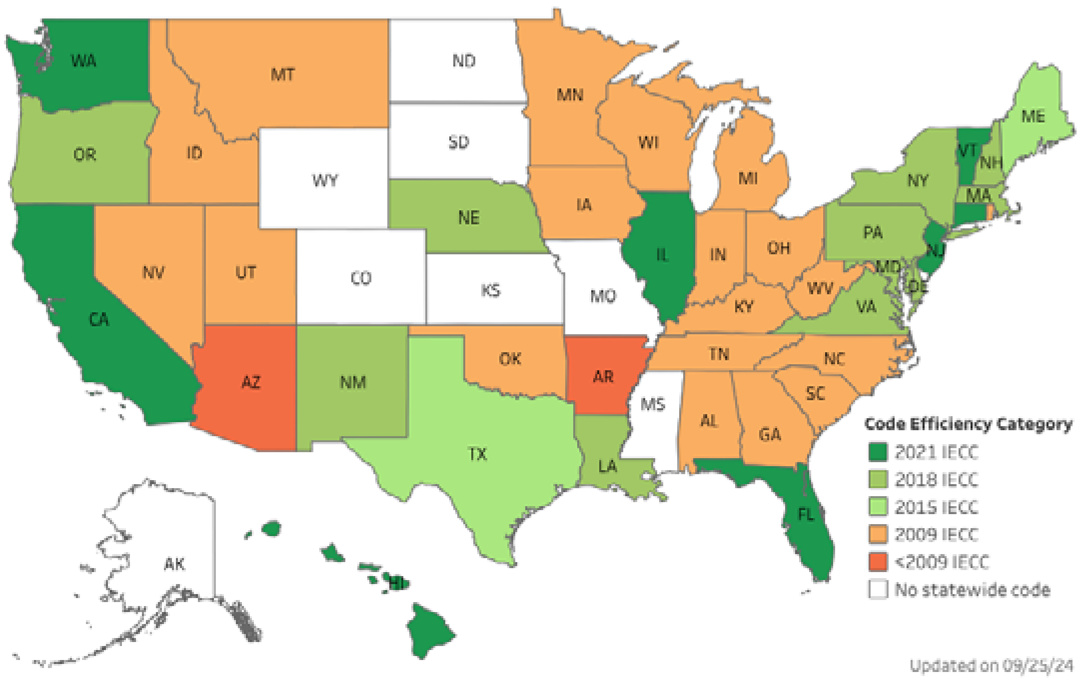
RESEARCH & TECHNOLOGY

ENERGY CODE COMPLIANCE FOR POST-FRAME BUILDINGS



Residential Energy Code Map image above taken from energycodes.gov/state-portal

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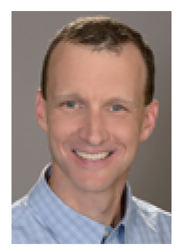

The International Energy Conservation Code (IECC) (published by the International Code Council, Inc.; see **Figure 1**) is a model building code commonly adopted by states and municipalities in the United States. It contains efficiency requirements for energy systems within a building, including heating, ventilation and air conditioning; service water heating; electrical power; lighting; and the building envelope. To determine which energy code is adopted in a particular state, see www.energycodes.gov/state-portal and notice that there is a portal at this site for both Residential and Commercial codes. While there, you can also find various code compliance tools under the "Tools & Modeling" menu, including the popular COMcheck (Commercial) and REScheck (Residential) tools.

One important part of the 2021 edition of the IECC for post-frame builders is the building envelope requirements. The IECC contains provisions for commercial (IECC §C402) and residential (IECC §R402) buildings. This article focuses on the commercial provisions, though the concepts and considerations are similar in the residential provisions.

The primary focus for building envelope compliance is demonstrating that there is adequate insulation in the building shell to create energy efficient heating and cooling based on the building's climate zone. The building envelope (see **Figure 2**) is defined by the limits of the conditioned space separated from unconditioned space or the outdoors. The 2021 IECC requires commercial buildings to comply with one of these three options, chosen by the building owner and the owner's designer (see C401.2):

1. IECC Prescriptive Compliance (C402 - C406)
2. IECC Total Building Performance method (C407)
3. ANSI/ASHRAE/IESNA 90.1-2019

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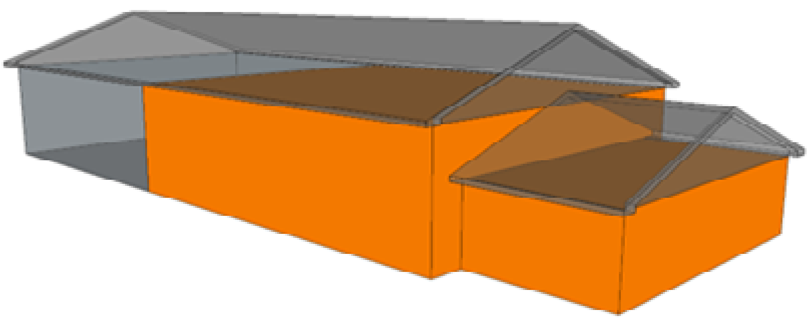
Figure 1:
The International Energy Conservation Code is a model building code published by the International Code Council and widely adopted throughout the United States.

Figure 2:
The extent of the building envelope in this example is represented by the orange surfaces. The unheated storage area (far end) and the vented attic spaces are not conditioned spaces and are excluded from the building envelope.



Designers for most projects tend to use the COMcheck tool to demonstrate how the IECC prescriptive requirements of C402-C406 will be satisfied. But within this compliance path, three options exist for satisfying the building envelope requirements in a prescriptive way:

1. R-value-based method (§C402.1.3)
2. U-/C-/F-factor-based method (§C402.1.4)
3. Component Performance Alternative (§C402.1.5).

My experience indicates that the Component Performance Alternative method provides the most flexible and economical compliance path for my own project design work. I have found it very helpful to review the example for this method shown in the IECC Commentary (see **Figure 3 on** page 22) to confirm that I understood the method properly before using it in my own designs.

Using COMcheck to document compliance for the entire building envelope allows a designer to enter all assemblies and components and their performance criteria into the software. The resulting report produces a summary of the envelope and any requirements that must be satisfied during and after construction. The COMcheck report also gives a convenient score showing the building envelope's performance as a percentage "better than" (passing) or "worse than" (failing) the code requirements.

Some requirements of the energy code are considered mandatory because they will always apply (i.e. cannot be 'traded off'), even when the energy efficiency of the project exceeds the code requirements. One mandatory example in the building envelope is resistance to air leakage (§C402.5) because even the most robustly insulated building will not be energy efficient if the envelope allows unconditioned air to pass into and out of the building when the wind blows.

Post-Frame buildings as a framing system do not have unique energy code requirements, but a few topics may frequently come up during project design and construction which may deserve mention:

- **R-values for wall and ceiling assemblies, with wider framing cavities than in standard construction**. Although using higher effective R-values in Post-Frame wall and ceiling cavities with common framing spacing of 6' on center to 10' on center (compared to 16" on center or 24" on center in standard wood frame construction) can be justified, the impact on code compliance software models is small and may not be worth specialized analysis. To determine appropriate U-values for walls and other assemblies in the UA / Component Performance Alternative calculation, designers should reference tables and methods within ASHRAE 90.1. In my experience it has been better to use a conservatively "safe" U-Value (slightly higher than what I think could be used), rather than trying to be so precise for the unique assembly framing and features that the authority having jurisdiction (AHJ) may not understand (nor agree with) the analysis presented.
- **U-values for large garage doors**. Most garage door manufacturers publish a nominal R-value for the door slab (R-12, R-15, etc.), but this cannot be converted directly into an effective U-value for the entire door. If the manufacturer does not provide an installed U-value, the code prescribes conservative default U-values for these doors in Table C303.1.3(2). Using these default values in buildings with many garage doors can make it difficult or impossible to meet the energy code envelope standards, so look for door manufacturers with published ANSI/DASMA 105-2017 high-performance U-Values, the lower, the better! (Door and Access Systems Manufacturers Association International, 2017).
- **Best ways to insulate foundations and building perimeter**. A 2010 Frame Building News article (Bohnhoff, 2010) discussed the importance of using

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vertical insulation at the edge of the concrete slab on grade and the disadvantage of using a sand layer between the concrete slab and a below-grade vapor barrier. It then presented three viable construction details for effectively insulating the building foundation for embedded-post projects.

- **Situations for applying or waiving the vestibule requirement**. Just as air leaking through a building's shell renders the insulation useless, frequently used exterior doors can drastically increase the amount of energy required to heat or cool the building as unconditioned outside air enters the conditioned space. The energy code default requirement is that all exterior doors shall have vestibules to minimize air infiltration, but some exemptions listed in the IECC could eliminate most (if not all) requirements for vestibules in your Post-Frame project. You should be aware of the requirement and the exemptions early in your project development.

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References

American Society of Heating, Refrigerating and Air-Conditioning Engineers. (2019). *Energy Standard for Buildings Except Low-Rise Residential Buildings.* ANSI/ASHRAE/IESNA 90.1 Atlanta, GA: ASHRAE.

Bohnhoff, D. R. (2010). Below-grade insulation for post-frame buildings, Part II: Preventing heat transfer. *Frame Building News*, 26(2), 56–63.

Door and Access Systems Manufacturers Association International. (2017). *Test Method for Thermal Transmittance and Air Infiltration of Garage Doors*. ANSI/DASMA 105-2017. Cleveland, OH: DASMA International.

International Code Council, Inc. (2018). International Energy Conservation Code and Commentary. Country Club Hills, IL: ICC, Inc.

C402.1.5 Component performance alternative. Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be permitted in lieu of compliance with the *U*-, *F*- and *C*-factors in Tables C402.1.3 and C402.1.4 and the maximum allowable fenestration areas in Section C402.4.1.

$$A + B + C + D + E \leq \text{Zero} \qquad \textbf{(Equation 4-2)}$$

A	-448	
B	12	
C	0	
D	164	
E	0	
Total	-272	PASSES

Since Total of Equation 4-2 is -272 and less than or Equal to Zero, the proposed design PASSES

A — Distinct Assemblies and Components OTHER than Slabs on Grade and Below-Grade Walls

Section	Area	Proposed U-Value	Proposed UA	Table U-Value	Tabular UA	UA Dif (Proposed - Table)
Roof	10000	0.03	300	0.034	340	-40
Wall	6000	0.09	540	0.078	468	72
Wall 2	4000	0.055	220	0.055	220	0
Floor Framed	5000	0.029	145	0.029	145	0
Skylight	100	0.5	50	0.5	50	0
VG 1 - Alum Curtain Wall	3000	0.22	660	0.38	1140	-480
VG 2 - Wood Framed	1000	0.3	300	0.3	300	0
Total						-448

B — Distinct Slab on Grade Perimeter Conditions (F-Values x Length)

Section	Length	Proposed F-Value	Proposed FL	Table F-Value	Tabular FL	FL Dif (Proposed - Table)
Assembly B1	200	0.54	108	0.528	105.6	2.4
Assembly B2	100	0.62	62	0.528	52.8	9.2
Total						11.6

C — Distinct Below Grade Wall Assembly Type (C-values x Area)

No Below Grade Wall Assemblies (C = 0)

Section	Area	Proposed C-Value	Proposed CA	Table C-Value	Tabular CA	CA Dif (Proposed - Table)
Assembly C1			0			
Total						0

D — Excess Vertical Glazing Area (for area exceeding C402.4.1 allowance). D = (DA x UV) - (DA x U Wall), but not less than 0

Assembly	D = DAxUV - DAxUWall
Per Example	164
Total	164

Based on Calculation for Vertical Glazing given in Code Text (D = 164)

E — Excess Skylight Area (for area exceeding C402.4.1 allowance). E = (EA x US) - (EA x U Roof) but not less than 0

Assembly	E = EAxUS - EAxURoof
Total	0

No Skylight Area in this project (C402.4.1 allowance not exceeded). (E = 0)

Figure 3: The example problem from IECC commentary (2015 edition) is re-presented here, to show how simple math is used in the method, where U-values (proposed design and code benchmarks) are multiplied by areas (or lengths). As with golf scores and U-values, lower values are better, so compliance is achieved if the sum of all sections A through E is less than or equal to zero.