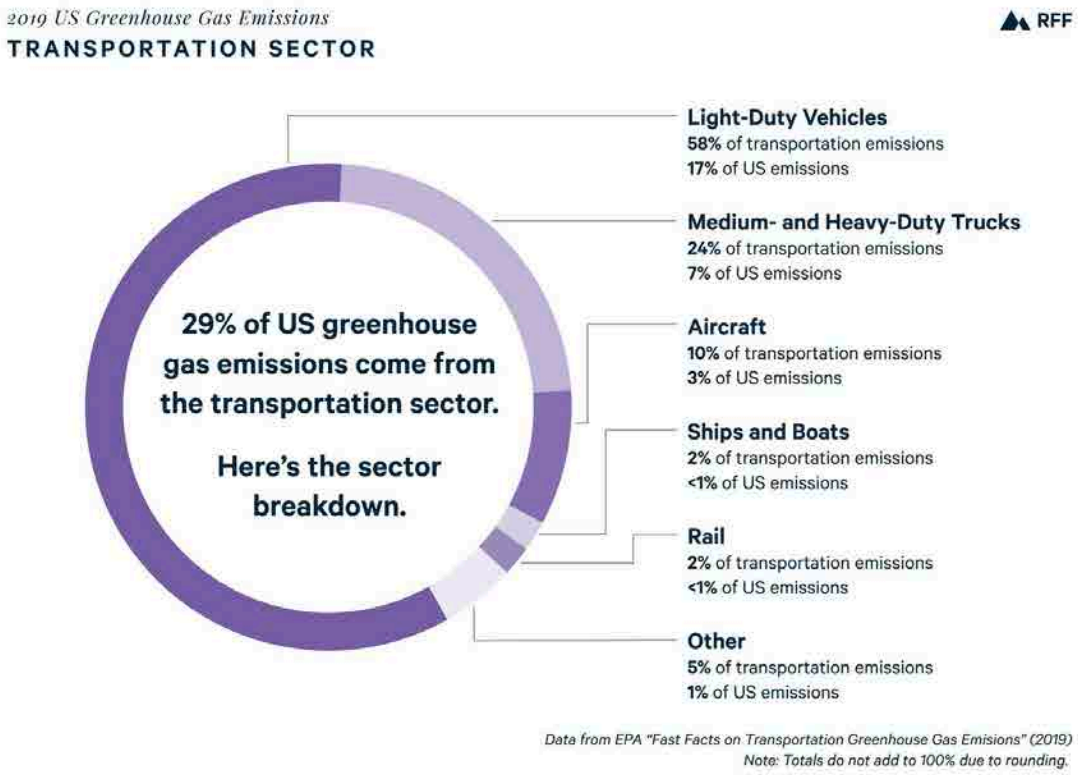
Potential for electrification varies greatly across and within sectors. While some sectors already have commercially ready technologies, others do not and could struggle both technologically and economically to electrify.

Electrification of the Transportation Sector

Overview

The transportation sector accounts for 29 percent of US greenhouse gas **emissions** (2019 data). Within the sector, 58 percent of **emissions** come from light-duty vehicles, 24 percent from medium- and heavy-duty vehicles, and the remainder from aircraft, ships, rail, and other sources. Given the limited electrification potential of aircraft and ships, and the small share of rail in the sector, this section will focus exclusively on electrification of light-, medium-, and heavy-duty vehicles.

For more about federal policy options to reduce transportation emissions, read "**Federal Climate Policy 104: The Transportation Sector**".



Benefits of Electrification

Most light-duty vehicles (like cars, SUVs, and small trucks) run on gasoline while heavy-duty vehicles (like buses or large trucks) typically run on diesel fuel. The Corporate Average Fuel Economy (CAFE) **Standards have required these vehicles to become more fuel-efficient over time, but** substantially reducing emissions from vehicles will ultimately require switching to a cleaner fuel like electricity. In addition to decreasing greenhouse gas emissions, transitioning to electric vehicles can benefit the electric grid and improve air quality.

As noted above, the range of benefits of vehicle electrification heavily depends on the types of fuels used for electricity generation. For example, a car that is charged in Washington state primarily with hydroelectric power will have a lower carbon footprint than a car charged in Wyoming using power from coal plants. However, even with these considerations, driving an electric car **currently produces** fewer carbon dioxide emissions than a typical gasoline car when charged anywhere in the United States. The reason is that in addition to not producing tailpipe emissions, electric vehicles are also more energy-efficient **fuel-efficient** relative to gasoline and diesel vehicles.

Electrification of transportation can also improve air quality. Switching to electric cars and trucks can reduce air pollution where the vehicles are operating, since they do not produce tailpipe emissions. Electrification of municipal buses could also be particularly beneficial for improving local air quality. While municipal buses account for a small portion of overall transportation CO_2 emissions, they typically run on diesel fuel or compressed natural gas (CNG) and produce tailpipe emissions containing other air pollutants (like nitrogen oxides and sulfur dioxide) that contribute to poor local air quality, while **electric buses do not**. Switching to electric buses could improve air quality, particularly in low-income neighborhoods that rely heavily on bus lines, and therefore provide health benefits for those communities.

In addition to environmental benefits, electric vehicles could also provide **benefits** to the electric grid by charging when electricity is abundant and demand is low and discharging to the grid when demand for electricity is high. This capability could be particularly useful for accommodating variations in electricity production from variable renewables.

Challenges and Barriers

Widespread electrification of light- and heavy-duty vehicles faces many economic and technological challenges. Many car manufacturers already sell electric cars, but these vehicles face barriers to widespread adoption, mainly due to limited charging infrastructure and the high price tag (largely attributable to battery costs). As the number of electric vehicles grow, they could also put **pressure** on the local power lines by substantially increasing the amount of electricity being used.

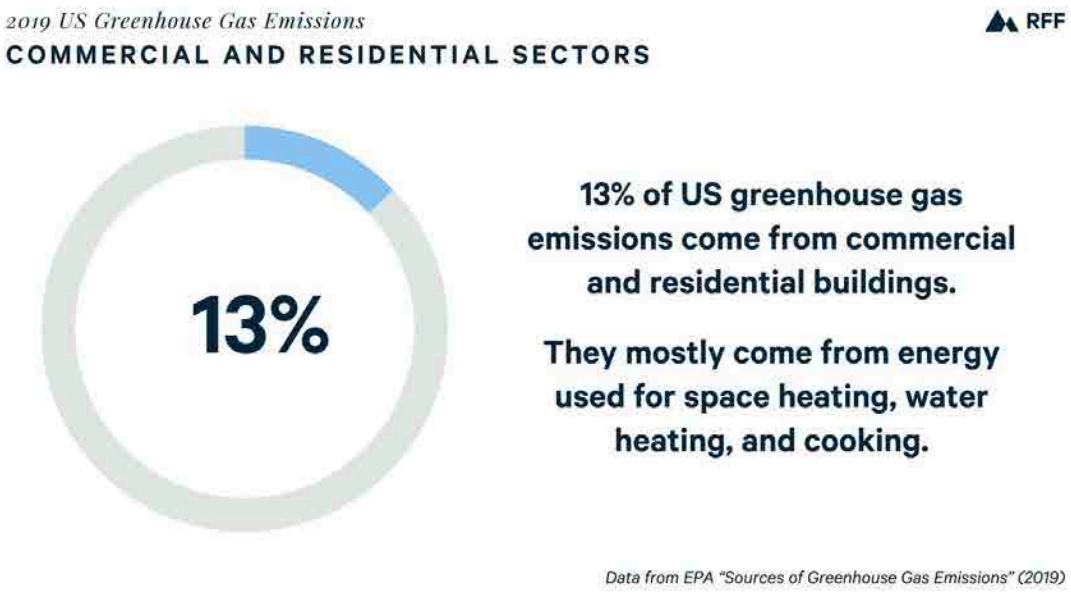
Heavy-duty vehicles face even more obstacles to electrification relative to light-duty vehicles. Heavy-duty trucks require large batteries that take up a lot of space, limiting the space available for carrying goods. Also, trucks often travel very long distances and may require frequent charging, which adds to travel time and makes limited charging infrastructure a significant barrier. These features could limit the ability for electric trucks to substitute for fossil fuel-burning trucks unless other measures are taken to reduce charging times, such as advances in fast charging technology or battery exchange (see **ICCT** for more).

Electrification of Buildings

Overview

Residential and commercial buildings contribute about **13 percent** of all US greenhouse gas emissions. A **majority** of commercial and residential buildings rely on fossil fuels—such as natural gas or oil—for space heating, water heating, and cooking.

For more about federal policy options to reduce transportation emissions, read "**Federal Climate Policy 106: The Building Sector**".



Benefits of Electrification

As with vehicles, carbon emissions from buildings can be **reduced** by switching from fossil fuels to electricity for energy needs. Additionally, switching to electric heating and cooking technologies can have substantial air quality benefits. Some electric appliances can be better for indoor air quality than their fossil fuel-based counterparts—natural gas cooking stoves, for example, **release** carbon monoxide, nitrogen dioxide, and other harmful pollutants when in use.

Challenges and Barriers

Electrification of buildings is quite feasible from a technological standpoint. Commercially available electric technologies for heating and cooking currently exist, including electric heat pumps, electric hot water heaters, and electric stoves. A **study** done by the Lawrence Berkeley National Laboratory (LBNL) estimates that nearly the entire sector could be electrified using existing technologies; however, electrification faces economic constraints.

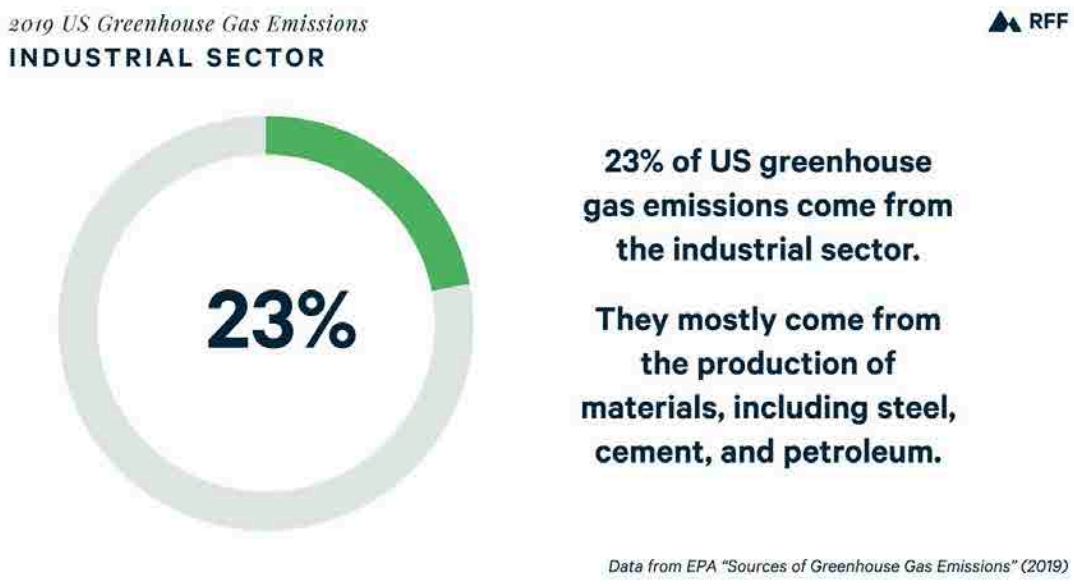
Economic feasibility varies geographically and by building type. For example, electric heaters (for heating both space and water) are **economically competitive** with existing fossil-fuel technologies in some areas of the United States (particularly the South and California). However, they struggle to achieve economic parity in other areas. LBNL claims that electric heat pumps make the most sense economically in areas with mild climates and low electricity prices. Additionally, they are more economically competitive when installed in new buildings than when they replace existing technologies in older buildings.

Electrification of the Industrial Sector

Overview

Industrial CO_2 emissions account for about **22 percent** of total US greenhouse gas emissions and are predominantly from the production of materials, such as steel, cement, glass, and petrochemicals. Most of these production processes use fossil fuels for heating and as feedstock (raw material) in their processes. When heated to very high temperatures, these materials emit carbon dioxide.

For more about federal policy options to reduce transportation emissions, read "**Federal Climate Policy 105: The Industrial Sector**".



Benefits of Electrification

Electricity can theoretically **substitute** for fossil fuels as an energy source in processes to produce some materials, such as **heating** required in the production of glass, paper, steel, and cement. For example, replacing natural gas furnaces with electrolytic reduction technology has the **potential** to significantly reduce CO_2 emissions in several industries, including textile, wood, paper, and chemicals.

Challenges and Barriers

Electrification of industrial processes faces more technological challenges than other sectors. Electrification **could** alter many existing processes, which could create complications, especially if the processes are intricate. Additionally, reducing emissions by replacing feedstock with non-fossil alternatives is challenging for many industries (particularly steel and cement production). **Alternative feedstocks** in these industries are still in early-stage research and development without commercial application.

In addition to technological challenges, electrification of industry faces economic challenges. Electrified industrial processes are currently more **expensive** than existing technologies to operate, as electricity is more expensive than natural gas per unit of energy.

Given these technical and economic barriers, the industrial sector may be the most difficult sector to fully electrify. In some cases, other alternatives for decarbonization might be more feasible and less expensive (such as implementing carbon capture and storage for existing processes).

Implications for Policy

Electrification is technologically feasible in many sectors, but it faces implementation challenges due to the high costs for replacing existing technologies and processes. If policymakers and electric utilities wish to reduce greenhouse gas emissions by encouraging electrification, policies and incentives that will help overcome these barriers may be needed.

Some policy **incentives** already exist to promote electrification, such as **tax credits** and rebates for the purchase of electric cars and heat pumps. While these policies can encourage a transition to electric technologies, a more economically efficient approach would be an economy-wide **carbon pricing policy**, such as a carbon tax or emissions cap-and-trade program, that affects all sectors rather than addressing each sector individually. If carbon dioxide emissions were priced across the entire economy, then fossil-fuel based technologies would become more expensive to operate, thus encouraging electrification of these technologies. A carbon price would also encourage fuel switching to cleaner energy sources within the electric sector, further improving the overall benefits of electrification.

If electric utilities wish to encourage electrification, they can also offer price incentives for the use of new electric technologies like cars or water heaters. For example, San Diego Gas & Electric (SDG&E) offers customers a **low electricity rate** specific for electric vehicle charging during off-peak hours.

Policymakers or utilities may also have to intervene to prevent potentially negative consequences from electrification. As more sectors become electrified, electric utilities may face challenges in meeting higher electricity demand, which might require infrastructure upgrades to accommodate the additional load. Alternatively, these impacts could be mitigated through other methods, such as **managed charging of cars** or **water heating**. Similarly, as the economy becomes more dependent on the electricity system rather than fossil fuel-burning technologies, policymakers and grid operators may need to take precautions to ensure that the power grid is able to maintain reliability and resilience in the face of possible power disruptions. Despite these challenges, electrification could be an effective tool for reducing carbon emissions, especially if it is encouraged through efficient policy design.

Authors



Kathryne Cleary
Senior Research Associate

Kathryne Cleary is a senior research associate at RFF where her work centers around the Future of Power Iniative. →

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Inside Climate News: “EPA’s Clean School Bus ‘Revamp’ Means Less Support for EVs”

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Gas Stoves: Health and Air Quality Impacts and Solutions

By Andee Krasner, Brady Seals

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Health Effects from Gas Stove Pollution

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released by gas stoves can have negative health effects, often exacerbating respiratory conditions like asthma.

Despite this growing body of evidence, indoor air pollution remains largely unregulated. In this report, we synthesize the last two decades of research and offer recommendations for policymakers, researchers, health care professionals, and the public to work to swiftly to mitigate the health risks associated with gas stoves. Air pollution is preventable, and we hope this report can spur the necessary action to protect public health.

Indoor Air Pollution: The Link between Climate and Health by Brady Seals

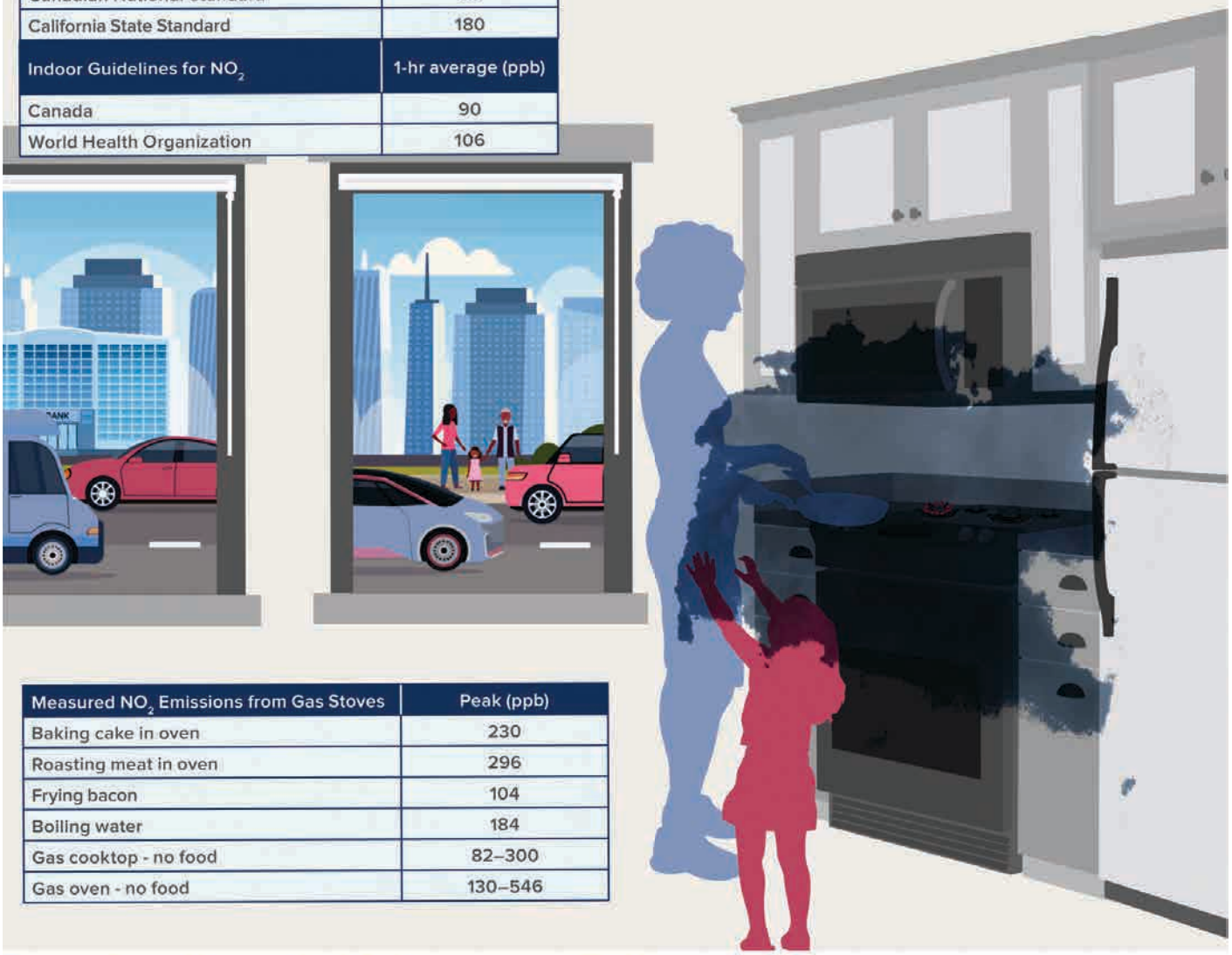
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Gas Stoves Can Emit Elevated Indoor Nitrogen Dioxide (NO_2) Levels Often Exceeding Indoor Guidelines and Outdoor Standards

Outdoor Standards for NO_2	1-hr average (ppb)
US National Standard (EPA)	100
Canadian National Standard	60
California State Standard	180
Indoor Guidelines for NO_2	**1-hr average (ppb)**
Canada	90
World Health Organization	106



Measured NO_2 Emissions from Gas Stoves	Peak (ppb)
Baking cake in oven	230
Roasting meat in oven	296
Frying bacon	104
Boiling water	184
Gas cooktop - no food	82–300
Gas oven - no food	130–546

Source: https://rmi.org/insight/gas-stoves-pollution-health

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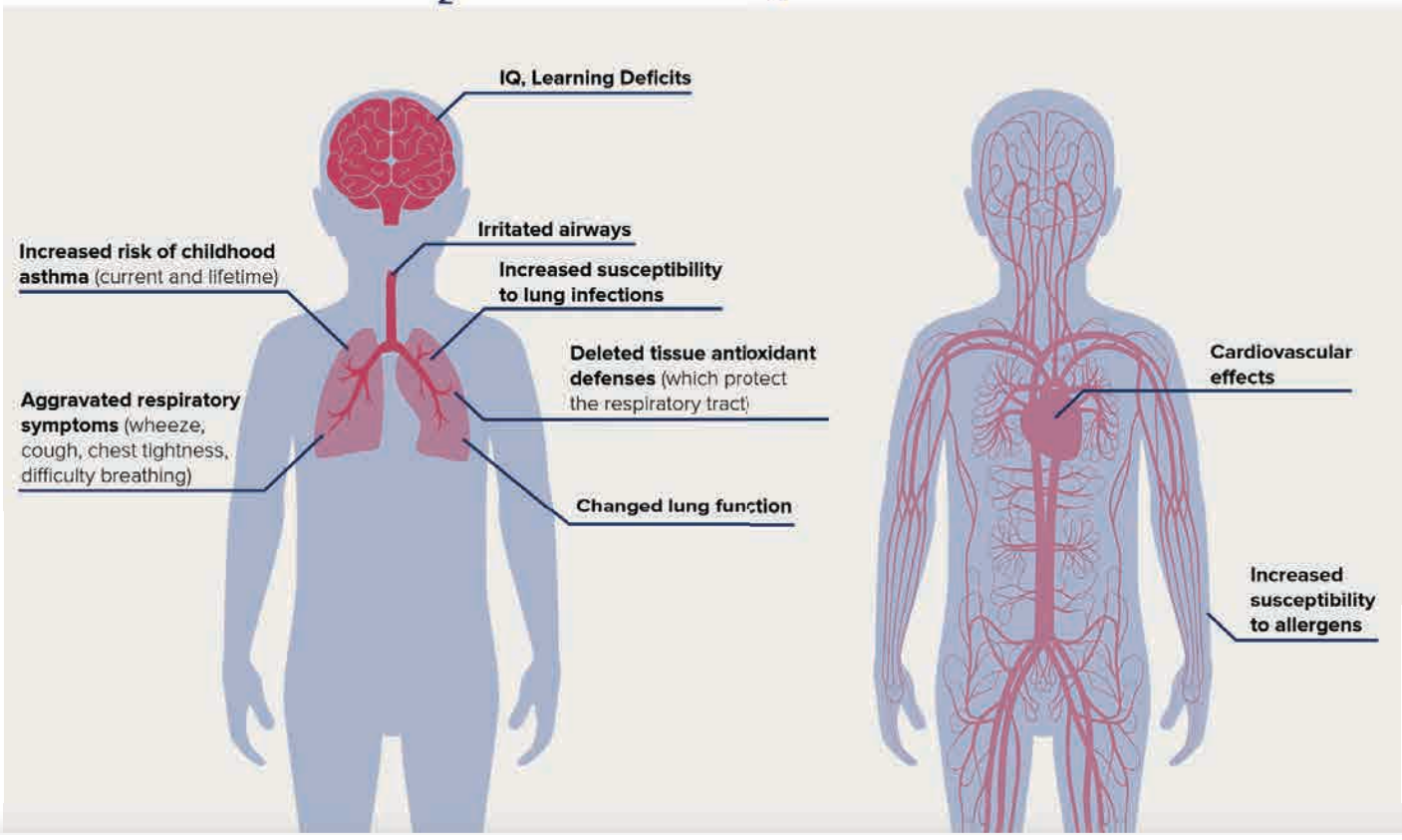
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Three Main Factors Why Children Are More Susceptible to Illnesses Associated with Air Pollution than Adults



Source: https://rmi.org/insight/gas-stoves-pollution-health

Gas stoves can produce elevated levels of Nitrogen Dioxide (NO_2), a toxic gas. Health Effects of NO_2 in Children May Include:



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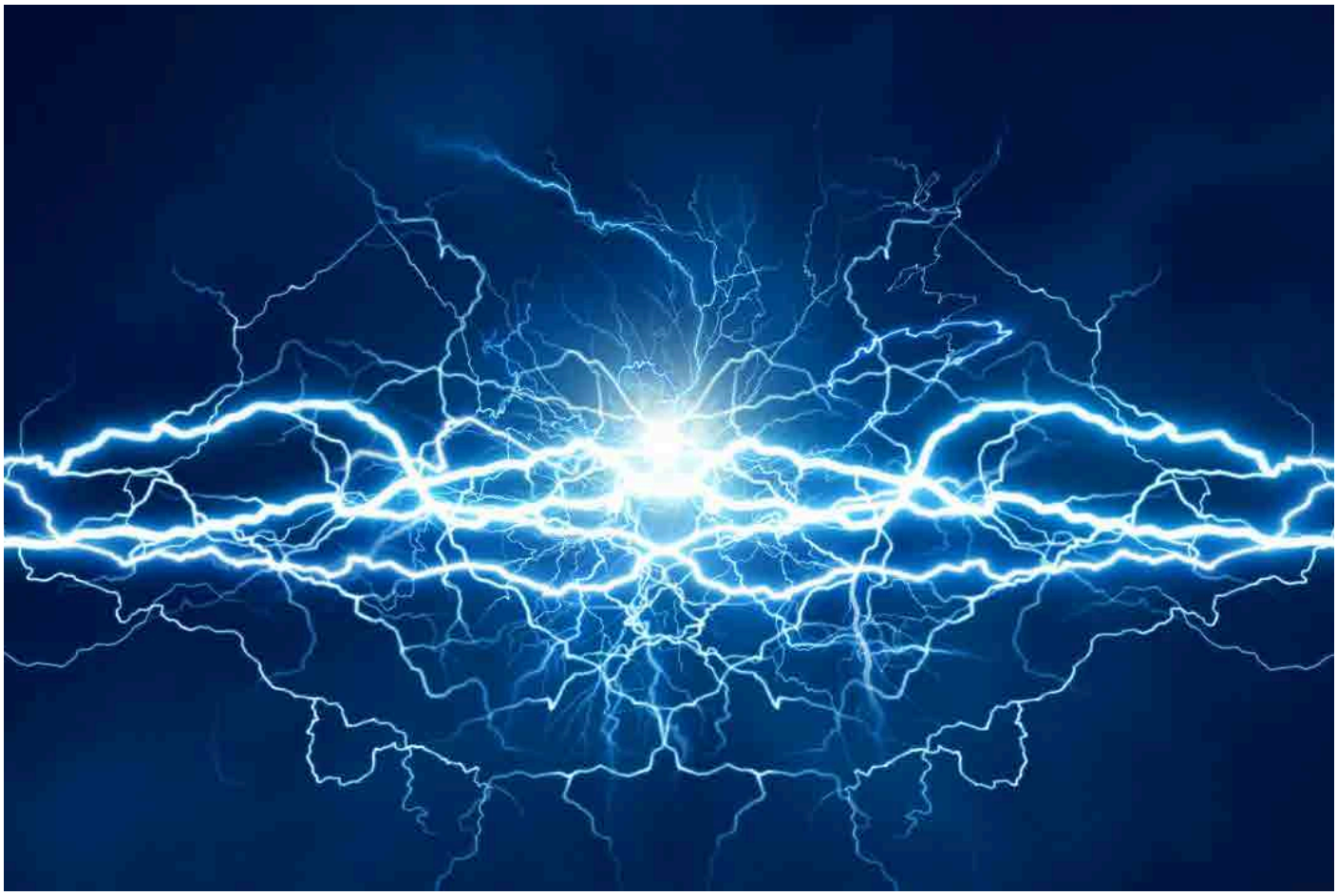
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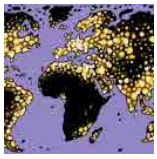


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REC-R404.7-24 – Staff Summary

Proponent: Bill Penniman, representing Sierra Club Virginia Chapter

Brief Description: Incorporates the non-mandatory 2024 IECC Appendix NK (RK) Electric-Ready Residential Building Provisions, making the requirements mandatory in Virginia.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second Energy Sub-Workgroup meeting on September 29, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce

- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

- **Monica R** expresses support.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Second GSW Meeting — 10/03/2025

Support: Brian Holland, NEMA.

Opposition: Steve Shapiro, AOBA and VAMA; Tread Willis, Prince William County and IAEI - Virginia Chapter; Andrew Clark, HBAV; Matthew Robinson, representing self; and David Beahm, Warren County and VBCOA.

Discussion:

Bill P provided an overview of the proposal.

a. **Shahriar Amiri** (Arlington County) stated that the proposal is unenforceable in its current form. Appreciated the intent but emphasized that the language "needs work" to be practically implemented.
b. **Mark Graver** (City of Waynesboro, Builder, VBCOA Region III) expressed uncertainty about how to determine the correct electrical service size for a building when accounting for all the proposed provisions.
    1. **Brian H** responded that all the relevant components have minimum ampacity ratings specified. Building services can be sized according to these published requirements.

c. **Brian H** expressed support for the proposal. Cited the need to mitigate the risk of house fires caused by improperly installed or unpermitted electrical equipment, suggesting that forward-thinking code requirements can improve safety.
d. **Steve S** opposed, stating that the proposal goes beyond the minimum requirements of the code and should remain as an optional provision in the appendices.
e. **Tread W** opposed, echoing the reasons given by other opponents.
f. **Andrew C** and **David B** expressed opposition.
g. **Matthew R** representing himself, opposed, arguing that the proposal would impose greater burdens on plan reviewers and inspectors, increasing complexity and possibly cost for stakeholders.

DHCD Staff Note: N/A

REC-R405.2-24

IRC: N1105.2 (R405.2), TABLE N1105.4.2(1) [R405.4.2(1)]

Proponents: Eric Lacey, representing Responsible Energy Codes Alliance (eric@reca-codes.com)

2024 International Residential Code

Revise as follows:

N1105.2 (R405.2) Simulated building performance compliance. Compliance based on *simulated building performance* requires that a *building* comply with the following:

1. The requirements of the sections indicated within Table N1105.2.
2. The proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the required total *building thermal envelope* TC using the prescriptive *U-factors* and *F-factors* from Table N1102.1.2 multiplied by 1.08 in *Climate Zones* 0, 1 and 2, and 1.15 in Climates Zones 3 through 8, in accordance with Equation 11-6 and Section N1102.1.5. The area-weighted maximum *fenestrationSHGC* permitted in Climate Zones 0 through 3 shall be 0.30.

$$\text{For Climate Zones 0–2: } TC_{Proposed\ design} \le 1.08 \times TC_{Prescriptive\ reference\ design}$$
$$\text{For Climate Zones 3–8: } TC_{Proposed\ design} \le 1.15 \times TC_{Prescriptive\ reference\ design}$$

Equation 11-6

3. For each *dwelling unit*~~with one or more fuel-burning *appliances* for space heating, water heating, or both, the annual *energy cost* of the *dwelling unit* shall be less than or equal to 80 percent of the annual *energy cost* of the *standard reference design*. For all other *dwelling units*,~~ the annual *energy cost* of the *proposed design* shall be less than or equal to 89 ~~85~~percent of the annual *energy cost* of the *standard reference design*. For each *dwelling unit* with greater than 5,000 square feet (465 m^2) of *living space* located above *grade plane*, the annual *energy cost* of the *dwelling unit* shall be reduced by an additional 5 percent of annual *energy cost* of the *standard reference design*. Energy prices shall be taken from an *approved source*, such as the US Energy Information Administration's State Energy Data System prices and expenditures reports. Code officials shall be permitted to require time-of-use pricing in *energy cost* calculations.

   Exceptions:

   1. The energy use based on source energy expressed in *Btu* or *Btu* per square foot of *conditioned floor area* shall be permitted to be substituted for the *energy cost*. The source energy multiplier for electricity shall be 2.51 . The source energy multipliers shall be 1.09 for natural gas, 1.15 for propane, 1.19 for *fuel oil*, and 1.30 for imported liquified natural gas.
   2. The energy use based on site energy expressed in *Btu* or *Btu* per square foot of *conditioned floor area* shall be permitted to be substituted for the *energy cost*.

TABLE N1105.4.2(1) [R405.4.2(1)] SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS
Portions of table not shown remain unchanged.

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Heating systems[d, e, j, k]	Fuel Type/Capacity: same as proposed design.	As proposed.
	Product class: same as proposed design.	As proposed.
	Efficiencies: For other than electric heating without a heat pump: same as proposed design. Where the proposed design utilizes electric heating without a heat pump, the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the *IECC* – Commercial Provisions.	As proposed.
	~~Heat pump: complying with 10 CFR §430.32~~	~~As proposed~~
	~~Fuel gas and liquid fuel furnaces: complying with 10 CFR §430.32~~	~~As proposed.~~
	~~Fuel gas and liquid fuel boilers: complying with 10 CFR §430.32~~	~~As proposed.~~
Cooling systems[d, f, k]	Fuel Type: electric Capacity: same as proposed design	As proposed.
	Efficiencies: ~~complying with 10 CFR §430.32~~ Same as proposed design.	As proposed.

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th>PROPOSED DESIGN</th></tr>
<tr><td>Service water heating[d, g, k]</td><td>Use, in units of gal/day = 25.5 + (8.5 × N_{br})
where: N_{br} = number of bedrooms.</td><td>Use, in units of gal/day = 25.5 + (8.5 × N_{br}) × (1 − HWDS)
where:
N_{br} = number of bedrooms.
HWDS = factor for the compactness of the hot water distribution system.
<table>
<tr><th colspan="2">Compactness ratio[l] factor</th><th>HWDS</th></tr>
<tr><td>1 story</td><td>2 or more stories</td><td></td></tr>
<tr><td>> 60%</td><td>> 30%</td><td>0</td></tr>
<tr><td>> 30% to ≤ 60%</td><td>> 15% to ≤ 30%</td><td>0.05</td></tr>
<tr><td>> 15% to ≤ 30%</td><td>> 7.5% to ≤ 15%</td><td>0.10</td></tr>
<tr><td>< 15%</td><td>< 7.5%</td><td>0.15</td></tr>
</table></td></tr>
<tr><td></td><td>Fuel type: same as proposed design</td><td>As proposed.</td></tr>
<tr><td></td><td>Rated storage volume: same as proposed design</td><td>As proposed.</td></tr>
<tr><td></td><td>Draw pattern: same as proposed design</td><td>As proposed.</td></tr>
<tr><td></td><td>Efficiencies: ~~Uniform Energy Factor complying with 10 CFR §430.32~~ Same as proposed design.</td><td>As proposed.</td></tr>
<tr><td></td><td>Tank temperature: 120°F (48.9°C)</td><td>Same as standard reference design.</td></tr>
<tr><td>Thermal distribution systems</td><td>Duct insulation: in accordance with Section N1103.3.3.</td><td>Duct insulation: as proposed.[m]</td></tr>
<tr><td></td><td>Duct location: Same as proposed design.</td><td>Duct location: as proposed.[l]</td></tr>
<tr><td></td><td>
<table>
<tr><td>~~Foundation type~~</td><td>~~Slab on grade~~</td><td>~~Unconditioned crawl space~~</td><td>~~Basement or conditioned crawl space~~</td></tr>
<tr><td>~~Duct location (supply and return)~~</td><td>~~One-story building: 100% in unconditioned attic~~
~~All other: 75% in unconditioned attic and 25% inside conditioned space~~</td><td>~~One-story building: 100% in unconditioned crawl space~~
~~All other: 75% in unconditioned crawl space and 25% inside conditioned space~~</td><td>~~75% inside conditioned space~~
~~25% unconditioned attic~~</td></tr>
</table></td><td>—</td></tr>
<tr><td></td><td>Duct system leakage to outside: for duct systems serving > 1,000 ft^2 of conditioned floor area, the duct leakage to outside rate shall be 4 cfm per 100 ft^2 of conditioned floor area.
For duct systems serving ≤ 1,000 ft^2 of conditioned floor area, the duct leakage to outside rate shall be 40 cfm.</td><td>Duct system leakage to outside: The measured total duct system leakage rate shall be entered into the software as the duct system leakage to outside rate.
Exceptions:
<table>
<tr><td>1.</td><td>Where duct system leakage to outside is tested in accordance ANSI/RESNET/ICC 380 or ASTM E1554, the measured value shall be permitted to be entered.</td></tr>
<tr><td>2.</td><td>Where total duct system leakage is measured without space conditioning equipment installed, the simulation value shall be 4 cfm per 100ft^2 of conditioned floor area.</td></tr>
</table></td></tr>
<tr><td></td><td>Distribution System Efficiency (DSE): for hydronic systems and ductless systems a thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies.</td><td>Distribution System Efficiency (DSE): f or hydronic systems and ductless systems, DSE shall be as specified in Table N1105.4.2(2).</td></tr>
</table>

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8, 1 degree = 0.79 rad, 1 cubic foot per minute = 28.317 L/min.

a. Hourly calculations as specified in the ASHRAE Handbook of Fundamentals , or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE Handbook of Fundamentals , page 26.24 and the “Whole-house Ventilation” provisions of 2001 ASHRAE Handbook of Fundamentals , page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design with a nonstorage-type water heater,For a proposed design without a proposed water heater, the following assumptions shall be made for both the proposed design and standard reference design. For a proposed design with a heat pump water heater, the following assumptions shall be made for the standard reference design, except the fuel type shall be electric:

Fuel Type: Same as the predominant heating fuel type

Rated Storage Volume: 40 gallons

Draw Pattern: Medium

Efficiency: Uniform Energy Factor complying with 10 CFR §430.32

h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

$AF = A_S \times FA \times F$

where:

AF = Total glazing area.

A_S = Standard reference design total glazing area.

FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).

F = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

and where:

- Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.
- Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.
- Below-grade boundary wall is any thermal boundary wall in soil contact.
- Common wall area is the area of walls shared with an adjoining dwelling unit.

i. The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the “hot water rectangle”) divided by the floor area of the dwelling.

1. Sources of hot water include water heaters, or in multiple-family buildings with central water heating systems, circulation loops or electric heat traced pipes.
2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.
3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.
4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.
5. The basement or attic shall be counted as a story when it contains the water heater.
6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor.

j. For a proposed design with electric resistance heating, a split system heat pump complying with 10 CFR §430.32 (2021) shall be assumed modeled in the standard reference design.

k. For heating systems, cooling systems, or water heating systems not included in this table, the standard reference design shall be the same as proposed design.

l. Only sections of ductwork that are installed in accordance with Section N1103.3.4, Items 1 and 2 are assumed to be located completely inside conditioned space. All other sections of ductwork are not assumed to be located completely inside conditioned space.

m. Sections of ductwork installed in accordance with Section N1103.3.5.1 are assumed to have an effective duct insulation *R*-value of R-25.

Reason Statement: The proposed changes above will reverse the largest efficiency rollbacks incorporated into the 2024 *IECC* and maintain Virginia's current performance path approach to efficiency trade-offs for heating, cooling, and water heating equipment. It will

also eliminate an unnecessary new credit for duct location. The proposal will also incorporate a single efficiency improvement to buildings with all equipment types based on the U.S. Department of Energy's Determination that the 2024 IECC reduced annual energy costs by roughly 6.6% as compared to the 2021 IECC. We believe the combination of these changes will allow Virginia code users to continue to use the performance path essentially as they do today, avoiding the controversies that have accompanied the 2024 IECC revisions to this section.

All of these new trade-off credits were included in the 2024 *IECC* as part of a large compromise among *IECC*-R Development Committee Members referred to as the "omnibus." However, significant portions of the omnibus related to electrification and decarbonization were removed from the 2024 *IECC* by the ICC Board of Directors as a result of several appeals, leaving in place several material efficiency rollbacks. These rollbacks would not have been approved in the 2024 *IECC* but for the omnibus compromise, and we recommend that Virginia eliminate these trade-off credits to be consistent with the 2021 *IECC* and the current VA Construction Code approach to equipment efficiency in the performance path.

Equipment trade-offs were correctly eliminated in the 2009 version of the *IECC* (and in Virginia's adoption of the 2009 IRC/IECC) and were consistently rejected in every *IECC* and Virginia code update cycle until the ICC Residential Committee-developed 2024 *IECC*. Nearly every state that adopts the *IECC* has eliminated these trade-offs as well. Equipment trade-offs reduce building efficiency because commonly installed cooling, heating, and water heating equipment typically exceeds the federal minimum efficiencies, but states are unable to set more reasonable efficiency requirements (or more reasonable assumptions in the standard reference design baseline) because of federal preemption. **The result is an unwarranted trade-off credit that allows buildings to be constructed 11-22% less efficient overall than if the trade-offs were not allowed**. *See* ICF International, *Review and Analysis of Equipment Trade-offs in Residential Energy Codes,* at ii (Sep. 23, 2013).

Although proponents of equipment trade-offs argue that they are "energy neutral," the reality is that they are a short-term trade-off that will have long-term negative impacts on homeowners –who are often unaware that such trade-offs are taking place. For example, if a trade-off is permitted for water heater efficiency, an instantaneous natural gas water heater would allow the builder to reduce the efficiency of the rest of the home by an average of 9%. The remaining home will be 9% less efficient for its entire useful lifetime. As the water heater is replaced every 10-15 years, the envelope of that home will continue to underperform by 9%. By contrast, under the current Virginia Construction Code (and the 2021 *IECC*), no trade-off credit is awarded for the instantaneous water heater, which means the rest of the home will be built to meet the code. As the water heater is swapped out in future years, a home built to the current Virginia UCC-compliant home will outperform a home built using a water heater performance trade-off allowed by 9%.

Regarding duct location, the current Virginia Uniform Construction Code does not award performance path trade-off credit for ducts located inside conditioned space. In both the prescriptive path and the performance path, builders are neither penalized nor credited for the location of duct systems. Although it is generally good building practice to locate all ducts and air handlers inside conditioned space, many builders in Virginia already do this.

The 2024 *IECC* already provides another performance-based alternative that provides credit for equipment efficiency and duct location (the Energy Rating Index), as well as multiple credits for equipment and duct location in Table R408.2. Both of these compliance paths do not carry such a high risk of free ridership (and reduced overall efficiency) as the proposed performance path credits. The simulated performance path lacks several of the built-in protections of the ERI path, and thus cannot guarantee an equivalent level of performance. We strongly recommend eliminating these loopholes from the performance path and implementing provisions consistent with the Virginia Construction Code and the 2021 *IECC*.

Finally, this proposal replaces the two multipliers in Section N1105.2(3)/R405.2(3) with a single multiplier. Although we do not oppose setting a different multiplier based on whether a home uses fossil fuel-fired or electric appliances, for a starting place we recommend setting a multiplier that is consistent with the U.S. Department of Energy's Determination on energy cost savings associated with the prescriptive path of the 2024 IECC, and one that properly reflects the impact of equipment trade-offs (if any). In December of 2024, U.S. DOE found that homes built to the 2024 IECC prescriptive path will have 6.6% lower annual energy costs than homes built to the 2021 IECC, on average. *See* U.S. Department of Energy, *Notification of Determination*, 89 Fed. Reg. 106458 (Dec. 30, 2024). The current Virginia Construction Code already requires that the proposed home in Section R405 not exceed 95% of the annual energy costs of the standard reference design home. A 6.6% reduction in energy costs is roughly 89%, and that number is proposed above as a single multiplier. We note, however, that if efficiency trade-offs are allowed for heating, cooling, water heating equipment, or for duct location, there would need to be additional changes to the multiplier, and the result would likely be lower than the 80/85% in the published 2024 IECC. However, for purposes of this proposal, assuming the equipment trade-offs and duct location credit are deleted, we view 89% as a reasonable starting place that would maintain consistency across compliance paths.

Cost Impact: The code change proposal will increase the cost This proposal improves the overall efficiency of the performance path by roughly 6.6%, which may increase costs depending on decisions made by code users. However, these changes, taken as a single package, would maintain consistency with improvements made in the prescriptive path.

REC-R405.2-24 – Staff Summary

Proponent: Eric Lacey, representing Responsible Energy Codes Alliance

Brief Description: Removes the ability to use equipment trade-offs as part of the Simulated Building Performance compliance option.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at each one of the three Energy Sub-Workgroup meetings on July 9, 2025, September 29, 2025, and November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — July 9, 2025:

- Steve Shapiro
- Sydney Roberts
- Mike O'Connor
- Corian Carney

- Dennis Hart
- D.A. Pierce
- Chelsea Harnish
- Stuart Nuckols – Sitting in for Andrew Green
- Mason Trimble
- Bill Penniman
- Mike Rhodes
- Eric Lacey
- William Drumeller
- Hana Nguyenky
- Sarah Thomas
- Andrew Clark

Other stakeholders in attendance — July 9, 2025:

- Nicholas Bowles – Building Official, Nottoway County
- Kyle Kratzer – Virginia Building and Code Officials Association
- Mike Hamilton – Arlington County
- Bill Riggs – Viridiant
- Bob Shippee – Virginia Citizen
- Susan Stillman – Virginia Citizen
- Jason Vandever – North American Insulation Manufacturers Association
- Monica Rokicki – Better Building Works

Discussion:

- **Eric** – Provides an overview of the proposal. This is more complicated because we're dealing with the performance path. Several moving parts that have to work together. We can't change the multiplier without changing the trade-offs. It may be helpful to have DOE help us with the correct multiplier. The 2024 IECC performance path takes us in a very different direction.
- **Monica** – Duct location has the highest amount of impact on overall performance rather than even equipment efficiency. It cannot be overstated how important that is. To have that excluded seems counterproductive to me.
- **Eric** – I should have talked about the duct location as well. Totally agree that ducting indoors has a huge impact on efficiency. What happened in 2024 is that there's an assumption that you'll only put 75% in foundations with basements and conditioned spaces. Our concern is the amount of unearned credit that gets lumped in here. We're not trying to encourage the installation of ducts outside of conditioned space.
- **Monica** – Wonders if there is an option like including the ducts in conditioned space but not equipment.
- **Steve** – The reason statement reads, in part, "We're maintaining Virginia's current performance path approach to equipment trade-offs. That's true, correct?"
- **Eric** – Correct. Virginia does not give credits for performance path tradeoffs, such as the location of equipment. The only change, though, is that we are adding an efficiency

improvement in the multiplier, which we set to mirror the prescriptive path.

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

- **D.A. Pierce** stated opposition to the proposal, arguing that it increases requirements beyond the base code.
- **Justin K** noted from a practical standpoint that homeowners have limited options for improving envelope efficiency after construction.
- **D.A. Pierce** asked if this proposal would modify the model code requirements for ERI path requirements.
    - **Eric L** clarified that the proposal does not affect the ERI path, which is rarely used, but only applies to the Performance path (Section R405). He explained that the proposal is aimed at closing loopholes that allow for less stringent outcomes than the prescriptive path.
    - **D.A. Pierce** acknowledged the proposal is complex and thanked **Eric L** for the clarification.
- **Monica R** asked whether the energy savings from the 4% duct allowance within the building enclosure were considered.

- **Eric L** responded that no specific analysis was provided regarding multipliers or potential free-rider credits, and it is uncertain how many home designs would change as a result; no formal analysis was included.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Eric L provided an overview of the proposal which maintains Virginia's current requirements for the Simulated Building Performance Compliance option and eliminates efficiency tradeoffs for heating, cooling, and water heating equipment that were adopted in the 2024 IECC.

D.A. Pierce opposed the proposal. VBCOA does not agree with changes to the model code requirements with software simulated performance as they do not support adding more stringent requirements for homeowners.

Eric L countered that changing the annual energy cost from 85 percent to 89 percent of the standard reference design is less stringent than the model code, but it removes the equipment

tradeoff from the performance path that is not part of Virginia's code. The goal is to keep what Virginia already has but improve efficiency as much as the 2024 model code improves efficiency.

D.A. Pierce simplified the proposal as a removal for the allowance for tradeoffs. He noted his own experience as a plan reviewer, that it is not common for builders to use these software-based paths of compliance as they use the prescriptive path. And VBCOA's concern is that they don't want to add additional requirements to homeowners if they choose to use the performance path.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Bob Shippee, Sierra Club; Jason Vandever, NAIMA; and Sydney Roberts, SEEA.

Opposition: D.A. Pierce, VBCOA Energy Committee; and Rick Hinson, American Council of Engineering Companies (ACEC).

Discussion:

Eric L provided an overview of the proposal.

a. **D.A. Pierce** acknowledged that it is less stringent with the limits that were offered up by the proponent, but most builders do not build to software simulation. VBCOA was opposed to any tradeoffs or allowances based on equipment efficiencies written in the code.

DHCD Staff Note:

This proposal conflicts with proposal REC-R405.2(1)-24, which was reviewed by stakeholders at the second Energy Sub-Workgroup (SWG) meeting on September 29, 2025, and at the second GSW meeting on October 3, 2025, where it received a Non-Consensus recommendation.

REC-R405.2(1)-24

IECC: R405.2

Proponents: William Penniman, representing Sierra Club Virginia Chapter (wpenniman@aol.com)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R405.2 Simulated building performance compliance.. Compliance based on *simulated building performance* requires that a *building* comply with the following:

1. The requirements of the sections indicated within Table R405.2 (N1105.2).
2. The proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the required total building thermal envelope TC using the prescriptive *U*-factors and *F*-factors from Table R402.1.2 multiplied by 1.08 in Climate Zones 0, 1 and 2, and 1.15 in Climate Zones 3 through 8, in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

$$\text{For Climate Zones 0–2: } TC_{Proposed\ design} \le 1.08 \times TC_{Prescriptive\ reference\ design}$$
$$\text{For Climate Zones 3–8: } TC_{Proposed\ design} \le 1.15 \times TC_{Prescriptive\ reference\ design}$$

Equation 4-2

3. For each *dwelling unit* with one or more fuel-burning appliances for space heating, water heating, or both, the annual ~~*energy cost*~~ site energy use expressed in Btu or Btu per square foot of conditioned floor area of the *dwelling unit* shall be less than or equal to 80 percent of the ~~annual *energy cost*~~ site energy use of the *standard reference design*. For all other *dwelling units*, the ~~annual *energy cost of the proposed design*~~ site energy use expressed in Btu or Btu per square foot of conditioned floor area shall be less than or equal to 85 percent of the annual ~~*energy cost*~~ site energy use of the *standard reference design*. For each dwelling unit with greater than 5,000 square feet (465 m^2) of *living space* located above grade plane, the annual ~~*energy cost of the dwelling unit*~~ site energy use expressed in Btu or Btu per square foot of conditioned floor area shall be reduced by an additional 5 percent of ~~annual *energy cost*~~ site energy use of the *standard reference design*. ~~Energy prices shall be taken from an *approved* source, such as the US Energy Information Administration's State Energy Data System prices and expenditures reports. Code officials shall be permitted to require time-of-use pricing in *energy cost* calculations.~~

~~Exceptions:~~

1. ~~The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the *energy cost*. The source energy multiplier for electricity shall be 2.51. The source energy multipliers shall be 1.09 for natural gas, 1.15 for propane, 1.19 for fuel oil, and 1.30 for imported liquified natural gas.~~
2. ~~The energy use based on site energy expressed in Btu or Btu per square foot of conditioned floor area shall be permitted to be substituted for the energy cost.~~

Reason Statement: This proposal provides that the TC calculations are to be based upon estimated the site energy usage of the specific building, not the imagined costs of miscellaneous fuels. This specifies use of one of the code options (Exception 2) presented by the IECC in Section 405.2, and prevents potentially inconsistent application of standards across the Commonwealth. The ICC's commentary recognizes that "some jurisdictions may require the comparison to be done on the basis of 'site energy' versus 'annual energy cost.'" It explains "Because of the fact that utility charges for various types of energy can change over time, some code officials may prefer that the comparison be made based on the amount of energy delivered to a residential building instead of the cost of that energy."

Making use of site-energy consistent across Virginia makes sense. Site energy usage is the only factor that can be consistently applied to assess new dwellings' energy efficiency, and it is also the only thing a builder or an occupant can control. Adopting a site-energy test will avoid basing Simulated Performance calculations upon past or current energy cost estimates that bear

no relation to actual energy costs that will be incurred while a dwelling is occupied. It will also eliminate risks of inconsistent implementation if designers or inspectors are left to choose among different tests.

Trying to compare the impact of energy efficiency choices based upon future upstream or delivered fuel and energy prices makes no sense.

Energy prices vary wildly over time. Just in the period 2020-2024, natural gas and coal prices varied as follows:

Natural gas Henry Hub	$1.49-$8.81/Mcf	https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm
Natural gas delivered to citygate	$3.05-$12.10/Mcf	https://www.eia.gov/dnav/ng/hist/n3050us3m.htm
Natural gas residential prices	$9.19-$25.39/Mcf	https://www.eia.gov/dnav/ng/hist/n3010us3m.htm
Coal prices	$50-$435/Ton	https://tradingeconomics.com/commodity/coal
Crude oil prices	$15.18-$113.77/ Barrel	https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=f000000__3&f=m

Over the likely 50-100+ years in which a dwelling will operate, energy prices will swing even more wildly than in the past five years.

Neither builders, nor inspectors nor the Board can reliably forecast future energy costs, which will change dramatically between code updates and change differently in the service areas of the multiple utilities operating in Virginia, including the IOUs, Coops, and municipal systems. Each has a different mix of supply costs, operating and fixed costs and rates.

The shift to zero-carbon sources for electricity over the next 20-25 years, as called for by Virginia law, will change the cost mix since wind and solar have zero fuel costs.

Utilities' future demand mixes and rate structures will likely change significantly, as will their supply mixes.

The multipliers assumed for upstream fuel supplies are not based on realistic data or assumptions specific to Virginia now or in the future. Again, each utility has a different mix of fuels – including growing zero-cost energy production – and a different mix of generators with different efficiencies. These will change annually depending on many factors including price fluctuations, future markets and weather changes driven by climate change.

Imagined fuel costs do not consider on-site renewable energy, which may be installed with initial construction or by the owner in the future.

Assumed fuel costs and multipliers do not take into account either pollution or climate costs from different fuels or the likely prices for carbon emissions, which will be restored when Virginia law requiring RGGI participation is enforced as it is written. Moreover, despite political vicissitudes it is generally recognized that there will be a price on carbon within the lives of buildings constructed under the 2024 code updates, and, if not, the damage costs to persons, properties and the economy will be far worse. None of these costs are reflected in the use of imagined fuel costs or multipliers.

Basing comparisons upon on-site energy usage will enhance resiliency. Residents of better-insulated buildings will be able to withstand periods of energy supply disruptions for longer periods.

In sum, the only reasonable measure is on-site energy consumption, which can be estimated based upon the construction choices.

Cost Impact: The code change proposal will not increase or decrease the cost

There are no foreseeable construction cost impacts. Attempting to estimate future fuel costs may or may not alter construction decisions but one cannot predict how. Incorporating estimated upstream and delivered fuel/energy costs will cause more confusion than benefits. This proposal should simplify implementation of the performance option.

TRADING ECONOMICS

Coal

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Coal prices climbed above $140 per ton, hitting their highest levels since November 2024 as the escalating conflict in the Middle East and resulting disruptions significantly heightened global energy supply risks. Oil also surged above $100 for the first time since 2022 after major Middle Eastern producers curtailed output as the Strait of Hormuz remains effectively shut. In addition, the shutdown of Qatar's massive liquefied natural gas production has boosted demand for fuel switching in the power sector. Qatar's main LNG export hub supplies about 20% of global LNG and has never fully halted operations in its 30-year history. With many Asian economies reliant on Qatari LNG, the region may be forced to ramp up coal-fired power generation if the disruption persists. Coal resources are also gaining strategic importance for China, both as an energy buffer and as a key feedstock for the chemical industry.



TRADING ECONOMICS

Coal

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Natural gas	3.04	▼	-0.0833	-2.67%	-3.87%	-31.81%
Heating Oil	3.37	▼	-0.2143	-5.98%	38.19%	52.34%
Coal	143.80	▲	6.50	4.73%	25.48%	37.48%
TTF Gas	45.43	▼	-11.02	-19.52%	41.24%	4.62%
UK Gas	115.81	▼	-27.7200	-19.31%	54.13%	12.13%
Bitumen	3,720.00	▼	-228.00	-5.78%	10.62%	5.92%
Ethanol	1.86	▼	-0.0475	-2.49%	12.20%	8.76%
Uranium	85.90	▼	-0.0500	-0.06%	-2.39%	33.39%
Cobalt	56,290.00	▲	0	0%	0%	108.79%
Lead	1,945.18	▲	14.73	0.76%	-2.58%	-5.17%
Aluminum	3,386.75	▲	2.30	0.07%	8.55%	25.20%
Tin	50,685.00	▲	620	1.24%	2.84%	55.19%
Zinc	3,345.05	▲	19.55	0.59%	-2.12%	14.65%
Nickel	17,610.00	▲	180	1.03%	-2.52%	6.86%

Show More

Coal

Coal futures are available for trading in the Intercontinental Exchange and on the New York Mercantile Exchange. The standard GC Newcastle contact listed on ICE weights 1,000 metric tonnes. Coal is the major fuel used for generating electricity worldwide. The biggest producer and consumer of coal is China. Other big producers include: United States,

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trading decisions. Trading Economics does not verify any data and disclaims any obligation to do so.

Actual	Previous	Highest	Lowest	Dates	Unit	Frequency
143.80	137.30	457.80	48.40	2008 - 2026	USD/MT	Daily

News Stream

Coal Hits 16-month High
Coal increased to 143.80 USD/T, the highest since November 2024. Over the past 4 weeks, Coal gained 18.62%, and in the last 12 months, it increased 32.98%.
2026-03-09

Coal Gains on Middle East Disruptions
Coal prices climbed above $140 per ton, hitting their highest levels since November 2024 as the escalating conflict in the Middle East and resulting disruptions significantly heightened global energy supply risks. Oil also surged above $100 for the first time since 2022 after major Middle Eastern pr... more
2026-03-09

Coal Climbs on Qatar LNG Disruptions
Coal prices rallied to a 15-month high of $138 per ton in early March before slightly pulling back to around $137, after a rare shutdown at Qatar's liquefied natural gas facilities boosted demand for fuel switching in the power sector. The move follows an Iranian drone strike on Qatar's main LNG exp... more
2026-03-03

+

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	Actual	Chg	%Chg
Crude Oil	84.363	▼ 10.41	-10.98%
Brent	88.525	▼ 10.44	-10.54%

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Gold	5200.98	▲ 61.42	1.20%
Silver	88.312	▲ 1.30	1.49%
Copper	5.8813	▲ 0.08	1.39%
Soybeans	1185.50	▲ 5.00	0.42%
Wheat	586.75	▼ 11.25	-1.88%
Coal	143.80	▲ 6.50	4.73%
Steel	3098.00	▼ 20.00	-0.64%
TTF Gas	45.43	▼ 11.02	-19.52%
Lumber	563.01	▲ 2.51	0.45%
Iron Ore CNY	784.00	▼ 0.50	-0.06%

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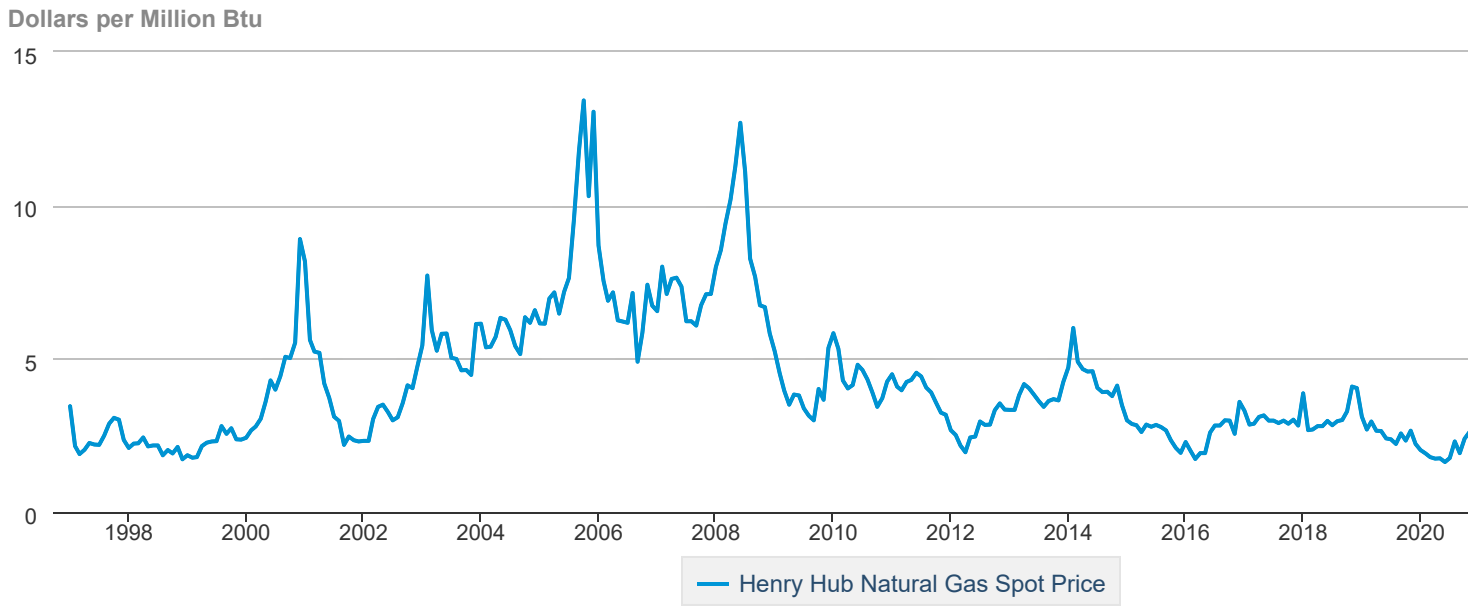
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Henry Hub Natural Gas Spot Price



THOMSON REUTERS

Chart Tools
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Henry Hub Natural Gas Spot Price (Dollars per Million Btu)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	3.45	2.15	1.89	2.03	2.25	2.20	2.19	2.49	2.88	3.07	3.01	2.35
1998	2.09	2.23	2.24	2.43	2.14	2.17	2.17	1.85	2.02	1.91	2.12	1.72
1999	1.85	1.77	1.79	2.15	2.26	2.30	2.31	2.80	2.55	2.73	2.37	2.36
2000	2.42	2.66	2.79	3.04	3.59	4.29	3.99	4.43	5.06	5.02	5.52	8.90
2001	8.17	5.61	5.23	5.19	4.19	3.72	3.11	2.97	2.19	2.46	2.34	2.30
2002	2.32	2.32	3.03	3.43	3.50	3.26	2.99	3.09	3.55	4.13	4.04	4.74
2003	5.43	7.71	5.93	5.26	5.81	5.82	5.03	4.99	4.62	4.63	4.47	6.13
2004	6.14	5.37	5.39	5.71	6.33	6.27	5.93	5.41	5.15	6.35	6.17	6.58
2005	6.15	6.14	6.96	7.16	6.47	7.18	7.63	9.53	11.75	13.42	10.30	13.05

2006	8.69	7.54	6.89	7.16	6.25	6.21	6.17	7.14	4.90	5.85	7.41	6.73
2007	6.55	8.00	7.11	7.60	7.64	7.35	6.22	6.22	6.08	6.74	7.10	7.11
2008	7.99	8.54	9.41	10.18	11.27	12.69	11.09	8.26	7.67	6.74	6.68	5.82
2009	5.24	4.52	3.96	3.50	3.83	3.80	3.38	3.14	2.99	4.01	3.66	5.35
2010	5.83	5.32	4.29	4.03	4.14	4.80	4.63	4.32	3.89	3.43	3.71	4.25
2011	4.49	4.09	3.97	4.24	4.31	4.54	4.42	4.06	3.90	3.57	3.24	3.17
2012	2.67	2.51	2.17	1.95	2.43	2.46	2.95	2.84	2.85	3.32	3.54	3.34
2013	3.33	3.33	3.81	4.17	4.04	3.83	3.62	3.43	3.62	3.68	3.64	4.24
2014	4.71	6.00	4.90	4.66	4.58	4.59	4.05	3.91	3.92	3.78	4.12	3.48
2015	2.99	2.87	2.83	2.61	2.85	2.78	2.84	2.77	2.66	2.34	2.09	1.93
2016	2.28	1.99	1.73	1.92	1.92	2.59	2.82	2.82	2.99	2.98	2.55	3.59
2017	3.30	2.85	2.88	3.10	3.15	2.98	2.98	2.90	2.98	2.88	3.01	2.82
2018	3.87	2.67	2.69	2.80	2.80	2.97	2.83	2.96	3.00	3.28	4.09	4.04
2019	3.11	2.69	2.95	2.65	2.64	2.40	2.37	2.22	2.56	2.33	2.65	2.22
2020	2.02	1.91	1.79	1.74	1.75	1.63	1.76	2.30	1.92	2.39	2.61	2.58
2021	2.71	5.35	2.62	2.66	2.91	3.26	3.84	4.07	5.16	5.51	5.05	3.76
2022	4.38	4.69	4.90	6.60	8.14	7.70	7.28	8.81	7.88	5.66	5.45	5.53
2023	3.27	2.38	2.31	2.16	2.15	2.18	2.55	2.58	2.64	2.98	2.71	2.52
2024	3.18	1.72	1.49	1.60	2.12	2.54	2.07	1.99	2.28	2.20	2.12	3.01
2025	4.13	4.19	4.12	3.42	3.12	3.02	3.20	2.91	2.97	3.19	3.79	4.26
2026	7.72	3.62										

- = No Data Reported; -- = Not Applicable; NA = Not Available; W = Withheld to avoid disclosure of individual company data.

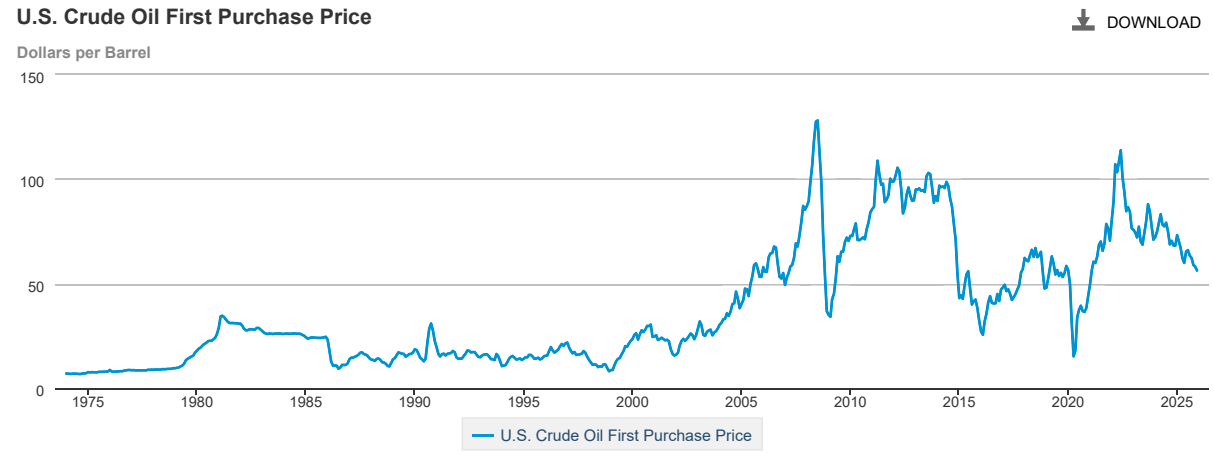
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eia Data source: U.S. Energy Information Administration

Chart Tools
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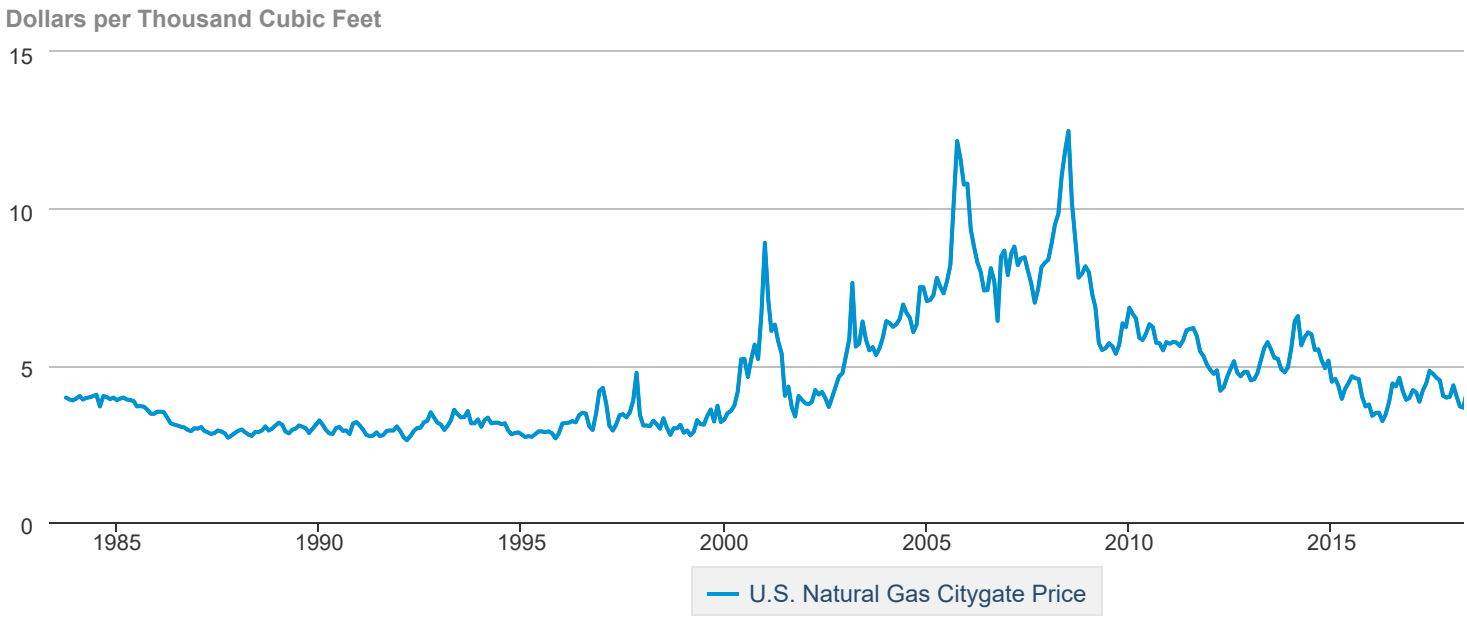
U.S. Crude Oil First Purchase Price (Dollars per Barrel)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	6.95	6.87	6.77	6.77	6.87	6.85	6.80	6.71	6.70	6.97	6.97	7.09
1975	7.61	7.47	7.57	7.55	7.52	7.49	7.75	7.73	7.75	7.83	7.80	7.93
1976	8.63	7.91	7.78	7.86	7.89	8.00	8.04	8.03	8.39	8.46	8.61	8.62
1977	8.50	8.56	8.45	8.41	8.49	8.44	8.47	8.45	8.43	8.72	8.69	8.81
1978	8.71	8.86	8.80	8.82	8.81	9.05	8.96	9.05	9.15	9.17	9.20	9.47
1979	9.46	9.69	9.83	10.33	10.71	11.70	13.39	14.00	14.57	15.06	15.52	17.00
1980	17.86	18.86	19.33	20.28	21.05	21.52	22.31	22.62	22.59	23.23	23.99	25.83
1981	28.81	34.30	34.59	33.92	32.73	31.68	31.10	31.10	31.10	30.98	30.97	30.80
1982	30.80	29.73	28.31	27.64	27.66	28.12	28.09	27.99	27.99	28.76	28.74	28.02
1983	27.22	26.41	26.08	25.85	26.08	25.98	25.86	26.03	26.08	26.04	26.09	25.88
1984	25.93	26.06	26.05	25.93	26.00	26.09	26.11	26.02	25.97	25.92	25.44	25.05
1985	24.26	23.64	23.89	24.19	24.18	24.07	24.04	23.99	23.96	24.10	24.27	24.51
1986	23.12	17.65	12.62	10.68	10.75	10.68	9.25	9.77	11.09	11.00	11.05	11.73
1987	13.79	14.51	14.54	14.95	15.29	15.95	16.88	17.06	16.25	15.95	15.46	14.27
1988	13.64	13.43	12.96	13.92	14.12	13.59	12.38	12.22	11.63	10.62	10.31	11.99
1989	13.80	14.24	15.65	17.04	16.76	16.42	16.32	15.01	15.58	16.25	16.30	17.01
1990	18.49	18.16	16.57	14.52	13.82	12.79	14.03	21.87	28.46	30.86	27.53	22.63
1991	19.60	16.28	15.13	16.16	16.44	15.58	16.36	16.60	16.71	17.72	17.12	14.68
1992	13.99	14.04	14.12	15.36	16.38	17.96	17.80	17.07	17.20	17.16	16.00	14.94
1993	14.70	15.53	15.94	16.15	16.03	15.06	13.83	13.75	13.39	16.27	15.21	12.95
1994	10.49	10.71	10.94	12.31	14.02	14.93	15.34	14.50	13.62	13.84	14.14	13.43
1995	14.00	14.71	14.68	15.84	15.85	15.02	14.01	14.13	14.49	13.68	14.03	15.02
1996	15.43	15.54	17.63	19.58	17.94	16.94	17.63	18.29	19.93	21.09	20.20	21.34
1997	21.76	19.38	17.83	16.63	17.23	15.88	15.89	16.19	16.41	17.66	16.83	15.04
1998	13.45	12.17	11.15	11.28	11.13	10.00	10.44	10.20	11.29	11.32	9.64	8.03

-- atural Gas

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U.S. Natural Gas Citygate Price



eia Data source: U.S. Energy Information Administration

Chart Tools
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This series is available through the EIA open data API and can be downloaded to Excel or embedded as an interactive chart or map on your w

U.S. Natural Gas Citygate Price (Dollars per Thousand Cubic Feet)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1978	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1982	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1983	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.97	3.91	3.88
1984	3.94	4.02	3.91	3.96	3.98	4.02	4.06	3.69	4.02	3.99	3.92	3.97
1985	3.89	3.94	3.97	3.91	3.89	3.86	3.69	3.70	3.68	3.59	3.46	3.45
1986	3.52	3.52	3.50	3.33	3.15	3.11	3.08	3.04	3.02	2.94	2.90	2.99
1987	2.98	3.03	2.91	2.86	2.81	2.84	2.92	2.89	2.83	2.69	2.76	2.84
1988	2.91	2.95	2.87	2.79	2.75	2.87	2.87	2.92	3.05	2.92	2.98	3.08
1989	3.17	3.10	2.89	2.83	2.94	2.98	3.08	3.04	2.99	2.84	2.98	3.10
1990	3.24	3.10	2.94	2.83	2.81	3.00	3.03	2.91	2.92	2.81	3.14	3.19
1991	3.08	2.94	2.78	2.74	2.76	2.86	2.74	2.78	2.91	2.92	2.92	3.05
1992	2.90	2.70	2.61	2.74	2.90	3.00	3.01	3.18	3.23	3.50	3.33	3.17
1993	3.11	2.94	3.06	3.24	3.58	3.44	3.34	3.35	3.54	3.15	3.15	3.27
1994	3.04	3.26	3.33	3.15	3.17	3.17	3.12	3.15	2.92	2.80	2.84	2.86
1995	2.79	2.71	2.74	2.72	2.80	2.89	2.89	2.87	2.89	2.83	2.67	2.83
1996	3.14	3.16	3.17	3.22	3.18	3.41	3.49	3.46	3.05	2.94	3.46	4.18
1997	4.28	3.76	3.07	2.92	3.11	3.41	3.44	3.34	3.50	3.86	4.76	3.42
1998	3.08	3.08	3.06	3.23	3.12	2.98	3.31	3.01	2.78	2.99	2.99	3.10
1999	2.85	2.92	2.77	2.88	3.25	3.12	3.11	3.39	3.59	3.21	3.71	3.19
2000	3.27	3.48	3.54	3.72	4.15	5.19	5.20	4.63	5.21	5.66	5.20	6.64
2001	8.91	7.08	6.10	6.30	5.77	5.38	4.03	4.32	3.66	3.37	4.02	3.90
2002	3.79	3.76	3.84	4.21	4.07	4.15	3.95	3.67	3.99	4.32	4.65	4.74
2003	5.28	5.83	7.63	5.60	5.69	6.40	5.83	5.48	5.58	5.33	5.54	5.89
2004	6.41	6.35	6.23	6.31	6.48	6.94	6.68	6.51	6.06	6.30	7.50	7.49
2005	7.05	7.09	7.24	7.79	7.51	7.30	7.68	8.20	10.26	12.16	11.57	10.77
2006	10.80	9.34	8.81	8.29	7.99	7.39	7.40	8.10	7.68	6.42	8.47	8.66
2007	7.88	8.57	8.79	8.20	8.41	8.45	8.02	7.60	7.00	7.43	8.14	8.27
2008	8.37	8.91	9.49	9.84	11.05	11.85	12.48	10.20	8.99	7.80	7.93	8.16
2009	7.97	7.26	6.85	5.71	5.49	5.55	5.70	5.61	5.37	5.65	6.34	6.22
2010	6.84	6.64	6.50	5.88	5.81	6.02	6.31	6.22	5.72	5.70	5.48	5.74
2011	5.69	5.75	5.73	5.62	5.80	6.12	6.16	6.19	5.94	5.45	5.29	5.03
2012	4.85	4.73	4.84	4.19	4.30	4.63	4.88	5.13	4.76	4.65	4.79	4.79

2013	4.52	4.56	4.75	5.16	5.55	5.74	5.51	5.24	5.21	4.88	4.78	4.93
2014	5.56	6.41	6.57	5.64	5.90	6.05	5.99	5.49	5.51	5.16	4.91	5.15
2015	4.48	4.57	4.35	3.93	4.25	4.44	4.65	4.59	4.56	4.00	3.69	3.75
2016	3.39	3.48	3.49	3.22	3.44	3.84	4.42	4.33	4.60	4.19	3.90	3.96
2017	4.21	4.13	3.84	4.20	4.42	4.82	4.73	4.61	4.52	4.03	3.97	4.00
2018	4.36	3.99	3.69	3.65	4.14	4.49	4.50	5.25	4.72	4.10	4.28	4.72
2019	4.03	3.91	4.07	3.72	3.66	4.17	4.17	4.15	4.07	3.42	3.46	3.50
2020	3.26	3.09	3.25	3.05	3.31	3.81	3.92	4.09	4.07	3.50	3.81	3.57
2021	3.27	12.10	4.09	3.92	4.34	5.05	5.58	5.72	5.95	6.43	6.04	5.87
2022	5.48	5.78	5.55	6.32	8.21	9.91	8.79	10.20	9.69	6.79	6.72	8.11
2023	9.12	6.57	5.11	4.31	4.01	4.54	4.82	4.86	4.90	4.11	4.37	4.44
2024	4.77	4.52	3.99	3.36	3.68	4.22	4.47	4.17	4.16	4.10	4.01	4.40
2025	4.86	4.84	4.87	4.51	4.62	4.85	5.18	5.15	5.07	4.34	4.74	5.10

- = No Data Reported; -- = Not Applicable; NA = Not Available; W = Withheld to avoid disclosure of individual company data.

Release Date: 2/27/2026
Next Release Date: 3/31/2026

Referring Pages:

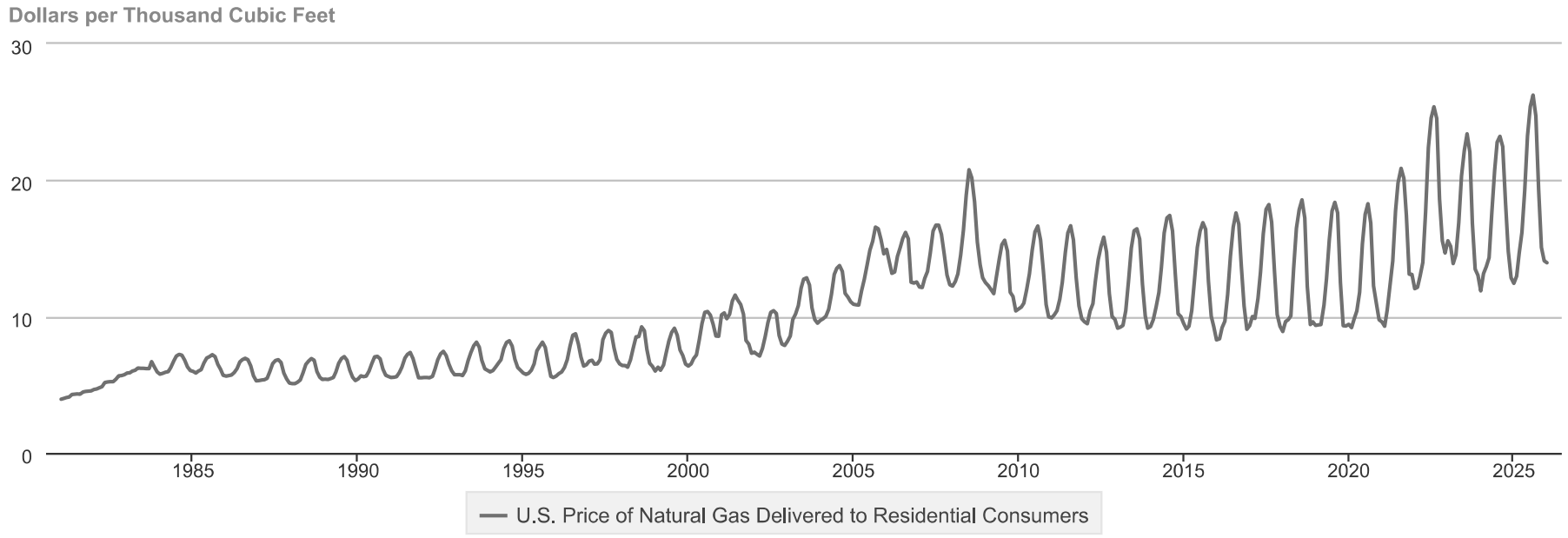
Natural Gas Citygate Price
U.S. Natural Gas Prices
Natural Gas Citygate Price (Summary)

-- atural Gas

View History: ○ Monthly ○ Annual | Download Data (XLS File)

U.S. Price of Natural Gas Delivered to Residential Consumers

DOWNLOAD



eia Data source: U.S. Energy Information Administration

Chart Tools
no analysis applied

This series is available through the EIA open data API and can be downloaded to Excel or embedded as an interactive chart or map on your website.

U.S. Price of Natural Gas Delivered to Residential Consumers (Dollars per Thousand Cubic Feet)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1978	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	3.94	3.99	4.06	4.11	4.29	4.30	4.32	4.30	4.47	4.50	4.53	4.55
1982	4.65	4.69	4.78	4.86	5.17	5.20	5.23	5.23	5.41	5.66	5.68	5.74
1983	5.86	5.87	6.00	6.06	6.22	6.20	6.21	6.18	6.19	6.70	6.30	5.94
1984	5.78	5.84	5.92	5.96	6.27	6.76	7.11	7.23	7.17	6.80	6.31	6.05
1985	5.97	5.86	5.99	6.11	6.59	6.96	7.07	7.21	7.06	6.50	6.13	5.70
1986	5.63	5.67	5.71	5.89	6.18	6.67	6.84	6.94	6.83	6.38	5.66	5.28
1987	5.30	5.34	5.36	5.46	5.98	6.55	6.78	6.84	6.64	5.85	5.42	5.13
1988	5.08	5.09	5.18	5.35	5.87	6.50	6.74	6.92	6.79	5.95	5.56	5.39
1989	5.41	5.38	5.45	5.54	5.93	6.58	6.92	7.07	6.80	6.06	5.56	5.30
1990	5.43	5.65	5.60	5.64	6.00	6.56	7.04	7.08	6.90	6.14	5.69	5.62
1991	5.54	5.56	5.60	5.90	6.28	6.97	7.23	7.36	6.92	6.20	5.51	5.51
1992	5.53	5.54	5.50	5.62	6.15	6.84	7.27	7.45	7.15	6.52	6.02	5.74
1993	5.73	5.73	5.67	6.02	6.78	7.37	7.86	8.13	7.75	6.79	6.17	6.07
1994	5.93	6.04	6.30	6.60	6.84	7.66	8.10	8.22	7.84	6.86	6.27	6.06
1995	5.85	5.76	5.84	6.06	6.54	7.49	7.82	8.13	7.73	6.62	5.61	5.54
1996	5.64	5.82	5.93	6.27	6.84	7.83	8.64	8.73	7.99	7.05	6.37	6.47

1997	6.74	6.79	6.52	6.53	6.83	8.30	8.78	8.99	8.84	7.69	6.86	6.54
1998	6.41	6.41	6.29	6.81	7.70	8.51	8.53	9.25	8.96	7.60	6.58	6.34
1999	6.00	6.29	6.06	6.44	7.30	8.20	8.83	9.14	8.63	7.56	7.15	6.51
2000	6.37	6.54	6.91	7.19	8.26	9.50	10.32	10.37	10.10	9.44	8.58	8.56
2001	10.12	10.26	9.85	10.16	11.14	11.58	11.22	10.89	10.17	8.24	7.98	7.30
2002	7.38	7.23	7.10	7.66	8.54	9.58	10.31	10.44	10.23	8.61	7.99	7.87
2003	8.18	8.58	9.77	10.18	10.79	12.08	12.75	12.84	12.31	10.64	9.77	9.51
2004	9.71	9.85	10.03	10.54	11.63	13.08	13.54	13.74	13.31	11.69	11.44	11.09
2005	10.90	10.87	10.84	11.88	12.74	13.79	14.86	15.51	16.56	16.44	15.64	14.60
2006	14.92	13.98	13.17	13.27	14.41	15.07	15.72	16.18	15.71	12.51	12.45	12.53
2007	12.17	12.13	12.81	13.31	14.69	16.28	16.71	16.71	16.03	14.57	13.04	12.34
2008	12.24	12.58	13.13	14.49	16.33	18.91	20.77	20.17	18.41	15.45	13.80	12.84
2009	12.49	12.26	11.98	11.68	12.86	14.26	15.27	15.61	14.80	11.78	11.48	10.42
2010	10.56	10.69	10.99	11.97	13.12	14.86	16.21	16.65	15.63	13.37	10.89	9.98
2011	9.90	10.14	10.43	11.27	12.50	14.70	16.14	16.67	15.63	12.85	10.78	9.83
2012	9.62	9.47	10.41	10.94	12.61	14.18	15.13	15.82	14.72	11.68	9.99	9.80
2013	9.15	9.23	9.35	10.43	12.61	15.02	16.30	16.43	15.69	12.38	10.04	9.14
2014	9.26	9.77	10.70	11.76	13.60	16.13	17.23	17.41	16.27	13.11	10.19	10.01
2015	9.50	9.08	9.28	10.43	12.73	15.07	16.28	16.88	16.40	12.60	10.02	9.27
2016	8.28	8.36	9.19	9.65	11.62	14.43	16.56	17.60	16.78	13.74	10.77	9.06
2017	9.32	10.01	9.86	11.34	13.25	16.06	17.86	18.22	16.92	13.39	10.14	9.29
2018	8.90	9.63	9.76	10.05	13.52	16.47	17.85	18.56	17.23	12.22	9.42	9.62
2019	9.36	9.40	9.42	10.85	12.76	15.60	17.74	18.37	17.61	12.50	9.33	9.30

2020	9.43	9.19	9.80	10.42	11.79	15.33	17.49	18.27	16.85	12.26	10.99	9.75
2021	9.62	9.28	10.47	12.27	14.07	17.74	19.81	20.86	20.13	17.40	13.11	13.08
2022	12.04	12.15	12.94	13.97	17.68	22.41	24.57	25.39	24.52	18.62	15.56	14.66
2023	15.56	15.15	13.88	14.54	16.86	20.31	22.18	23.41	22.05	16.85	13.47	13.03
2024	11.89	13.14	13.66	14.32	17.67	20.72	22.78	23.22	22.46	18.38	14.79	12.85
2025	12.44	12.97	14.62	16.17	19.24	23.26	25.41	26.24	24.70	19.32	15.07	14.09
2026	13.94											

- = No Data Reported; – = Not Applicable; NA = Not Available; W = Withheld to avoid disclosure of individual company data.

Release Date: 3/31/2026
Next Release Date: 4/30/2026

Referring Pages:

Average Residential Price
U.S. Natural Gas Prices
Natural Gas Residential Price (Summary)

REC-R405.2(1)-24 – Staff Summary

Proponent: William Penniman, representing Sierra Club Virginia Chapter

Brief Description: Requires that calculations for the Simulated Building Performance compliance option be based on annual site energy use, expressed in Btu or Btu per square foot of conditioned floor area, instead of annual energy cost.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the second Energy Sub-Workgroup meeting on September 29, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith

- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

- **Florin Moldovan** (DHCD staff) addresses the group and notes that if there are two proposals addressing the same section, such as this proposal and the previous proposal by **Eric L**, staff will identify these proposals for the Board to make them aware of the competing outcomes if both proposals are approved.
    - **Bill P** provides an overview of the proposal, and no further discussion occurred.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Second GSW Meeting — 10/03/2025

Support: None

Opposition: Mike O'Connor, VPCMA and VAPGA.

Discussion:

Bill P provides an overview of the proposal.

a. **Dan Willham** [Fairfax County and Virginia Building and Code Officials Association (VBCOA)] asked what difference it makes if you use BTUs (energy units) or dollars (cost) to calculate this ratio.
    i. **Bill P** explained that if you base the calculation on dollars, you are subject to the volatility of changing energy prices.
    ii. **Dan W** countered that in practice, you would use the same cost rates for both your actual

design and the code's reference design, so the calculation should remain correlated.

iii. **Bill P** reiterated that using BTUs means the analysis is based on energy consumption alone, avoiding the complications of fluctuating prices. Using dollars introduces a multiplier—the energy price—that can swing widely and unpredictably.

b. **Shahriar Amiri** (Arlington County) asked for clarification: "What is the standard reference design?"
   i. **Bill P** answered that the standard reference design is the minimum requirements of the code.

c. **Mike O'** asked for justification of the cost impact statement, noting that the proponent's reason statement addresses the future re-enforcement of RGGI (Regional Greenhouse Gas Initiative), which, anecdotally, has increased the cost of utilities.
   i. **Bill P** replied that costs are coming down because the energy mix is shifting toward solar, wind, and nuclear, which are becoming cheaper over time. RGGI will influence the supply of these alternate forms of energy.

d. **Andrew C** asked for clarification on whether it is the builder's choice to follow the simulated performance path for compliance, or if it is being mandated.
   i. **Bill P** responded that it is the builder's choice.

DHCD Staff Note:

This proposal conflicts with proposal REC-R405.2-24, which was reviewed by stakeholders at each one of the three Energy Sub-Workgroup meetings on July 9, 2025, September 29, 2025, and November 14, 2025, and at the third GSW meeting on January 5, 2026, where it received a Non-Consensus recommendation.

REC-R405.2(2)-24

IECC: R405.2, R406.3

Proponents: Eric Lacey, representing Responsible Energy Codes Alliance (eric@reca-codes.com)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R405.2 Simulated building performance compliance.. Compliance based on *simulated building performance* requires that a *building* comply with the following:

1. The requirements of the sections indicated within Table R405.2.
2. The proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the required total building thermal envelope TC using the prescriptive *U*-factors and *F*-factors from Table R402.1.2 multiplied by 1.08 ~~in Climate Zones 0, 1 and 2, and 1.15 in Climate Zones 3 through 8,~~ in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

   Equation 4-2 ~~For Climate Zones 0–2:~~ $TC_{Proposed\ design} \leq 1.08 \times TC_{Prescriptive\ reference\ design}$

   ~~For Climate Zones 3–8: $TC_{Proposed\ design} \leq 1.15 \times TC_{Prescriptive\ reference\ design}$~~

3. For each *dwelling unit* with one or more fuel-burning appliances for space heating, water heating, or both, the annual *energy cost* of the *dwelling unit* shall be less than or equal to 80 percent of the annual *energy cost* of the *standard reference design*. For all other *dwelling units*, the annual *energy cost* of the proposed design shall be less than or equal to 85 percent of the annual *energy cost* of the *standard reference design*. For each dwelling unit with greater than 5,000 square feet (465 m^2) of *living space* located above grade plane, the annual *energy cost* of the *dwelling unit* shall be reduced by an additional 5 percent of annual *energy cost* of the *standard reference design*. Energy prices shall be taken from an *approved* source, such as the US Energy Information Administration's State Energy Data System prices and expenditures reports. Code officials shall be permitted to require time-of-use pricing in *energy cost* calculations.

   Exceptions:

   1. The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the *energy cost*. The source energy multiplier for electricity shall be 2.51. The source energy multipliers shall be 1.09 for natural gas, 1.15 for propane, 1.19 for fuel oil, and 1.30 for imported liquified natural gas.
   2. The energy use based on site energy expressed in Btu or Btu per square foot of conditioned floor area shall be permitted to be substituted for the energy cost.

R406.3 Building thermal envelope.. The proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the required total *building thermal envelope* TC using the prescriptive *U*-factors and *F*-factors from Table R402.1.2 multiplied by 1.08 ~~in Climate Zones 0, 1 and 2, and by 1.15 in Climates Zones 3 through 8,~~ in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

Reason Statement: The most cost-effective time to properly insulate homes is at construction, when an incremental investment in envelope efficiency will pay dividends over the 70-100 year useful life of the home. As such, the code should not allow unlimited trade-offs of envelope efficiency for other measures.

This proposal updates the thermal envelope trade-off backstops to reflect Virginia's weaker wall insulation requirements. The IECC allows

substantial trade-off flexibility in the performance path and Energy Rating Index (and in above-code programs), but these trade-offs are not unlimited. The 2024 IECC allows the thermal envelope to be (on average) 15% less efficient than the IECC prescriptive envelope requirements in Virginia's climate zones, as long as the efficiency losses are accounted for elsewhere.

In Virginia, the current wall insulation requirements allow even weaker envelope efficiency (because the baseline to which 15% is applied is already much lower). Based on a simple REScheck-Web analysis of a sample 2500 square-foot home, we found that on an envelope-only (Total UA) comparison, Virginia's residential thermal envelope currently under-performs the 2024 IECC envelope by about 20%. If the wall insulation is improved to R-20, REScheck shows that the envelope is still 7.6% worse than the 2024 IECC envelope. Compliance reports from REScheck are linked at the bottom of this proposal.

This proposal modifies the envelope backstop from a 15% maximum trade-off cap to an 8% cap, which means envelope efficiency can still be 8% worse than Virginia's code (with R-20 wall insulation requirements), and approximately 15% weaker than an unamended 2024 IECC. While we would prefer to see all new homes perform at the same level, irrespective of compliance path, this proposal limits the underperformance of homes built to Sections R405 and R406 to approximately the same level of performance allowed under the 2024 IECC. Again, this adjustment is based on a scenario where Virginia updates its wall insulation requirement to R-20; if that requirement remains at R-15, we recommend an even more stringent backstop.

Cost Impact: The code change proposal will not increase or decrease the cost

This proposal will neither increase nor decrease the cost of construction. This proposal does not require anything more than what is already required for code compliance. It just ensures that in any performance-based compliance path, the thermal envelope efficiency cannot be more than 8% worse than a home built to the prescriptive path of Virginia's 2024 IECC with an R-20 wall insulation requirement.

Attached Files

- **Sample VA Home - R15 Walls.pdf**
  https://va.cdpaccess.com/proposal/1511/2223/files/download/1000/
- **Sample VA Home - R20 Walls.pdf**
  https://va.cdpaccess.com/proposal/1511/2223/files/download/999/
- **Sample VA Home - Full 2024 IECC.pdf**
  https://va.cdpaccess.com/proposal/1511/2223/files/download/998/

Compliance Certificate

Project Information

Project Title:	**A Sample Project**
Energy Code:	2024 IECC
Location:	Glen Allen, Virginia
Construction Type:	Single Family
Project Type:	New Construction
Project Sub Type:	None
Orientation:	Bldg. faces 180 deg. from North
Conditioned Floor Area:	2500 ft2
Glazing Area:	14%
Climate Zone:	4a (4220 HDD)
Project No:	1629133
All Electric:	false
Is Renewable:	false
Has Battery:	false
Has Charger:	false
Has Heat Pump	false

Construction Site:

123 Main St.
Glen Allen , VA

Owner/Agent:

Designer/Contractor:

Project Notes:

Energy Credits

Description	Credits
R408.2.3(1)(a): Gas-fired storage water heaters (Option 1)	5.0
R408.2.2(2): High Performance Cooling (Option 1)	2.0
R408.2.2(4): High Performance Gas furnace (Option 1)	5.0

Required: 10 Proposed: 12

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Prop. U-Factor/ F-Factor	Req. U-Factor/ F-Factor	Prop. UA	Req. UA
my Ceiling: Flat Ceiling or Scissor Truss	2500	49.0	0.0	0.026	0.026	65	65
Floor: Slab-On-Grade (Unheated) Insulation depth: 3.00' Insulation position: Fully Insulated (uniform R-value across perimeter and under slab)	70		10.0	0.360	0.510	25	36
Wall 1: Wood Frame, 24" o.c. Orientation: Front	1200	15.0	0.0	0.074	0.045	67	41
Window: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Window 2: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Door 2: Solid Door (under 50% glazing) Orientation: Front	32			0.300	0.300	10	10
Wall 2: Wood Frame, 24" o.c. Orientation: Front	1200	15.0	0.0	0.074	0.045	77	47
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Door 1 Copy: Solid Door (under 50% glazing) Orientation: Front	32			0.300	0.300	10	10
Wall 3: Wood Frame, 24" o.c. Orientation: Front	1200	15.0	0.0	0.074	0.045	79	48
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Wall 4: Wood Frame, 24" o.c. Orientation: Front	1200	15.0	0.0	0.074	0.045	79	48
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39

Compliance: Fails using UA trade-off

Compliance: 21.4% Worse Than Code	Max UA: 500	Your UA: 607	Max SHGC: 0.40	Your SHGC: 0.40

The % Better or Worse Than Code Index reflects how close to compliance the house is based on code trade-off rules. It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

Inspection Checklist

Energy Code: 2024 IECC

Requirements: 96% were addressed directly in the RES*check* software

Text in the "Comments/Assumptions" column is provided by the user in the REScheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Pre-Inspection/Plan Review

Section # & Req.ID	Pre-Inspection/Plan Review	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
105.1, 105.2 [PR1][1]	Construction drawings and documentation demonstrate energy code compliance for the building envelope. Thermal envelope and energy compliance path represented on construction documents.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
105.1, 105.2, 403.8 [PR3][1]	Construction drawings and documentation demonstrate energy code compliance for lighting and mechanical systems. Systems serving multiple dwelling units must demonstrate compliance with the IECC Commercial Provisions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
302.1, 403.7 [PR2][1]	Heating and cooling equipment is sized per ACCA Manual S based on loads calculated per ACCA Manual J or other methods approved by the code official.	Heating: Btu/hr Cooling: Btu/hr	Heating: Btu/hr Cooling: Btu/hr	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Foundation Inspection

Section # & Req.ID	Foundation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.2, 402.2.10 [FO2][1]	Slab edge insulation installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.8 [FI91][2]	Systems serving multiple dwelling units comply with Sections C403 and C404 of the commercial code.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.1 [FI92][2]	Heating systems installed for outdoor heating are radiant systems controlled by occupancy sensing or timer switch.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.2, 403.9.3, 403.9.4 [FI92][2]	Snow and ice-melting system controls installed to shut off system when pavement temperature > 50F and no precipitation or automatic controls to shut off the system when outdoor temperature > 40F.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.2 [FO1][1]	Slab edge insulation R-value.	R-☐ Unheated ☐ Heated	R-☐ Unheated ☐ Heated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
402.1.2 [FO3][1]	Slab edge insulation depth/length.	☐ ft	☐ ft	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Framing / Rough-In Inspection

Section # & Req.ID	Framing / Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1.3 [FR4][1]	U-factors of fenestration products are determined in accordance with the NFRC test procedure or taken from the default table.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.1.1 [FR23][1]	Air barrier and thermal barrier installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.3 [FR20][1]	Fenestration that is not site built is listed and labeled as meeting AAMA /WDMA/CSA 101/I.S.2/A440 or has infiltration rates per NFRC 400 that do not exceed code limits.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.4 [FR16][2]	IC-rated recessed lighting fixtures sealed at housing/interior finish and labeled to indicate ≤2.0 cfm leakage at 75 Pa.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4 [FR17][2]	HVAC piping conveying fluids above 105 ºF or chilled fluids below 55 ºF are insulated to ≥R-3.	R-☐	R-☐	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6 [FR19][2]	Automatic or gravity dampers are installed on all outdoor air intakes and exhausts for mechanical ventilation systems.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.1 [FR30][2]	Ventilation systems in climate zones 6, 7 & 8 shall utilize heat or energy recovery with balanced ventilation and a sensible recovery efficiency (SRE) >= 65% at 32 F.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.3 [FR12][1]	Supply and return ducts in attics insulated >= R-8 where duct is >= 3 inches in diameter and >= R-6 where < 3 inches.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Framing / Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.3.6 [FR13][1]	Ducts, air handlers and filter boxes are sealed with joints/seams compliant with International Mechanical Code or International Residential Code, as applicable.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4.1 [FR24][1]	Protection of insulation on HVAC piping.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.2 [FR18][2]	Hot water pipes are insulated to ≥ 1 inch of insulation.	R-☐	R-☐	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.5 [FR29][2]	Air-sealed electrical and communication boxes installed in the thermal boundary of the envelope sealed to limit air leakage between conditioned and unconditioned spaces.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.1 [FR12][1]	Duct systems are design and sized in accordance with ACCA Manual D. Duct systems serving multiple dwelling units is sized in accordance with ASHRAE Handbook of Fundamentals, ACCA Manual D or an equivalent methodology.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.4.4 [FR1][1]	Door U-factor.	U-☐	U-☐	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
402.1, 402.4.1, 402.4.3, 402.6 [FR2][1]	Glazing U-factor (area-weighted average).	U-☐	U-☐	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Insulation Inspection

Section # & Req.ID	Insulation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1 [IN13][2]	All installed insulation is labeled or the installed R-values provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [IN4][1]	Wall insulation is installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.2.6, 402.2.7 [IN3][1]	Wall insulation R-value. If this is a mass wall with at least ½ of the wall insulation on the wall exterior, the exterior insulation requirement applies (FR10).	R- ☐ Wood ☐ Mass ☐ Steel	R- ☐ Wood ☐ Mass ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Final Inspection Provisions

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1.1.1, 303.2 [FI2][1]	Ceiling insulation installed per manufacturer's instructions. Blown insulation marked every 300 ft².			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.3 [FI18][3]	Manufacturer manuals for mechanical and water heating systems have been provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2 [FI26][2]	Hot water boilers have automatic outdoor setback control to lower boiler water temperature based on outdoor temperature, indoor temperature or water temperature sensing.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.6.1 [FI24][1]	Air handler leakage designated by manufacturer at <=2% of design air flow.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.7 [FI27][1]	Ducts are pressure tested in accordance with ANEI/RESNET/ICC 380 or ASTME1554 to determine air leakage with either: Rough-in test: Total leakage measured with a pressure differential of 0.1 inch w.g. across the system including the manufacturer's air handler enclosure if installed at time of test. Postconstruction test: Total leakage measured with a pressure differential of 0.1 inch w.g. across the entire system including the manufacturer's air handler enclosure.	☐ cfm/100 ft^2	☐ cfm/100 ft^2	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.8 [FI4][1]	Duct tightness test result of <=4 cfm/100 ft2 across the system or <=3 cfm/100 ft2 without air handler @ 25 Pa. Duct tightness <= 8 cfm/100 ft2 for ducts within thermal envelope. For rough-in tests, verification may need to occur during Framing Inspection.	☐ cfm/100 ft^2	☐ cfm/100 ft^2	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1 [FI11][2]	Circulating service hot water systems have automatic or accessible manual controls.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1.1.1 [FI32][2]	Demand recirculation water systems have automatic controls to start pump when hot water is requested.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.5.1.1 [FI28][2]	Heated water circulation systems have a circulation pump. The system return pipe is a dedicated return pipe or a cold water supply pipe. Gravity and thermos-syphon circulation systems are not present. Controls for circulating hot water system pumps start the pump with signal for hot water demand within the occupancy. Controls automatically turn off the pump when water is in circulation loop is at set-point temperature and no demand for hot water exists.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1.2 [FI29][2]	Electric heat trace systems comply with IEEE 515.1 or UL 515. Controls automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.3 [FI31][2]	Drain water heat recovery units tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units < 3 psi for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units < 2 psi for individual units connected to three or more showers.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
401.3 [FI7][2]	Compliance certificate posted with building specifications, compliance path, R408 energy credits, results and solar ready zone if provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.2 [FI25][2]	403.6.2: All mechanical ventilation system fans meet efficacy and air flow limits per Table R403.6.2.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.3 [FI33][2]	Mechanical ventilation systems tested and verified to meet the minimum flow rates required by Section R403.6.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.5 [FI34][2]	Intermittent exhaust for bathrooms/toilet rooms has automatic control, occupant sensor control, humidity control or contaminant control.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.2.1, 402.2.2, 402.2.7 [FI1][1]	Ceiling insulation R-value.	R- ☐ Wood ☐ Steel	R- ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.13, 403.13.1 [FI35][3]	Gas fireplaces equipped with on-demand pilot, intermittent ignition or interrupted ignition. Fireplace efficiency > 50% in accordance with CSA P.4.1			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1 [FI6][1]	100% of permanent fixtures have high efficacy lamps.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1.2 [FI35][3]	Exterior lighting power is below the allowable wattage in Table R404.1.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1.5 [FI23][3]	Fuel gas lighting systems have no continuous pilot light.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.2.1, 404.2.2 [FI36][3]	Permanent interior lighting shall be controlled with either a manual dimmer, occupancy sensor or auto shut off control based on occupancy built with manual override.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.3 [FI37][3]	Exterior lighting >= 30 watts shall have the following controls: manual on/off switch with automatic shut-off, automatic shut-off in daylight hours, and controls that override automatic shutoff that returns to automatic control within 24 hours.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.4 [FI36][3]	Where renewable energy generation equipment is installed, renewable energy credits (RECs) or energy attributable certificates (EACs) associated with the renewable energy used for compliance are provided to the code official.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.4 [FI22][2]	Vented attics with air permeable insulation include baffle adjacent to soffit and eave vents that extends over insulation.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
408.2.2.1(2) [FI46][1]	Air conditioner installed with efficiency >= 15.2 SEER2/12.0 EER2 for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
408.2.2.1(4) [FI48][1]	Gas furnace installed with efficiency >= 97 AFUE for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.5 [FI3][1]	Attic access hatch and door insulation ≥R-value of the adjacent assembly.	R-	R-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
408.2.3(1)(a) [FI59][1]	Gas-fired storage water heater efficiency >= 0.81 UEF for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.1.3 [FI17][1]	Blower door test @ 50 Pa. <=4.0 ACH50 in Climate Zones 1-2, <=3.0 ACH50 in Climate Zones 3-5 and <= 2.5 ACH50 in Climate Zones 6-8.	ACH 50 =	ACH 50 =	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.3 [FI43][2]	Radiant barriers are installed in accordance with ASTM C1743	R- ☐ Wood ☐ Steel	R- ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
403.1.1 [FI9][2]	Programmable thermostats installed for control of primary heating and cooling systems and initially set by manufacturer to code specifications.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

2024 IECC Energy Efficiency Certificate

Insulation Rating	R-Value
Above-Grade Wall	15.00
Below-Grade Wall	0.00
Floor	10.00
Ceiling / Roof	49.00
Ductwork (unconditioned spaces):	____

Glass & Door Rating	U-Factor	SHGC
Window	0.30	0.40
Door	0.30	
Skylight	0.00	

Heating & Cooling Equipment	Efficiency
Heating System: _____	_____
Cooling System: _____	_____
Water Heater: _____	_____

Signature

Name: _____ **Date:** _____

Comments:

Compliance Certificate

Project Information

Project Title:	**A Sample Project**
Energy Code:	2024 IECC
Location:	Glen Allen, Virginia
Construction Type:	Single Family
Project Type:	New Construction
Project Sub Type:	None
Orientation:	Bldg. faces 180 deg. from North
Conditioned Floor Area:	2500 ft2
Glazing Area:	14%
Climate Zone:	4a (4220 HDD)
Project No:	1629133
All Electric:	false
Is Renewable:	false
Has Battery:	false
Has Charger:	false
Has Heat Pump	false

Construction Site:

123 Main St.
Glen Allen , VA

Owner/Agent:

Designer/Contractor:

Project Notes:

Energy Credits

Description	Credits
R408.2.2(4): High Performance Gas furnace (Option 1)	5.0
R408.2.2(2): High Performance Cooling (Option 1)	2.0
R408.2.3(1)(a): Gas-fired storage water heaters (Option 1)	5.0

Required: 10 Proposed: 12

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Prop. U-Factor/ F-Factor	Req. U-Factor/ F-Factor	Prop. UA	Req. UA
my Ceiling: Flat Ceiling or Scissor Truss	2500	49.0	0.0	0.026	0.026	65	65
Floor: Slab-On-Grade (Unheated) Insulation depth: 3.00' Insulation position: Fully Insulated (uniform R-value across perimeter and under slab)	70		10.0	0.360	0.510	25	36
Wall 1: Wood Frame, 24" o.c. Orientation: Front	1200	20.0	0.0	0.057	0.045	52	41
Window: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Window 2: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Door 2: Solid Door (under 50% glazing) Orientation: Front	32			0.300	0.300	10	10
Wall 2: Wood Frame, 24" o.c. Orientation: Front	1200	20.0	0.0	0.057	0.045	59	47
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Door 1 Copy: Solid Door (under 50% glazing) Orientation: Front	32			0.300	0.300	10	10
Wall 3: Wood Frame, 24" o.c. Orientation: Front	1200	20.0	0.0	0.057	0.045	61	48
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Wall 4: Wood Frame, 24" o.c. Orientation: Front	1200	20.0	0.0	0.057	0.045	61	48
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39

Compliance: Fails using UA trade-off

Compliance: 7.6% Worse Than Code	Max UA: 500	Your UA: 538	Max SHGC: 0.40	Your SHGC: 0.40

The % Better or Worse Than Code Index reflects how close to compliance the house is based on code trade-off rules. It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

Inspection Checklist

Energy Code: 2024 IECC

Requirements: 96% were addressed directly in the RES*check* software

Text in the "Comments/Assumptions" column is provided by the user in the REScheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Pre-Inspection/Plan Review

Section # & Req.ID	Pre-Inspection/Plan Review	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
105.1, 105.2 [PR1][1]	Construction drawings and documentation demonstrate energy code compliance for the building envelope. Thermal envelope and energy compliance path represented on construction documents.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
105.1, 105.2, 403.8 [PR3][1]	Construction drawings and documentation demonstrate energy code compliance for lighting and mechanical systems. Systems serving multiple dwelling units must demonstrate compliance with the IECC Commercial Provisions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
302.1, 403.7 [PR2][1]	Heating and cooling equipment is sized per ACCA Manual S based on loads calculated per ACCA Manual J or other methods approved by the code official.	Heating: Btu/hr Cooling: Btu/hr	Heating: Btu/hr Cooling: Btu/hr	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Foundation Inspection

Section # & Req.ID	Foundation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.2, 402.2.10 [FO2][1]	Slab edge insulation installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.8 [FI91][2]	Systems serving multiple dwelling units comply with Sections C403 and C404 of the commercial code.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.1 [FI92][2]	Heating systems installed for outdoor heating are radiant systems controlled by occupancy sensing or timer switch.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.2, 403.9.3, 403.9.4 [FI92][2]	Snow and ice-melting system controls installed to shut off system when pavement temperature > 50F and no precipitation or automatic controls to shut off the system when outdoor temperature > 40F.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.2 [FO1][1]	Slab edge insulation R-value.	R-☐ Unheated ☐ Heated	R-☐ Unheated ☐ Heated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
402.1.2 [FO3][1]	Slab edge insulation depth/length.	☐ ft	☐ ft	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Framing / Rough-In Inspection

Section # & Req.ID	Framing / Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1.3 [FR4][1]	U-factors of fenestration products are determined in accordance with the NFRC test procedure or taken from the default table.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.1.1 [FR23][1]	Air barrier and thermal barrier installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.3 [FR20][1]	Fenestration that is not site built is listed and labeled as meeting AAMA /WDMA/CSA 101/I.S.2/A440 or has infiltration rates per NFRC 400 that do not exceed code limits.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.4 [FR16][2]	IC-rated recessed lighting fixtures sealed at housing/interior finish and labeled to indicate ≤2.0 cfm leakage at 75 Pa.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4 [FR17][2]	HVAC piping conveying fluids above 105 ºF or chilled fluids below 55 ºF are insulated to ≥R-3.	R-☐	R-☐	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6 [FR19][2]	Automatic or gravity dampers are installed on all outdoor air intakes and exhausts for mechanical ventilation systems.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.1 [FR30][2]	Ventilation systems in climate zones 6, 7 & 8 shall utilize heat or energy recovery with balanced ventilation and a sensible recovery efficiency (SRE) >= 65% at 32 F.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.3 [FR12][1]	Supply and return ducts in attics insulated >= R-8 where duct is >= 3 inches in diameter and >= R-6 where < 3 inches.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Framing / Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.3.6 [FR13][1]	Ducts, air handlers and filter boxes are sealed with joints/seams compliant with International Mechanical Code or International Residential Code, as applicable.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4.1 [FR24][1]	Protection of insulation on HVAC piping.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.2 [FR18][2]	Hot water pipes are insulated to ≥ 1 inch of insulation.	R-	R-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.5 [FR29][2]	Air-sealed electrical and communication boxes installed in the thermal boundary of the envelope sealed to limit air leakage between conditioned and unconditioned spaces.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.1 [FR12][1]	Duct systems are design and sized in accordance with ACCA Manual D. Duct systems serving multiple dwelling units is sized in accordance with ASHRAE Handbook of Fundamentals, ACCA Manual D or an equivalent methodology.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.4.4 [FR1][1]	Door U-factor.	U-	U-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
402.1, 402.4.1, 402.4.3, 402.6 [FR2][1]	Glazing U-factor (area-weighted average).	U-	U-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Insulation Inspection

Section # & Req.ID	Insulation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1 [IN13][2]	All installed insulation is labeled or the installed R-values provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [IN4][1]	Wall insulation is installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.2.6, 402.2.7 [IN3][1]	Wall insulation R-value. If this is a mass wall with at least ½ of the wall insulation on the wall exterior, the exterior insulation requirement applies (FR10).	R- ☐ Wood ☐ Mass ☐ Steel	R- ☐ Wood ☐ Mass ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Final Inspection Provisions

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1.1.1, 303.2 [FI2][1]	Ceiling insulation installed per manufacturer's instructions. Blown insulation marked every 300 ft².			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.3 [FI18][3]	Manufacturer manuals for mechanical and water heating systems have been provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2 [FI26][2]	Hot water boilers have automatic outdoor setback control to lower boiler water temperature based on outdoor temperature, indoor temperature or water temperature sensing.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.6.1 [FI24][1]	Air handler leakage designated by manufacturer at <=2% of design air flow.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.7 [FI27][1]	Ducts are pressure tested in accordance with ANEI/RESNET/ICC 380 or ASTME1554 to determine air leakage with either: Rough-in test: Total leakage measured with a pressure differential of 0.1 inch w.g. across the system including the manufacturer's air handler enclosure if installed at time of test. Postconstruction test: Total leakage measured with a pressure differential of 0.1 inch w.g. across the entire system including the manufacturer's air handler enclosure.	☐ cfm/100 ft²	☐ cfm/100 ft²	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.8 [FI4][1]	Duct tightness test result of <=4 cfm/100 ft2 across the system or <=3 cfm/100 ft2 without air handler @ 25 Pa. Duct tightness <= 8 cfm/100 ft2 for ducts within thermal envelope. For rough-in tests, verification may need to occur during Framing Inspection.	☐ cfm/100 ft²	☐ cfm/100 ft²	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1 [FI11][2]	Circulating service hot water systems have automatic or accessible manual controls.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1.1.1 [FI32][2]	Demand recirculation water systems have automatic controls to start pump when hot water is requested.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.5.1.1 [FI28][2]	Heated water circulation systems have a circulation pump. The system return pipe is a dedicated return pipe or a cold water supply pipe. Gravity and thermos-syphon circulation systems are not present. Controls for circulating hot water system pumps start the pump with signal for hot water demand within the occupancy. Controls automatically turn off the pump when water is in circulation loop is at set-point temperature and no demand for hot water exists.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1.2 [FI29][2]	Electric heat trace systems comply with IEEE 515.1 or UL 515. Controls automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.3 [FI31][2]	Drain water heat recovery units tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units < 3 psi for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units < 2 psi for individual units connected to three or more showers.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
401.3 [FI7][2]	Compliance certificate posted with building specifications, compliance path, R408 energy credits, results and solar ready zone if provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.2 [FI25][2]	403.6.2: All mechanical ventilation system fans meet efficacy and air flow limits per Table R403.6.2.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.3 [FI33][2]	Mechanical ventilation systems tested and verified to meet the minimum flow rates required by Section R403.6.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.5 [FI34][2]	Intermittent exhaust for bathrooms/toilet rooms has automatic control, occupant sensor control, humidity control or contaminant control.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.2.1, 402.2.2, 402.2.7 [FI1][1]	Ceiling insulation R-value.	R-☐ ☐ Wood ☐ Steel	R-☐ ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.13, 403.13.1 [FI35][3]	Gas fireplaces equipped with on-demand pilot, intermittent ignition or interrupted ignition. Fireplace efficiency > 50% in accordance with CSA P.4.1			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1 [FI6][1]	100% of permanent fixtures have high efficacy lamps.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1.2 [FI35][3]	Exterior lighting power is below the allowable wattage in Table R404.1.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1.5 [FI23][3]	Fuel gas lighting systems have no continuous pilot light.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.2.1, 404.2.2 [FI36][3]	Permanent interior lighting shall be controlled with either a manual dimmer, occupancy sensor or auto shut off control based on occupancy built with manual override.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.3 [FI37][3]	Exterior lighting >= 30 watts shall have the following controls: manual on/off switch with automatic shut-off, automatic shut-off in daylight hours, and controls that override automatic shutoff that returns to automatic control within 24 hours.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.4 [FI36][3]	Where renewable energy generation equipment is installed, renewable energy credits (RECs) or energy attributable certificates (EACs) associated with the renewable energy used for compliance are provided to the code official.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.4 [FI22][2]	Vented attics with air permeable insulation include baffle adjacent to soffit and eave vents that extends over insulation.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
408.2.2.1(2) [FI46][1]	Air conditioner installed with efficiency >= 15.2 SEER2/12.0 EER2 for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
408.2.2.1(4) [FI48][1]	Gas furnace installed with efficiency >= 97 AFUE for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.5 [FI3][1]	Attic access hatch and door insulation ≥R-value of the adjacent assembly.	R-	R-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
408.2.3(1)(a) [FI59][1]	Gas-fired storage water heater efficiency >= 0.81 UEF for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.1.3 [FI17][1]	Blower door test @ 50 Pa. <=4.0 ACH50 in Climate Zones 1-2, <=3.0 ACH50 in Climate Zones 3-5 and <= 2.5 ACH50 in Climate Zones 6-8.	ACH 50 =	ACH 50 =	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.3 [FI43][2]	Radiant barriers are installed in accordance with ASTM C1743	R- ☐ Wood ☐ Steel	R- ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
403.1.1 [FI9][2]	Programmable thermostats installed for control of primary heating and cooling systems and initially set by manufacturer to code specifications.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

2024 IECC Energy Efficiency Certificate

Insulation Rating	R-Value
Above-Grade Wall	20.00
Below-Grade Wall	0.00
Floor	10.00
Ceiling / Roof	49.00
Ductwork (unconditioned spaces):	____

Glass & Door Rating	U-Factor	SHGC
Window	0.30	0.40
Door	0.30	
Skylight	0.00	

Heating & Cooling Equipment	Efficiency
Heating System: _____	_____
Cooling System: _____	_____
Water Heater: _____	_____

Signature

Name: _____ **Date:** _____

Comments:

Compliance Certificate

Project Information

Project Title:	**A Sample Project**
Energy Code:	2024 IECC
Location:	Glen Allen, Virginia
Construction Type:	Single Family
Project Type:	New Construction
Project Sub Type:	None
Orientation:	Bldg. faces 180 deg. from North
Conditioned Floor Area:	2500 ft2
Glazing Area:	14%
Climate Zone:	4a (4220 HDD)
Project No:	1629133
All Electric:	false
Is Renewable:	false
Has Battery:	false
Has Charger:	false
Has Heat Pump	false

Construction Site:

123 Main St.
Glen Allen , VA

Owner/Agent:

Designer/Contractor:

Project Notes:

Energy Credits

Description	Credits
R408.2.3(1)(a): Gas-fired storage water heaters (Option 1)	5.0
R408.2.2(2): High Performance Cooling (Option 1)	2.0
R408.2.2(4): High Performance Gas furnace (Option 1)	5.0

Required: 10 Proposed: 12

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Prop. U-Factor/ F-Factor	Req. U-Factor/ F-Factor	Prop. UA	Req. UA
my Ceiling: Flat Ceiling or Scissor Truss	2500	49.0	0.0	0.026	0.026	65	65
Floor: Slab-On-Grade (Unheated) Insulation depth: 3.00' Insulation position: Fully Insulated (uniform R-value across perimeter and under slab)	70		10.0	0.360	0.510	25	36
Wall 1: Wood Frame, 24" o.c. Orientation: Front	1200	30.0	0.0	0.047	0.045	43	41
Window: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Window 2: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Door 2: Solid Door (under 50% glazing) Orientation: Front	32			0.300	0.300	10	10
Wall 2: Wood Frame, 24" o.c. Orientation: Front	1200	30.0	0.0	0.047	0.045	49	47
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Door 1 Copy: Solid Door (under 50% glazing) Orientation: Front	32			0.300	0.300	10	10
Wall 3: Wood Frame, 24" o.c. Orientation: Front	1200	30.0	0.0	0.047	0.045	50	48
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39
Wall 4: Wood Frame, 24" o.c. Orientation: Front	1200	30.0	0.0	0.047	0.045	50	48
Window 2 Copy: Vinyl Frame SHGC: 0.4 Orientation: Front	130			0.300	0.300	39	39

Compliance: Passes using UA trade-off

Compliance: 0.6% Better Than Code	Max UA: 500	Your UA: 497	Max SHGC: 0.40	Your SHGC: 0.40

The % Better or Worse Than Code Index reflects how close to compliance the house is based on code trade-off rules. It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

Compliance Statement

The proposed building design described here is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the 2024 IECC requirements in RES*check*-Web and to comply with the mandatory requirements listed in the REScheck Inspection Checklist.

Name - Title	Signature	Date

Inspection Checklist

Energy Code: 2024 IECC

Requirements: 96% were addressed directly in the RES*check* software

Text in the "Comments/Assumptions" column is provided by the user in the REScheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Pre-Inspection/Plan Review

Section # & Req.ID	Pre-Inspection/Plan Review	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
105.1, 105.2 [PR1][1]	Construction drawings and documentation demonstrate energy code compliance for the building envelope. Thermal envelope and energy compliance path represented on construction documents.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
105.1, 105.2, 403.8 [PR3][1]	Construction drawings and documentation demonstrate energy code compliance for lighting and mechanical systems. Systems serving multiple dwelling units must demonstrate compliance with the IECC Commercial Provisions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
302.1, 403.7 [PR2][1]	Heating and cooling equipment is sized per ACCA Manual S based on loads calculated per ACCA Manual J or other methods approved by the code official.	Heating: Btu/hr Cooling: Btu/hr	Heating: Btu/hr Cooling: Btu/hr	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Foundation Inspection

Section # & Req.ID	Foundation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.2, 402.2.10 [FO2][1]	Slab edge insulation installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.8 [FI91][2]	Systems serving multiple dwelling units comply with Sections C403 and C404 of the commercial code.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.1 [FI92][2]	Heating systems installed for outdoor heating are radiant systems controlled by occupancy sensing or timer switch.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.2, 403.9.3, 403.9.4 [FI92][2]	Snow and ice-melting system controls installed to shut off system when pavement temperature > 50F and no precipitation or automatic controls to shut off the system when outdoor temperature > 40F.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.2 [FO1][1]	Slab edge insulation R-value.	R-☐ Unheated ☐ Heated	R-☐ Unheated ☐ Heated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
402.1.2 [FO3][1]	Slab edge insulation depth/length.	☐ ft	☐ ft	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Framing / Rough-In Inspection

Section # & Req.ID	Framing / Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1.3 [FR4][1]	U-factors of fenestration products are determined in accordance with the NFRC test procedure or taken from the default table.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.1.1 [FR23][1]	Air barrier and thermal barrier installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.3 [FR20][1]	Fenestration that is not site built is listed and labeled as meeting AAMA /WDMA/CSA 101/I.S.2/A440 or has infiltration rates per NFRC 400 that do not exceed code limits.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.4 [FR16][2]	IC-rated recessed lighting fixtures sealed at housing/interior finish and labeled to indicate ≤2.0 cfm leakage at 75 Pa.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4 [FR17][2]	HVAC piping conveying fluids above 105 ºF or chilled fluids below 55 ºF are insulated to ≥R-3.	R-☐	R-☐	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6 [FR19][2]	Automatic or gravity dampers are installed on all outdoor air intakes and exhausts for mechanical ventilation systems.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.1 [FR30][2]	Ventilation systems in climate zones 6, 7 & 8 shall utilize heat or energy recovery with balanced ventilation and a sensible recovery efficiency (SRE) >= 65% at 32 F.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.3 [FR12][1]	Supply and return ducts in attics insulated >= R-8 where duct is >= 3 inches in diameter and >= R-6 where < 3 inches.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Framing / Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.3.6 [FR13][1]	Ducts, air handlers and filter boxes are sealed with joints/seams compliant with International Mechanical Code or International Residential Code, as applicable.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4.1 [FR24][1]	Protection of insulation on HVAC piping.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.2 [FR18][2]	Hot water pipes are insulated to ≥ 1 inch of insulation.	R-	R-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.5 [FR29][2]	Air-sealed electrical and communication boxes installed in the thermal boundary of the envelope sealed to limit air leakage between conditioned and unconditioned spaces.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.1 [FR12][1]	Duct systems are design and sized in accordance with ACCA Manual D. Duct systems serving multiple dwelling units is sized in accordance with ASHRAE Handbook of Fundamentals, ACCA Manual D or an equivalent methodology.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.4.4 [FR1][1]	Door U-factor.	U-	U-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
402.1, 402.4.1, 402.4.3, 402.6 [FR2][1]	Glazing U-factor (area-weighted average).	U-	U-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Insulation Inspection

Section # & Req.ID	Insulation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1 [IN13][2]	All installed insulation is labeled or the installed R-values provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [IN4][1]	Wall insulation is installed per manufacturer's instructions.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.2.6, 402.2.7 [IN3][1]	Wall insulation R-value. If this is a mass wall with at least ½ of the wall insulation on the wall exterior, the exterior insulation requirement applies (FR10).	R- ☐ Wood ☐ Mass ☐ Steel	R- ☐ Wood ☐ Mass ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Final Inspection Provisions

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1.1.1, 303.2 [FI2][1]	Ceiling insulation installed per manufacturer's instructions. Blown insulation marked every 300 ft².			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.3 [FI18][3]	Manufacturer manuals for mechanical and water heating systems have been provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2 [FI26][2]	Hot water boilers have automatic outdoor setback control to lower boiler water temperature based on outdoor temperature, indoor temperature or water temperature sensing.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.6.1 [FI24][1]	Air handler leakage designated by manufacturer at <=2% of design air flow.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.7 [FI27][1]	Ducts are pressure tested in accordance with ANEI/RESNET/ICC 380 or ASTME1554 to determine air leakage with either: Rough-in test: Total leakage measured with a pressure differential of 0.1 inch w.g. across the system including the manufacturer's air handler enclosure if installed at time of test. Postconstruction test: Total leakage measured with a pressure differential of 0.1 inch w.g. across the entire system including the manufacturer's air handler enclosure.	☐ cfm/100 ft^2	☐ cfm/100 ft^2	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.8 [FI4][1]	Duct tightness test result of <=4 cfm/100 ft2 across the system or <=3 cfm/100 ft2 without air handler @ 25 Pa. Duct tightness <= 8 cfm/100 ft2 for ducts within thermal envelope. For rough-in tests, verification may need to occur during Framing Inspection.	☐ cfm/100 ft^2	☐ cfm/100 ft^2	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1 [FI11][2]	Circulating service hot water systems have automatic or accessible manual controls.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1.1.1 [FI32][2]	Demand recirculation water systems have automatic controls to start pump when hot water is requested.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.5.1.1 [FI28][2]	Heated water circulation systems have a circulation pump. The system return pipe is a dedicated return pipe or a cold water supply pipe. Gravity and thermos-syphon circulation systems are not present. Controls for circulating hot water system pumps start the pump with signal for hot water demand within the occupancy. Controls automatically turn off the pump when water is in circulation loop is at set-point temperature and no demand for hot water exists.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.1.2 [FI29][2]	Electric heat trace systems comply with IEEE 515.1 or UL 515. Controls automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5.3 [FI31][2]	Drain water heat recovery units tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units < 3 psi for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units < 2 psi for individual units connected to three or more showers.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
401.3 [FI7][2]	Compliance certificate posted with building specifications, compliance path, R408 energy credits, results and solar ready zone if provided.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.2 [FI25][2]	403.6.2: All mechanical ventilation system fans meet efficacy and air flow limits per Table R403.6.2.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.3 [FI33][2]	Mechanical ventilation systems tested and verified to meet the minimum flow rates required by Section R403.6.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6.5 [FI34][2]	Intermittent exhaust for bathrooms/toilet rooms has automatic control, occupant sensor control, humidity control or contaminant control.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1, 402.2.1, 402.2.2, 402.2.7 [FI1][1]	Ceiling insulation R-value.	R- ☐ Wood ☐ Steel	R- ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.13, 403.13.1 [FI35][3]	Gas fireplaces equipped with on-demand pilot, intermittent ignition or interrupted ignition. Fireplace efficiency > 50% in accordance with CSA P.4.1			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1 [FI6][1]	100% of permanent fixtures have high efficacy lamps.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1.2 [FI35][3]	Exterior lighting power is below the allowable wattage in Table R404.1.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1.5 [FI23][3]	Fuel gas lighting systems have no continuous pilot light.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.2.1, 404.2.2 [FI36][3]	Permanent interior lighting shall be controlled with either a manual dimmer, occupancy sensor or auto shut off control based on occupancy built with manual override.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.3 [FI37][3]	Exterior lighting >= 30 watts shall have the following controls: manual on/off switch with automatic shut-off, automatic shut-off in daylight hours, and controls that override automatic shutoff that returns to automatic control within 24 hours.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.4 [FI36][3]	Where renewable energy generation equipment is installed, renewable energy credits (RECs) or energy attributable certificates (EACs) associated with the renewable energy used for compliance are provided to the code official.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.4 [FI22][2]	Vented attics with air permeable insulation include baffle adjacent to soffit and eave vents that extends over insulation.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
408.2.2.1(2) [FI46][1]	Air conditioner installed with efficiency >= 15.2 SEER2/12.0 EER2 for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Section # & Req.ID	Final Inspection Provisions	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
408.2.2.1(4) [FI48][1]	Gas furnace installed with efficiency >= 97 AFUE for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.5 [FI3][1]	Attic access hatch and door insulation ≥R-value of the adjacent assembly.	R-	R-	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
408.2.3(1)(a) [FI59][1]	Gas-fired storage water heater efficiency >= 0.81 UEF for additional efficiency credit			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.5.1.3 [FI17][1]	Blower door test @ 50 Pa. <=4.0 ACH50 in Climate Zones 1-2, <=3.0 ACH50 in Climate Zones 3-5 and <= 2.5 ACH50 in Climate Zones 6-8.	ACH 50 =	ACH 50 =	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.3 [FI43][2]	Radiant barriers are installed in accordance with ASTM C1743	R- ☐ Wood ☐ Steel	R- ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	*See the Envelope Assemblies table for values*
403.1.1 [FI9][2]	Programmable thermostats installed for control of primary heating and cooling systems and initially set by manufacturer to code specifications.			☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

2024 IECC Energy Efficiency Certificate

Insulation Rating	R-Value
Above-Grade Wall	30.00
Below-Grade Wall	0.00
Floor	10.00
Ceiling / Roof	49.00
Ductwork (unconditioned spaces):	____

Glass & Door Rating	U-Factor	SHGC
Window	0.30	0.40
Door	0.30	
Skylight	0.00	

Heating & Cooling Equipment	Efficiency
Heating System: _____	_____
Cooling System: _____	_____
Water Heater: _____	_____

Signature

Name: _____ **Date:** _____

Comments:

REC-R405.2(2)-24 – Staff Summary

Proponent: Eric Lacey, representing Responsible Energy Codes Alliance

Brief Description: Changes the multiplier used to determine the proposed total building thermal envelope thermal conductance (TC) for compliance with the Simulated Building Performance method, reducing it from 1.15 to 1.08.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at the third Energy Sub-Workgroup meeting on November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman

- D.A. Pierce
- Dennis Hart
- Eric Lacey
- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Note: The original proposal number was REC-R405.2(1) but was changed to REC-R405.2(2) due to a naming conflict with another proposal submitted prior.

Eric L provided an overview of the proposal which modifies the 15 percent maximum trade-off cap in the IECC to 8 percent in the performance compliance path for an anticipated adoption of R-20 wall insulation in the 2024 VECC.

Bill P pointed out that this proposal's success might be dependent on the outcome of the wall insulation and air leakage proposals and recommended **Eric L** have a floor modification prepared at the next General Stakeholder Workgroup Meeting.

Florin Moldovan (DHCD staff) added that the fate of any proposal is unknown until the Board makes their decisions. There will be several competing proposals with several different outcomes. Staff will try to highlight competing proposals for the Board's convenience.

Bill P proposed linking proposals if there is broad support.

Florin M reemphasized that the purpose of these meetings is to bring stakeholders together to discuss proposals and facilitate consensus building wherever possible. That may involve a "give and take" between proponents to get consensus on as many proposals as possible. **Florin M**

strongly encouraged further discussion outside of this meeting before the final General Stakeholder Workgroup Meeting.

Michael R supported this proposal because envelope trade offs can have unintended consequences.

Sydney R supported this proposal.

Andrew G brought up that wall insulation is the most long-term investment in the home that can be made upfront and the most intrusive to upgrade as the home ages and that working together to reach consensus promotes ongoing affordability.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Janson Vandever, NAIMA; Justin Koscher, PIMA; and Sydney Roberts, SEEA.

Opposition: D.A. Pierce, VBCOA Energy Committee.

Discussion:

Eric L provided an overview of the proposal.

a. **Jason V** stated that it is shortsighted to trade off building equipment such as mechanical or lighting for a building component that will last forever.
b. **Justin K,** referring to some of his earlier comments, indicated that this is getting into that consumer protection, delivering something to the owners that they may have very little control over; therefor he supports the modest efficiency this proposal is after.
c. **Sydney R** explained that the importance of a backstop cannot be overstated and supports having a performance path that allows flexibility.
d. **D.A. Pierce** opposed any modifications to the software simulated path of compliance and wanted to leave in place any flexibility that exists.
e. **Eric L** clarified that the performance path uses Virginia's prescriptive baseline as its foundation, so if we don't modify this, then we are allowing the Virginia prescriptive path to weaken the software model. This proposal is trying to bring the software modeling back up to an equivalent level to an unamended 2024 IECC and not something less than code.

DHCD Staff Note: N/A

REC-R408.2.9-24

IRC: N1108.2.9 (R408.2.9)

Proponents: Eric Lacey, representing Responsible Energy Codes Alliance (eric@reca-codes.com)

2024 International Residential Code

Delete without substitution:

~~**N1108.2.9 (R408.2.9) Opaque walls.** For *buildings* in Climate Zones 4 and 5, the maximum *U-factor* of 0.060 shall be permitted to be used for wood-framed walls for compliance with Table N1102.1.2 where complying with one or more of the following:~~

~~1. Primary space heating is provided by a *heat pump* that meets one of the efficiencies in Section N1108.2.2.~~

~~2. All installed *water heaters* are *heat pumps* that meet one of the efficiencies in Section N1108.2.3.~~

~~3. In addition to the number of credits required by Section N1108.2, three additional credits are achieved.~~

~~4. *Renewable energy resources* are installed to meet the requirements of Section N1108.2.7.~~

Reason Statement: New Section R408.2.9 is an efficiency loophole incorporated into the 2024 *IECC* with potential long-term negative impacts. It allows a reduction in wall insulation where one of four conditions is met. There are several problems with this section:

1. None of the specific measures will provide efficiency for as long as the wall insulation being traded off. Measures 1 and 2 have significantly shorter useful lifetimes than wall insulation; measure 4 creates an efficiency trade-off for renewable energy, which is not allowed in either the prescriptive or performance paths of the *IECC*; and measure 3 allows a code user to select 3 more credits from Table R408.2, effectively creating a prescriptive envelope trade-off for 40+ measures that may or may not match the longevity or efficiency of wall insulation. No analysis was provided to justify this trade-off or to quantify whether these measures could save a comparable amount of energy as well-insulated walls.

2. Some advocates have been urging states to allow double-counting of these measures, effectively reducing envelope efficiency without any improvements elsewhere in the building. The charging language does not clarify whether measures 1, 2, and 4 are *in addition to* measures already used to comply with Section R408.2, or whether a code user may simply double-count these measures and reduce envelope efficiency. Neither the proponent's reason statement for this measure (REPI-33-21) nor any of the debate in the 2024 IECC development cycle addressed the possibility of double-counting, and it would seem to contradict language in measure 3 (which requires 3 credits "in addition to the number of credits required by Section R408.2"). Yet advocates at the state and national level have argued that code users should receive credit for these measures both to comply with Section R408.2 and to receive the benefits of an insulation reduction under R408.2.9.

This entire section is problematic, and will only to lead to reduced efficiency. The only reason it is included in the 2024 IECC is because it was part of a deal among IECC Residential Consensus Committee members where sustainability measures and efficiency rollbacks that failed to achieve the required number of votes were grouped into a large "omnibus" package. In response to several appeals, the ICC Board of Directors later reversed the portions of the omnibus related to sustainability, but left in place the efficiency rollbacks, making the 2024 IECC less stringent than the 2021 IECC in several places. Other states considering the 2024 IECC have either deleted this controversial section or are in the process of debating it. We strongly recommend deleting the entire section and maintaining the stringency of the IECC.

Cost Impact: The code change proposal will not increase or decrease the cost This section is a problematic and confusing exception that was introduced in the 2024 IECC. Eliminating it does not change the base efficiency requirements of the code, so it will neither increase nor decrease costs for code users.

REC-R408.2.9-24 – Staff Summary

Proponent: Eric Lacey, representing Responsible Energy Codes Alliance

Brief Description: Deletes, without substitution, Section N1108.2.9 (R408.2.9), which is new to the 2024 IECC and allows a reduction in wall insulation when one of four qualifying conditions is met in Climate Zones 4 and 5.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

The proposal was reviewed and discussed by the Energy Sub-Workgroup members and other interested stakeholders in attendance at each one of the three Energy Sub-Workgroup meetings on July 9, 2025, September 29, 2025, and November 14, 2025.

Energy Sub-Workgroup Membership and Representation

- DeAnthony (D.A.) Pierce – Virginia Building and Code Officials Association (VBCOA)
- Corian Carney – International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)
- Andrew Clark – Home Builders Association of Virginia (HBAV)
- Sarah Thomas – Virginia Association for Commercial Real Estate (VACRE)
- Steven Shapiro – Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA)
- Hana Nguyenky – American Institute of Architects, VA Chapter (AIA-VA)
- Chelsea Harnish – Virginia Energy Efficiency Council (VAEEC)
- Sydney Roberts – Southeast Energy Efficiency Alliance (SEEA)
- Eric Lacey – Responsible Energy Codes Alliance (RECA)
- Michael Rhodes or Justin Koscher – Polyisocyanurate Insulation Manufacturers Association (PIMA)
- Bill Penniman – Sierra Club (VA Chapter)
- Andrew Green – Viridiant
- Mason Trimble – Virginia Department of Energy (VA Energy)
- Dennis Hart – Virginia Plumbing and Mechanical Inspectors Association (VPMIA)
- Mike O'Connor – Virginia Propane Gas Association, Virginia Petroleum and Convenience Marketers Association (VPCMA)
- William Drumeller – Responsible House
- Ashish Kapoor – The Piedmont Environmental Council
- Dwayne Smith – Department of General Services/Division of Engineering and Buildings (DGS/DEB)

Sub-Workgroup members attendance — July 9, 2025:

- Steve Shapiro
- Sydney Roberts
- Mike O'Connor

- Corian Carney
- Dennis Hart
- D.A. Pierce
- Chelsea Harnish
- Stuart Nuckols
- Mason Trimble
- Bill Penniman
- Mike Rhodes
- Eric Lacey
- William Drumeller
- Hana Nguyenky
- Sarah Thomas
- Andrew Clark

Other stakeholders in attendance — July 9, 2025:

- Nicholas Bowles – Building Official, Nottoway County
- Kyle Kratzer – Virginia Building and Code Officials Association
- Mike Hamilton – Arlington County
- Bill Riggs – Viridiant
- Bob Shippee – Virginia Citizen
- Susan Stillman – Virginia Citizen
- Jason Vandever – North American Insulation Manufacturers Association
- Monica Rokicki – Better Building Works

Discussion:

- **Eric** – Provides an overview of the proposal, prevents double-counting appliance efficiency and envelope efficiency.
- **Bill P** - Appliance efficiency is not equivalent to envelope efficiency; the envelope lasts the life of the building.
- **Mike** - Trading off thermal efficiency reduces passive survivability.

Sub-Workgroup members attendance — September 29, 2025:

- Corian Carney
- Mason Trimble
- Dwayne Smith
- D.A. Pierce
- Steve Shapiro
- Andrew Clark
- Dennis Hart
- Bill Penniman
- Chelsea Harnish
- Eric Lacey
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Justin Koscher

Other stakeholders in attendance — September 29, 2025:

- Mike Hamilton – Virginia Building and Code Officials Association (VBCOA)
- Ross Shearer – Virginia Citizen
- Susan Stillman – Sierra Club, VA Chapter
- Stuart Nuckols – Viridiant
- Ron Clements – Chesterfield County
- Kyle Kratzer – Virginia Citizen
- Monica Rokicki – Better Building Works
- Christopher Leyen – Piedmont Environmental Council

Discussion:

D.A. Pierce stated that VBCOA supports this proposal, as well as any measures that provide loopholes for reducing wall insulation requirements.

Bill P interpreted the proposal differently, expressing a preference for retaining the current language in Section R408.2.9. He emphasized that while he does not believe the proposal would undermine the integrity of the thermal envelope, it would reduce overall energy efficiency.

D.A. Pierce reiterated his view that the thermal envelope is a long-lasting building component, so weakening its requirements could have future negative impacts, particularly as HVAC equipment is upgraded with the expectation of certain insulation levels.

Justin K supported deleting the existing provisions, arguing that they diminish long-term energy savings.

Eric L added that, as seen in states like Illinois that adopt the full 2024 IECC, RECA recommends deleting these provisions; he asserted that such measures are not equivalent and that they sacrifice lasting efficiency for short-term benefits.

Monica R likened the trade-off provisions to "blindfolded archery," suggesting they are unpredictable and risky.

Bill P noted that if the 0.60 U-factor from the 2024 IECC is adopted, this change should be viewed as an additive measure—complementary to other proposed improvements in the thermal envelope, not detraction.

Sub-Workgroup members attendance — November 14, 2025:

- Andrew Clark
- Andrew Grigsby – Viridiant, Sitting in for Andrew Green
- Bill Penniman
- D.A. Pierce
- Dennis Hart
- Eric Lacey

- K.C. Bleile – Virginia Energy Efficiency Council (VAEEC), Sitting in for Chelsea Harnish
- Mason Trimble
- Michael Rhodes
- Mike O'Connor
- Sarah Thomas
- Scott Pedowitz – (AOBA/VAMA) Sitting in for Steven Shapiro
- Sydney Roberts
- William Abrahamson – (AIA-VA) Sitting in for Hana Nguyenky

Other stakeholders in attendance — November 14, 2025:

- Bob Shippee – Private Citizen
- Chris Leyen – Piedmont Environmental Council
- Kara Alley - HBAV
- Michelle Coward - VBCOA
- Mike Hamilton – VBCOA
- Stephen Evanko – VAEEC
- Stuart Nuckols – Viridiant
- Susan Stillman – Sierra Club, VA Chapter

Discussion:

Eric L provided an overview of the proposal and clarified that the existing provisions only apply where the required wall insulation is greater than R-20. This new section should be deleted as it is not applicable in Virginia.

D.A. Pierce and **Michael R** supported the proposal.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: D.A. Pierce, VBCOA Energy Committee; and Jason Vandever, NAIMA.

Opposition: Andrew Clark, HBAV.

Discussion:

Eric L provided an overview of the proposal.

a. **D.A. Pierce** remarked that equipment can change but the thermal envelope remains the same and should not be reduced.

DHCD Staff Note: N/A

E2701.1.1-24

VCC: 2701.1.1

Proponents: Eric Mays, representing Prince William County (emays@pwcgov.org)

2021 Virginia Construction Code

Revise as follows:

2701.1.1 Changes to NFPA 70. The following changes shall be made to NFPA 70 :

1. Change Sections 334.10(2) and 334.10(3) of NFPA 70 to read:

   (2) Multifamily dwellings not exceeding four floors above grade and multifamily dwellings of any height permitted to be of Types III, IV and V construction except in any case as prohibited in 334.12.

   (3) Other structures not exceeding four floors above grade and other structures of any height permitted to be of Types III, IV and V construction except in any case as prohibited in 334.12. In structures exceeding four floors above grade, cables shall be concealed within walls, floors or ceilings that provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

   For the purpose of Items 2 and 3 above, the first floor of a *building* shall be that floor that has 50 percent or more of the exterior wall surface area level with or above finished grade. One additional level that is the first level and not designed for human habitation and used only for vehicle parking, storage or similar use shall be permitted.

2. Change Section 700.12(F)(2)(6) of NFPA 70 to read:

   (6) Where the normal power branch circuits that supply luminaires providing illumination immediately on the inside and outside of exit doors are supplied by the same service or feeder, the remote heads providing emergency illumination for the exterior of an exit door shall be permitted to be supplied by the unit *equipment* serving the area immediately inside the exit door.

3. Delete Section 210.8(F) in its entirety.

4. Change Section 210.52.(C)(2) of NFPA 70 to read:

(2) Island and Peninsular Countertops and Work Surfaces. Receptacle outlets shall be installed in accordance with 210.52(C)(3).

Reason Statement: The core principle of the Virginia Uniform Statewide Building Code is minimum safety at minimum cost. Article 210.52(C)(2) of the 2023 National Electrical Code does not adhere to this core principle. Specifically, the 2023 NEC introduces permissive language that reduces long-term safety by inducing the use of electrical extension cords and promoting future unpermitted electrical work. Additionally, it will be significantly more expensive to install code-compliant receptacle outlets to serve island and peninsular countertops and work surfaces after the original completion of construction.

One should not minimize the historical significance of NFPA's decision. The Consumer Product Safety Act was passed in 1972, which led to the creation of the Consumer Product Safety Commission (CPSC). Amongst the CPSC's many initiatives, the CPSC started tracking injuries and fires associated with the use of electrical extension cords.

In 1990, the CPSC issued a Press Release titled, "*Limit Extension Cords To Reduce Risk Of Fire*." [https://www.cpsc.gov/Newsroom/News-Releases/1990/Limit-Extension-Cords-To-Reduce-Risk-Of-Fire] The release stated in part, "If you use a lot of extension cords in your home or apartment, government safety experts say doing away with as many cords as possible can improve the safety of your home. According to CPSC estimates, there are some 4,600 residential home fires each year associated with extension cords; these fires kill 70 persons and injure some 230 others annually. Apart from fires, another 2,200 shock-related injuries happen with extension cords every year."

Consistent with the CPSC's recommendation, the 1990 edition of the National Electrical Code (NFPA 70) was amended to include the

requirements for providing receptacles for island and peninsular countertops and work surfaces to prevent the use of extension cords. The requirements were first enforced in Virginia through the 1992 edition of the CABO One and Two Family Dwelling Code.

NFPA’s decision to make the installation of receptacle outlets on island and peninsular countertops and work surfaces optional is an aberration. Residential receptacle outlet spacing and GFCI and AFCI protection are not optional. Why would NFPA set aside 35 years of precedence and support the use of electrical extension cords, promote future unpermitted electrical work, and incur higher future costs for owners?

Most importantly, why would Virginia follow NFPA’s current direction?

(NOTE: This Code change to the 2023 NEC is a companion change to the Code change to the 2024 VRC, titled RE3901.4.2-24.)

Cost Impact: The code change proposal will decrease the cost

The code change will decrease the cost by preventing fires and tripping hazards created by extension cords. Additionally, the code change will prevent future occupants from paying the increased cost of installing a code-compliant receptacle outlet after construction is completed. Lastly, cost will be decreased by preventing noncompliant unpermitted potentially hazardous electrical work being installed in the future (i.e., receptacle outlet below the counter edge).

An official website of the United States government Here's how you know

United States
CONSUMER PRODUCT SAFETY COMMISSION

Limit Extension Cords To Reduce Risk Of Fire

Release Date: May 01, 1990

If you use a lot of extension cords in your home or apartment, government safety experts say doing away with as many cords as possible can improve the safety of your home.

According to CPSC estimates, there are some 4,600 residential home fires each year associated with extension cords; these fires kill 70 persons and injure some 230 others annually. Apart from fires, another 2,200 shock-related injuries happen with extension cords every year.

CPSC offered the following safety hints for using extension cords:

- Don't use an extension cords unless absolutely necessary. If you do, it must be marked #16 or some lower AWG number (the lower the number, the larger the wire and the more current the cord can safely carry). Also, the cord should bear the certification label of an independent testing laboratory. Do not use #18 extension cords which were previously used for floor lamps and other low-wattage electrical products.

- Always use 3-wire extension cords for appliances with 3-prong plugs. Never remove the third prong which is a safety feature designed to reduce chances of shock or electrocution.

- When disconnecting cords from outlets, always pull on the plug rather than the cord itself. Discard any old, cracked, worn or damaged extension cords.

- Don't overload cords by plugging in appliances that draw more watts than the rating of the cord. You can check this easily by examining the cord to see what its wattage rating is. Use heavy-duty cords for high wattage appliances. Use extension cords labeled for outdoor use when powering tools and garden products outside the home. Also, it is good practice to plug into an outlet protected

by a ground-fault circuit interrupter (GFCI). The device shuts down power in milliseconds if the consumer is exposed to an electrocution or electrical burn hazard.

- Don't run cords under carpets or rugs since they prevent heat from being released by the cord.

A free brochure on safe use of extension cords is available from CPSC by sending a postcard to Cords, Washington, D.C. 20207.

Release Number
90-086

About the U.S. CPSC

The U.S. Consumer Product Safety Commission (CPSC) is charged with protecting the public from unreasonable risk of injury associated with the use of thousands of types of consumer products. Deaths, injuries, and property damage from consumer product-related incidents cost the nation more than $1 trillion annually. Since the CPSC was established more than 50 years ago, it has worked to ensure the safety of consumer products, which has contributed to a decline in injuries associated with these products.

Federal law prohibits any person from selling products subject to a Commission ordered recall or a voluntary recall undertaken in consultation with the CPSC.

For lifesaving information:

- Visit CPSC.gov.
- Sign up to receive our email alerts.
- Follow us on Facebook, Instagram, X, BlueSky, Threads, LinkedIn and Truth Social.
- Report a dangerous product or a product-related injury on www.SaferProducts.gov.
- Call CPSC's Hotline at 800-638-2772 (TTY 800-638-8270).
- Contact a media specialist.

Media Contact	Please use the below phone number for all media requests. **Phone: (301) 504-7908** **Spanish: (301) 504-7800** View CPSC contacts for specific areas of expertise

E2701.1.1-24 – Staff Summary

Proponent: Eric Mays, representing Prince William County

Brief Description: Removes the option to provide provisions for the future installation of receptacles at an island or peninsular countertop or work surface, instead requiring receptacles to be installed at the time of construction.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Shahriar Amiri, Arlington County.

Opposition: Corian Carney, York County and International Alliance of the Electrical Industry, VA Chapter (IAEI-VA); Ryan Celestino, City of Newport News and IAEI-VA; Gerry O'Connor, Eaton; and Kyle Kratzer, Fairfax County and Virginia Building and Code Officials Association (VBCOA).

Discussion:

Tread Willis (speaking on behalf of the proponent) provided an overview of the proposal.

a. **Shahriar A** indicated that he is a part of inner jurisdictional meetings that have had a lot of discussion regarding this proposal.
b. **Cory C** noted that National Fire Protection Association (NFPA) has done research that has shown that having receptacles serving island and peninsula countertops and work surfaces is either as unsafe or more unsafe than not having them. NFPA has added the option to not have receptacles serving these countertops and work surfaces.
c. **Gerry O** brought up that there have been approximately 10,000 recorded emergency room cases since the early 90's.
d. **Tread W** added that this change is to the National Electrical Code and would include R-2 and R-3 dwelling units.
e. **Dan Willham** (Fairfax County and VBCOA) stated that having cords on the counters that can drape off whether there are receptacles on the side or not, there is going to be a tradeoff either way because people will just use extension cords.
f. **Gerry O** remarked that kitchen appliances are required to have a cord that is 24 inches or less, which is why the two-foot and four-foot rule for receptacle locations on kitchen countertops exist. So, these codes are designed to be aligned with the standards for these appliances.

g. **Kyle K** commented that this proposal still does not prevent a receptacle from being installed on the countertop at the edge of an island where a cord could hang over the side.

DHCD Staff Note:

VRC companion proposal RE3901.4.2-24 was reviewed by stakeholders at the first GSW meeting on July 29, 2026, and was ultimately carried over to the second GSW to allow for additional stakeholder collaboration. The proposal was reviewed again at the second GSW on October 3, 2025, and received a Non-Consensus recommendation. The excerpts from the first and second GSW meeting summaries pertaining to RE3901.4.2-24 are provided below.

GSW Meeting Summary Excerpts

First GSW Meeting — 07/29/2025

Support: None

Opposition: None

Discussion:

a. **Tread W** – Provides overview of the proposal.
i. **Dennis H** – Representing self. As I understand it, it's not required to have an outlet in an island or peninsula. This would still put the use of extension cords at risk of getting pulled over the countertop because they could choose not to install the receptacle in that island or that peninsula.
ii. **Tread W** – Asks for floor amendment. Get rid of the comma and the "if."
iii. **Sean Farrell** (Prince William County) – It still doesn't make it mandatory.
iv. **David Beahm** (Warren County) – No, it doesn't.
b. **Kyle Kratzer** [Fairfax County, Virginia Building and Code Officials Association (VBCOA)] – Is it your intention to keep the current provisions of 9 square ft and every 18 square ft after that? Or are we back to 1 outlet can work for the entire island?
i. **Tread W** – One outlet can work for the entire island. But it must be installed.
c. **Ron Clements** (Chesterfield County) – As the building official of my locality, I'm going to say this is still optional, the way it's written. This won't be enforced uniformly across the state.
d. **Jeff Brown** (DHCD staff) – This is a substantive change based on statements made; there appear to still be questions as to what is required in the 2024 IRC. We do have time for a couple more meetings.
e. **David B** – Verification of the other requirement is going to be critical. Because if not, you are just saying that no island needs an outlet.
f. **Corian Carney** [Independent Alliance of the Electrical Industry (IAEI), VA Chapter] – I'm neutral on this one.

g. **Dennis H** – People don't want the pop-up receptacles. I don't think you'll get a consensus if we require the pop-ups altogether.
    i. **Tread W** – Pop-ups aren't the only option. That is an option to achieve compliance, but it's not the only option.
h. **Jeff B** – Do you agree with carrying this one over?
    i. **Tread W** – We'll table and re-work.

i. Carried Over

Second GSW Meeting — 10/03/2025

Support: None

Opposition: Kyle Kratzer, representing himself; Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and VBCOA PMG Code Committee.

Discussion:

Eric Mays provided an overview of the proposal, including historical background with regard to how the provisions regarding island and peninsular countertop receptacles became code.

a. **Andrew Clark** [Home Builders Association of Virginia (HBAV)] asked if, based on the background narrative presented by the proponent, there is another proposal coming forward for consideration that aims to address the concerns with appliances falling off of the counter and causing injury.
    i. **Eric M** stated that an alternate proposal would be reverting back to the 2018 language, which worked for 85 million people.
    ii. **Andrew C** asked if carry over is possible to discuss with HBAV membership.
    iii. **Eric M** expressed interest in having this proposal be non-consensus so that he can work with **Andrew C** and HBAV on a separate proposal.
b. **Kyle K** (representing himself) pointed out that this change doesn't solve the problems and dangers associated with receptacles installed at the end of the island, noting that you can still install the receptacle at the end of the island, on top of the countertop, and the cord could still be hanging over.
    i. **Tread W** reaffirmed that this proposal seeks to mitigate the problem, not solve the problem.
c. **Dennis H** noted that the feedback he received is that this proposal essentially requires a pop-up receptacle installed in the countertop, which creates a situation where spills and debris can get into the assembly.
d. **Bryan Holland** [National Electrical Manufacturers Association (NEMA)] stated that every solution that has been developed at the national level has created an unintended worse consequence and that he does not believe there is a good answer to this problem. He suggested going with the design that worked for 30 years.

E2701.1.1(1)-24

VCC: CHAPTER 27, SECTION 2701, 2701.1.1

Proponents: Andrew Clark, representing Home Builders Association of Virginia (aclark@hbav.com)

2021 Virginia Construction Code

CHAPTER 27
ELECTRICAL

SECTION 2701
GENERAL

Revise as follows:

2701.1.1 Changes to NFPA 70. The following changes shall be made to NFPA 70 :

1. Change Sections 334.10(2) and 334.10(3) of NFPA 70 to read:

   (2) Multifamily dwellings not exceeding four floors above grade and multifamily dwellings of any height permitted to be of Types III, IV and V construction except in any case as prohibited in 334.12.

   (3) Other structures not exceeding four floors above grade and other structures of any height permitted to be of Types III, IV and V construction except in any case as prohibited in 334.12. In structures exceeding four floors above grade, cables shall be concealed within walls, floors or ceilings that provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

   For the purpose of Items 2 and 3 above, the first floor of a *building* shall be that floor that has 50 percent or more of the exterior wall surface area level with or above finished grade. One additional level that is the first level and not designed for human habitation and used only for vehicle parking, storage or similar use shall be permitted.

2. Change Section 700.12(F)(2)(6) of NFPA 70 to read:

   (6) Where the normal power branch circuits that supply luminaires providing illumination immediately on the inside and outside of exit doors are supplied by the same service or feeder, the remote heads providing emergency illumination for the exterior of an exit door shall be permitted to be supplied by the unit *equipment* serving the area immediately inside the exit door.

3. Delete Section 210.8(F) in its entirety.

4. Change Section 210.8(A)(5) to read:

(5)	Unfinished portions or areas of the basement not intended as habitable rooms

Reason Statement: This amendment removes the blanket requirement for all basement receptacles to be GFCI-protected, restoring the previous limitation to unfinished portions of basements. Prior to the 2020 NEC, GFCI protection was required only in unfinished basement areas. The 2020 expansion to all basement areas was adopted without substantiation of field incidents or documented hazards in finished basements that would justify the change.

Finished basements are typically conditioned, enclosed, and protected from dampness through current building code requirements and construction practices. They do not present the same level of risk as unfinished areas where occupants may use portable equipment in contact with grounded surfaces. Extending GFCI requirements to all finished basement areas—where no plumbing fixtures, laundry facilities, or similar hazards are present—provides no demonstrated safety benefit and imposes unnecessary cost and complexity on new construction and renovation projects.

The original rationale cited by the code panel—that “basements, whether finished or unfinished, are prone to moisture including flooding”—does not reflect current building code and regulatory standards. Modern construction requirements under the International

Residential Code (IRC) and National Flood Insurance Program (NFIP) prohibit or tightly restrict basements below the design flood elevation and require waterproofing systems, drain tile, and vapor barriers that significantly reduce moisture intrusion. Electrical components located below the design flood elevation must also be installed or protected to prevent water entry or accumulation. These provisions collectively mitigate the moisture hazards once associated with older basements.

For more than three decades, the NEC's prior approach—limiting GFCI protection to unfinished basement areas—proved effective and commensurate with actual risk. The absence of data showing increased shock incidents in finished basements underscores that the expansion was unnecessary. Several jurisdictions, including Oregon and Utah, have already reverted to this approach, and South Carolina exempts finished walk-out basements from full GFCI coverage where no other provisions apply.

This amendment aligns the NEC with long-standing, evidence-based safety practice by maintaining GFCI protection where genuine hazards exist while avoiding regulatory overreach in areas where conditions do not warrant it.

Cost Impact: The code change proposal will decrease the cost This code change proposal will result in a modest reduction in the cost of construction.

E2701.1.1(1)-24 – Staff Summary

Proponent: Andrew Clark, representing Home Builders Association of Virginia

Brief Description: Limits the requirements for GFCI protection of basement receptacles to unfinished portions or areas of the basement not intended as habitable rooms. Currently, all basement receptacles must be GFCI protected.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Corian Carney, York County and International Alliance of the Electrical Industry, VA Chapter (IAEI-VA); and Paul Messplay, Hanover County.

Discussion:

Andrew Clark provided an overview of the proposal.

Cory C believed that there was a misunderstanding why GFCI protection was added in basements. This was added based on the type of floor finish that is often found in residential basements.

DHCD Staff Note: N/A

M1109.3.2-24

VMC: 1109.3.2

Proponents: Thomas Deary, representing AHRI (tdeary@ahrinet.org)

2021 Virginia Mechanical Code

Revise as follows:

1109.3.2 Shaft ventilation. Required ~~R~~refrigerant pipe shafts with systems using Group A2L or B2L refrigerant shall be naturally or mechanically ventilated. The shaft ventilation exhaust outlet shall comply with Section 501.3.1 . Naturally ventilated shafts shall have a pipe, duct or conduit not less than 4 inches (102 mm) in diameter that connects to the lowest point of the shaft and extends to the outdoors. The pipe, duct or conduit shall be level or pitched downward to the outdoors. Mechanically ventilated shafts shall have a minimum airflow velocity in accordance with Table 1109.3.2 . The mechanical ventilation shall be continuously operated or activated by a refrigerant detector. Systems utilizing a refrigerant detector shall activate the mechanical ventilation at a maximum refrigerant concentration of 25 percent of the lower flammable limit of the refrigerant. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The shaft shall not be required to be ventilated for double-wall refrigerant pipe where the interstitial space of the double-wall pipe is vented to the outdoors. For refrigeration systems used in residential occupancies serving only a single dwelling unit or sleeping unit, shaft ventilation shall not be required where the pipe or tube is continuous without fittings in the shaft

Reason Statement: Due to the approval of the proposal from Mr. Greg Johnson (M1109.2.5-24), many refrigerant pipe shafts for A2L refrigerants would no longer be required because the maximum amount of refrigerant that could be released would be within the safe release limits specified by the IMC in Table 1103.1.

Where no shaft is required, A2L refrigerant piping could be run through stud cavities as permitted by Sec. 1109.2.2. (Note that Sec. 1109.3 requires that A2L piping systems comply with the provisions of Sec. 1109.3.1 for protection against physical damage).

If a shaft is not required, but the designer chooses to run A2L refrigerant piping in a shaft anyway for ease of construction, the requirements of Sec. 1109.3.2 should not apply. A refrigerant leak in a non-required shaft would be no more hazardous than a refrigerant leak in a stud cavity. If the stud cavity would not require ventilation and drainage, then a non-required shaft should not require ventilation and drainage.

Cost Impact: The code change proposal will decrease the cost By clarifying when shafts are needed for refrigerant piping, and thus when they are not needed, this will reduce the cost of construction. Table 1103.1 identifies the parameters under which pipe shafts and ventilation are not required for A2L refrigerants.

Attached Files

- **M75-24.pdf**
  https://va.cdpaccess.com/proposal/1521/2228/files/download/1016/
- **M62-24 refrigerant piping - single unit - no joints.pdf**
  https://va.cdpaccess.com/proposal/1521/2228/files/download/1015/

M75-24

IMC®: 1109.2.5

Proponents: Greg Johnson, Johnson & Associates Consulting Services, National Multifamily Housing Council (gjohnsonconsulting@gmail.com); Vladimir G. Kochkin, National Association of Home Builders - NAHB, NAHB (vkochkin@nahb.org); Andrew Klein, A S Klein Engineering, PLLC, BOMA International (andrew@asklein.com); Emily Toto, ASHRAE, ASHRAE (etoto@ashrae.org)

2024 International Mechanical Code

Revise as follows:

1109.2.5 Refrigerant pipe shafts. Refrigerant piping that penetrates two or more floor/ceiling assemblies shall be enclosed in a fire-resistance-rated shaft enclosure. The fire-resistance-rated shaft enclosure shall comply with Section 713 of the International Building Code.

Exceptions:

1. *Refrigeration* systems using R-718 refrigerant (water).
2. Piping in a direct refrigeration system ~~using Group A1 refrigerant~~ where the refrigerant quantity does not exceed the limits of Table 1103.1 for the smallest occupied space through which the piping passes.
3. Piping located on the exterior of the *building* where vented to the outdoors.

Reason: JOHNSON: This will make the IMC consistent with Section 9.12.1.5 of ASHRAE 15-2022. Note that IMC Section 1109.2.2 still requires piping protection, either within building elements or protective enclosures.

TOTO: This section was added to the IMC before the completion of the changes to ASHRAE 15. ASHRAE 15 removed the limitation in exception 2 as applying only to Group A1 refrigerants. It was determined that any refrigerant meeting the limitations of Table 1103.1 are safe to install without a shaft enclosure. This modification is consistent with ASHRAE 15-2022.

Cost Impact: Decrease

Estimated Immediate Cost Impact:

JOHNSON: Costs are estimated to be reduced by roughly $1,000 per piping run per floor of an R-2 multifamily building.
TOTO: This may reduce the cost of construction by eliminating the shaft requirements for all refrigerants that do not exceed the safe limitations in the code. $22,400 estimated avoided total cost per mechanical room.

Estimated Immediate Cost Impact Justification (methodology and variables):

JOHNSON: Lineal feet of shaft-wall system avoided estimated to be 20 feet. Height of ceiling estimated to be 9 feet. Cost of installed shaft system estimated to be $7.00 per square foot. 20 X 9 X $7 = $960. $960 was rounded to $1,000.
TOTO: This change provides a lower cost alternative to the installation of a pipe shaft. Assumed area of avoided shaft wall system = 10 ft high X 40 lineal ft ($ sided enclosure) = 400 sf of shaft wall area. Assume shaft liner wall board is $34 per sf (kamcoboston.com), assume shaft framing materials are $8 per sf (schillings.com), assume $4 per sf labor (forbes.com), = $56 per sf for installed shaft wall without finishing. $56 per sf X 400 sf = **$22,400 estimated avoided total cost per mechanical room.**

Estimated Life Cycle Cost Impact:

JOHNSON: N/A

Estimated Life Cycle Cost Impact Justification (methodology and variables):

JOHNSON: N/A

M62-24

IMC®: CHAPTER 11, SECTION 1101, 1101.1, 1101.1.1, 1107.4, 1107.5, 1109.2.7, 1109.3.2, ASHRAE Chapter 15 (New)

Proponents: Emily Toto, ASHRAE, ASHRAE (etoto@ashrae.org)

2024 International Mechanical Code

CHAPTER 11
REFRIGERATION

SECTION 1101
GENERAL

1101.1 Scope. This chapter shall govern the design, installation, construction and repair of *refrigeration systems* . Permanently installed refrigerant storage systems and other components shall be considered as part of the *refrigeration system* to which they are attached.

Revise as follows:

1101.1.1 Refrigerants other than ammonia. *Refrigeration systems* using a refrigerant other than ammonia shall comply with this chapter, the International Fire Code, and either ASHRAE 15 or ASHRAE 15.2, as applicable~~and the *International Fire Code*~~. *Refrigeration systems* containing carbon dioxide as the refrigerant shall also comply with IIAR CO2 .

1107.4 Piping materials standards. Refrigerant pipe shall conform to one or more of the standards *listed* in Table 1107.4. For refrigeration systems used in residential occupancies serving only a single dwelling unit or sleeping unit, refrigerant piping and tubing shall be limited to aluminum, copper, and copper alloy. The exterior of the pipe shall be protected from corrosion and degradation.

1107.5 Pipe fittings. Refrigerant pipe fittings shall be *approved* for installation with the piping materials to be installed, and shall conform to one of more of the standards listed in Table 1107.5 or shall be *listed* and *labeled* as complying with UL 207. For refrigeration systems used in residential occupancies serving only a single dwelling unit or sleeping unit, refrigerant fittings shall be limited to aluminum, copper, copper alloys, stainless steel, and steel.

1109.2.7 Pipe identification. Refrigerant pipe located in areas other than the room or space where the refrigerating *equipment* is located shall be identified. The pipe identification shall be located at intervals not exceeding 20 feet (6096 mm) on the refrigerant piping or pipe insulation. The minimum height of lettering of the identification label shall be $^{1}/_{2}$ inch (12.7 mm). The identification shall indicate the *refrigerant designation* and safety group classification of refrigerant used in the piping system. For Group A2L and B2L refrigerants, the identification shall also include the following statement: “WARNING—Risk of Fire. Flammable Refrigerant.” For Group A2, A3, B2 and B3 refrigerants, the identification shall also include the following statement: “DANGER—Risk of Fire or Explosion. Flammable Refrigerant.” For any Group B refrigerant, the identification shall also include the following statement: “DANGER—Toxic Refrigerant.”

Exception: For refrigeration systems used in residential occupancies serving only a single dwelling unit or sleeping unit pipe identification shall not be required.

1109.3.2 Shaft ventilation. Refrigerant pipe shafts with systems using Group A2L or B2L refrigerant shall be naturally or mechanically ventilated. Refrigerant pipe shafts with one or more systems using any Group A2, A3, B2 or B3 refrigerant shall be continuously mechanically ventilated and shall include a refrigerant detector. The shaft ventilation exhaust outlet shall comply with Section 501.3.1. Naturally ventilated shafts shall have a pipe, duct or conduit not less than 4 inches (102 mm) in diameter that connects to the lowest point of the shaft and extends to the outdoors. The pipe, duct or conduit shall be level or pitched downward to the outdoors. Mechanically ventilated shafts shall have a minimum airflow velocity in accordance with Table 1109.3.2. The mechanical ventilation shall be continuously operated or activated by a refrigerant detector. Systems utilizing a refrigerant detector shall activate the mechanical ventilation at a maximum refrigerant concentration of 25 percent of the lower flammable limit of the refrigerant. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The shaft shall not

be required to be ventilated for double-wall refrigerant pipe where the interstitial space of the double-wall pipe is vented to the outdoors. For refrigeration systems used in residential occupancies serving only a single dwelling unit or sleeping unit, shaft ventilation shall not be required where the pipe or tube is continuous without fittings in the shaft.

Add new standard(s) as follows:

15.2-2022 Safety Standard for Refrigeration Systems in Residential Applications

Reason: This code change proposal adds the reference to ASHRAE 15.2, the installation standard for residential air conditioning systems used for a single dwelling or sleeping unit. This addition addresses a gap created in the Code when ASHRAE 15 split its scope between standards 15 and 15.2. As some systems covered by the scope of ASHRAE 15.2 are also covered by the IMC, its inclusion within the IMC is necessary.With the separation between ASHRAE 15 and ASHRAE 15.2, there were certain changes that impact the refrigerant piping requirements. For residential systems, the piping material is limited to aluminum, copper, and copper alloy pipe or tube. The fitting requirements are similar material requirements with the addition of stainless steel and steel.

Pipe identification is not required for piping system regulated by ASHRAE 15.2. The reason for this is that the refrigerant piping is obvious not needing to be individually identified. Whereas in commercial buildings there are often multiple piping systems where the type of piping system is not obvious.

For shaft ventilation, there is an allowance in residential systems to eliminate the ventilation of the shaft when the piping system is continuous without fittings in the shaft. This provision was added to the end of the section.

Cost Impact: The change proposal is editorial in nature or a clarification and has no cost impact on the cost of construction

Justification for no cost impact:

The inclusion of ASHRAE 15.2 into the IMC is editorial in nature, and as such will not impact the cost of construction. Changes to piping for ASHRAE 15.2 may actually reduce the cost of construction, by not requiring shaft ventilation when no joints are present in the shaft.

Staff Analysis: A review of the standard proposed for inclusion in the code, ASHREA 15.2 Safety Standard for Refrigeration Systems in Residential Applications, with regard to some of the key ICC criteria for referenced standards (Section 4.6 of CP#28) will be posted on the ICC website on or before March 18, 2024.

M1109.3.2-24 – Staff Summary

Proponent: Thomas Deary, representing AHRI

Brief Description: Adds an exception from the ventilation shaft requirements when the refrigeration systems are serving only a single dwelling or sleeping unit and the refrigeration piping is continuous without fittings in the shaft.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and Virginia Building and Code Officials Association (VBCOA) PMG Code Committee; and Steve Shapiro, Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA).

Opposition: Shahriar Amiri, Arlington County.

Discussion:

Florin Moldovan (DHCD staff) provided an overview of the proposal.

a. **Dennis H** stated that requiring ventilation and drainage for shafts that are not otherwise required will introduce inconsistent requirements that are not tied to a demonstrable increase in risk. The proposal maintains the internal level of safety while applying the code only where the risk justifies additional control.
b. **Steve S** noted that this is going to decrease construction costs because we will no longer have to ventilate pipe shafts that aren't required to be ventilated.
c. **Shahriar A** questioned why the proposal was needed because a single-family dwelling will not exceed the maximum limit on refrigeration so a shaft would not be required anyway.
d. **Florin M** clarified the proposal was not intended to apply to single-family dwellings. It is intended to apply to a dwelling in a commercial building where you might only have a single dwelling unit in a mixed-use occupancy. In this situation, the designer would have a choice to run uninterrupted piping with no joints through a shaft that doesn't have to meet the requirements of a shaft.
e. **Steve S** added that the third paragraph of the reason statement explains that you don't have to ventilate the shaft if the shaft isn't required.
f. **Shahriar A** countered that the code does not impose requirements on non-required equipment in Chapter 1 of the Virginia Construction Code (VCC).

DHCD Staff Note: N/A

M15-24

VMC: ASHRAE Chapter 15, UL Chapter 15; VRC: ASHRAE Chapter 44, UL Chapter 44

Proponents: Thomas Deary, representing AHRI (tdeary@ahrinet.org)

2021 Virginia Mechanical Code

ASHRAE

15—~~2019:~~ 2024:	Safety Standard for Refrigeration Systems
34—~~2019:~~ 2024:	Designation and Safety Classification of Refrigerants
UL/CSA 60335-2-40—~~19:~~ 22:	Household and Similar Electrical Appliances—Safety—Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers

2021 Virginia Residential Code

ASHRAE

ASHRAE 34—~~2019:~~ 2024:	Designation and Safety Classification of Refrigerants
60335-2-40—2019/CAN/CSA C22.2 No.60335-2-40-~~19:~~ 22:	Standard for Household and Similar Electrical Appliances, Safety Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers

Reason Statement: This proposal updates ASHRAE 15, ASHRAE 34, and UL 60335-2-40 to their most current editions. These updates are critical to ensure that systems using A2L refrigerants, which are allowed under Virginia's codes, point to the current industry standards that contain all of the relevant requirements for such products.

Cost Impact: The code change proposal will not increase or decrease the cost This proposal only updates previously incorporated standards to their current editions. It does not impact cost.

M15-24 – Staff Summary

Proponent: Thomas Deary, representing AHRI

Brief Description: Updates ASHRAE 15 and ASHRAE 34 to their most current editions, the 2024 editions. The 2024 IMC references the 2022 editions.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Steve Shapiro**,** Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA).

Discussion:

Florin Moldovan (DHCD staff) provided an overview of the proposal.

a. **Steve S** asked if these editions of the standard are what is in the 2024 International Mechanical Code (IMC).
b. **Dennis Hart** (Virginia Plumbing and Mechanical Inspectors Association) answered that the 2024 editions have not been adopted in the 2027 IMC and they will be the 2022 editions.
c. **Steve S** was against putting in a standard that has not yet been recognized by the IMC.

DHCD Staff Note: N/A

P306.2.5-24

IPC: 306.2.5 (New)

Proponents: James Walls, representing Cast Iron Soil Pipe Institute (jwalls@cispi.org)

2024 International Plumbing Code

Add new text as follows:

306.2.5 Plastic Sewer and DWV piping installation. Plastic sewer and DWV piping installed underground shall be installed in accordance with the manufacturer's installation instructions.Trench width shall be controlled to not exceed the outside pipe diameter plus 16 inches or in a trench which has a controlled width equal to the nominal diameter of the diameter of the piping multiplied by 1.25 plus 12 inches.The piping shall be bedded in 4 inches of granular fill.
Exception: Residential occupancies 75 feet in height above grade or less.

Reason Statement: The intent of this code change is to align the code and notify the inspector and all other parties that there are specific requirements by the manufacturers of these products for their installation. There are many methods available for enforcement of this change including: AHJ may require a Special inspection by a licensed engineer or other technically qualified individual, AHJ may elect to enforce on their own, etc. The exception is to allow for projects where geo technical expertise is not common on the project.

Cost Impact: The code change proposal will not increase or decrease the cost There will be no additional cost with this code proposal.

P306.2.5-24 – Staff Summary

Proponent: James Walls, representing Cast Iron Soil Pipe Institute

Brief Description: Limits the trench width for plastic sewer and DWV piping and requires the piping to be bedded in four inches of granular fill.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and Virginia Building and Code Officials Association (VBCOA) PMG Code Committee; Shahriar Amiri, Arlington County; and Mark Graver, City of Waynesboro and VBCOA Region III.

Discussion:

James W provided an overview of the proposal.

a. **Steve S** shared concern over the language, "Trench width shall be controlled to not exceed….".
b. **James W** responded that the language was taken from ASTM D2321 and "controlled" means the trench width as the minimum width to withstand the side wall.
c. **Steve S** proposed to remove the word "control", both instances in the second sentence.
d. **James W** agreed to the modification.
e. **Florin Moldovan** (DHCD staff) asked if the residential occupancies 75 feet in the exception refers to the height of the building or floor height above grade. **Michael D** noted that he had similar questions.
f. **James W** responded that he was fine with adding "above grade" as a floor modification.
g. **Dennis H** stated that they were not aware of widespread failures of plastic piping.
h. **Shahriar A** questioned where the 16-inches and 12-inches come from and why the exception only applies to residential occupancies.
i. **Mark G** commented that picking out sections out of a standard could leave out the nuance that goes along with it.

DHCD Staff Note: N/A

P306.3.1-24

IPC: 306.3.1 (New)

Proponents: James Walls, Cast Iron Soil Pipe Institute, representing Cast Iron Soil Pipe Institute (jwalls@cispi.org)

2024 International Plumbing Code

Add new text as follows:

306.3.1 Plastic sewer and DWV piping installation. The compaction of backfill shall be to a minimum of 85 percent standard proctor density and extend to a minimum of 6 inches above the top of the pipe. Compaction testing shall be performed by an approved third-party and approved by the engineer of record. A written report of the test results shall be signed and sealed by the engineer of record and provided to the code official.

Exception: Residential occupancies 75 feet in height or less.

Reason Statement: The intent of this code change is to align the code and notify the inspector and all other parties that there are specific requirements by the manufacturers of these products for their installation. There are many methods available for enforcement of this change including: AHJ may require a Special inspection by a licensed engineer or other technically qualified individual, AHJ may elect to enforce on their own, etc. The exception is to allow for projects where geo technical expertise is not common on the project.

Cost Impact: The code change proposal will not increase or decrease the cost There will be no additional increase with this code proposal.

P306.3.1-24 – Staff Summary

Proponent: James Walls, representing Cast Iron Soil Pipe Institute

Brief Description: Requires backfill for plastic sewer and DWV piping to be compacted to a minimum of 85 percent Proctor density and requires compaction testing to be performed by an approved third party and approved by the engineer of record.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/05/2026

Support: None

Opposition: Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and Virginia Building and Code Officials Association (VBCOA) PMG Code Committee; Steve Shapiro, Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA); Shahriar Amiri**,** Arlington County; and Rick Hinson, American Council of Engineering Companies (ACEC).

Discussion:

James W provided an overview of the proposal.

a. **Dennis H** had the same comments as proposal P306.2.5-24. Also, the added costs were a concern of the PMG committee, specifically the added costs associated with third-party testing.
b. **Steve S** seconded that concern.
c. **Dan W** commented that the Engineer of Record language is not specific as to who that would be.
d. **Ron Clements** (Chesterfield County, VBCOA Admin and Existing Building Code Committees) brought up that there are certain installations in Virginia that do not require an engineer, and testing can be submitted by a contractor.
e. **Michael Dellinger** (Albemarle County, VBCOA Region IV) reiterated his comments for proposal P306.2.5-24 regarding grade plane, which also applies to this proposal.
f. **Shahriar A** remarked that when the code sets certain standards for different types of materials, you follow the standard. It is not the place of the code to add additional requirements because of the type of material.
g. **Rick H** explained that engineers are not going to seal documents just because someone wants a seal. Engineers are going to have to be involved on many levels, otherwise they

cannot legally seal it, and that adds serious cost.

DHCD Staff Note:

Excerpt from the third GSW meeting summary pertaining to proposal P306.2.5-24 are provided below.

Support: None

Opposition: Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and Virginia Building and Code Officials Association (VBCOA) PMG Code Committee; Shahriar Amiri, Arlington County; and Mark Graver, City of Waynesboro and VBCOA Region III.

Discussion:

James W provided an overview of the proposal.

a. **Steve S** shared concern over the language, "Trench width shall be controlled to not exceed….".
b. **James W** responded that the language was taken from ASTM D2321 and "controlled" means the trench width as the minimum width to withstand the side wall.
c. **Steve S** proposed to remove the word "control", both instances in the second sentence.
d. **James W** agreed to the modification.
e. **Florin Moldovan** (DHCD staff) asked if the residential occupancies 75 feet in the exception refers to the height of the building or floor height above grade. **Michael D** noted that he had similar questions.
f. **James W** responded that he was fine with adding "above grade" as a floor modification.
g. **Dennis H** stated that they were not aware of widespread failures of plastic piping.
h. **Shahriar A** questioned where the 16-inches and 12-inches come from and why the exception only applies to residential occupancies.
i. **Mark G** commented that picking out sections out of a standard could leave out the nuance that goes along with it.

RE3601.8-24

IRC: , E3601.6.2

Proponents: Corian Carney, York County, representing Virginia Chapter IAEI, Eastern Virginia Division IAEI (corian.carney@yorkcounty.gov); Charles Stiles, Spotsylvania County, representing VA Chapter IAEI (cstiles@spotsylvania.va.us); Ryan Celestino, City of Newport News, representing VA Chapter IAEI (celestinore@nnva.gov); Joseph Willis, Prince William County, representing Virginia Chapter IAEI (jwillis@pwcgov.org)

2024 International Residential Code

Delete without substitution:

~~**E3601.8 Emergency disconnects.** For one- and two-family *dwelling units*, all service conductors shall terminate in disconnecting means having a short-circuit current rating equal to or greater than the available fault current, installed in a readily accessible outdoor location. If more than one disconnect is provided, they shall be grouped. Each disconnect shall be one of the following:~~

1. ~~Service disconnects marked as follows: EMERGENCY DISCONNECT, SERVICE DISCONNECT.~~
2. ~~Meter disconnect switches that have a short-circuit current rating equal to or greater than the available fault current and all metal housings and service enclosures are grounded in accordance with Section E3908.7 and bonded in accordance with Section E3609. A meter disconnect switch shall be capable of interrupting the load served and shall be marked as follows: EMERGENCY DISCONNECT, METER DISCONNECT, NOT SERVICE EQUIPMENT.~~
3. ~~Other *listed* disconnect switches or circuit breakers that are marked suitable for use as service equipment, but not marked as suitable only for use as service equipment and marked as follows: EMERGENCY DISCONNECT, NOT SERVICE EQUIPMENT.~~

~~Markings shall comply with Section E3404.12 and both of the following:~~

1. ~~The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.~~
2. ~~The letters shall be at least $1/2$ inch (13mm) high. [230.82 (3), 230.85]~~

Revise as follows:

E3601.6.2 Service disconnect location. The service disconnecting means shall be installed ~~at~~ in a readily accessible ~~location either outside of a~~*building* ~~or inside nearest the point of entrance of the service conductors.~~outdoor location in accordance with one of the following:

1. On the dwelling unit.
2. Within sight of the dwelling unit in accordance with E3405.8

Service disconnecting means shall not be installed in bathrooms. Each occupant shall have *access to* the disconnect serving the *dwelling unit* in which they reside. [230.70(A)(1)(2), 230.72(C)]

Reason Statement: The proposed regulations for the 2026 National Electrical Code remove the options for Emergency Disconnects from Article 230 (Services), and relocate them to Article 225 (Feeders). The language in the 2020 and 2023 National Electrical Code unintentionally contradicts intent in other code sections related to service conductors and grounding electrode system connection. Removal of this language from the 2024 Virginia Residential Code will allow Virginia to keep up with more current safety standards provided by the National Electrical Code, and eliminate confusion between contractors and building department staff.

Cost Impact: The code change proposal will decrease the cost by eliminating potential for multiple disconnecting means being installed

or from reworking of installations due to confusion or misinterpretation of the code language.

Attached Files

- **70_A2025_NEC_P10_FD_BallotFinal.pdf**
  https://va.cdpaccess.com/proposal/1259/1893/files/download/925/

230.70 General.

Means shall be provided to disconnect all ungrounded conductors in a building or ~~other~~ structure from the service conductors.

(A) Service Disconnect Location.

~~The service disconnecting means~~ Service disconnects shall be installed in accordance with 230.70(A)(1), 230.70(A)(2) , 230.70(A)(3) , and 230.70(A)(4) .

(1) Readily Accessible Location.

~~The service disconnecting means~~ Service disconnects shall be installed at a readily accessible location either outside of a building or structure or inside nearest the point of entrance of the service conductors.

(2) One- and Two-Family Dwellings.

Service disconnects shall be installed in a readily accessible outdoor location on or within sight of the one- or two-family dwelling unit.

(3) Bathrooms.

Service disconnecting means shall not be installed in bathrooms.

(4) Remote Control.

~~Where a~~ If a remote- control device(s) is used to actuate the service ~~disconnecting means~~ disconnect , the service ~~disconnecting means~~ disconnect shall be located in accordance with 230.70(A)(1). Remote-control devices shall not be used as a service disconnect for one- and two-family dwellings.

(B) Service Disconnect Marking.

~~Each service disconnect shall be permanently marked to identify it as a service disconnect~~ Service disconnects shall be marked in accordance with 230.70(B)(1) and 230.70(B)(2) .

(1) Marking.

Service disconnects shall be marked as “SERVICE DISCONNECT” and the marking shall comply with 110.21(B) .

(2) One- and Two-Family Dwellings.

Service disconnects for one- and two-family dwellings shall be marked as follows:

EMERGENCY DISCONNECT, SERVICE DISCONNECT

Markings shall comply with 110.21(B) and both of the following:

(1) The markings shall be located on the outside front of the disconnect enclosure with a red background and white text.

(2) The letters shall be at least 13mm (½ in.) high.

(C) Suitable for Use.

~~Each service disconnecting means shall be suitable for the prevailing conditions.~~ Service equipment installed in hazardous (classified) locations shall comply with the hazardous location requirements.

(D) Identification of Other Source Disconnects.

Where equipment for disconnection of other energy source systems is not located adjacent to the service disconnect required by this section, a plaque or directory identifying the location of all equipment for disconnection of other energy sources shall be located adjacent to the service disconnect.

Informational Note: See 445.18 , 480.7 , 705.20 , and 706.15 for examples of other energy source system disconnection means.

(E) Replacement.

Replacement of service equipment for one- and two- family dwellings shall comply with 230.70(A) , 230.70(B) , and 230.70(C) .

Exception: If only meter sockets, service entrance conductors, or related raceways and fittings are replaced, the requirements of 230.70(A)(2) and 230.70(B)(2) shall not apply.

Supplemental Information

File Name	Description	Approved
70_NEC_CMP10_A2025NEC_230.70_FR9155.docx	For staff use only	
70_NEC_CMP10_A2025NEC_230.70_FR9155.docx	For prod use	

Submitter Information Verification

Committee: NEC-P10

Submittal Date: Thu Jan 25 15:02:03 EST 2024

Correlating Committee Actions

The correlating committee may override this FR with a First Correlating Revision or with a Committee Note

Create FCR or CN

Committee Statement

Committee Statement: Requirements related to emergency disconnects found in Section 230.85 of the NEC have caused confusion for the electrical industry since it was not clear what specific types of disconnects were allowed to meet the requirements. It was also unclear how to ensure the emergency disconnect equipment is protected from available fault current. In addition, there has been confusion when applying the requirements for grounding and bonding of Article 250 when an emergency disconnect is installed on the supply-side of a service disconnecting means. This First Revision in conjunction with other First Revisions to 230.82 and 230.85, do not delete requirements for emergency disconnects for one-and two family dwellings, rather the requirements are greatly simplified by requiring the service disconnecting means for the dwelling to be located at a readily accessible location on the outside of the dwelling. Such service disconnecting means will also serve as the emergency disconnect for one- and- two family dwellings. This change will resolve issues related to what type of equipment can be installed for the emergency disconnect, how grounding and bonding is required to be installed, and the issues related to available fault current are addressed by the fact that service equipment is required to have appropriate overcurrent protection.

The concerns of the submitter for Public Input 2191 have been addressed with the First Revision of 230.70. The specific marking is added to better align with the requirement in 230.70(B)(2).

Concerning Public Input 2512, removing the existing requirement does not change the

requirements already specified in the NEC. Such existing text is unnecessary. The second sentence is retained as it’s considered to provide clarity.

Response Message: FR-9155-NFPA 70-2024

Public Input No. 2191-NFPA 70-2023 [Section No. 230.70(B)]

Public Input No. 2023-NFPA 70-2023 [Section No. 230.70(C)]

Public Input No. 2512-NFPA 70-2023 [Section No. 230.70(C)]

Public Input No. 2022-NFPA 70-2023 [Section No. 230.70(B)]

Public Input No. 2021-NFPA 70-2023 [Section No. 230.70(A)]

Public Input No. 2582-NFPA 70-2023 [Section No. 230.70(A)(1)]

Ballot Results

This item has passed ballot

18 Eligible Voters
0 Not Returned
15 Affirmative All
3 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Anderson, Jr., Richard P.

Arnold, Kevin S.

Blizard, Scott A.

Dawes, Anthony John

Dollar, Randy

Gomez, Adam Wesley Thomas

Hansen, Clint Lee

Lofton, II, Richard E.

Philips, Nathan

Pisani, Mark K.

Robey, Derrick

Schmidt, Alan

Sparks, III, Roy K.

Wingate, Mark W.

Zia, Danish

Affirmative with Comment

Ayer, Lawrence S.

List item (4) as presently written doesn't work. Just because a remote control device is used doesn't mean the disconnect should not be readily accessible. All service disconnects are readily accessible.

Koepke, Ed

No comment

Williams, David A.

The new requirements of 230.70(A)(2) uses the phrase "within sight". However, if the definition of “within sight” is deleted (since such definition includes requirements, which is a violation of the Style Manual) then a direct reference to 110.29 will be required for determining the maximum distance of 50 feet to still be considered within sight. For example, in 225.31(B) we added: “within sight of the building in accordance with 110.29.” This section also needs the reference to 110.29.

230.85 Emergency Disconnects.

For one- and two-family dwelling units, an emergency disconnecting means shall be installed.

(A) General.

(1) Location.

The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.

Exception: *Where the requirements of* *225.41* *are met, this section shall not apply.*

(2) Rating.

The disconnecting means shall have a short-circuit current rating equal to or greater than the available fault current.

(3) Grouping.

If more than one disconnecting means is provided, they shall be grouped.

(B) Disconnects.

Each disconnect shall be one of the following:

(0) Service disconnect

(0) A meter disconnect integral to the meter mounting equipment not marked as suitable only for use as service equipment installed in accordance with 230.82

(0) Other listed disconnect switch or circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, installed on the supply side of each service disconnect

Informational Note 1: Conductors between the emergency disconnect and the service disconnect in 230.85(2) and 230.85(3) are service conductors.

Informational Note 2: Equipment marked “Suitable only for use as service equipment” includes the factory marking “Service Disconnect”.

(C) Replacement.

Where service equipment is replaced, all of the requirements of this section shall apply.

Exception: *Where only meter sockets, service entrance conductors, or related raceways and fittings are replaced, the requirements of this section shall not apply.*

(D) Identification of Other Isolation Disconnects.

Where equipment for isolation of other energy source systems is not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all equipment for isolation of other energy sources shall be located adjacent to the disconnecting means required by this section.

Informational Note: See 445.18 , 480.7 , 705.20 , and 706.15 for examples of other energy source system isolation means.

(E) Marking.

~~**(1)** Marking Text.~~

~~The disconnecting means shall marked as follows:~~

(0) ~~Service disconnect~~

~~EMERGENCY DISCONNECT, SERVICE DISCONNECT~~

(0) ~~Meter disconnects installed in accordance with 230.82 (3) and marked as follows:~~

~~EMERGENCY DISCONNECT, METER DISCONNECT, NOT SERVICE EQUIPMENT~~

(0) ~~Other listed disconnect switches or circuit breakers on the supply side of each service disconnect that are marked suitable for use as service equipment and marked as follows:~~

~~EMERGENCY DISCONNECT, NOT SERVICE EQUIPMENT~~

~~**(2)** Marking Location and Size.~~

~~Markings shall comply with 110.21(B) and both of the following:~~

(0) ~~The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.~~

(0) ~~The letters shall be at least 13 mm (½ in.) high.~~

Submitter Information Verification

Committee: NEC-P10

Submittal Date: Thu Jan 25 16:00:42 EST 2024

Correlating Committee Actions

The correlating committee may override this FR with a First Correlating Revision or with a Committee Note

Create FCR or CN

Committee Statement

Committee Statement: In conjunction with the proposed First Revision to section 230.70, section 230.85 has been proposed to be deleted as emergency disconnects are now service disconnects.

Response Message: FR-9179-NFPA 70-2024

Public Input No. 2578-NFPA 70-2023 [Section No. 230.85]

Public Input No. 2583-NFPA 70-2023 [Section No. 230.85]

Public Input No. 3801-NFPA 70-2023 [Section No. 230.85]

Public Input No. 1925-NFPA 70-2023 [Sections 230.85, 230.85]

Public Input No. 4427-NFPA 70-2023 [Section No. 230.85(B)]

Ballot Results

✔ **This item has passed ballot**

18 Eligible Voters

0 Not Returned

17 Affirmative All

1 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Anderson, Jr., Richard P.
Arnold, Kevin S.
Ayer, Lawrence S.
Blizard, Scott A.
Dawes, Anthony John
Dollar, Randy
Gomez, Adam Wesley Thomas
Hansen, Clint Lee
Lofton, II, Richard E.
Philips, Nathan
Pisani, Mark K.
Robey, Derrick
Schmidt, Alan
Sparks, III, Roy K.
Williams, David A.
Wingate, Mark W.
Zia, Danish

Affirmative with Comment

Koepke, Ed
No comment

RE3601.8-24 – Staff Summary

Proponent: Corian Carney, York County, representing Virginia Chapter IAEI, Eastern Virginia Division IAEI; Charles Stiles, Spotsylvania County, representing VA Chapter IAEI; Ryan Celestino, City of Newport News, representing VA Chapter IAEI; Joseph Willis, Prince William County, representing Virginia Chapter IAEI

Brief Description: Requires the service disconnecting means for one-and two-family dwellings and townhouses to be installed in a readily accessible outdoor location. Installation of service disconnecting means indoors no longer allowed.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

First GSW Meeting — 07/29/2025

Discussion:

a. **Corian Carney** [International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)] – Provides overview of the proposal.
   i. **Andrew Clark** [Home Builders Association of Virginia (HBAV)] – Is this truly a cleanup, or am I missing something? HBAV members are unclear.
   ii. **Tread Willis** (IAEI-VA) – This isn't really a change; it's an alignment. Current disconnecting means provisions are muddled and confusing, and people don't know how to address them. The 2026 NEC proposal says, "You shall install the service disconnect means outside." This will happen in the 2026 National Electrical Code, and then we will be a code cycle ahead of it. We treat this as a service disconnect, not a servicing disconnect, or emergency disconnect, or meter disconnect, where the location of the grounding electrode system may change, or the location of the main overcurrent device may change. This gives it some consistency across the board, no matter where you are in the Commonwealth. The service disconnect, which has your overcurrent protection and your grounding electrode system established there, is outside for first responders. And there is no confusion about where it is and where it is not.

b. **Jeff Brown** (DHCD staff) – To clarify, this is a change from what's in the code now, where you don't have to place your service disconnect on the exterior.
   i. **Tread W** – That's correct. You have the servicing disconnect that says, "This shall be the service disconnect."
   ii. **Corian C** – The way it's written now, you have to have a disconnect outside. It

doesn't have to be a service disconnect, but that's what everyone is suggesting. So it is a change.

c. **Andrew C** – Asks proponents to get together with HBAV members to explain the proposal better.
   i. **Corian C** – Agrees to carry over the proposal and work with HBAV.
d. Carried Over

Second GSW Meeting — 10/03/2025

Support: Bryan Holland, National Electrical Manufacturers Association (NEMA).

Discussion:

Tread W provided an overview of the proposal.

a. **Andrew Clark** [Home Builders Association of Virginia (HBAV)] asked the proponent if he could table the proposal to give Andrew time to review the proposal with HBAV membership.
b. **Tread W** agreed.
c. Carried Over

Third GSW Meeting — 01/05/2026

Support: Ryan Celestino, City of Newport News and IAEI – Virginia Chapter; Gerry O'Connor, EATON; and Joseph Wages, NEMA.

Opposition: Andrew Clark**,** HBAV.

Discussion:

Cory C provided an overview of the proposal.

a. **Ryan C** spoke in support as a current inspector; the options are often troublesome for the contractors as well as other inspectors.
b. **Gerry O** concurred, noting that the 2023 National Electrical Code (NEC) language was burdensome to the installer and the home builder.
c. **Andrew C** brought up an issue expressed by builders – not having the option of installing the service disconnect inside the dwelling unit; and noted that he is trying to understand what "within sight of the dwelling unit" means.
d. **Cory C** responded that you are not allowed to have only an interior disconnect. As far as removing the ability to disconnect it from the interior, it must be disconnected on the outside, whether you call it an emergency disconnect or a service disconnect, this makes no difference. It still must be disconnected from the exterior. The easier option is to just install the service disconnect outside. Now you can put your panel board anywhere in that house that you want.
e. **Gerry O** added once you take the main breaker and put it on the outside, a main breaker panel board is no longer required. What you're doing is moving the main

breaker from inside or in a main panel board, putting it on the outside, and then feeding the panel board inside at any location. It doesn't have to be within a certain distance of entering the building.

f. **Andrew C** asked for clarity if the Board will hear feedback from stakeholders between now and their May meeting.

g. **Jeff B** (DHCD) stated that proposals will go in front of the Board for consideration regardless of consensus or non-consensus. If the position of a stakeholder on any given proposal changes between now and then, they could submit a public comment for the Board's consideration or speak in front of the Board during the public comment portion of the meeting.

DHCD Staff Note: N/A

RE3901.4.2-24

IRC: E3901.4.2

Proponents: Joseph Willis, representing Prince William County (jwillis@pwcgov.org); Eric Mays, representing Prince William County (emays@pwcgov.org)

2024 International Residential Code

Revise as follows:

E3901.4.2 Island and peninsular countertops and work surfaces. Receptacle outlets ~~, if installed to serve an island or peninsular countertop or work surface,~~ shall be installed in accordance with Section E3901.4.3. ~~If a receptacle outlet is not provided to serve an island or peninsular countertop or work surface, provisions shall be provided at the island or peninsula for future addition of a receptacle outlet to serve the island or peninsular countertop or work surface.~~

Reason Statement: The language in the 2024 International Residential Code provides the installer the option to either install a receptacle outlet or provide future provisions for a receptacle outlet at peninsular and island work surfaces. By eliminating the language to allow for future provisions, the temptation to perform unpermitted and potentially non-compliant work will be drastically decreased as the convenience of having future provisions will no longer be available. In addition, the temptation to utilize extension cords from a nearby receptacle to place a small appliance on these work surfaces is also eliminated. This particular code section is the only code section in the electrical provisions of the 2024 IRC that allows the installation of wiring for future use and one of only six times that “future” is used as it pertains to installations for use at an undetermined time. The other instances apply to plumbing as it relates to drainage and venting and mechanical and gas sections pertaining to dryer exhaust duct. The specific requirements to have receptacle outlet serve island and peninsular countertop work surfaces has been a requirement since the 1990 edition of NFPA 70, The National Electrical Code. This code change proposal to the 2024 Virginia Residential Code fully addresses the safety deficiencies identified by the NFPA in the commentary for the 2023 Edition of the National Electrical Code.

Cost Impact: The code change proposal will not increase or decrease the cost

This code change proposal will have no cost impact to the owner/designer/contractor chooses to install receptacles on the island and/or peninsular countertop work surfaces. In addition to the zero-cost impact, the removal of the future provisions will save money in the long run as the cost of material and labor continue to increase.

RE3901.4.2-24 – Staff Summary

Proponent: Joseph Willis, representing Prince William County; Eric Mays, representing Prince William County

Brief Description: Removes the option to provide provisions for the future installation of receptacles at an island or peninsular countertop or work surface, instead requiring receptacles to be installed at the time of construction.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

First GSW Meeting — 07/29/2025

Support: None

Opposition: None

Discussion:

a. **Tread W** – Provides overview of the proposal.
   i. **Dennis H** – Representing self. As I understand it, it's not required to have an outlet in an island or peninsula. This would still put the use of extension cords at risk of getting pulled over the countertop because they could choose not to install the receptacle in that island or that peninsula.
   ii. **Tread W** – Asks for floor amendment. Get rid of the comma and the "if."
   iii. **Sean Farrell** (Prince William County) – It still doesn't make it mandatory.
   iv. **David Beahm** (Warren County) – No, it doesn't.
b. **Kyle Kratzer** [Fairfax County, Virginia Building and Code Officials Association (VBCOA)] – Is it your intention to keep the current provisions of 9 square ft and every 18 square ft after that? Or are we back to 1 outlet can work for the entire island?
   i. **Tread W** – One outlet can work for the entire island. But it must be installed.
c. **Ron Clements** (Chesterfield County) – As the building official of my locality, I'm going to say this is still optional, the way it's written. This won't be enforced uniformly across the state.
d. **Jeff Brown** (DHCD staff) – This is a substantive change based on statements made; there appear to still be questions as to what is required in the 2024 IRC. We do have time for a couple more meetings.
e. **David B** – Verification of the other requirement is going to be critical. Because if not, you are just saying that no island needs an outlet.
f. **Corian Carney** [Independent Alliance of the Electrical Industry (IAEI), VA Chapter] – I'm neutral on this one.

g. **Dennis H** – People don't want the pop-up receptacles. I don't think you'll get a consensus if we require the pop-ups altogether.
    i. **Tread W** – Pop-ups aren't the only option. That is an option to achieve compliance, but it's not the only option.
h. **Jeff B** – Do you agree with carrying this one over?
    i. **Tread W** – We'll table and re-work.
i. Carried Over

Second GSW Meeting — 10/03/2025

Support: None

Opposition: Kyle Kratzer, representing himself; Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and VBCOA PMG Code Committee.

Discussion:

Eric Mays provided an overview of the proposal, including historical background with regard to how the provisions regarding island and peninsular countertop receptacles became code.

a. **Andrew Clark** [Home Builders Association of Virginia (HBAV)] asked if, based on the background narrative presented by the proponent, there is another proposal coming forward for consideration that aims to address the concerns with appliances falling off of the counter and causing injury.
    i. **Eric M** stated that an alternate proposal would be reverting back to the 2018 language, which worked for 85 million people.
    ii. **Andrew C** asked if carry over is possible to discuss with HBAV membership.
    iii. **Eric M** expressed interest in having this proposal be non-consensus so that he can work with **Andrew C** and HBAV on a separate proposal.
b. **Kyle K** (representing himself) pointed out that this change doesn't solve the problems and dangers associated with receptacles installed at the end of the island, noting that you can still install the receptacle at the end of the island, on top of the countertop, and the cord could still be hanging over.
    i. **Tread W** reaffirmed that this proposal seeks to mitigate the problem, not solve the problem.
c. **Dennis H** noted that the feedback he received is that this proposal essentially requires a pop-up receptacle installed in the countertop, which creates a situation where spills and debris can get into the assembly.
d. **Bryan Holland** [National Electrical Manufacturers Association (NEMA)] stated that every solution that has been developed at the national level has created an unintended worse consequence and that he does not believe there is a good answer to this problem. He suggested going with the design that worked for 30 years.

DHCD Staff Note:

The VCC companion proposal E2701.1.1-24 was reviewed by stakeholders at the third GSW meeting on January 5, 2026, and received a Non-Consensus recommendation. The excerpt from the third GSW meeting summary pertaining to E2701.1.1-24 is provided below.

January 5, 2026, GSW Meeting Summary Excerpt

Support: Shahriar Amiri, Arlington County.

Opposition: Corian Carney, York County and International Alliance of the Electrical Industry, VA Chapter (IAEI-VA); Ryan Celestino, City of Newport News and IAEI-VA; Gerry O'Connor, Eaton; and Kyle Kratzer, Fairfax County and Virginia Building and Code Officials Association (VBCOA).

Discussion:

Tread Willis (speaking on behalf of the proponent) provided an overview of the proposal.

a. **Shahriar A** indicated that he is a part of inner jurisdictional meetings that have had a lot of discussion regarding this proposal.
b. **Cory C** noted that National Fire Protection Association (NFPA) has done research that has shown that having receptacles serving island and peninsula countertops and work surfaces is either as unsafe or more unsafe than not having them. NFPA has added the option to not have receptacles serving these countertops and work surfaces.
c. **Gerry O** brought up that there have been approximately 10,000 recorded emergency room cases since the early 90's.
d. **Tread W** added that this change is to the National Electrical Code and would include R-2 and R-3 dwelling units.
e. **Dan Willham** (Fairfax County and VBCOA) stated that having cords on the counters that can drape off whether there are receptacles on the side or not, there is going to be a tradeoff either way because people will just use extension cords.
f. **Gerry O** remarked that kitchen appliances are required to have a cord that is 24 inches or less, which is why the two-foot and four-foot rule for receptacle locations on kitchen countertops exist. So, these codes are designed to be aligned with the standards for these appliances.
g. **Kyle K** commented that this proposal still does not prevent a receptacle from being installed on the countertop at the edge of an island where a cord could hang over the side.

RE3901.4.2(1)-24

VCC: 2701.1.1; IRC: E3901.4.2, E3901.4.3

Proponents: Andrew Clark, representing Home Builders Association of Virginia (aclark@hbav.com)

2021 Virginia Construction Code

Revise as follows:

2701.1.1 Changes to NFPA 70. The following changes shall be made to NFPA 70 :

1. Change Sections 334.10(2) and 334.10(3) of NFPA 70 to read:

   (2) Multifamily dwellings not exceeding four floors above grade and multifamily dwellings of any height permitted to be of Types III, IV and V construction except in any case as prohibited in 334.12.

   (3) Other structures not exceeding four floors above grade and other structures of any height permitted to be of Types III, IV and V construction except in any case as prohibited in 334.12. In structures exceeding four floors above grade, cables shall be concealed within walls, floors or ceilings that provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

   For the purpose of Items 2 and 3 above, the first floor of a *building* shall be that floor that has 50 percent or more of the exterior wall surface area level with or above finished grade. One additional level that is the first level and not designed for human habitation and used only for vehicle parking, storage or similar use shall be permitted.

2. Change Section 700.12(F)(2)(6) of NFPA 70 to read:

   (6) Where the normal power branch circuits that supply luminaires providing illumination immediately on the inside and outside of exit doors are supplied by the same service or feeder, the remote heads providing emergency illumination for the exterior of an exit door shall be permitted to be supplied by the unit *equipment* serving the area immediately inside the exit door.

3. Delete Section 210.8(F) in its entirety.

4. Change Section 210.52(C)(2) of NFPA 70 to read:

   Island and Peninsular Countertops and Work Surfaces. At least one receptacle shall be installed at each island and peninsular countertop space with a long dimension of 24 inches (610 mm) or greater and a short dimension of 12 inches (305 mm) or greater. A peninsular countertop is measured from the connected perpendicular wall.

5. Add exception to Section 210.52(C)(3) of NFPA 70 to read:

   Exception: To comply with the following conditions (1) and (2), receptacle outlets shall be permitted to be mounted not more than 12 inches (305 mm) below the countertop or work surface.

   (1) Construction for the physically impaired

   (2) On island and peninsular countertops or work surface where the surface is flat across its entire surface (no backsplashes, dividers, etc.) and there are no means, such as an overhead cabinet, to mount a receptacle within 20 inches (508 mm) above the countertop or work surface.

   Receptacles mounted below a countertop or work surface in accordance with this exception shall not be located where the countertop or work surface extends more than 6 inches (150 mm) beyond its support base.

2024 International Residential Code

Revise as follows:

E3901.4.2 Island and peninsular countertops and work surfaces. ~~Receptacle outlets, if installed to serve an island or peninsular~~

~~countertop or work surface, shall be installed in accordance with Section E3901.4.3. If a receptacle outlet is not provided to serve an island or peninsular countertop or work surface, provisions shall be provided at the island or peninsula for future addition of a receptacle outlet to serve the island or peninsular countertop or work surface.~~ At least one receptacle shall be installed at each island and peninsular countertop space with a long dimension of 24 inches (610 mm) or greater and a short dimension of 12 inches (305 mm) or greater. A peninsular countertop is measured from the connected perpendicular wall.

E3901.4.3 Receptacle outlet location. Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks, or rangetops as covered in the exception to Section E3901.4.1, or appliances occupying assigned spaces shall not be considered as these required outlets. Required receptacle outlets shall be located in one or more of the following:

1. On or above, but not more than 20 inches (508 mm) above, the countertop or work surface.
2. In a countertop using receptacle outlet assemblies listed for the use in countertops.
3. In a work surface using receptacle outlet assemblies listed for use in work surfaces or listed for use in countertops. [210.52(C)(3)]

Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks, or rangetops as covered in E3901.4.1, Exception 1, or appliances occupying assigned spaces shall not be considered as these required outlets.

Exception: To comply with the following conditions (1) and (2), receptacle outlets shall be permitted to be mounted not more than 12 inches (305 mm) below the countertop or work surface. Receptacles mounted below a countertop or work surface in accordance with this exception shall not be located where the countertop or work surface extends more than 6 inches (150 mm) beyond its support base.

1. Construction for the physically impaired
2. On island and peninsular countertops or work surface where the surface is flat across its entire surface and there are no means to mount a receptacle within 20 inches (508 mm) above the countertop or work surface, such as an overhead cabinet

Reason Statement: Summary of Changes: This proposal (i) removes the requirement for provisions for a future receptacle to be provided if no receptacle on the island or peninsula is installed, (ii) reinstates the 2017 Edition requirement for at least one receptacle at each island or peninsula, and (iii) restores the exception allowing receptacles to be installed below the countertop on qualifying islands and peninsulas, including those installed to meet accessibility requirements.

Reason Statement:

The proposed prohibition on receptacles below countertops on islands and peninsulas lacks sufficient justification. As a minimum code, the NEC should establish baseline requirements supported by clear evidence of necessity. While data from the U.S. Consumer Product Safety Commission was cited in support of this change, the available incident records do not specifically establish that receptacles positioned below island or peninsular countertops were the contributing factor in accidents. Additionally, there is insufficient evidence demonstrating that this proposed change will produce measurable safety benefits.User responsibility remains central to electrical appliance safety. Appliance manufacturers have implemented multiple safeguards to mitigate risks. Manufacturers of cooking appliances routinely include comprehensive warnings in instruction manuals, such as:

- "Close supervision is necessary when any appliance is used by or near children."
- "Do not let cord hang over the edge of table or counter or touch hot surfaces."
- "Use deep fryer only on a clean, dry, level, stable, and heat-resistant surface, away from countertop edge."
- "Close supervision is necessary when any appliance is used by or near children. Hot oil can cause serious and painful burns."

Beyond warnings, manufacturers have developed design innovations specifically addressing this concern. Magnetic cord connectors, which detach readily when pulled, provide effective protection across all applications, including environments with receptacles installed below countertops.

Furthermore, the proposed change carries limitations that diminish its intended effect. The provision applies only to receptacles installed "to serve" an island or peninsular countertop or work surface, as specified in 210.52(C)(4). Convenience receptacles installed at standard

height (18 inches above finished floor) do not serve the work surface and therefore remain permissible. Additionally, because this requirement is located within Part III of Article 210 (Required Outlets, beginning at Section 210.50), it applies exclusively to required outlets. Supplemental outlets below countertops would continue to be permitted, further limiting the practical scope of this requirement.

The justification offered during the panel discussion—that post-construction receptacle installation in islands and peninsulas on slab-on-grade floors presents impracticable difficulties—warrants reconsideration. According to recent data, more than one-third of new single-family homes are constructed over basements or crawl spaces, providing practical access for future installation if needed. Imposing this requirement across all construction types may be unnecessarily restrictive.

Additional concerns relate to enforcement consistency. The language "provisions shall be provided" is sufficiently open-ended to generate varying interpretations among code officials, ranging from no additional requirements when subsurface access exists to the installation of complete powered circuits with electrical boxes. Requirements subject to interpretive discretion are frequently enforced more stringently than the intent suggests, potentially imposing unwarranted costs on homeowners.

The NEC undergoes frequent revisions, each introducing complexity and potential unintended consequences. Adoption of provisions that may require subsequent modification contributes to cumulative confusion among all code users and stakeholders.

Cost Impact: The code change proposal will decrease the cost Code change proposal will decrease construction costs

RE3901.4.2(1)-24 – Staff Summary

Proponent: Andrew Clark, representing Home Builders Association of Virginia

Brief Description: Requires at least one receptacle to be installed at each island or peninsula and allows receptacles to be installed below the countertop. (Reinstates the 2017 NEC requirements)

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

Third GSW Meeting — 01/05/2026

Support: Shahriar Amiri, Arlington County

Opposition: Corian Carney, York County and International Alliance of the Electrical Industry, VA Chapter (IAEI-VA)

Discussion:

Andrew C (HBAV) provided an overview of the proposal.

Jeff Brown (DHCD staff) reiterated to the stakeholders that this proposal is like another proposal (E2701.1.1-24) already heard. When there are similar proposals, regardless of whether it is Consensus for Approval or Non-Consensus, DHCD staff will flag those for the Board.

a. **Shahriar A** proclaimed that homeowners aren't going to get permits to install future receptacles and they will just use extension cords. Anything is better than the unedited current code.

DHCD Staff Notes:

This proposal conflicts with proposal RE3901.4.2-24 and its VCC companion proposal E2701.1.1-24.

- Proposal RE3901.4.2-24 was reviewed by stakeholders at the first GSW meeting, on July 29, 2025, and was ultimately carried over to the second GSW to allow for additional stakeholders collaboration. The proposal was reviewed again at the second GSW, on October 3, 2025, and received a Non-Consensus recommendation.
- Proposal E2701.1.1-24 was reviewed by stakeholders at the third GSW meeting, on January 5, 2026, and received a Non-Consensus recommendation.

RE3902.20-24

VRC: E3902.20

Proponents: Corian Carney, York County, representing Virginia Chapter IAEI, Eastern Virginia Division IAEI (corian.carney@yorkcounty.gov); Ryan Celestino, City of Newport News, representing Virginia Chapter IAEI, Eastern Virginia Division IAEI (celestinore@nnva.gov); Joseph Willis, Prince William County, representing Virginia Chapter IAEI (jwillis@pwcgov.org)

2021 Virginia Residential Code

Revise as follows:

E3902.20 Arc-fault circuit interrupter protection. Branch circuits that supply 120-volt, single-phase, 15- and 20- ampere outlets installed in kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, *sunrooms*, recreations rooms, closets, hallways, laundry areas and similar rooms or areas shall be protected by any of the following: [210.12(A)]

1. A *listed* combination-type arc-fault circuit interrupter, installed to provide protection of the entire branch circuit. [210.12(A)(1)]
2. A *listed* branch/feeder-type AFCI installed at the origin of the branch-circuit in combination with a *listed* outlet branch-circuit-type arc-fault circuit interrupter installed at the first outlet box on the branch circuit. The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet of the circuit. [210.12(A)(2)]
3. A *listed* supplemental arc-protection circuit breaker installed at the origin of the branch circuit in combination with a *listed* outlet branch-circuit-type arcfault circuit-interrupter installed at the first outlet box on the branch circuit where all of the following conditions are met:
   3.1. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit arc-fault circuit interrupter.
   3.2. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 50 feet (15.2 m) for 14 AWG conductors and 70 feet (21.3 m) for 12 AWG conductors.
   3.3. The first outlet box on the branch circuit shall be marked to indicate that it is the first outlet on the circuit.[210.12(A)(3)]
4. A *listed* outlet branch-circuit-type arc-fault circuit interrupter installed at the first outlet on the branch circuit in combination with a *listed* branch-circuit overcurrent protective device where all of the following conditions are met:
   4.1. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit arc-fault circuit interrupter.
   4.2. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 50 feet (15.2 m) for 14 AWG conductors and 70 feet (21.3 m) for 12 AWG conductors.
   4.3. The first outlet box on the branch circuit shall be marked to indicate that it is the first outlet on the circuit.
   4.4. The combination of the branch-circuit overcurrent device and outlet branch-circuit AFCI shall be identified as meeting the requirements for a system combination-type AFCI and shall be *listed* as such. [210.12(A)(4)]
5. Where metal raceways, metal wireways, metal auxiliary gutters or Type MC or Type AC cable meeting the applicable requirements of Section E3908.9 with metal boxes, metal conduit bodies and metal enclosures are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, a *listed* outlet branch-circuit type AFCI installed at the first outlet shall be considered as providing protection for the remaining portion of the branch circuit. [210.12(A)(5)]
6. Where a *listed* metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 2 inches (50.8 mm) of concrete for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, a *listed* outlet branch-circuit-type AFCI installed at the first outlet shall be considered as providing protection for the remaining portion of the branch circuit. [210.12(A)(6)]

Exceptions:

1. AFCI protection shall not be required for an individual branch circuit supplying a fire alarm system where the branch circuit is installed in a metal raceway, metal auxiliary gutter, steelarmored cable, Type MC or Type AC, meeting the requirements of Section E3908.9 , with metal boxes, conduit bodies and enclosures.

~~2. AFCI protection is not required where GFCI protection is required in accordance with Section E3902 and NEC 210.8(A).~~

Reason Statement: The previous exemption for arc-fault requirements where ground-fault protection is required allowed for a grace period to adjust to the full requirements. Prior to that exemption, AFCI protection was only required in bedrooms. This proposal will bring Virginia back in line with the national safety standard provided in NFPA 70 (NEC).

Cost Impact: The code change proposal will increase the cost Cost will increase by approximately $60-$120 per new construction home to account for 1-2 additional AFCI devices.

Public Comments (PCH) for: RE3902.20-24

Discussion by Joseph Wages

Jul 28, 2025 13:26 UTC

The National Electrical Manufacturers Association (NEMA) supports proposal RE3902.20-24 that deletes Exception No. 2 to Section E3902.20 covering AFCI protection. NEMA fully agrees with the reason statement provided by the proponent and urges the board to restore AFCI protection as published in the 2024 IRC.

Proposal # 1264

RE3902.20-24 – Staff Summary

Proponent: Corian Carney, York County, representing Virginia Chapter IAEI, Eastern Virginia Division IAEI; Ryan Celestino, City of Newport News, representing Virginia Chapter IAEI, Eastern Virginia Division IAEI; Joseph Willis, Prince William County, representing Virginia Chapter IAEI

Brief Description: Removes the existing Virginia amendment that exempts branch circuits requiring GFCI protection from the AFCI protection requirements.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

First GSW Meeting — 07/29/2025

Opposition: Andrew Clark, Home Builders Association of Virginia (HBAV).

Discussion:

a. **Corian Carney** – Provides overview of the proposal.
   i. **Andrew C** – The cost impact is minimal. To get our members comfortable, they want to see if there's a demonstrated need that this would address in Virginia.
   ii. **Gerry O'Connor** (Eaton). Based on national fire fighter association or FEMA data on fires dating back to 2002, which is when AFCI requirements were introduced to bedrooms (and has over time expanded to every space except attics, bathrooms, and garages), if there is a GFCI already on the circuit, this is a $5-7 add-on to protect the entire circuit.
   iii. **Andrew Clark** – We could find cost data all over the place.
b. **Gerry O'** – From a fire perspective, home fires have roughly stayed steady. They might have declined 1-2%. If you base it on the number of homes built in 2000 compared to today, we've almost doubled the number of homes we build in a year.
   i. **Andrew C** – In Virginia, that trend is the opposite. Our permit data has gone down significantly. A substantially smaller number of homes are being built each year.
   ii. **Gerry O'** – I'm basing it on the number of fires. It's hard to place a true stat number on electrical fires based on electrical wiring versus electrical cooking on a countertop that started a fire.
   iii. **Andrew C** – The fire services folks are beginning to amp up how they collect data, specifically for this purpose. We can then really hone in and say, "Are we addressing a perceived problem or do we have data that shows there is an issue?"
   iv. **Gerry O'** – I can tell you that after doing studies, I receive a lot of calls and reports from NEMA on unwanted tripping or nuisance tripping. Is it really a nuisance if it's doing its job? It could be an unwanted trip that causes

discomfort to reset the breaker. From our perspective, we have an excellent AFCI algorithm programmed into our devices. I want to say 80% of the items that we send a tech out to inspect are due to circuit overload. And any breaker would do it, whether it's AFCI or GFCI. If you overload a 20-amp circuit, it will trip.

c. **Jeff Brown** (DHCD staff) – Andrew, are you in opposition at this point?
    i. **Andrew C** – At this point.
    ii. **Corian C** – I'm not sure if there is a world in which we all agree, so we will move forward with it as non-consensus.

DHCD Staff Note: N/A

EB801.3-24

VEBC: 801.3 (New), 801.4

Proponents: Allison Cook, Arlington. Virginia, representing Arlington, Virginia (acook1@arlingtonva.us); Ron Clements, Chesterfield, representing Building Inspection Department (clementsro@chesterfield.gov)

2021 Virginia Existing Building Code

Add new text as follows:

801.3 Compliance with the building code.. Alterations or additions to buildings that convert the building to types, or create building features, within the scope of Chapter 4 of the VCC shall conform to the applicable requirements for the work as classified in this code and as modified by this chapter.

Exceptions:

1.In existing buildings where the highest occupied floor or occupied roof is less than the height for a *high-rise building* compliance with section 403 of the VCC is required when the alteration or addition causes the building to become a *high-rise building*.

2.In existing buildings that are a *high-rise building* and do not have elevators sized to accommodate a fire service access elevator, compliance with section 403.6.1 of the VCC is required only for the addition where two or more stories are added for fire department emergency access to all floors of the addition.

Revise as follows:

~~**801.3**~~ **801.4 Other work.** Any repair or alteration work within an *existing building* to which an addition is being made shall comply with the applicable requirements for the work as classified in this code.

Reason Statement: The Existing Building Code was written with horizontal additions in mind, it does not account for vertical additions. As a result of adaptive reuse, Northern Virginia is seeing more and more additions to add floors and / or an occupied roof to existing buildings. This code change is to provide consistency in the interpretation of "create" or "extend" a nonconformity when it comes to vertical additions associated with high-rise buildings.

It also helps to ensure that additions will not be cost prohibitive or technically infeasible while maintaining minimum life safety standards for existing buildings that are not currently a high-rise but the addition of another story or an occupied roof would create a high-rise.

Cost Impact: The code change proposal will not increase or decrease the cost This is being interpreted differently across Northern Virginia, with many already requiring code modification related to compliance with VCC Chapter 4 for high-rise buildings. This code change may cause some jurisdictions to be more restrictive and others to be less restrictive.

EB801.3-24 – Staff Summary

Proponent: Allison Cook, representing Arlington, Virginia; and Ron Clements, Chesterfield, representing Building Inspection Department

Brief Description: Allows the addition of one story atop an existing high-rise building without requiring a fire service access elevator, when the existing building cannot accommodate a fire service access elevator.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

N/A

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Third GSW Meeting — 01/06/2026

Support: Gregg Fields, City of Alexandria; and Shahriar Amiri, Arlington County.

Opposition: Andrew Milliken, Stafford County Fire Marshal's Office and VFSB Codes and Standards Committee (VFSB); Matthew Robinson, Spotsylvania County and VFSB; and Doug Banks, Henrico County.

Discussion:

Ron C provided an overview of the proposal.

a. **Dan Willham** [Fairfax County, Virginia Building and Code Officials Association (VBCOA)] asked for clarification that the proposal allows the addition of one story without requiring a fire service access elevator.
b. **Shahriar A** commented that this was correct.
c. **Andrew M** voiced concern over the second exception because if an owner is willing to spend the money to increase the number of stories to a building, then the new work should incorporate all the protections that would be necessary. Andrew M added the example of adding one story with an occupied roof where the roof area is not considered a story.
d. **Shahriar A** countered that adding a fire service access elevator to a high rise building that does not already have one is very expensive. Adding a fire service access elevator does not just involve altering an elevator shaft, but also potentially shear walls. Currently, the code does not require adding a fire service access elevator if the number of stories increase in an existing high-rise building. This proposal adds that requirement if more than one story is added.
e. **Matthew R** brought up that the example being given is changing the building from office use to a residential use which is a change of occupancy.
f. **Ron C** reminded the group that this proposal does not exempt any vertical additions from the

requirements in Chapter 7 of the VEBC.

g. **Doug B** cited Section 601.1 as a non-conformity cannot be created.

h. **Shahriar A** answered that if the existing building is conforming to the building code under which it was built and the new addition applies to the current code, then you are not extending a non-conformity.

DHCD Staff Note: N/A

PM602.2(1)-24

VPMC: 602.2, 602.4

Proponents: Honore Tchou, representing Myself and fellow tenants (hwt2@georgetown.edu)

2021 Virginia Property Maintenance Code

Revise as follows:

602.2 ~~Heat~~ Heating and cooling supply. Every *owner* and *operator* of a Group R-2 apartment *building* or other residential *building* who rents, leases, or lets one or more *dwelling unit*, rooming unit, dormitory, or guestroom on terms, either expressed or implied, to furnish ~~heat~~ heating or cooling to the *occupants* thereof shall supply ~~heat during the period from October 15 to May 1 to~~ heating or cooling to maintain a temperature of not less than ~~68°F (20°C)~~ 65°F (18°C) and no more than 75°F (24°C) in all habitable rooms, bathrooms, and toilet ~~rooms. The *code official* may also consider modifications as provided in Section 104.5.2 when requested for unusual circumstances or may issue notice approving *building owners* to convert shared heating and cooling piping HVAC systems 14 calendar days before or after the established dates when extended periods of unusual temperatures merit modifying these dates.Exception~~ rooms throughout the year.

Exception: When the outdoor temperature is higher than the summer design temperature or below the winter outdoor design temperature for the locality, maintenance of the minimum room temperature shall not be required provided ~~that~~ the heating or cooling system is operating at its full design capacity. The winter outdoor design temperature for the locality shall be as indicated in Appendix D of the IPC. The summer design temperature for the locality shall be as indicated in the IECC.

Delete without substitution:

~~602.4 Cooling supply.~~ ~~Every *owner* and *operator* of a Group R-2 apartment *building* who rents, leases, or lets one or more *dwelling units*, rooming units, or guestrooms on terms, either expressed or implied, to furnish cooling to the *occupants* thereof shall supply cooling during the period from May 15 to October 1 to maintain a temperature of not more than 77°F (25°F) in all habitable rooms. The *code official* may also consider modifications as provided in Section 104.5.2 when requested for unusual circumstances or may issue notice approving *building owners* to convert shared heating and cooling piping HVAC systems 14 calendar days before or after the established dates when extended periods of unusual temperatures merit modifying these dates.~~

~~**Exceptions:** When the outdoor temperature is higher than the summer design temperature for the locality, maintenance of the room temperature shall not be required provided that the cooling system is operating at its full design capacity. The summer outdoor design temperature for the locality shall be as indicated in the IECC.~~

Reason Statement: The reasoning for this proposal is three fold: (1) reduce ambiguities and misunderstandings in interpreting the current code, (2) align heating and cooling requirements to new realities of today's climate change, and (3) apply new scientific evidence that show the positive affects of cooler temperatures inside homes for tenant health and overall energy cost savings.

1. The proposal seeks to integrate and streamline the heating (602.2) and cooling code (602.4) while doing away with set dates to clarify and simplify the code. As currently written the code establishes two variables that create confusion for building operators and tenants. To illustrate, the heating code says, "... shall supply heat during the period from October 15 to May 1 to maintain a temperature of not less than 68F (20C) ..." This sentence creates confusion because there are two variables at play that can be at cross purposes with each other. Readers may also cherry pick the variable out of fear of being in non-compliance. For example, imagine it is April 10, and the temperature inside the building is 82F (exceedingly hot and uncomfortable). The operator may interpret the code to say that they must keep the heat on from October 15 to May 1 regardless of how hot it may be inside the building for tenants. Surely it cannot be the intention of the code to create a possible situation where operators keep running the heat regardless of whether their tenants could faint out of heat and exhaustion? And yet this is, in fact, happening in my very building where the operator refuses to turn off the heating system in April despite the temperatures being extremely elevated inside the building (see attachment - the inside of the building reached 82 while it was 74 degrees outside due to the continued use of the heating system). In addition, it is quite arbitrary that the heating system would be maintained all through April 30 at which point, at the stroke of midnight, the AC would be turned on as if the weather

transformed from winter cold to summer hot within one night. Finally, another reading of the sentence could argue that the dates should not be read as the operative part of the intent of the code in so far as it is the temperature inside the building that matters (whether it is achieve through heating, cooling, or other). If so, why not remove the dates? As such, the proposal recommends integrating the heat and cooling code and simplifying and clarifying the code by removing the dates and focusing on one variable -- the temperature range.

2. Recent weather patterns are becoming more erratic and seasons no longer adhere to traditional timetables. The current code handcuffs building operators with set dates that are no longer reflective of today's climate change. For example, the heating code says that heat must be maintained until May 1. However, as seen recently the weather turned excessively warm starting in early April, reaching over 80 degrees for many days. Yet heating continued to be deployed leading to a tremendous waste of money and gas, while making tenants uncomfortable and increasing the carbon footprint. As such, the proposal (in line with rationale 1) recommends removing the set dates to provide flexibility for operators to use either heating, cooling, or no system to maintain a general temperature range within the building of 65-75 degrees.

3. Recent scientific evidence shows that excessive heat particular at night while sleeping can be detrimental to health. See the attached files, "The Best Temperature for Sleep" and "How Your Home Temperature Can Affect Your Health." As such, this proposal recommends lowering the minimum floor to 65F degrees and the maximum ceiling to 75F for more positive health effects for tenants while also saving costs in heating bills.

If accepted, the proposal will provide flexibility for building operators to stop blindly following preset dates and be more responsive to tenants and their comfort and health based on weather forecasts and changing patterns. A plausible outcome for a building operator could be that during the winter months an operator would turn on the heating system; during shoulder season, the operator would turn off the the heating system; and during the summer months turn on the cooling system, as long as the temperature range is achieved. This way year to year variations can be taken into account by an increasingly empowered building operator freed from a preset timetable.

DHCD Staff Note: the original designation of the proposal was PM602.2-24. The "(1)" was added after the section number later in the cycle when another proposal was submitted with the intent of changing the same section(s).

Cost Impact: The code change proposal will decrease the cost I do not have statistics to back this up, but common sense would say that heating and cooling bills should go down as building operators are more empowered to turn off the heating or cooling system when it is no longer desirable.

Attached Files

- **Attachment - Excessive Heat.pdf**
  https://va.cdpaccess.com/proposal/1272/1849/files/download/923/
- **Turn off boilers.pdf**
  https://va.cdpaccess.com/proposal/1272/1849/files/download/922/
- **The Best Temperature for Sleep.pdf**
  https://va.cdpaccess.com/proposal/1272/1849/files/download/920/
- **How Your Home Temperature Can Affect Your Health.pdf**
  https://va.cdpaccess.com/proposal/1272/1849/files/download/919/

From: **Honore Tchou** hwt2@georgetown.edu
Subject: Re: Turn off boilers
Date: March 31, 2025 at 11:29 AM
To: River Place South office@riverplacesouth.com

Hi Richard and team,

Hope you're well!

I know we already discussed the Virginia building code, but I still wanted to share this pic for your awareness. The temperature in my unit is exceeding 80 degrees while the temp outside is lower. It's making river place south harder and harder to live/work in under these conditions. Thanks for listening and troubleshooting to the extent you can. I have not heard back from the housing authorities but will share if I hear anything. Thank you!

Honore



Honoré

Sent from my iPhone

> On Mar 19, 2025, at 4:01 PM, Honore Tchou <hwt2@georgetown.edu> wrote:
>
> Thanks, Richard, for the non-smoking reminder which would let me open the window more frequently. And crossing fingers that those cooler days mean cooler temps in my unit. I may need to experiment with using ice and a fan. We shall see!

Honore

> On Mar 19, 2025, at 3:49 PM, River Place South <office@riverplacesouth.com> wrote:
>
> Hi Honore,
>
> Yes. Of course we will remind residents of our non-smoking rule.
>
> I see that cooler temperatures are forecasted for the next 9 days.
>
> Best,
>
> Richard
>
> *Richard Villegas - General Manager*
> River Place South Housing Corporation
> 1011 Arlington Blvd #350
> Arlington, Va. 22209
> 703-528-3555
>
> ---
>
> **From:** Honore Tchou <hwt2@georgetown.edu>
> **Sent:** Wednesday, March 19, 2025 3:30 PM
> **To:** River Place South <office@riverplacesouth.com>
> **Subject:** Re: Turn off boilers
>
> Hi Richard,
>
> Thanks again for sharing these documents. I reviewed them and see the mention of May 1. Quite fascinating that Virginia uses dates rather than temperature readings. To let you know I have emailed the Virginia Housing Division to see if there are any exceptions to the rule, and can share whatever they may say, although I don't expect much.
>
> Which leaves me to my current predicament, that I am pretty much on my own during these shoulder seasons. With that said, can I ask you for a small favor when convenient? Can you remind folks that RPS is a non-smoking building? As I was trying to cool off yesterday with the window open, cigarette smoke would just waft through the window, another reason why it's been difficult to deal with the heat. Any help on this front is appreciated.
>
> Thank you, Richard!
>
> Honore
>
> FYI: this is the temperature reading at 10:00 am in my unit (78.4) while it's 53 outside (a 25 degree difference) despite the heat turned off and shades down. Imagine when it becomes 60 or 70 outside. Hot!
>
> <image001.jpg>

> On Mar 17, 2025, at 11:34 AM, River Place South <office@riverplacesouth.com> wrote:
>
> Hi Honore,
>
> Of course. Our pleasure.
>
> Please see link to Arlington County describing the heat requirement:
>
> https://www.google.com/url?q=https://www.arlingtonva.us/Government/Programs/Housing/Get-Help/Rental-Services/Tenant-Landlord-Rights-Responsibilities%23:~:text%3DBuilding%2520owners%2520are%2520legally%2520obligated,maintenance%2520codes%2520in%2520Arlington%2520County&source=gmail-imap&ust=1742830455000000&usg=AOvVaw1ktwqyJaL4BpcnOF0Eietq.
>
> Arlington County also provides a reference to the Virginia Uniform Statewide Building Code:
>
> https://www.google.com/url?q=https://www.dhcd.virginia.gov/virginia-uniform-statewide-building-code-usbc&source=gmail-imap&ust=1742830455000000&usg=AOvVaw1S4Ib8eiYVc2PmDNGup40K
>
> Best regards,
>
> Richard
>
> Richard Villegas - General Manager
> River Place South Housing Corporation
> 1011 Arlington Blvd #350
> Arlington, Va. 22209
> 703-528-3555
>
> -----Original Message-----
> From: Honore Tchou <hwt2@georgetown.edu>
> Sent: Monday, March 17, 2025 10:46 AM
> To: River Place South <office@riverplacesouth.com>
> Subject: Re: Turn off boilers
>
> Hi Richard,
>
> Thanks for the response, and I appreciate your acknowledgment of my past and recurring challenges with the heat at RPS, which makes it painful for me to work, rest, and sleep in my unit.
>
> I appreciate you referencing a Virginia law that requires compliance. Can you help me and clarify which Virginia law you are referencing? It would be new to me that any Virginia law directs heating or cooling of the building based on the outside temperature, but rather my understanding is that it is based on the inside temperature of the building, which is significantly higher due to insulation and ambient heat.
>
> Any assistance would be appreciated. Thank you again, Richard!
>

> Honore
>
>
>> On Mar 17, 2025, at 9:50 AM, River Place South <office@riverplacesouth.com> wrote:
>>
>> Hi Honore,
>>
>> Good morning. Hope all is well. Thank you for your email. We understand that the air flow to your convector is currently turned off which is the best we can do for the time being. If you would like us to have our team double check it, we'd be glad to.
>>
>> I believe we've explained in the past that our boilers automatically shut off when it's over 65 degrees outside. Under Virginia law we are required to maintain heat until May 1.
>>
>> As we have done in previous year, our team will continue to monitor temperatures through the month of April, but bear in mind that for example this week low temps are expected in the high 30's.
>>
>> Please le us know if you have any questions.
>>
>> Best,
>>
>> Richard
>>
>> Richard Villegas - General Manager
>> River Place South Housing Corporation
>> 1011 Arlington Blvd #350
>> Arlington, Va. 22209
>> 703-528-3555
>>
>> -----Original Message-----
>> From: Honore Tchou <hwt2@georgetown.edu>
>> Sent: Sunday, March 16, 2025 11:22 PM
>> To: River Place South Housing Corporation <riverplaceSouth@comcast.net>
>> Subject: Turn off boilers
>>
>> Hi Gail, Richard, and the River Place team,
>>
>> I hope you had a great weekend!
>>
>> Would it be possible to consider turning off the boilers? It has already become very hot in the apartment and the next two weeks will see us hitting sixties and seventies which makes the units much too hot to bear. For your info I already have the hot air turned off.
>>
>> I hope this is a reasonable request and thank you for your consideration!
>>
>> Honoré
>> 839 South
>>
>> Sent from my iPhone



From: **River Place South** office@riverplacesouth.com
Subject: RE: Turn off boilers
Date: March 17, 2025 at 9:50 AM
To: Honore Tchou hwt2@georgetown.edu

RS

Hi Honore,

Good morning. Hope all is well. Thank you for your email. We understand that the air flow to your convector is currently turned off which is the best we can do for the time being. If you would like us to have our team double check it, we'd be glad to.

I believe we've explained in the past that our boilers automatically shut off when it's over 65 degrees outside. Under Virginia law we are required to maintain heat until May 1.

As we have done in previous year, our team will continue to monitor temperatures through the month of April, but bear in mind that for example this week low temps are expected in the high 30's.

Please le us know if you have any questions.

Best,

Richard

Richard Villegas - General Manager
River Place South Housing Corporation
1011 Arlington Blvd #350
Arlington, Va. 22209
703-528-3555

-----Original Message-----
From: Honore Tchou <hwt2@georgetown.edu>
Sent: Sunday, March 16, 2025 11:22 PM
To: River Place South Housing Corporation <riverplaceSouth@comcast.net>
Subject: Turn off boilers

Hi Gail, Richard, and the River Place team,

I hope you had a great weekend!

Would it be possible to consider turning off the boilers? It has already become very hot in the apartment and the next two weeks will see us hitting sixties and seventies which makes the units much too hot to bear. For your info I already have the hot air turned off.

I hope this is a reasonable request and thank you for your consideration!

Honoré
839 South

Sent from my iPhone

November 16, 2021 / Living Healthy / Sleep

What's the Best Temperature for Sleep?

Sleeping too hot or too cold can affect a good night's rest



Which category of “sleeper” do you fall into? While some people like to keep their bedrooms cool because they “sleep hot,” others prefer to crank up the bedroom temperature because they “sleep cold.”

It can pose for an interesting debate — especially if you’re sharing a bed/bedroom with someone who doesn’t quite vibe with your sleep style. But it *is* possible to find a healthy and happy medium.

As a rule of thumb, sleep psychologist Michelle Drerup, PsyD, says to keep your bedroom at 60 to 67° F (15 to 19° C) and to think of your bedroom as your ‘cave.’ “It should be cool, dark and quiet to enhance your sleep.”

So, how exactly does temperature affect your sleep? Learn about the health implications of sleeping too hot or too cold and what your ideal sleeping temperature should be, below.

How temperature impacts sleep

We've all experienced a terrible night's sleep. We wake up the next day feeling groggy and moody, moving slowly and looking forward to the moment we can once again shut our eyes and get some rest.

There are several factors that can contribute to sleeping troubles, one being temperature.

"If your bedroom becomes uncomfortably hot or cold, you are more likely to wake up," says Dr. Drerup.

But why is this the case? One study shares that too much heat or cold exposure is directly linked to increased wakefulness and decreased rapid eye movement (REM) sleep (the stage in which one dreams). "Thermoregulation is very important for staying in restorative, slow-wave sleep stages," says Dr. Drerup. "These are the stages in which we get the most rest."

Sleeping too hot

When we sleep, our core body temperature decreases as part of the sleep initiation process, so you may crave the heat to get warm and cozy under the covers. But — if the temperature of your bedroom is too hot or humid, chances are you'll experience more restlessness and have more trouble falling/staying asleep.

"Heat is a huge disruptor for REM sleep," Dr. Drerup says. With the heat of the room, your body temperature will also rise, thus undoing the sleep initiation process entirely.

If your bedroom temperature is above 70° F, it's too hot.

Sleeping too cold

On the flip side, sleeping too cold also has its downsides. It may not affect your sleep cycles as drastically as sleeping too hot, but it may lead to other health issues.

“When we’re cold, our body kicks into high gear to try and get us warm again,” says Dr. Drerup. Blood vessels become constricted, breathing becomes shallow and it puts extra pressure on our cardiovascular system to get our body temperatures regulated again, she adds.

If your bedroom temperature is lower than 60° F, it’s too cold.

Does ideal sleep temperature change with age?

As we age, our bodies go through many changes — one, being a decrease in body temperature and another being a decrease in melatonin (a hormone released at night associated with sleep control) and cortisol (stress hormone) levels. You may need to adjust your sleeping temperature depending on your body, but you should avoid changing it too drastically one way or the other. Talk with your doctor to see if your sleep temperature should change.

So, now that you know it’s not ideal to sleep in too hot or too cold of temperatures, what *is* the best sleeping temperature? “Typically it is suggested that the optimal sleeping temperature in the bedroom for adults should be between 60 and 67° F,” says Dr. Drerup. This range of temperature is thought to actually help facilitate the stability of REM sleep.

What is the ideal sleeping temperature for babies?

The best sleeping temperature for babies and toddlers is a bit higher, between 65 and 70° F.

“Sleeping on the warmer end of the ideal sleep temperature scale is more conducive for those with smaller bodies that are still developing,” says Dr. Drerup. “They are not yet able to regulate their body temperature like adults can.”

Keep your baby’s bedroom temperature too warm though, and you run the risk of overheating. Put your child in something breathable to sleep in and try to limit the number of blankets in their crib/bed.

If you’re concerned about your child being too hot while they sleep, touch the back of their neck or stomach to test your theory. If their skin is sweaty, remove a layer or decrease the temperature of the room a bit.

How to keep the ideal sleep temperature

Before you head to bed tonight, set your thermostat to the optimal sleeping temperature (60 to 67° F) and try these other tips for getting a good night’s rest:

- Keep a fan in your room, so that in the case you do feel too warm, it will be easy to cool down the rest of the room.
- Avoid drinking caffeine or eating foods high in sugar (which can increase your body temperature).

- Sleep for the season, with appropriate, breathable pajamas, bed sheets and blankets.

Now it's time to put your temperature regulations to the test! If you're still experiencing sleep issues at a regulated temperature, consult with your primary doctor, who can refer you to a sleep psychologist.

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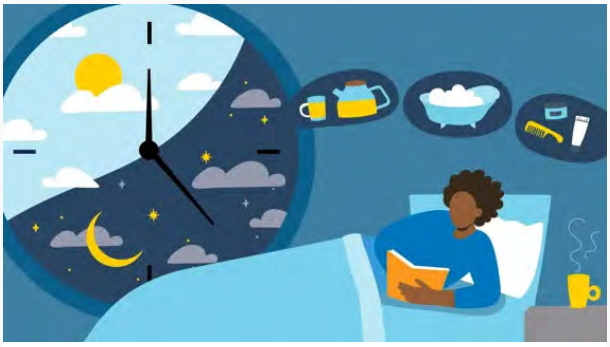
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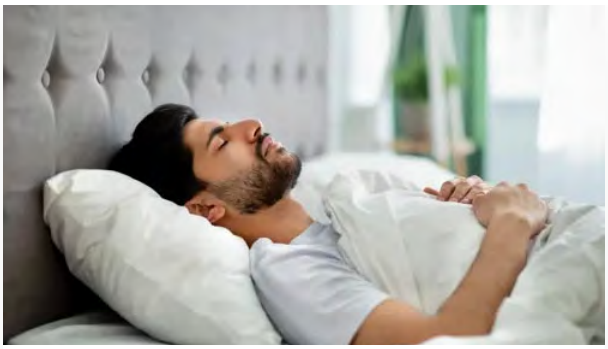
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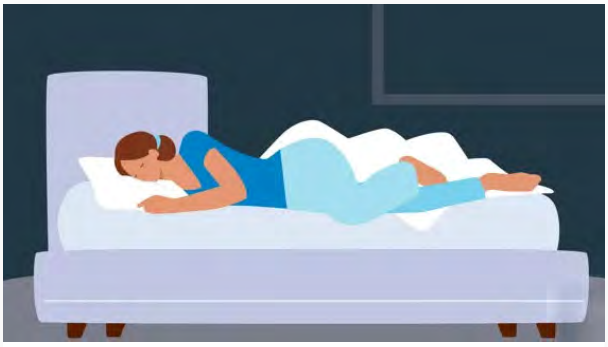


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How Your Home's Temperature Can Affect Your Health

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Did you know that the temperature of your home can significantly impact your health? Whether it's the biting chill of winter or the sweltering heat ...

Posted by Glenn | December 27, 2023

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> Did you know that the temperature of your home can significantly impact your health? Whether it's the biting chill of winter or the sweltering heat of summer, finding the right balance is crucial for your well-being. Here, we explore the effects of both extremes and discuss the ideal temperature range for a healthy home.

THE GOLDILOCKS ZONE: FINDING THE PERFECT TEMPERATURE

Maintaining a comfortable temperature at home is essential for your well-being. The ideal temperature for your home depends on several factors, including your age, health, and personal preferences. During the summer months, the ideal temperature for your home is around 25.5°C (78°F). However, this temperature can vary depending on your personal preferences and the climate in your region. You can also use air conditioning, insulation, certain building materials, wall thickness, shading from direct sunlight, natural ventilation, and increased air motion (fans) to cool indoor temperatures and protect yourself against heat and heat-related illnesses.

It's important to note that an indoor temperature of less than 16°C increases the risk of

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Therefore, maintaining an ideal temperature in your home is crucial for your health and comfort. The ideal temperature can vary based on personal preferences and the clima in your region, but it's recommended to set your thermostat to 20°C (68°F) during the winter months and around 25.5°C (78°F) during the summer months.

FACTORS THAT CAN AFFECT INDOOR TEMPERATURE

Maintaining a comfortable indoor temperature is essential for your health and well-being. The temperature inside your home can be affected by various factors, including:

1. Insulation

Poor insulation can lead to significant heat loss, making it difficult to maintain a comfortable temperature indoors. If your home is not well insulated, you may need to use more energy to heat or cool your home, which can increase your energy bills.

2. Building Materials

The materials used to construct your home can also affect its temperature. For instance, homes made of brick or stone tend to retain heat better than those made of wood. Additionally, the thickness of your walls can also impact your home's temperature.

3. Sunlight

Direct sunlight can significantly increase the temperature inside your home, especially during the summer months. Shading your windows or using curtains can help block out the sun's rays and keep your home cooler.

4. Airflow

Proper ventilation is crucial for maintaining a comfortable indoor temperature. Airflow can be improved by opening windows, using fans, or installing an air conditioning system. Increased air motion can also help cool indoor temperatures.

5. Outdoor Temperature

The temperature outside your home can also affect the temperature inside. During the winter months, colder temperatures outside can lead to lower indoor temperatures, while during the summer, hotter temperatures outside can cause your home to become

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Maintaining the right temperature in your bedroom is crucial for a good night's sleep. According to the Sleep Foundation, the ideal temperature for sleep is between 60-68°F. Your body's temperature naturally drops as you sleep, so a cooler room makes it easier to fall and stay asleep.

On the flip side, sleeping in a room that is too warm or too cold can disrupt your sleep. When you are too warm, your body struggles to cool down, leading to restlessness and discomfort. According to the Cleveland Clinic, sleeping too cold can also have its downsides. When you are too cold, your body kicks into high gear to try and get you warm again, leading to restlessness and discomfort.

Being in a comfortable environment is essential for healthy sleep. Keeping your sleeping quarters at a temperature near 18.3°C (65°F), give or take a few degrees, is ideal, according to Healthline. Your body temperature naturally fluctuates throughout the night, so a slightly cooler room can help regulate your body temperature and promote restful sleep.

A good night's sleep is dependent on maintaining the right bedroom temperature. Sleeping in a room that is too warm or too cold can disrupt your sleep and lead to restlessness and discomfort. Keeping your sleeping quarters at a temperature near 18.3°C (65°F) is ideal for promoting restful sleep.

FAQs

Is it Healthier to Keep Your House Cold or Warm?

Striking the right temperature balance is like finding the Goldilocks zone for your health. While personal preferences vary, experts generally agree that maintaining a moderate temperature is key. Extreme cold or heat can strain your body, affecting everything from sleep quality to overall comfort.

What is the Healthiest Temperature to Keep in Your House?

The sweet spot for indoor temperature is typically around 20-22 degrees Celsius (68-72 degrees Fahrenheit). This range promotes better sleep, aids concentration, and supports overall physical comfort. Straying too far from this range may lead to health issues.

What are the Benefits of Living in a Cold House?

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While there are benefits, it's essential to consider the downsides of a cold home. Exposure to low temperatures for extended periods can strain your cardiovascular system, potentially leading to health issues. Cold indoor environments might also contribute to discomfort and increase the risk of respiratory problems.

What Temperature is Too Cold for a House?

Experts suggest avoiding indoor temperatures below 15 degrees Celsius (60 degrees Fahrenheit) for extended periods. Prolonged exposure to colder temperatures can lead to health issues, including increased vulnerability to respiratory infections.

HOW TO KEEP CONSISTENT TEMPERATURES

Invest in a Programmable Thermostat: Installing a programmable thermostat allows you to set specific temperatures for different times of the day. This not only ensures comfort but also helps you optimize energy usage, saving on utility bills.

Seal Leaks and Insulate: Identify and seal any gaps or leaks in windows, doors, and walls. Proper insulation is key to preventing heat loss in the winter and maintaining a cool interior during the summer. Consider upgrading insulation in attics and walls for better temperature control.

Regular HVAC Maintenance: Schedule routine maintenance for your heating, ventilation, and air conditioning (HVAC) system. This includes cleaning or replacing filters, checking for leaks, and ensuring all components function efficiently. A well-maintained HVAC system contributes to consistent temperature regulation.

Use Curtains and Blinds Strategically: Curtains and blinds are more than just decorative; they play a crucial role in temperature control. Close them during the hottest parts of the day to block out sunlight and heat and open them on cooler days to let in natural warmth. Consider using thermal curtains for added insulation.

Consider Zoning Systems: Zoning systems allow you to control the temperature of different areas or rooms independently. This is particularly useful for larger homes or multi-story residences, ensuring that each space is heated or cooled according to its specific needs.

Adjustable Vent Covers: Invest in adjustable vent covers to control the airflow in each room.

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strategically use accessories like curtains and rugs. For personalized advice on

enhancing your home's temperature control, consider reaching out to **Always Plumbing and Heating.**

STRIVE FOR BALANCE

Now you know your home's temperature plays a significant role in your overall health. Striving for a balanced and comfortable environment is essential for quality sleep, mental well-being, and immune system support.
Ready to achieve temperature stability in your home? **Contact us** for expert guidance on optimizing your HVAC system and maintaining a comfortable living space. Subscribe to our newsletter for more tips on creating a consistent and cozy home environment.

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PM602.2(1)-24 – Staff Summary

Proponent: Honore Tchou, representing Myself and fellow tenants

Brief Description: Removes the heating and cooling date restrictions and sets a temperature range of not less than 65°F (18°C) and no more than 75°F (24°C) to be maintained throughout the year.

STUDY GROUP OR SUB-WORKGROUP INFORMATION

This proposal underwent detailed review by the Heating and Cooling Study Group (SG) at its meeting, on June 23, 2025.

The SG brought together local building officials, property managers, code officials, DHCD staff, and legislators to review possible updates to Virginia's Property Maintenance Code related to heating and cooling requirements for multi-unit residential buildings, including seasonal transition dates and system constraints. An emphasis was placed on dwelling units intended to be rented, leased or let on terms, either expressed or implied, to furnish heating or cooling to the occupants thereof.

Several concerns related to this proposal were raised during the SG discussion, including enforceability and technical issues, regional climate differences, and practical challenges for building owners and tenants. See Book 2, Tab 10 for the Heating and Cooling Study Group meeting summary.

SG members volunteered to draft a separate code change proposal [PM602.2(2)-24] based on feedback shared during SG discussion.

GENERAL STAKEHOLDER WORKGROUP INFORMATION

Second GSW Meeting — 10/03/2025

Support: None

Opposition: Shahriar Amiri, Arlington County; Steve Shapiro, Virginia Apartment Management Association, Apartment & Office Building Association of Metropolitan Washington (AOBA/VAMA); Andrew Clark, Home Builders Association of Virginia (HBAV); and Dennis Hart, Dennis Hart, Virginia Plumbing and Mechanical Inspectors Association (VPMIA) and Virginia Building and Code Officials Association (VBCOA) PMG Code Committee.

Discussion:

Jeff Brown (DHCD staff) provided an overview of the proposal on behalf of the proponent.

The stakeholders favored the alternative proposal PM602.2(2)-24.

DHCD Staff Note:

This proposal conflicts with proposal PM602.2(2)-24. The Heating and Cooling Study Group discussions and feedback directly informed the development of proposal PM602.2(2)-24, which was reviewed by stakeholders at the second GSW meeting on October 3, 2025, and received a Consensus Approval recommendation.