The Energy Code Myths That Haunt Us

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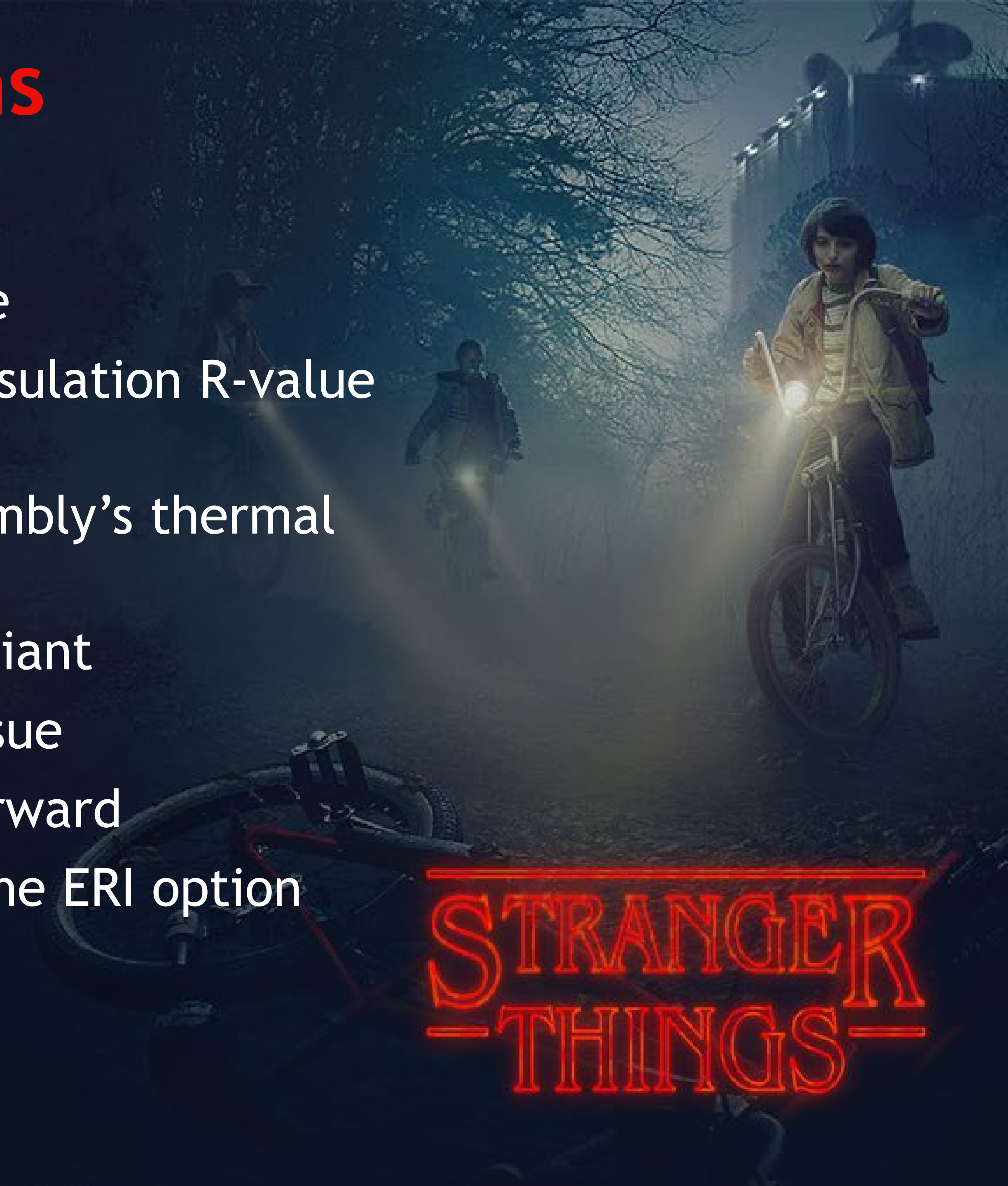
Foam sheathing research reports, code compliance documents, educational programs and best practices can be found at www.continuousinsulation.org.

Foam Plastic Applications for Better Building

Haunting Myths

- 20+5 = 25
- The Energy Code is not a life safety code
- Any material can be used to meet the insulation R-value requirements
- Any air-space can help achieve the assembly's thermal performance requirements
- All above code programs are code compliant
- Moisture management isn't an energy issue
- Compliance requirements are straightforward
- An envelope backstop is not needed in the ERI option



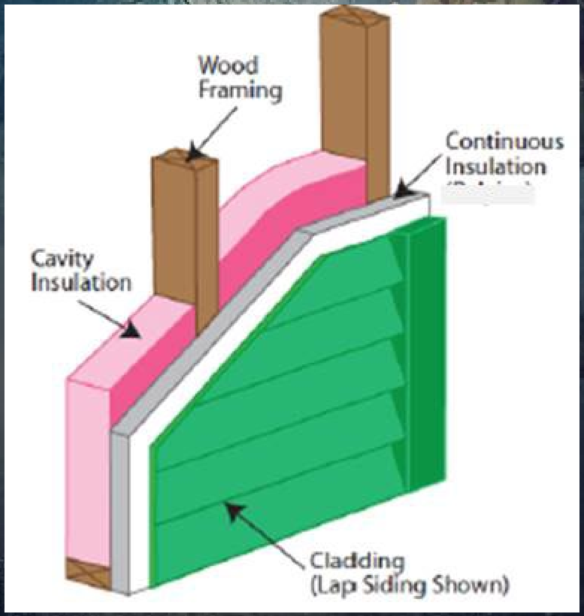
Myth: 20 + 5 = 25 ?

- Isn't 20 +5 always equal to 25?
- SIMPLE ANSWER: No. They are not equal when the 20 and the 5 are really two different things. This is the classic "apples and oranges" fallacy.
  - "Apples" = Cavity insulation in cavities which includes framing of lower R-value
  - "Oranges" = Continuous insulation without framing thermal bridges
- In the real wall assembly, these two insulation components contribute differently to the effective or total R-value of the assembly.
- They can't be simply added to get the right answer
  - "20 + 5" is really just a symbol for communicating how to insulate an assembly (like "4 x 4" is used to signify a 4-wheel drive truck).
  - It was never meant to be a math equation for determining the actual R-value or alternative insulation strategies for wall assemblies.

STRANGER THINGS

“20 + 5” = 22.4 and “25” = 18.6

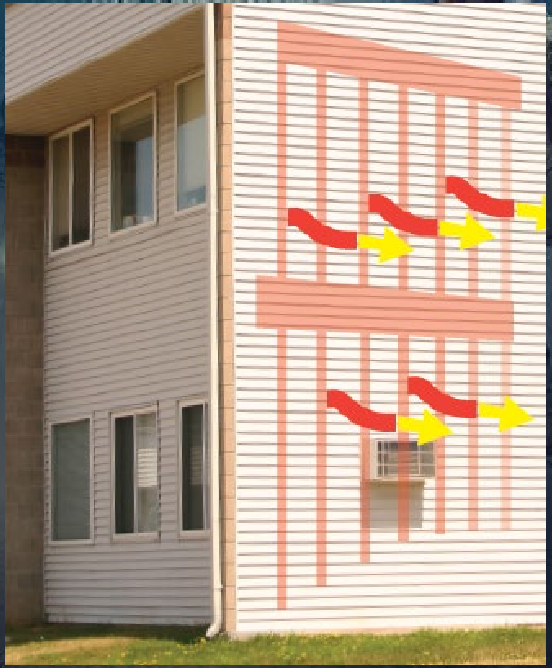
- Why does “20 + 5” equal 22.4 ? Why does “25” = 18.6? This is very strange math, or is it?
- KEY: The math must properly account for the way heat actually flows through the assembly.
- There are two paths for heat flow:
    - Framing path
    - Cavity path
        - Note that continuous insulation insulates both paths, but the cavity insulation only insulates the cavity path



STRANGER THINGS

Myth Solved – Parallel Path Math

- First, add up the R-value <u>for each heat flow path</u> through the R25 and R20+5ci wall assemblies:



	R25 + 0ci Wall		R20 + 5ci Wall	
Layer	**Framing Path**	**Cavity Path**	**Framing Path**	**Cavity Path**
Outside Air Film	R-0.17	R-0.17	R-0.17	R-0.17
Siding	R-0.62	R-0.62	R-0.62	R-0.62
Continuous Insulation	---	---	R-5	R-5
7/16" OSB	R-0.62	R-0.62	R-0.62	R-0.62
SPF 2x6 Stud	R-6.875	---	R-6.875	---
Cavity Insulation	---	R-25	---	R-20
½" Drywall	R-0.45	R-0.45	R-0.45	R-0.45
Inside Air Film	R-0.68	R-0.68	R-0.68	R-0.68
Total	**R-9.415**	**R-27.54**	**R-14.415**	**R-27.54**

<u>Note</u>: Multiple cavity insulation layers can be added to get a total cavity R-value and multiple continuous insulation layers can be added to get a total continuous insulation R-value. This is the ONLY case where R-values can be added.

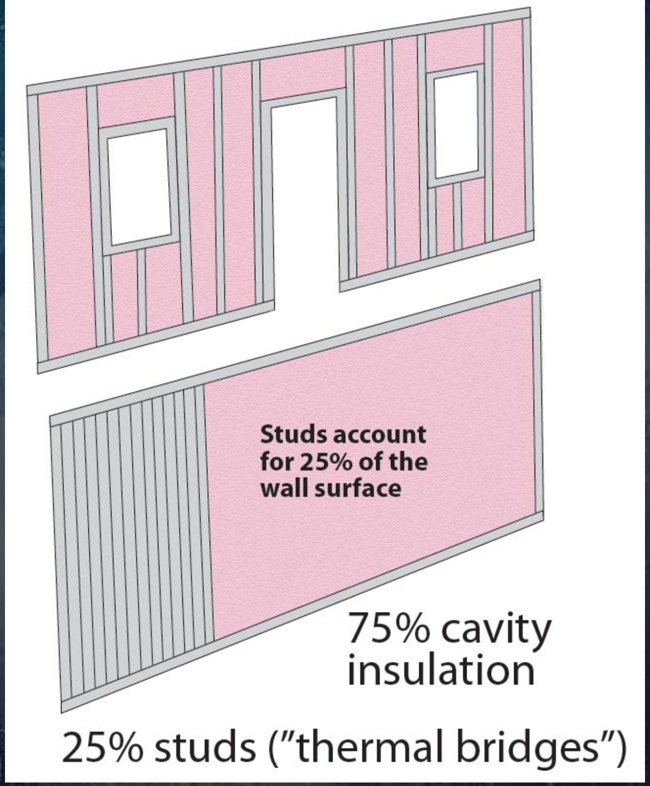
STRANGER THINGS

Myth Solved – Parallel Path Math

- Second, weight the heat flow or conductance (1/R) of each path by the percentage area of each path as follows:

$$U = ff_{framing} * \frac{1}{R_{framing}} + ff_{cavity} * \frac{1}{R_{cavity}}$$

	R25 + 0ci Wall	R20 + 5ci Wall
Effective U-factor	0.0538	0.0446
Effective R-value	**R-18.59**	**R-22.43**
Qualifying Climate Zones	3, 4, 5	6, 7, 8
Climate Zone Required U-factor	0.060	0.045
Climate Zone Required eff. R-value	R-16.7	R-22.2

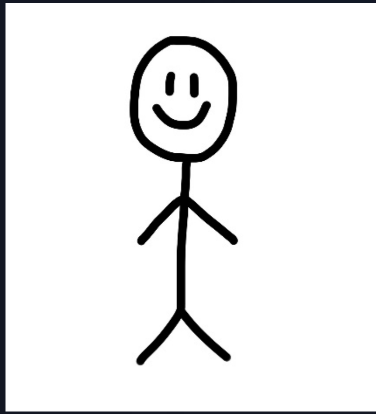


- **CONCLUSION:** An "R25" wall has an effective R-value of **R-18.6** (U = 0.054). An "R20 + 5ci" wall has a much greater effective R-value of **R-22.4** (U = 0.045) because the continuous insulation insulates both paths while the cavity insulation insulates only the cavity.
- So, "20 + 5" does not equal "25" when the R-value math is done properly for each heat flow path in an assembly.

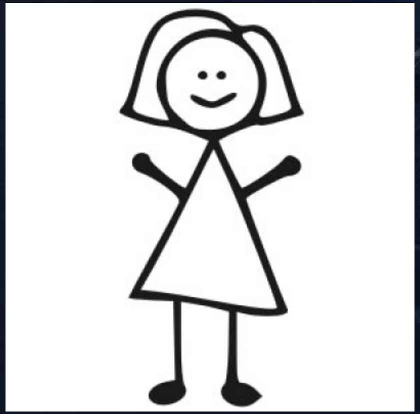
STRANGER THINGS

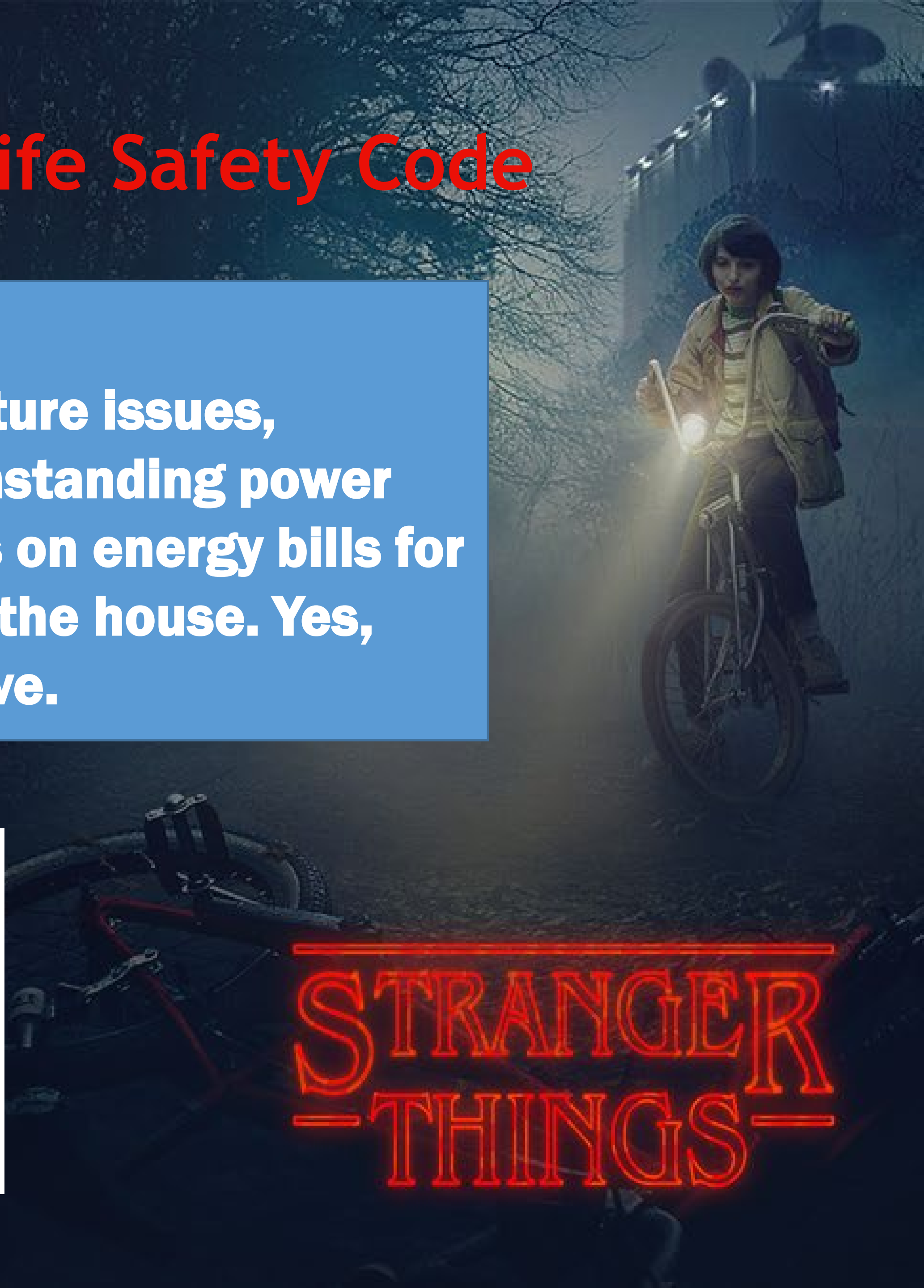
Myth: The Energy Code is not a Life Safety Code

Skeptic:
The energy code is a “nice to have.”



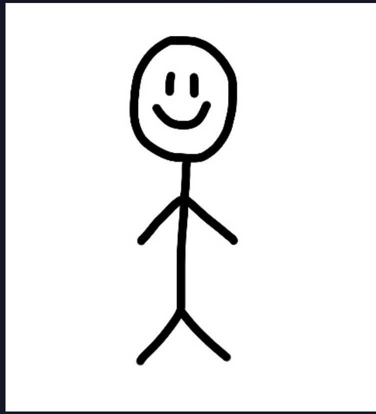
Me:
Preventing moisture issues, comfortably withstanding power outages, savings on energy bills for the entire life of the house. Yes, that’s nice to have.



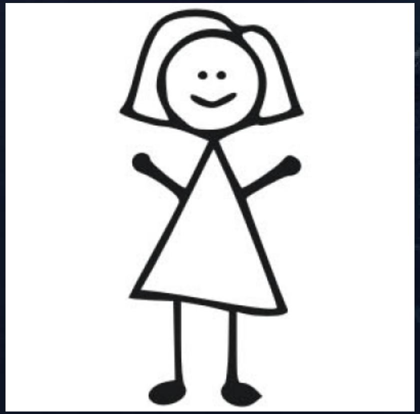


Myth Busted: The Energy Code IS a Life Safety Code

Skeptic:
"You all think that it's the energy code that keeps buildings from falling down."



Me:
"Yes indeed."



The Energy Code IS a Life Safety Code

ENERGY CODE PROVISIONS CONTROLLING MOISTURE:

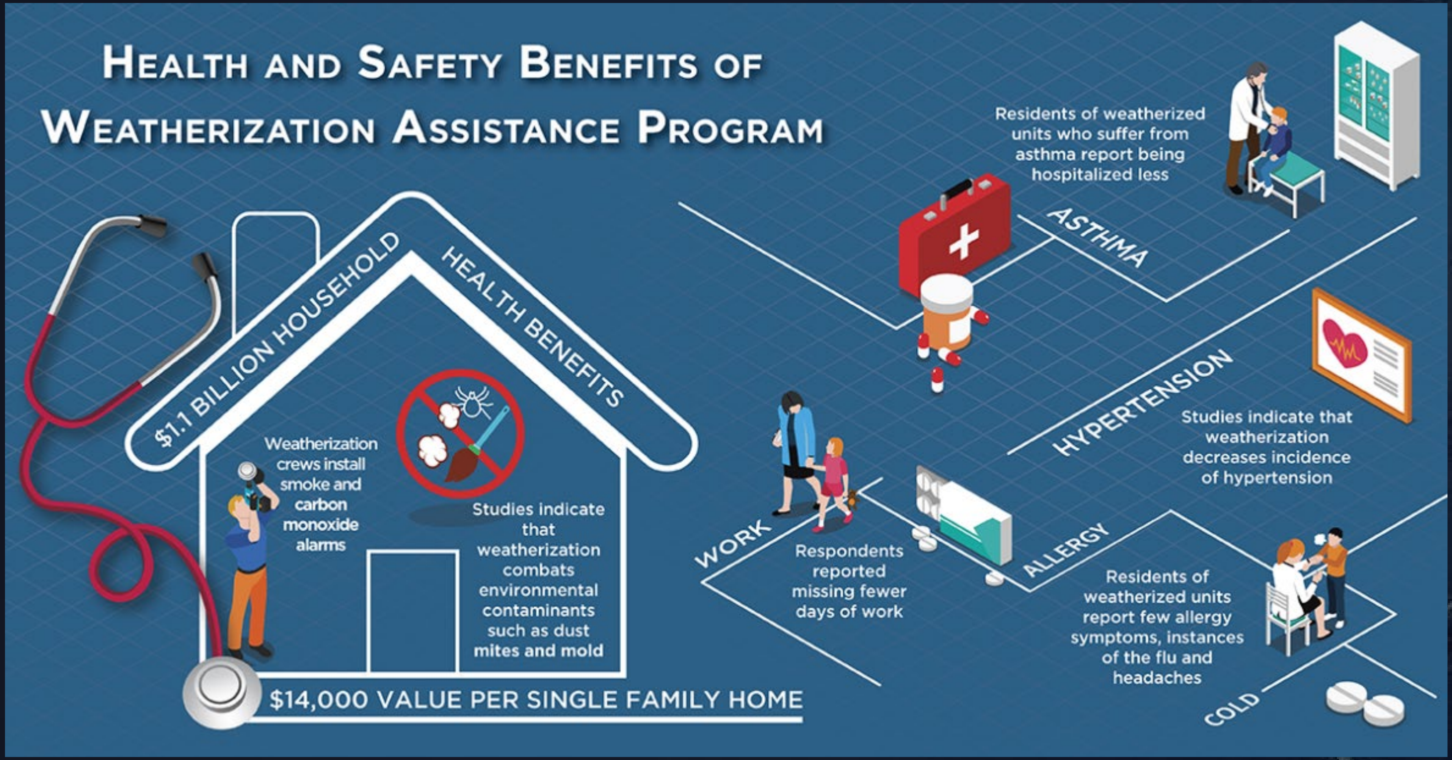
- AIR BARRIERS
- SLAB-ON-GRADE INSULATION
- RIM JOISTS
- WINDOW CONDENSATION
- ICE DAMMING

For the best results:

- Carefully consider the best insulation and fenestration strategy for the job
- Select the appropriate vapor retarder and location
- Install properly!!!

STRANGER THINGS

The Energy Code IS a Life Safety Code



https://energy.gov/eere/articles/3-health-benefits-weatherizing-your-home

Nationwide, reducing electricity consumption by 15% for a single year would result in

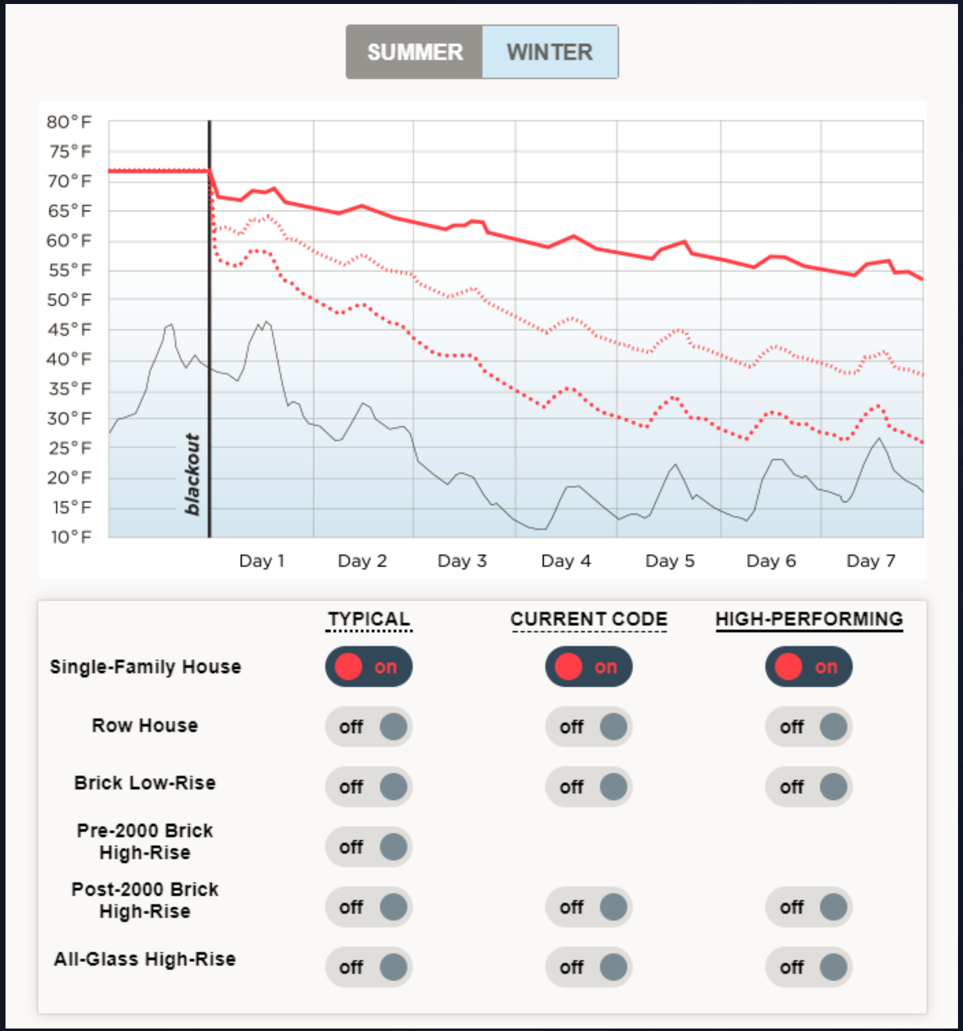
- More than six lives saved each day
- Up to $20 billion in avoided health harms
- Nearly 30,000 fewer asthma episodes

The dollars saved through avoided health harms in our scenario would be enough to pay the annual health

http://aceee.org/sites/default/files/publications/researchreports/h1801.pdf

STRANGER THINGS

The Energy Code IS a Life Safety Code



Typical buildings would be between 32°F and 43°F indoors. New buildings are a little better, but still not resilient. A high-performing building that has better windows, fewer air leaks and more insulation would do much better. Without power, these buildings would stay at 54-66°F for a week or more.

Baby It’s Cold Inside, 2014 report by Urban Green a Chapter of USGBC, modeling by Atelier Ten

STRANGER THINGS

Beyond Life Safety

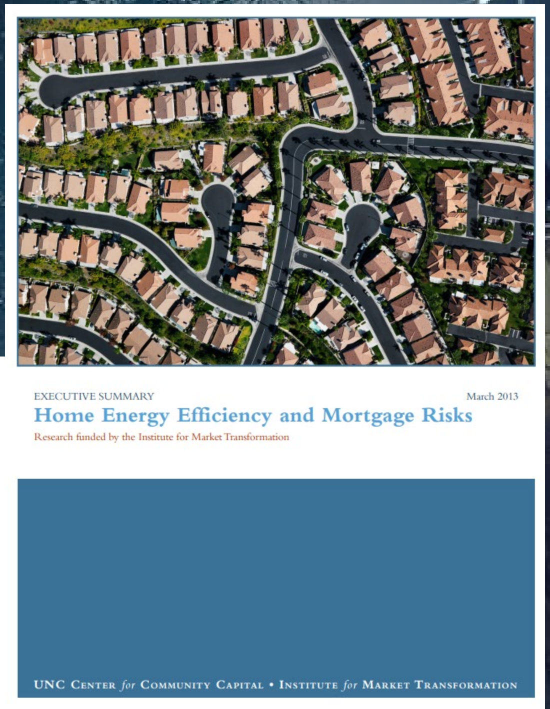
The Energy Code is the ONLY code that reduces energy bills and overall cost of ownership.

Table 4.3. Life Cycle Cost Savings for the 2015 IECC

Climate Zone	Compared to the 2012 IECC ($/residence-yr)	Compared to the 2009 IECC ($/residence-yr)
1	+193	+4,418
2	+119	+5,725
3	+156	+6,569
4	+154	+8,088
5	+153	+7,697
6	+142	+11,231
7	+200	+17,525
8	+438	+24,003

Based on 30 Year Life Cycle: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24948Rev1.pdf

The study indicates that default risks are on average 32 percent lower in energy-efficient homes, controlling for other loan determinants.



STRANGER THINGS

Myth: Any material can be used to meet insulation R-value requirements

- SIMPLE ANSWER: Yes and No. It depends.
- The R-values for insulation components in the R-value compliance path assume certain building materials are present and contribute a baseline R-value to the assembly.
- A parallel path calculation must be done and U-factors used to demonstrate assembly performance (as shown in prior slides).
- <u>Example 1: Siding Building Material</u>
  - Siding = R-0.62 assumed in R-value tables.
  - Implication: Using a siding with a lower R-value will increase the insulation R-value required or reduce performance; Using a siding with a higher R-value than 0.62 can be used to reduce insulation required (or improve performance).
  - Insulated siding cannot be fully added to continuous insulation to get a net R-value for continuous insulation without first reducing the R-value of the insulated siding by R-0.6 to avoid double counting the R-0.62 already assumed to be present for siding when using the prescriptive R-value path.

Myth: Any material can be used to meet insulation R-value requirements

- Example 2: Structural Sheathing Building Material
  - Structural sheathing with R-0.62 (e.g., 7/16” OSB) is assumed present in the tabulated insulation R-value requirements
  - Using thinner or thicker structural sheathing may slightly increase or decrease performance, but can only be counted through the parallel path calculations (U-factor compliance)
  - This building material is not continuous insulation and does not have “rated” R-values for FTC R-value rule. Thus, it cannot be added to ci R-value to get a net ci R-value.
    - Structural insulated panels are an exception if tested and rated for R-value per FTC R-value Rule as a composite panel.

Myth: Any material can be used to meet insulation R-value requirements

- Example 3: Framing Materials
  - Advanced framing can be used as a means to reduce prescribed insulation R-value requirements or improve the performance of an assembly.
  - True, but..
    - The benefit is found in having a lower “framing factor” than assumed as a baseline in the code (i.e., less than 25% framing factor)
    - When framing practices are used as a means for thermal performance, those practices become as important to inspect for energy code compliance as the insulation materials.

STRANGER THINGS

Myth: Any material can be used to meet insulation R-value requirements

- How are lower framing factors confirmed through plan review and field inspection/rating ? How do they vary with fenestration amounts and structural framing conditions? Are shop drawings available for each wall assembly to guide framers and inspectors?
- Simply relying on a specified lay-out stud spacing (e.g., 24"oc instead of 16"oc) does not capture or control the true framing factor that may result in the field.

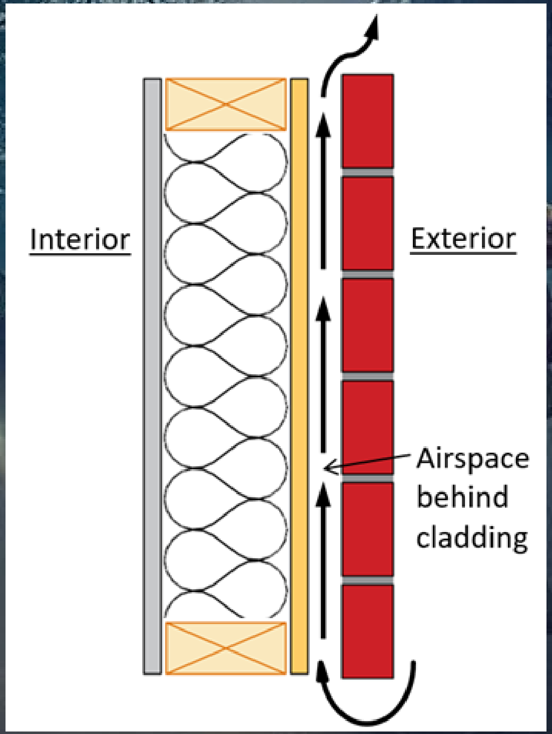
What is the framing factor of this wall segment?

The Air Space R-value Enigma

- Can air space R-values can be determined using ASHRAE Handbook of Fundamentals or ASHRAE 90.1 Appendix A (Section A9.4.2)?
- SIMPLE ANSWER: Yes and No. It depends on the air space.
- ASHRAE HOF Ch26, Table 3, footnote ‘b’ (6 font):
  - “b. …Values apply for ideal conditions (i.e., air spaces of uniform thickness bounded by plane, smooth, parallel surfaces with no air leakage to or from the space).”
  - Read the above footnote carefully:
  - “…Values apply for ideal conditions (i.e., air spaces of uniform thickness bounded by plane, smooth, parallel surfaces with no air leakage to or from the space).”

The Air Space R-value Enigma

- What is the impact of airflow into and out of a non-ideal air space?
  - Air changes per hour can approach 400 ACH for vented or ventilated air spaces behind cladding (typical 90 – 150 ACH)
    - Ventilation of cladding for moisture control and drying competes with the ability to use those same air spaces for R-value.
    - ACH varies widely and depends on cladding type, arrangement of vents, vent screens, air-flow pathways, wind speed (point-in-time or annualized), etc.
  - This airflow can help lower solar heat gain through southerly-facing facades in the summer, but the same effect reduces apparent R-value of the air-space in the winter for all façade orientations.
  - ASTM C1363 tests with and without induced ventilation air-flow behind cladding indicate assumed ideal R-values for air spaces (no air leakage) should be significantly reduced.
    - For example, a tabulated R-value of R-2.96 for foil-backed vinyl siding may actually be only R-0.62 due to impact of air exchange rate (see ASHRAE HOF Ch26, Table 1). Similar impacts expected for vented brick veneer.
    - The performance of reflective air spaces is especially affected by leakiness of the air space because the R-value is larger and more sensitive to departure from assumed ideal air space conditions.
    - The same impact occurs to non-reflective air spaces and is only less significant because the ideal R-values are generally less than R-1.0.
- For additional information, refer to: https://www.appliedbuildingtech.com/system/files/abtgrr_1601_02_air_space_r_value_0.pdf

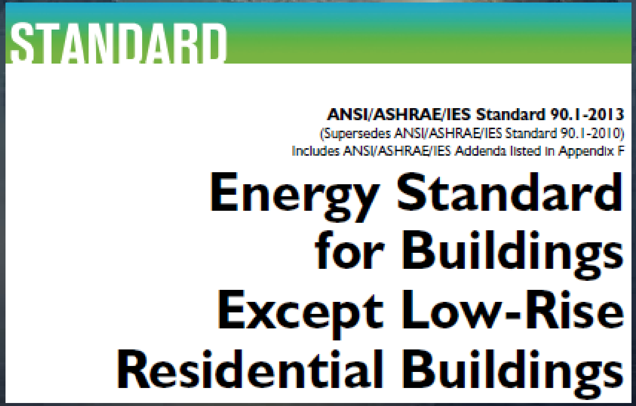


Note: Applies to any vented or air-permeable siding, not just brick.

STRANGER THINGS

Myth Solved: Air Space R-value

- ASHRAE 90.1-2016 Section A9.4.2 Air Spaces:
  - "The air space shall be an enclosed and unventilated cavity designed to minimize airflow into and out of the enclosed air space."
    - This effectively requires a sealed air space which is consistent with the basis of the ideal air space R-values provided in ASHRAE 90.1 and ASHRAE HOF
  - Limited practical exception provided:
    - "Airflow shall be deemed minimized when the enclosed air space is located on the interior of the continuous air barrier and bounded on all sides by building components."
  - Air spaces behind claddings do not meet this criteria and have R-values less than those commonly used in the past.
- ASHRAE Research Project is funded to provide guidance for determination of appropriate R-values for "non-ideal" air spaces.


STANDARD

ANSI/ASHRAE/IES Standard 90.1-2013
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2010)
Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

Energy Standard for Buildings Except Low-Rise Residential Buildings

STRANGER THINGS

Myth Solved: Air Space R-value

- 2018 IECC takes a similar approach, but adds an exception to allow R-values to be tested for “non-ideal” air spaces (i.e., vented or unsealed or unenclosed).

C402.2.7 Airspaces. Where the thermal properties of airspaces are used to comply with this code in accordance with Section C401.2, such airspaces shall be enclosed in an unventilated cavity constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.

> **Exception:** The thermal resistance of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.

STRANGER THINGS

Myth: All "Above Code" programs are code compliant

- Many states and jurisdictions allow above code programs as an alternate to code compliance

R102.1.1 Above code programs. The *code official* or other authority having jurisdiction shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. *Buildings approved* in writing by such an energy-efficiency program shall be considered to be in compliance with this code. The requirements identified as "mandatory" in Chapter 4 shall be met.

Based on 2015 IECC

N1101.7 (R102.1.1) Above code programs. The state construction code commission may evaluate and approve a national, state or local energy efficiency program to exceed the energy efficiency required by this code. Buildings approved in writing by such an energy efficiency program, such as ICC 700-2012 "silver" or energy star version 3 (rev. 07) shall be considered in compliance with this code. The requirements identified as "mandatory" in chapter shall be met.

State modified IECC
Based on 2015

Myth: All"Above Code" programs are code compliant

- Definitely not all. It depends . . .
- Important considerations for evaluating code compliant alternatives:
  - What version of the model code is the local code based on?
  - Is the base code amended? Stronger? Weaker?
  - What version of the above code program is being used?
  - Is there analysis/modeling available showing equivalence?

STRANGER THINGS

Let’s Compare: Energy Star

- EASY: Analysis done for you
- The proper version must be used
- Version for home rule states with local adoptions are not so clear
- Applicable Energy Star checklist must be used

Program Requirements	State/Territory	Applicable to Homes Permitted On or After the Following Date
National Version 3	AL, AK, AZ, AR, CO, GA, IN, ID, KS, KY, LA, ME, MS, MO, NE, NH, NM, NC, ND, OH, OK, PA, SC, SD, TN, UT, VA, WV, WI, WY	07/01/2012
Tropics Version 3	HI	07/01/2012
	PR	04/01/2013
	GU	04/01/2014
	NMI, USVI	07/01/2016
National Version 3.1	MA	01/01/2015
	DC, IL, MD, RI	04/01/2015 (except Calvert County and St. Mary's County in MD, for which the applicable permit date is on or after 07/01/2015)
	IA	06/01/2015
	DE	12/01/2015
	MT, OR	01/01/2016
	MN, VT	04/01/2016
	NV	10/01/2016
	MI, NJ	04/01/2017
	CT, NY	10/01/2017
	TX	07/01/2018
Florida Version 3.1	FL	07/01/2012
California Version 3.2	CA	07/01/2018
Washington Version 3.2	WA	07/01/2018

https://www.energystar.gov/newhomes/homes_prog_reqs/national_page

Let's Compare: Environments for Living

- Performance based program

- EFL Certified Green = 20% energy savings (baseline not specified)
- EFL Gold = 12% above 2009 IECC
- EFL Platinum = 18% above 2009 IECC
- EFL Diamond = 30% above 2009 IECC

- MUST ensure mandatory code requirements are met for code compliance
- Check to see if plan review service for code compliance is included

Plan Review Services:

- Local Code Compliance; 2006, 2009, 2012 IECC
- ENERGY STAR® for New Homes
- LEED® for Homes
- Builders Challenge
- Green Building Programs
- HERS® Scores/Certificates

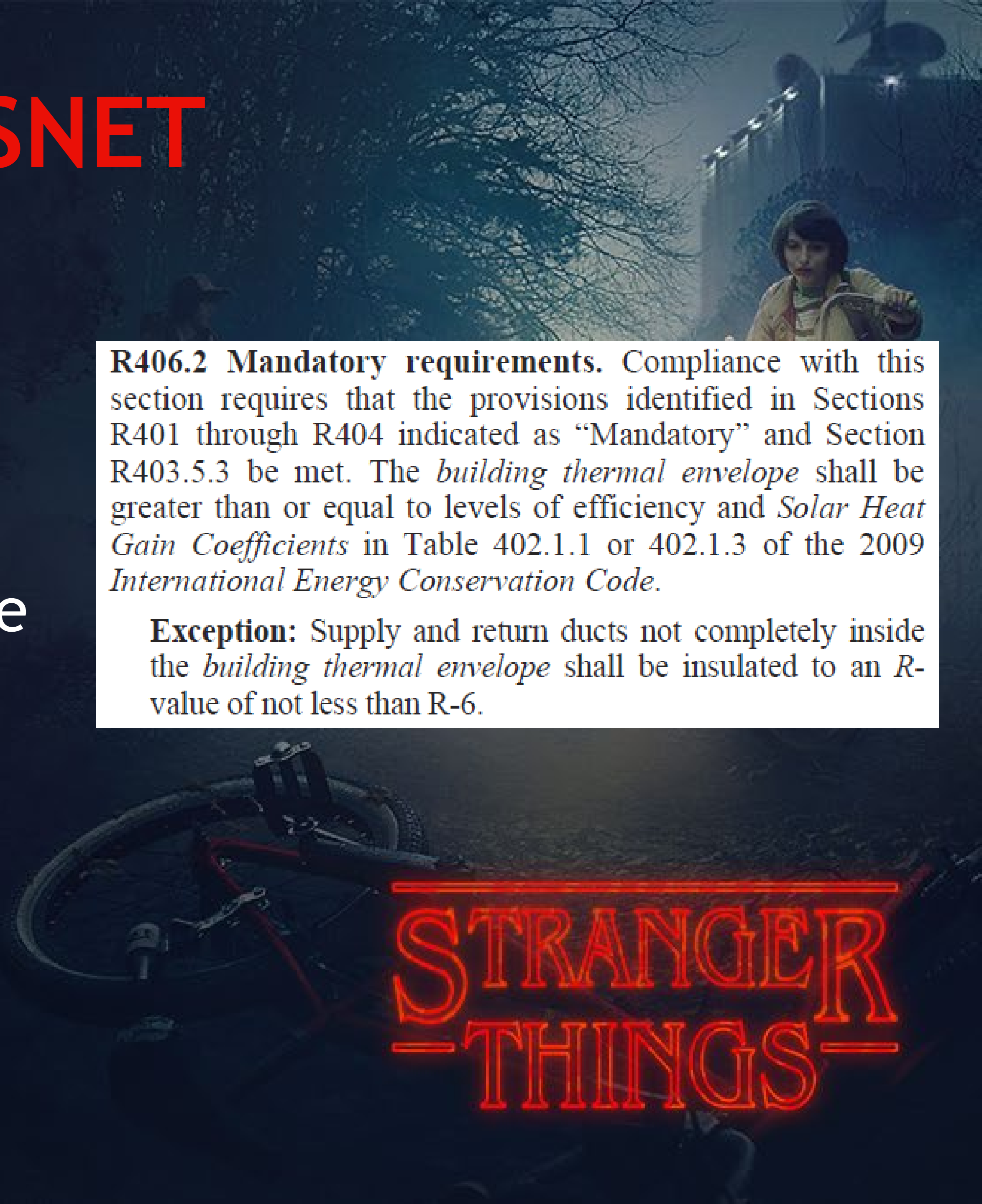
http://www.environmentsforliving.com/EFLPublicSite/index.jsp?action=bd_testing

Let's Compare: RESNET HERS/ERI

- Performance based program
- Benefit of having specific ERI path in the 2015 & 2018 IECC, Section R406
- Compliance for earlier versions of the code more fuzzy
- The code includes mandatory requirements beyond HERS/ERI
- Must have a rating at or below that which is specified in the code

R406.2 Mandatory requirements. Compliance with this section requires that the provisions identified in Sections R401 through R404 indicated as "Mandatory" and Section R403.5.3 be met. The *building thermal envelope* shall be greater than or equal to levels of efficiency and *Solar Heat Gain Coefficients* in Table 402.1.1 or 402.1.3 of the 2009 *International Energy Conservation Code*.

> **Exception:** Supply and return ducts not completely inside the *building thermal envelope* shall be insulated to an *R*-value of not less than R-6.



Let's Compare: RESNET HERS/ERI

R406.4 ERI-based compliance. Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI less than or equal to the appropriate value indicated in Table R406.4 when compared to the *ERI reference design*.

TABLE R406.4
MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX[a]
1	57
2	57
3	57
4	62
5	61
6	61
7	58
8	58

a. Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the building shall meet the mandatory requirements of Section R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2015 *International Energy Conservation Code*.

- Solar can be included in the modeling for code compliance with mandatory 2015 IECC envelope (2018 IECC)
- Approved software for modeling is required per RESNET/ICC 301
- Some states have amended ERI targets

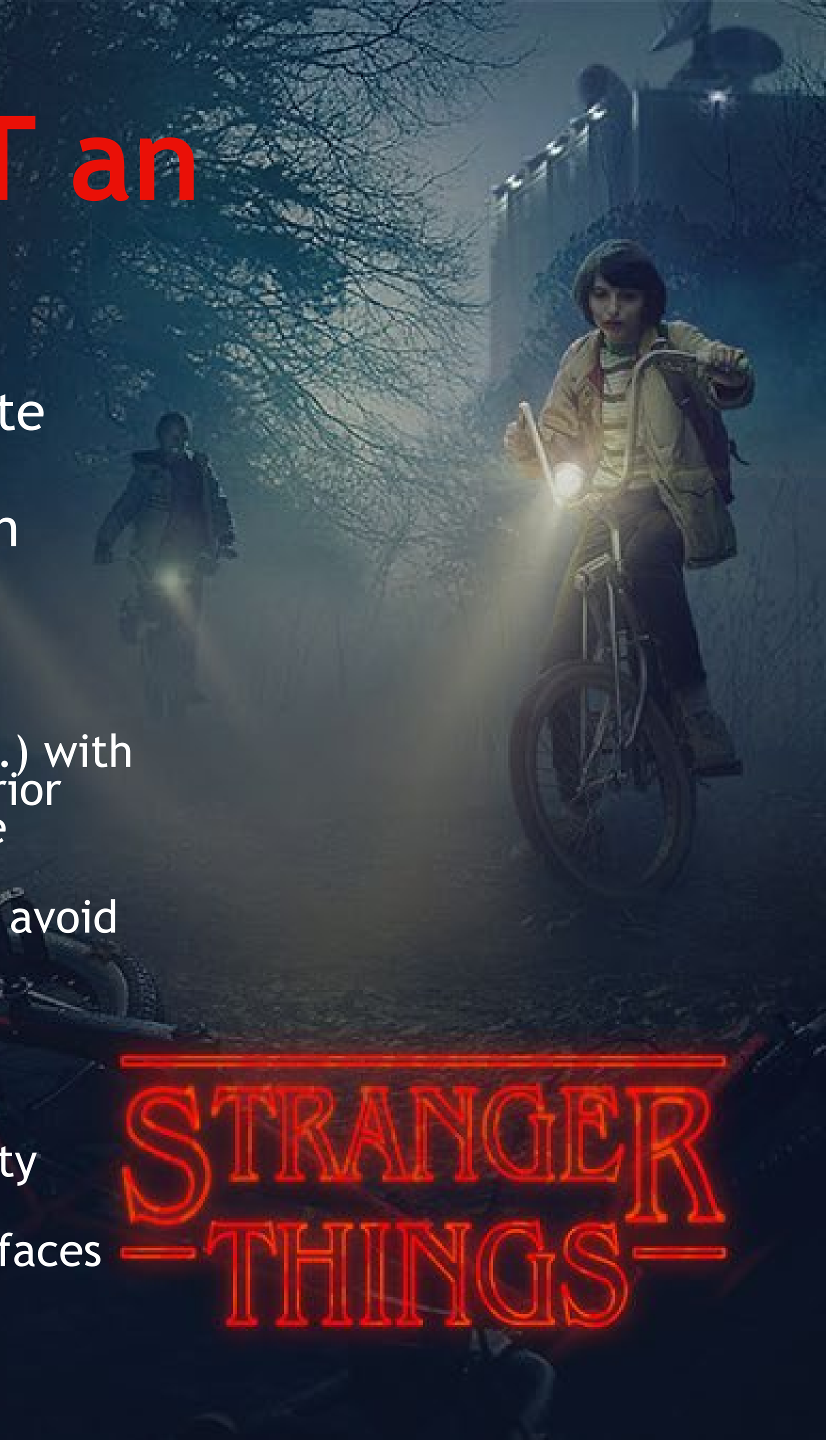
STRANGER THINGS

Myth: Moisture Control is NOT an Energy Code Issue

- Myth: Are all of these wall insulation assembly options equivalent?
  - R13 + 10ci (2x4, std. 16”oc framing w/ ff=25%) – R-value for CZ 6-8 in IECC
  - R15 + 8.4ci (2x4)
  - R19 + 5.6ci (2x6)
  - R20 + 5ci (2x6) - R-value for CZ 6-8 in IECC
  - R23 + 3.4ci (2x6)
  - R29 cavity (2x6, adv. Framing w/ ff=18%)
  - R29 cavity (2x8, std. 16”oc framing w/ ff=25%)
- SIMPLE ANSWER: Yes and maybe. It depends.
  - <u>Yes.</u> From a thermal performance standpoint, they are all approximately equivalent (U-factor ~ 0.045) {see earlier slides on parallel path math}
  - <u>Maybe.</u> From a moisture control standpoint, they may not be equivalent depending on climate, interior vapor retarder selection, vapor permeance of exterior material layers, etc.
  - Energy code compliance must be coordinated with somewhat incomplete building code requirements for vapor retarders and moisture control.
  - Thus, moisture control is an energy code <u>and</u> a building code coordination issue.
  - The location and type of insulation and climate affect decisions regarding the optimal moisture control approach for the assembly.

Myth: Moisture Control is NOT an Energy Code Issue

- All high performance walls are faced with a challenge to coordinate energy code requirements with adequate moisture control
- This can be achieved in different ways depending on the insulation methodology used and other factors.
- For walls with all cavity insulation:
  - Can use an adequate amount of low-perm (e.g., ccSPF) cavity insulation.
  - Can use vapor permeable insulation (e.g., FG batts, ocSPF, cellulose, etc.) with proper selection of interior vapor retarder and vapor permeance of exterior material layers (which side should have higher or lower vapor permeance depends on climate)
  - These walls rely on control of vapor flow into and out of the assembly to avoid high moisture accumulation and balance seasonal changes in vapor flow direction.
- For walls with cavity + continuous insulation (or all continuous insulation)
  - The key here is having the right ci R-value relative to the R-value of cavity insulation, climate, and interior vapor retarder
  - These walls rely more heavily on controlling temperature of material surfaces inside the assembly to prevent condensation and moisture accumulation.



Myth: Moisture Control is NOT an Energy Code Issue

- Code Coordination Problem:
  - The energy code specifies insulation amounts only from a thermal perspective.
  - IRC residential building code specifies minimum continuous insulation for moisture control only when optionally using a Class III (latex paint) interior vapor retarder.
  - IRC is silent regarding the same when a Class I (poly) or II (kraft paper) vapor retarder is used.
  - The National Building Code of Canada is the opposite: it specifies only what to do with continuous insulation amount when a Class I or II vapor retarder is used and does not recognize Class III vapor retarders.
- SOLUTIONS:
  - Must consider both the IRC and NBC and combine the best of both to allow the full spectrum of moisture control solutions to be coordinated with energy code insulation requirements.
  - Alternatively, conduct a project specific hygrothermal analysis, but beware of data inputs and assumptions. It is a design tool and, like a hammer, it's quality of work is dependent on what the user does.

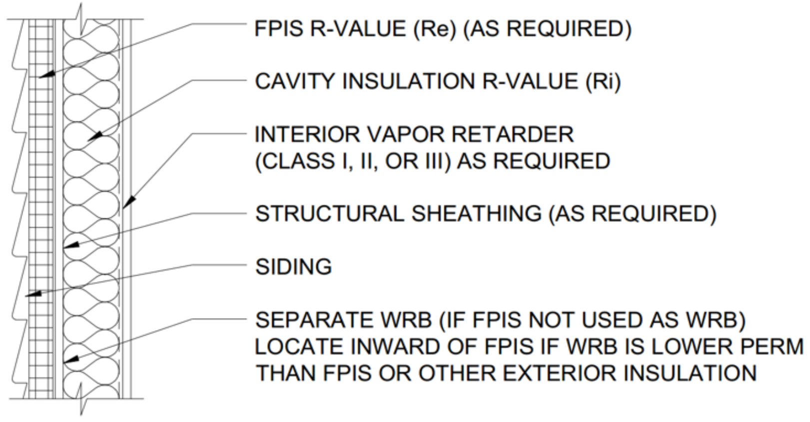
Myth: Moisture Control is NOT an Energy Code Issue

- Example:
  - How to coordinate continuous insulation and cavity insulation for energy code compliance and moisture control (insulation ratio method):

MINIMUM INSULATION RATIO OR CONTINUOUS INSULATION R-VALUE FOR LIGHT-FRAME WALLS WHERE EXTERIOR CONTINUOUS INSULATION (ci) IS USED [a,b,c,d]

Climate Zone (Fig. 7.3.1)	Maximum Heating Degree Days (65F basis)	Interior Vapor Retarder (VR) Class			
		Class I	Class II	Class III	No VR[e]
1	N/A	NP	NP[f]	R-2ci minimum	R-2ci minimum
2	N/A	NP	NP[f]	R-2ci minimum	R-2ci minimum
3	3,600	NP	R-2ci minimum	R-2ci minimum	0.4
4	5,400	NP	R-2ci minimum	0.2	0.9
5	7,200	0.2	0.2	0.35	1.3
6	9,000	0.2	0.2	0.5	1.7
7	12,600	0.35	0.35	0.8	2.3
8[g]	16,200	0.5	0.5	1.1	2.8

Cavity + Continuous + Interior VR



Insulation Ratio = Re / Ri
Example: An R20+5ci wall has an insulation ratio of 5/20 = 0.25

STRANGER THINGS

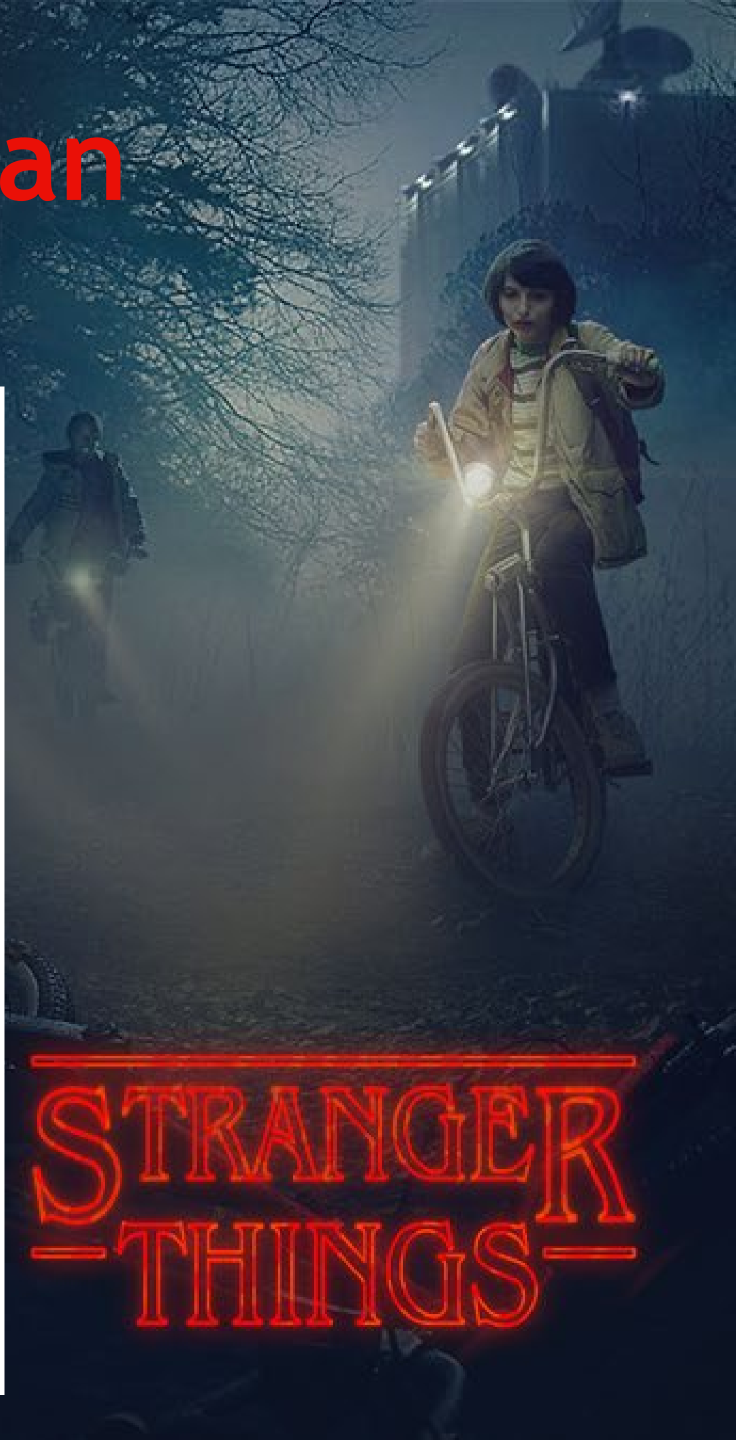
MINIMUM INSULATION RATIO OR CONTINUOUS INSULATION R-VALUE
FOR LIGHT-FRAME WALLS WHERE EXTERIOR CONTINUOUS INSULATION (ci) IS USED [a,b,c,d]

Myth: Moisture Control is NOT an Energy Code Issue

- Prescriptive Method
  - This "look-up" table is based on the insulation ratios (previous slide)
  - No insulation ratio calculations required
- These requirements can be compared with energy code compliant assemblies to select the optimal insulation strategy and moisture control approach.
- These can also be used together with ERI analysis to evaluate appropriateness of wall insulation methods for moisture control.
- Additional considerations are important for all walls…(see next slide)

MINIMUM REQUIRED R-VALUE FOR FPIS CONTINUOUS INSULATION ON THE EXTERIOR SIDE OF WOOD-FRAMED WALL ASSEMBLIES FOR VARIOUS INTERIOR VAPOR RETARDERS[a]

CLIMATE ZONE (Figure 7.3.1)	Interior Vapor Retarder Class			
	Hybrid Wall Options			"Perfect Wall"
	Class I[b]	Class II	Class III	No interior VR[c,d]
1-2	Not Permitted	Not Permitted	FPIS Continuous insulation with R-value ≥ 2	FPIS Continuous insulation with R-value ≥ 2
3	Not Permitted	FPIS Continuous insulation with R-value ≥ 2	FPIS Continuous insulation with R-value ≥ 2	FPIS Continuous insulation with R-value ≥ 3
4	Not Permitted	FPIS Continuous insulation with R-value ≥ 2	FPIS Continuous insulation with R-value ≥ 2.5 over 2x4 wall. FPIS Continuous insulation with R-value ≥ 3.75 over 2x6 wall	FPIS Continuous insulation with R-value ≥ 4.5
5	FPIS Continuous insulation with R-value ≥3 over 2x4 wall. FPIS Continuous insulation with R-value ≥5 over 2x6 wall		FPIS Continuous insulation with R-value ≥ 5 over 2x4 wall. Continuous insulation with R-value ≥ 7.5 over 2x6 wall	FPIS Continuous insulation with R-value ≥ 6.5
6			FPIS Continuous insulation with R-value ≥ 7.5 over 2x4 wall. FPIS Continuous insulation with R-value ≥ 11.25 over 2x6 wall	FPIS Continuous insulation with R-value ≥ 8.5
7	FPIS Continuous insulation with R-value ≥5 over 2x4 wall. FPIS Continuous insulation with R-value ≥7.5 over 2x6 wall		FPIS Continuous insulation with R-value ≥ 10 over 2x4 wall. FPIS Continuous insulation with R-value ≥ 15 over 2x6 wall	FPIS Continuous insulation with R-value ≥ 11.5
8	FPIS Continuous insulation with R-value ≥7.5 over 2x4 wall. FPIS Continuous insulation with R-value ≥10 over 2x6 wall		FPIS Continuous insulation with R-value ≥ 12.5 over 2x4 wall. FPIS Continuous insulation with R-value ≥ 20 over 2x6 wall	FPIS Continuous insulation with R-value ≥ 14



Myth: Moisture Control is NOT an Energy Code Issue

- All wall types and insulation strategies must consider the following to ensure good and reliable moisture performance:
  - Control of indoor relative humidity (HVAC design and operation)
  - Control of rain-water leakage (WRB, flashing details, drainage, etc.)
  - Air sealing to prevent moist air intrusion.
- For more information and guidance:
  - Wall Calculator Tool (https://www.appliedbuildingtech.com/fsc/calculator)
  - Model Moisture Control Guidelines (https://www.appliedbuildingtech.com/rr/1701-01)
  - Moisture Control Methods Research Report (https://www.appliedbuildingtech.com/rr/1410-03)
  - ASHRAE STP 1599 Paper (https://www.astm.org/DIGITAL_LIBRARY/STP/PAGES/STP159920160097.htm)
- Visit https://www.continuousinsulation.org/ for these and many other resources.

Myth: Compliance Options are Straightforward

- Example 1
- Section R403.1 Controls (Mandatory)
- Section R403.1.1 Programmable thermostat ???
- Section R403.1.2 Heat pump supplementary heat (Mandatory)

- Where does that leave programmable thermostats?
- Can we assume they are Mandatory?

R403.1 Controls (Mandatory). Not less than one thermostat shall be provided for each separate heating and cooling system.

R403.1.1 Programmable thermostat. The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature setpoints at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures of not less than 55°F (13°C) to not greater than 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F (21°C) and a cooling temperature setpoint of not less than 78°F (26°C).

R403.1.2 Heat pump supplementary heat (Mandatory). Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

STRANGER THINGS

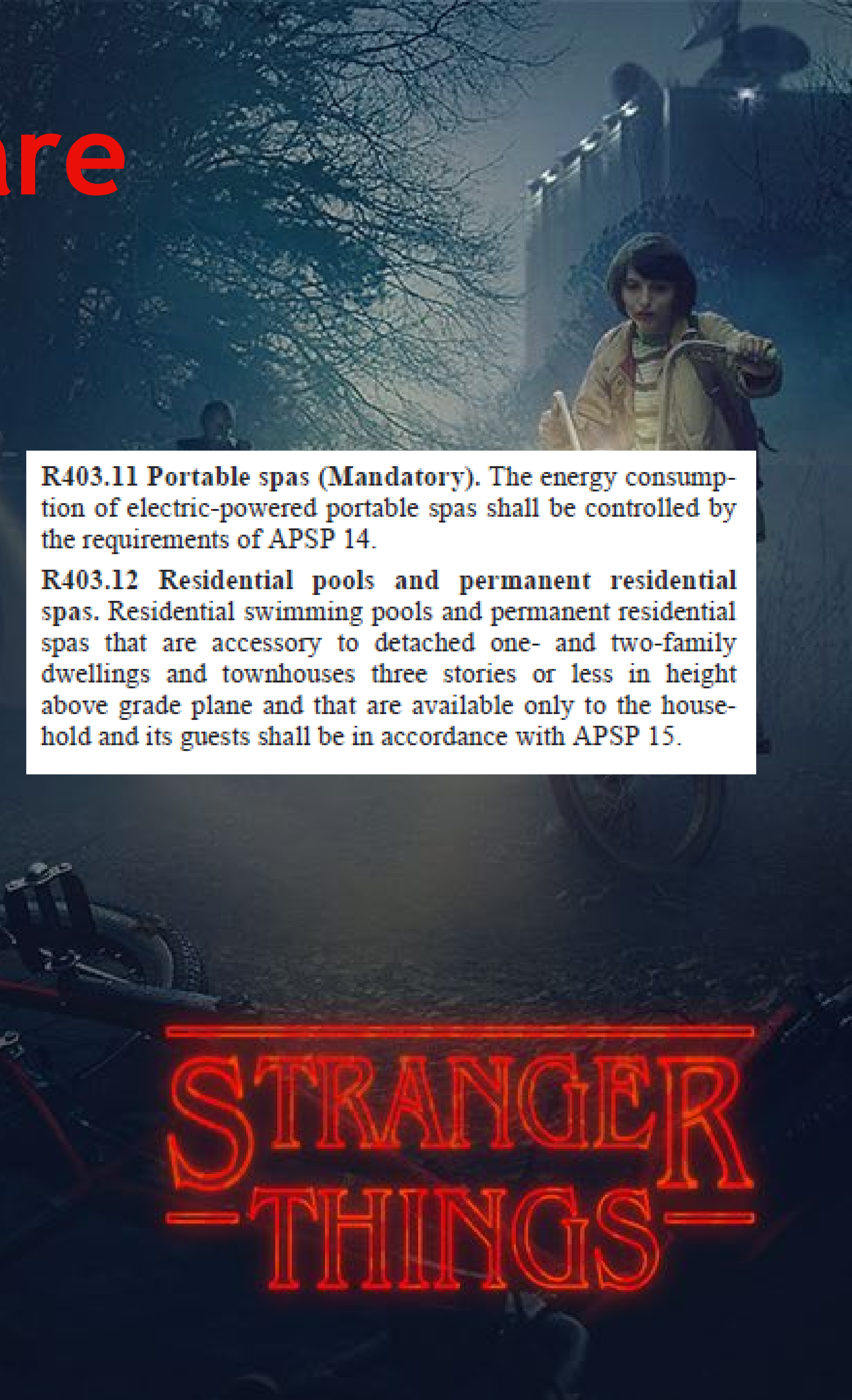
Myth: Compliance Options are Straightforward

- Example 2
- Section R403.9 Snow and ice melt systems (Mandatory)
- Section R403.10 Pools and permanent spa energy consumption (Mandatory)
- Section R403.11 Portable spas (Mandatory)
- Section R403.12 Residential pools and spas ???

- Where does that leave residential pools and spas?
- Can we assume they are Mandatory?

R403.11 Portable spas (Mandatory). The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.

R403.12 Residential pools and permanent residential spas. Residential swimming pools and permanent residential spas that are accessory to detached one- and two-family dwellings and townhouses three stories or less in height above grade plane and that are available only to the household and its guests shall be in accordance with APSP 15.



Myth: Compliance Options are Straightforward

- Example 3
- Per Section R402.2 Specific insulation requirements are (Prescriptive)
- Section R402.2.3 Eave baffle, falls under this prescriptive grouping

R402.2 Specific insulation requirements (Prescriptive). In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through R402.2.13.

R402.2.3 Eave baffle. For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal or greater than the size of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

- If using the performance or ERI compliance option are baffles required (Mandatory)when air-permeable insulations is installed in that location?

STRANGER THINGS

Myth: Compliance Options are Straightforward

- ICC’s SEHPCAC is working on fixing the issue identified by the first two examples
- Others will have to try and address the third example

- It will likely take YEARS and a lot of grey hair and wrinkles before it is straightened out!

STRANGER THINGS

Myth: An Envelope "Backstop" is Not Needed in the ERI Path

- This myth is founded on several subtle ideas that can be tested:
  - Trade-offs are "energy neutral"
  - The same energy amount of energy is used in the end
  - A "Btu is a Btu"
- Why an envelope "backstop" is needed:
  - Performance-based design for energy conservation is not just a "Btu for Btu" issue and is not actually energy neutral.
  - It does matter to what degree the performance of one building assembly or component is traded-off for improvements in another.
    - ANALOGY: Would you weaken the brakes on a car because air-bags have been improved? You could do this in such a way that it is "safety neutral". But, does it make sense?
    - Similarly, there are consequences if trade-offs occur in building energy conservation designs without reasonable constraints that maintain overall system reliability, performance, and cost-effectiveness.
  - Just as a building structural system is only as strong and reliable as its weakest link, the long-term energy savings performance of building's energy code compliance strategy are subject to the weakest link theory.

Myth: An Envelope "Backstop" is Not Needed in the ERI Path

- Trading off envelope performance has the following implications:
  - DURABILITY: The envelop provides the most durable and lasting form of energy efficiency. It works 24-7 for 365 days a year over the life of a building. It is the most permanent and reliable energy efficiency practice and requires the least maintenance and replacement. When done well, it also protects the durability of the structure and its contents.
  - COST-EFFECTIVENESS: The most cost-effective time to maximize efficiency of the building is when it is constructed. It is very expensive to make improvements to the envelope after construction.
  - AFFORDABILITY: There is no free lunch! This is a matter of pay now or pay later. The new energy efficient homes of today are the energy efficient affordable existing homes of tomorrow. Affordability is primarily a matter of land and development costs; for those on the margin of new housing ownership, it is primarily a matter of controlling land costs, house size, and cost of amenities. ERI should be modified to properly account for house size in the rating methodology such that smaller homes are rewarded and larger homes that use more energy are held to a higher standard to offset greater energy use in a balanced approach.
  - COMFORT: Well insulated and air-sealed envelopes with mitigated thermal bridges provide a more comfortable and easier to control indoor environment. Occupants tend to offset uncomfortable conditions by increasing or lowering set point temperature, resulting in more energy use and also potentially increased risk of moisture problems.

Myth: An Envelope "Backstop" is Not Needed in the ERI Path

- EQUIPMENT TRADE-OFF: When this method is used, it is a "fake" trade. It is not based on typical equipment efficiencies but rather outdated federally mandated minimums. Thus, for nothing more than common equipment, the home envelope is weakened in a subsidized trading scheme. Plus, the equipment must be sized larger (and all future replacement equipment). The consumer get's the short end of the stick on using envelope weakening to subsidize equipment sales as a kick-back behind the scenes.

- SOLAR TRADE-OFF: This is like the HVAC equipment subsidy described above. Except, the inclusion of on-site solar power generation is used to weaken the envelope such that there is no net decrease in use of power from the grid which is sourced primarily from non-renewable fuels. So the net energy used is increased by decreasing insulation of the envelope and adding solar. This is a classic "shell game". [IECC 2018 has implemented a backstop for renewables]

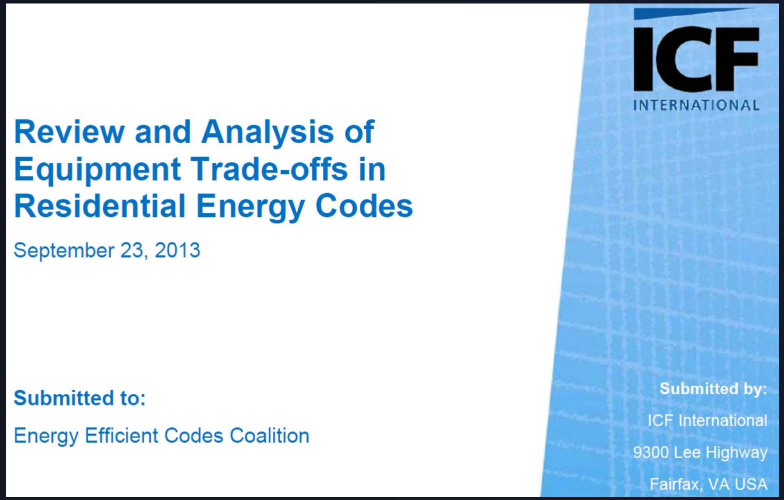
Gas Furnace Efficiency Levels	Estimated Market Penetrations	
	North Climate Zones	South Climate Zones
80-89.9	30%	73%
90-91.9	15%	4%
92-94.9	32%	15%
95-97.9	22%	8%
≥98	1%	0%

In northern climates, 70% of gas furnaces sold have an efficiency of 90% or greater. Why then is 80% efficiency used as the baseline for trade-offs to weaken the envelope?

STRANGER THINGS

Myth: An Envelope "Backstop" is Not Needed in the ERI Path

- So, what is the evidence to support need for a backstop?
  - Refer to ICF study (http://energyefficientcodes.com/wp-content/uploads/2013/08/2013-9-23-FIN-Review-Analysis-of-Equipment-Trade-offs-in-Residential-IECC.FIN_.pdf)


ICF INTERNATIONAL

Review and Analysis of Equipment Trade-offs in Residential Energy Codes

September 23, 2013

Submitted to:

Energy Efficient Codes Coalition

Submitted by:

ICF International

9300 Lee Highway

Fairfax, VA USA

- Trade-off using common 90% AFUE gas equipment has a $400,000,000 net present value of increased energy bills for each year's housing starts using the trade-off scheme with gas furnaces.
- The trade-off is not "energy neutral" and is likely worse since this study made conservative assumptions.

Myth: An Envelope “Backstop” is Not Needed in the ERI Path

- Example reduction in envelope requirements where 5kW PV system used in ERI path to trade-off:

Climate Zone	2015 IECC Path	Wall R-value	Ceiling R-value	Window U-factor / SHGC	Thermal Envelope Criteria Comparative Code Version
1	ERI	0	0	1.20 / 0.25	Pre-Energy Code
	Prescriptive	13	30	0.50 / 0.25	
2	ERI	0	0	1.20 / 0.25	Pre-Energy Code
	Prescriptive	13	38	0.40 / 0.25	
3	ERI	0	0	1.20 / 0.25	Pre-Energy Code
	Prescriptive	20	38	0.35 / 0.25	
4	ERI	4	5	1.20 / 0.40	Pre-Energy Code
	Prescriptive	20	49	0.35 / 0.40	
5	ERI	11	13	1.20 / NR	~MEC 1992
	Prescriptive	20	49	0.32 / NR	
6	ERI	11	11	0.60 / NR	~MEC 1992
	Prescriptive	20+5	49	0.32 / NR	
7	ERI	13	11	0.60 / NR	~MEC 1992
	Prescriptive	20+5	49	0.32 / NR	
8	ERI	13	15	0.32 / NR	~IECC 2006
	Prescriptive	20+5	49	0.32 / NR	

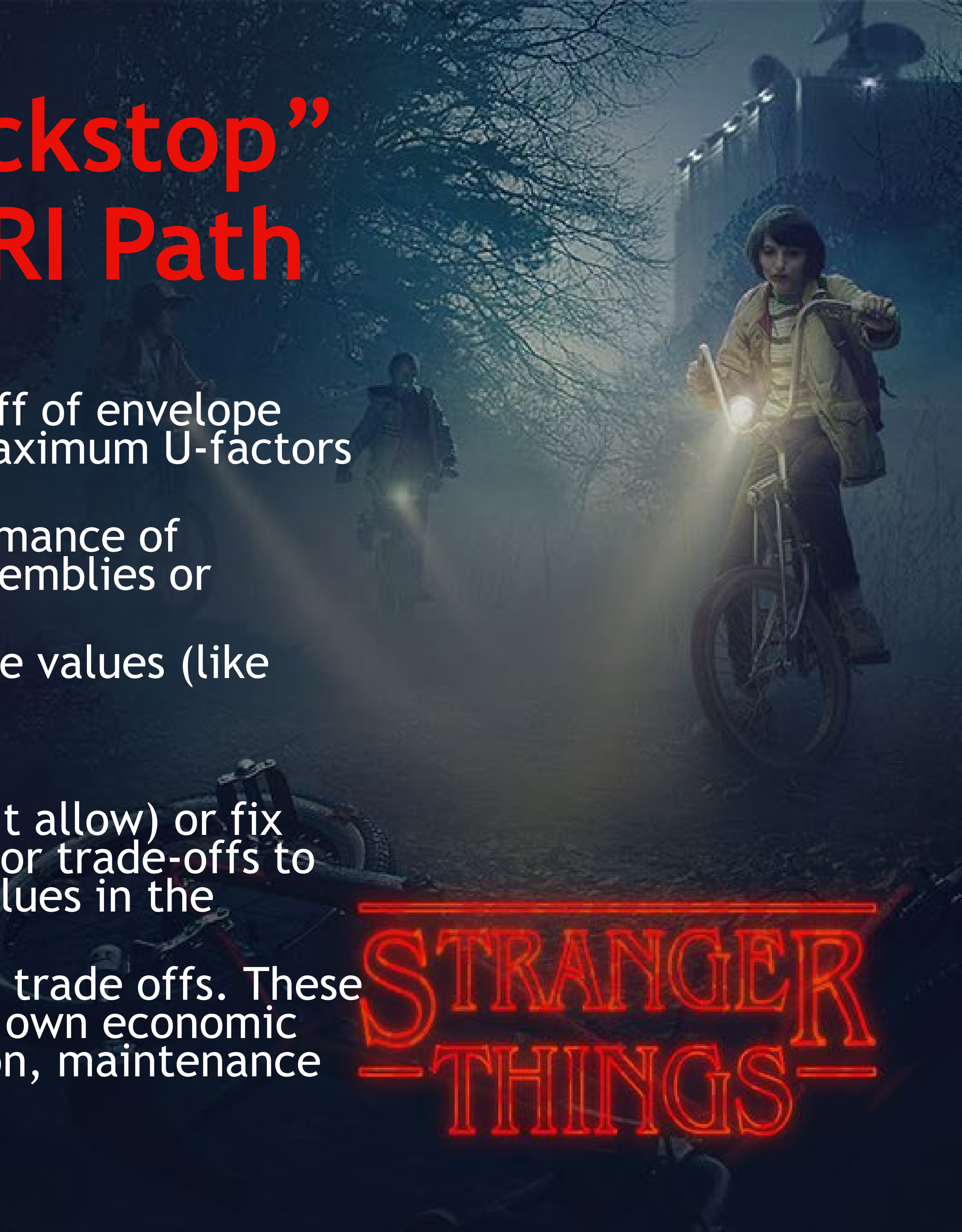
Table courtesy of Charlie Hack

VS.

STRANGER THINGS

Myth: An Envelope "Backstop" is Not Needed in the ERI Path

- Some possible solutions:
  - Create a separate backstop table to limit trade-off of envelope components (minimum R-values for insulation, maximum U-factors & SHGC for windows, etc.)
  - Allow a maximum percentage reduction in performance of envelope when trading off by improving other assemblies or systems.
  - Limit envelop trades to not be less than prior code values (like 2009 or later editions of IECC)
- Better yet, remove the subsidy schemes:
  - Don't allow equipment trades (as the IECC doesn't allow) or fix federal mandates to allow equipment efficiency for trade-offs to be set at median/typical equipment efficiency values in the market.
  - Don't allow or limit solar PV or on-site renewable trade offs. These systems should be evaluated on the basis of their own economic and energy producing merits, including installation, maintenance and replacement costs.



Have we missed any of your haunting myths?

Questions?

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