Structural Systems Under Pressure: Impacts of Advanced Energy Codes on Structural Systems

Presented By: Matthew Brown, CGP

APA – The Engineered Wood Association

www.apawood.org

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Director of Energy Policy and Code

- 20 years' experience in the building industry.
- 15 years of energy rating, engineering and code development experience.
- Advocate for advancing energy efficiency in a cost-effective manner, balancing energy efficiency and structural design.

Matt Brown, CGP

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1. Energy Code Development
2. Impacts of Energy Codes
3. Wall Systems
4. Floor and Roof Systems
5. Above Codes Programs
6. What's Next

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Energy Code Development

I-Codes
Code Development Committees (CDC)
Energy

Energy Conservation Consensus Committees

The IECC uses the approved ICC Consensus Procedures for its development. Separate consensus committees oversee the development of the IECC Commercial and Residential provisions.

The IECC Residential committee also oversees the Energy Efficiency provisions in Chapter 11 of the IRC and its energy related appendices. With the publishing of the 2024 IECC the code will go into continuous maintenance with publication every three years.

ICC Codes & Standards Home

Committee Overview

STATUS
Active

MEETING INFO
Commercial Meeting Notices
Residential Meeting Notices

MEMBERSHIP
Commercial Roster
Residential Roster

DOCUMENTS

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U.S. DEPARTMENT OF ENERGY

Estimated Improvement in Residential & Commercial Energy Codes (1975 - 2022)

Pacific Northwest NATIONAL LABORATORY

*Net energy use includes the contribution of renewable energy generation

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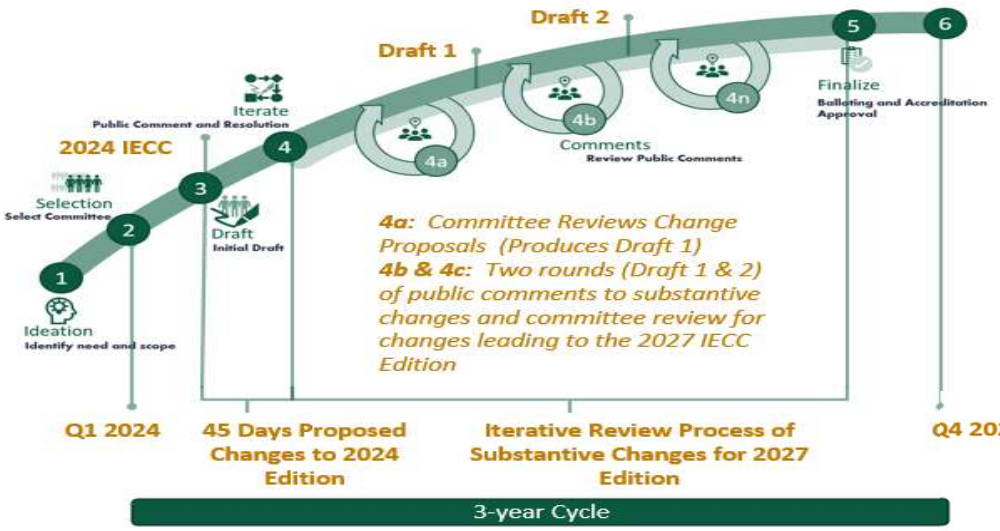

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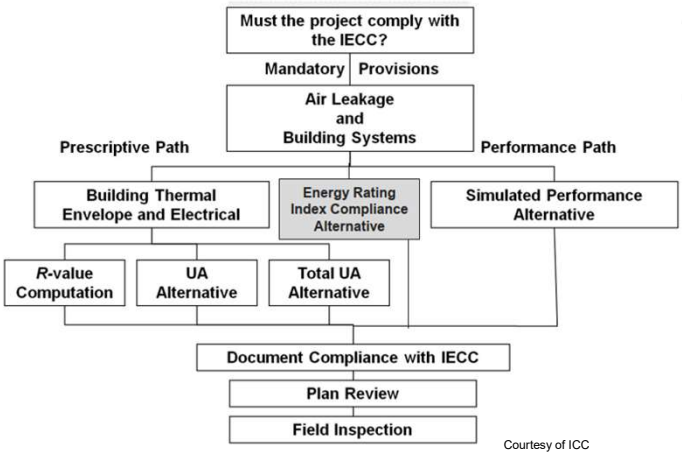
IECC Flow Chart



Courtesy of ICC

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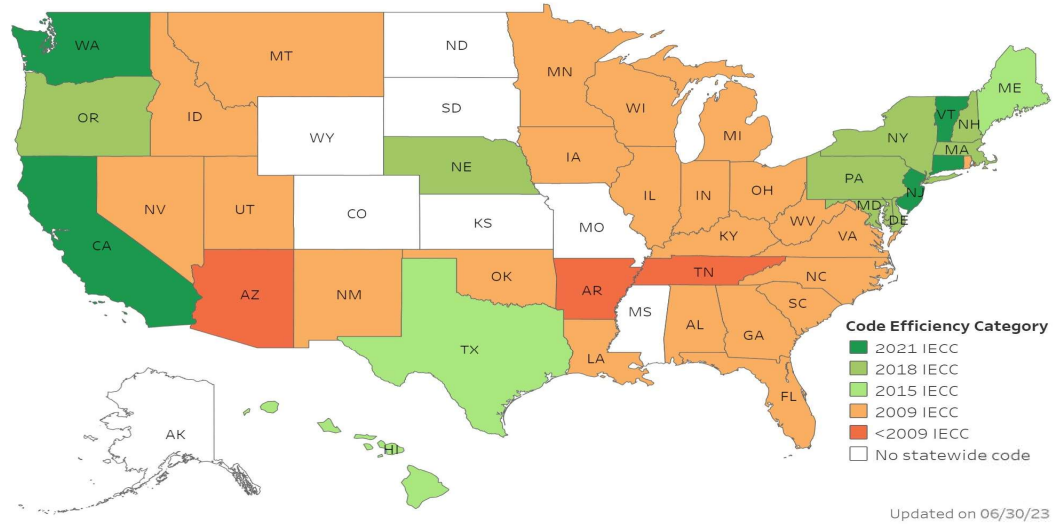

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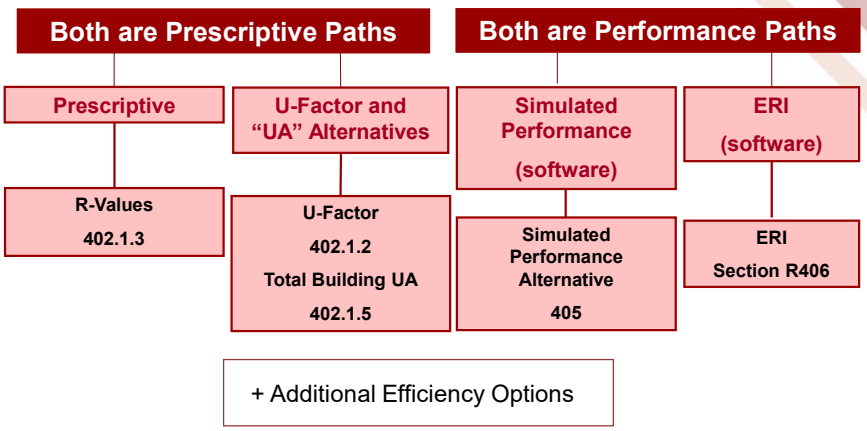
IECC Compliance - Four Options



+ Additional Efficiency Options

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2018-IECC Building Envelope

CLIMATE ZONE	FENE-STRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENE-STRATION SHGC[b, e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WAL R-VALUE[i]	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

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2021 IECC – Building Envelope

CLIMATE ZONE	FENE-STRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENE-STRATION SHGC[b, e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WAL R-VALUE[i]	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
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2	.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	10 , 2 ft	5/13
4 except Marine	0.35	0.55	0.40	60	20 +5 or 13+10[h]	8/13	19	10/13	10, 4 ft	10/13
5 and Marine 4	0.32	0.55	NR	60	20+5 or 13+10[h]	13/17	30[g]	15/19	10, 4 ft	15/19
6	0.32	0.55	NR	60	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	60	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

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Additional Efficiency Options

- R408.2.1 – Enhanced envelope performance option
  - Design UA <= Standard UA * 0.95
- R408.2.2 – More efficient HVAC equipment performance option
  - Furnace >= 95 AFUE and AC >= 16 SEER
  - Air Source Heat Pump >= 10 HSPF/16 SEER
  - Ground Source Heat Pump >= 3.5 COP
- R408.2.3 – Reduced energy use in service water heating option
  - Fossil fuel water heater >= 0.82 EF
  - Electric water heater >= 2.0 EF
  - Solar water heater >= 0.4 solar fraction
- R408.2.4 – More efficient duct thermal distribution system option
  - 100% of ducts and air handler inside building thermal envelope
  - 100% of ductless or hydronic system inside building thermal envelope
  - 100% of duct thermal distribution system located in conditioned space
- R408.2.5 – Improved air sealing and efficient ventilation system option
  - Air Leakage <= 3.0 ACH50
  - HRV (75% Sensible Recovery Efficiency) or ERV (50% Latent Recovery/Moisture Transfer)

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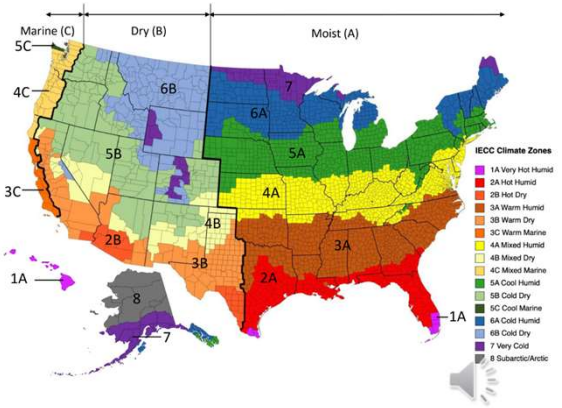
International Energy Conservation Code/Building Science

- 2021 IECC
  - Requires continuous insulation (CI) on wall assemblies from Climate Zone 4 and north.
  - CI on exterior walls has the potential to reduce WSP market share.
    - Incentivizes builders switching to competitive insulated sheathing products.
    - Potential for builders to switch from continuous sheathing with WSP to intermittent wall bracing, reducing WSP wall sheathing by as much as 75% per home.



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2024 IECC – Building Envelope

CLIMATE ZONE	FENE-STRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENE-STRATION SHGC[b, e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WAL R-VALUE[i]	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
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2	.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.32	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	10 , 2ft	5/13
4 except Marine	0.30	0.55	0.40	49	20 +5 or 13+10[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.28	0.55	NR	49	20+5 or 13+10[h]	13/17	30[g]	15/19	10, 4 ft	15/19
6	0.28	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.27	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

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2024 IECC -Additional Efficiency

TABLE R408.2CREDITS FOR ADDITIONAL ENERGY EFFICIENCY

MEASURE NUMBER	MEASURE DESCRIPTION	CREDIT VALUE								
		Climate Zones 0 & 1	Climate Zone 2	Climate Zone 3	Climate Zone 4 except Marine	Climate Zone 4 Marine	Climate Zone 5	Climate Zone 6	Climate Zone 7	Climate Zone 8
R408.2.1.1(1)	≥ 2.5% Reduction in total TC	0	0	0	1	1	1	1	1	1
R408.2.1.1(2)	≥ 5% reduction in total TC	0	1	1	2	1	2	2	2	2
R408.2.1.1(3)	> 7.5% reduction in total TC	0	1	2	2	2	2	3	3	3
R408.2.1.1(4)	> 10% reduction in total TC	1	1	2	3	3	4	4	5	5
R408.2.1.1(5)	> 15% reduction in total TC	1	2	2	4	4	5	6	7	8
R408.2.1.1(6)	> 20% reduction in total TC	2	4	4	5	6	7	8	9	11
R408.2.1.1(7)	> 30% reduction in total TC	3	6	6	8	8	11	12	13	16
R408.2.1.2(1)	*U*-factor and SHGC for vertical fenestration per Table R408.2.1.2	1	1	1	2	1	1	1	1	1

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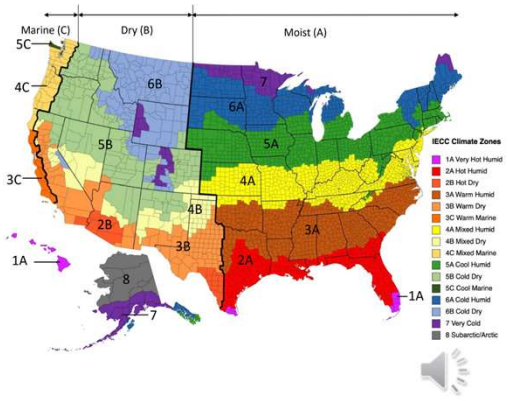
International Energy Conservation Code/Building Science

- 2024 IECC
  - Allows flexibility in exterior walls
    - R-20 exterior walls if heat pump equipment is installed.
  - Lower ceiling insulation requirements
  - Adjustments in foundation insulation
  - Lower fenestration U-factors
  - More trade-off options
  - Additional efficiency items change



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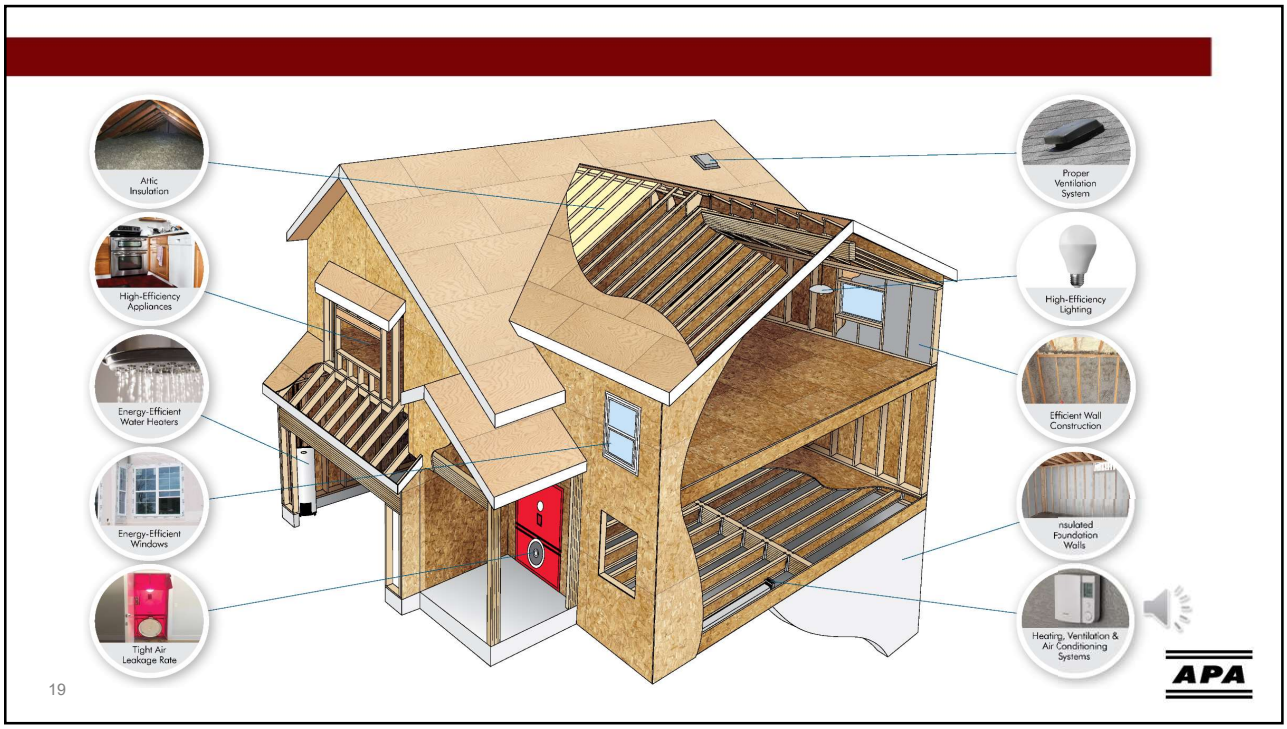

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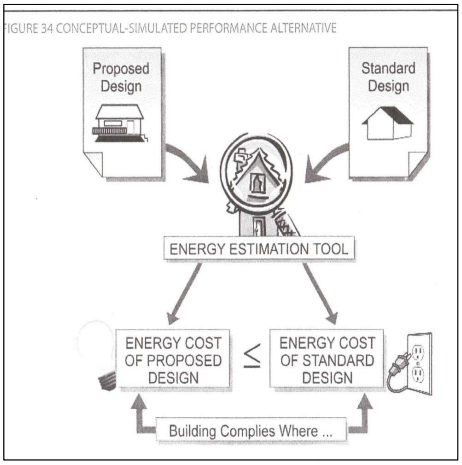
Performance & ERI Modeling



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Wall Systems – 2021 & 2024 IECC

Climate Zones 4-8:

- R-30 Cavity

OR

- R-20+5 c.i.

OR

- R-20 c.i.

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Potential Impacts to WSP

- Intermittent WSP Wall Sheathing
- Competitive Products

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2021 IECC

- Prescriptive Approach
  - Dual-Layer Sheathing
  - Combination WSP/C.I. Panels
  - Double Wall
- Performance Approach
  - 2x4 and 2x6 Walls Depending on Climate Zone w/WSP
  - Advanced Frame Walls
  - Radiant Barriers

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2024 IECC

- Prescriptive Approach
  - Dual Layer Sheathing
  - Combination WSP/C.I. Panels
  - Double Wall
  - Heat Pumps: R-20 Wall Exception
- Performance Approach
  - 2x4 and 2x6 Walls Depending on Climate Zone w/WSP
  - Advanced Frame Walls
  - Radiant Barriers
  - High-Performance HVAC Equipment

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Headers

TABLE R402.5.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER, AIR SEALING CRITERIA	INSULATION INSTALLATION CRITERIA
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior building thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.

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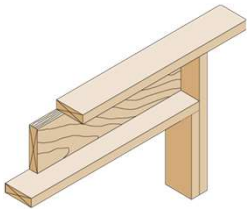
EWP Solutions

- Single-Ply EWP Headers
- Insulated Dual-Ply Headers
- Full-Thickness Exception



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Floor System - Threats

- Ducts in Conditioned Space
- Affordability Concerns
- Moisture Management

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Floor System - Threats

TABLE R408.2CREDITS FOR ADDITIONAL ENERGY EFFICIENCY

MEASURE NUMBER	MEASURE DESCRIPTION	CREDIT VALUE								
		Climate Zones 0 & 1	Climate Zone 2	Climate Zone 3	Climate Zone 4 except Marine	Climate Zone 4 Marine	Climate Zone 5	Climate Zone 6	Climate Zone 7	Climate Zone 8
R408.2.4(1)[c]	Ductless or hydronic thermal distribution	3	4	5	7	8	10	10	10	14
R408.2.4(2)[c]	100% of duct systems in conditioned space	2	3	4	6	7	9	9	9	13
R408.2.4(3)[c]	≥ 80% of ductwork inside conditioned space	2	3	3	5	6	7	7	7	9

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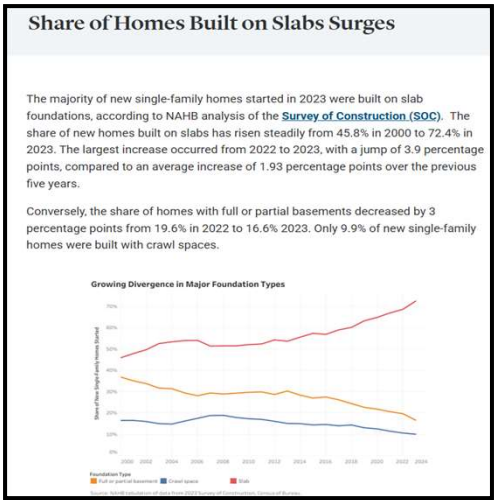
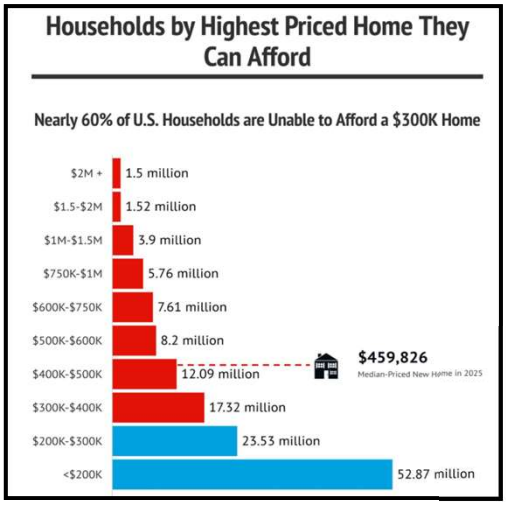
Floor System - Threats





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Images courtesy of NAHB

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Floor System - Threats

Improper Ventilation and Insulation

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Floor System - Opportunities

- Deeply Buried Ducts
- Reduced Energy and Embodied Carbon

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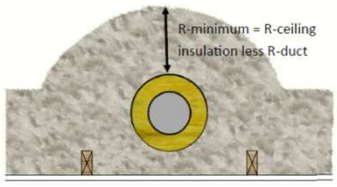
Ducts Considered in Conditioned Space

IECC Climate Zones	2	3	4	5	6	7
Ducts considered in conditioned space	-5	-6	-7	-8	-8	-9

Buried Ducts considered Inside Conditioned Space –

When using a simulated energy performance analysis, buried ducts may be considered as ducts inside conditioned space (ICS) provided the air distribution system complies with the general buried duct criteria above (need not comply with deeply buried ducts) and these additional requirements:

1. the air handler is located inside conditioned space (not in the attic)
2. duct leakage is within prescribed, more stringent limits (see sidebar for details)
3. the R-value of insulation above the duct is at least the proposed ceiling insulation R-value, used in the model, less the R-value of the duct insulation (Figure 5)



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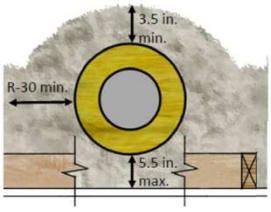
Ducts- Deeply Buried

IECC Climate Zones	2	3	4	5	6	7
Deeply Buried Ducts	-2	-2	-2	-1	-2	-2

Deeply Buried Ducts —

When using a simulated energy performance analysis, an effective duct insulation value of R-25 may be used in the energy model for sections of ducts that comply with the general buried duct criteria above and these three additional requirements (see Figure 4):

1. the duct is located directly on the ceiling or within 5.5 in. of the ceiling
2. the duct is surrounded with ceiling insulation of at least R-30
3. the duct is covered on top with at least 3.5 in. of ceiling insulation (approximately R-11 assuming a minimum R-value of R-3.2 per in.)



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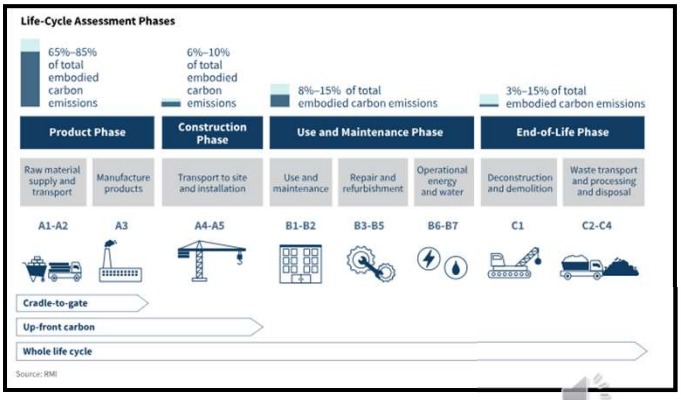
Floor System - Opportunities

- Crawl space and basement foundations are 3% more efficient than slab on grade homes.
- Lower embodied carbon cradle to grave.



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Roof Systems - Opportunities

- Raised Heel Trusses
- Eaves and Overhangs
- Radiant Barrier Attics

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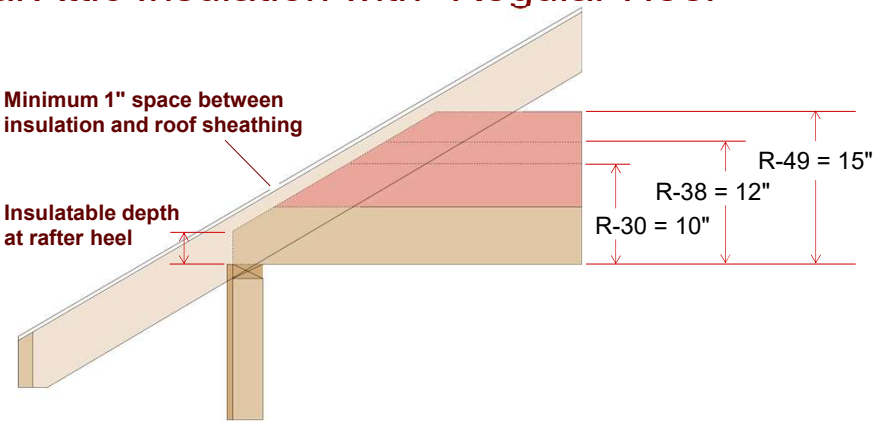
Ceiling Frame – Attic Insulation

Typical Attic Insulation with “Regular Heel”



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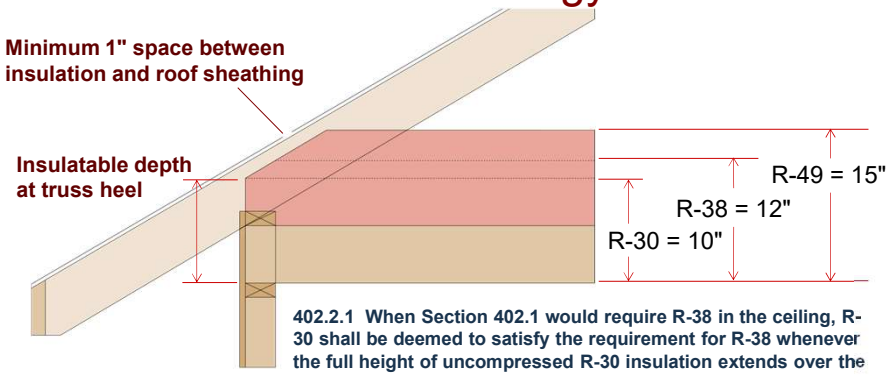
Ceiling Frame – Attic Insulation

Typical Attic Insulation with "Energy Heel"



402.2.1 When Section 402.1 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 whenever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly, R-38 shall be deemed to satisfy the requirement for R-49…….

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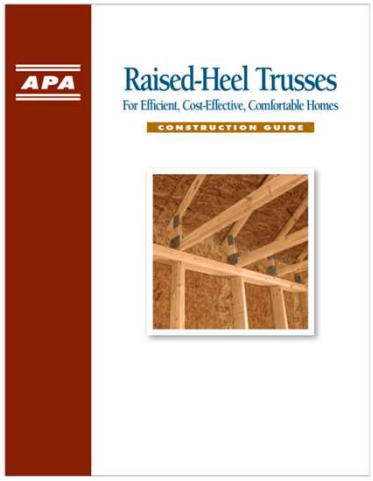
Raised-Heel Trusses

- 4%-6% more energy efficient.
- WSP connection details for fast installation.



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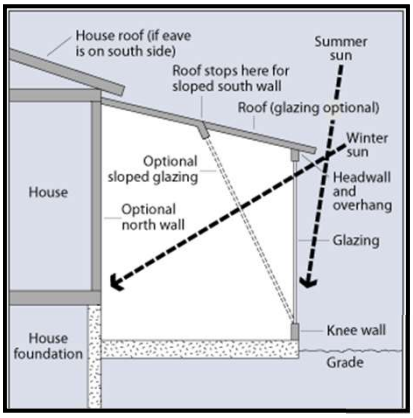
Roof Overhangs and Eaves

- Benefits for southern climate zones.
- 2% improved energy efficiency.



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Radiant Barrier Roofs

IECC Climate Zones	2	3	4	5	6	7
Radiant Barrier Sheathing	-3	-2	-1	-1	See Footnote K	

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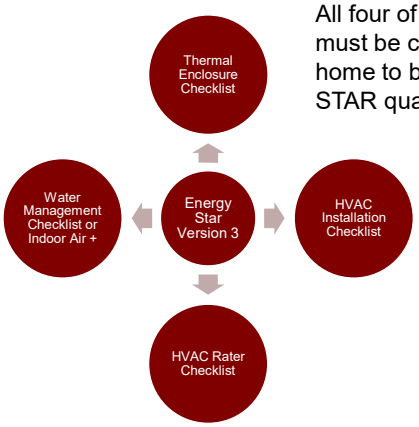
Requirements



All four of these checklists must be completed for a home to be ENERGY STAR qualified.

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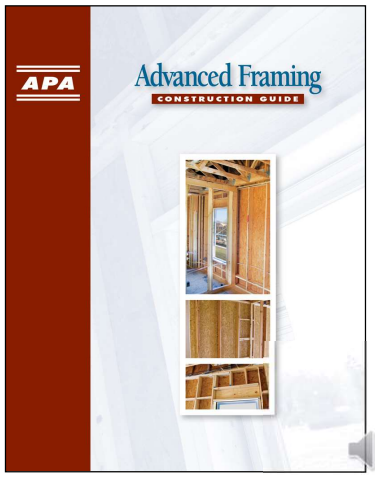
Advanced Framing

APA Construction Guide

- APA Form Number M400
- Free download at www.performancewalls.org



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Requirements: (M400)

All corners insulated ≥ R-6 to edge **AND**

All headers above windows and doors are insulated **AND**

Framing is limited at windows and doors **AND**

All interior/ exterior wall intersections are fully insulated **AND**

Minimum stud spacing 16” o.c. 2x4, 24” o.c. 2x6 or R-20 wall assembly.

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Finding ENERGY STAR Builders:

www.energystar.gov/homes
Partner locater: Builder partners

A 100% symbol next to the builder's name means they have signed a MOU with ENERGY STAR to build 100% of their homes to ENERGY STAR for Homes certification guidelines.

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Zero Energy Ready Homes Program

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

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What is a Zero Energy Ready Home?

A DOE Zero Energy Ready Home is a high-performance home that is so energy efficient that a renewable energy system could offset most or all the home's annual energy use. Each DOE Zero Energy Ready Home meets rigorous efficiency and performance criteria found in the DOE Zero Energy Ready Home National Program Requirements. Most types of new homes in the U.S. are eligible to participate in the DOE Zero Energy Ready Home program, and the homes are verified by a qualified third-party as part of the certification process.

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Zero Energy Ready Homes Program

Component	Mandatory Requirements
1. **ZERH National Rater Checklist**	1.1 Rater completes the DOE ZERH Single Family Homes Version 2 (Rev. 2) National Rater Checklist.
2. **ENERGY STAR Baseline**	2.1 The home is certified under ENERGY STAR Single Family New Homes Version 3.2.[13]
3. **Envelope**	3.1 Ceiling, wall, floor, and slab insulation meet or exceed 2021 IECC UA levels.[14, 15, 16] 3.2 Windows meet high performance requirements based on climate zone.[17, 18]
4. **Duct System**	4.1 All heating and cooling distribution ducts and heating and cooling air-handling equipment are located within the thermal and air barrier boundary.[19]
5. **Water Heating Efficiency** (comply with 5.1, 5.2, ***or*** 5.3)	5.1 Hot water delivery systems meet efficient design requirements.[20] 5.2 Water heater and fixtures meet efficiency criteria.[21, 22] 5.3 Home is certified under WaterSense Labeled Homes Version 2.0.

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National Green Building Standard

Errors on page, no Level reached
Points away from: Bronze: 43, Silver: 59, Gold: 89, Emerald: 119
Add'l pts earned above: Bronze: 0, Silver: 0, Gold: 0, Emerald: 0
Total Chapter Points needed for: Bronze: 43, Silver: 59, Gold: 89, Emerald: 119
Revision Date: 7/23/2024

NGBS GREEN
Home Innovation Research Labs

Mandatory Information is missing on the Overview (Design) page!
There is mandatory information or practices missing from this Chapter!

Practice #		Chapter 6: Resource Efficiency	Points Available	Points Claimed	Status	Notes
613 RESILIENT CONSTRUCTION						
613.1		**613.1 Intent.** Design and construction practices developed by a licensed design professional or equivalent are implemented that enhance the resilience and durability of the structure (above building code minimum design loads) so the structure can better withstand forces generated by; flooding, snow, wind or seismic activity (as applicable) and reduce the potential for the loss of life and property.		0		
	(a)	**Minimum structural requirements (base design).** The building is designed and constructed in compliance with structural requirements in the IBC or IRC as applicable.	2			
	(b)	**Enhanced resilience – 10% above base design.** Design and construction practices are implemented that enhance the resilience and durability of the structure by designing and building to forces generated by; flooding, snow, wind or seismic (as applicable) that are 10% higher than the base design.	3			
	(c)	**Enhanced resilience – 20% above base design.**	5			
	(d)	**Enhanced resilience – 30% above base design.**	10			
	(e)	**Enhanced resilience – 40% above base design.**	12			
	(f)	**Enhanced resilience – 50% above base design.**	15			
END OF CHAPTER 6					CLICK TO PROCEED TO CHAPTER 7 >>	

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APA

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Summary

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APA

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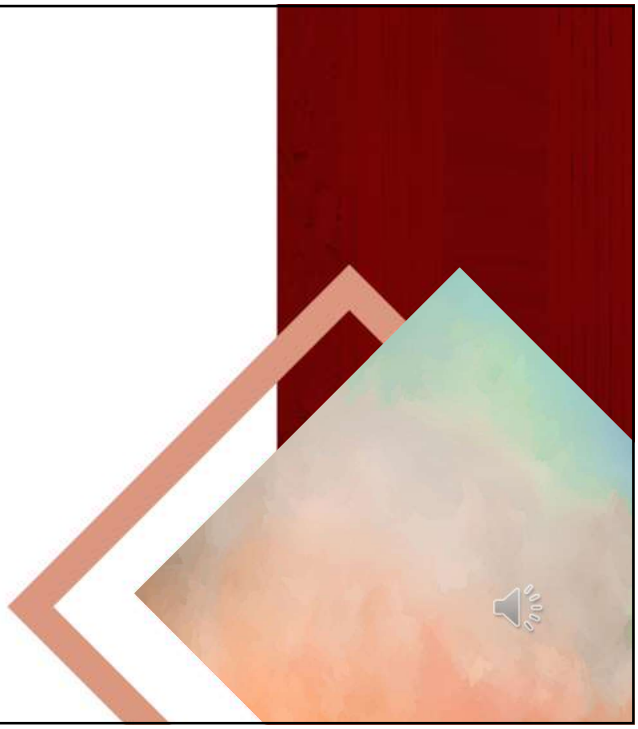
Questions?



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