The HERS Associate and Taking the Performance Path

Module 3 – Demystifying Energy Modeling

VIRTUAL HIGH PERFORMANCE HOME SUMMIT 2020

EEBA SEPT 29 - OCT 9 | ONLINE VIA WHOVA

Presented by:
Mike Barcik

Southface

About EEBA

EEBA

For over 35 years, EEBA has provided the most trusted resources for building science information and education in the construction industry. EEBA delivers turn-key educational resources and events designed to transform residential construction practices through high performance design, marketing, materials, and technologies. Through our educational events, annual Summit and various publications and resources, EEBA reaches thousands of key decision makers and other important industry players each year.

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Introductions

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About Southface

- *Building a Regenerative Economy, Responsible Resource Use & Social Equity Through a Healthy Built Environment for All*

www.southface.org

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AIA Continuing Education Provider

Poll: Who is attending?

Module Learning Objectives

- Review the basic energy equations
- Differentiate between a UA trade-off, load calc and a simulation
- What happens when an energy model simulates
- Review tools that can perform energy modeling
- See example modeling results to achieve a target index

The house as a system

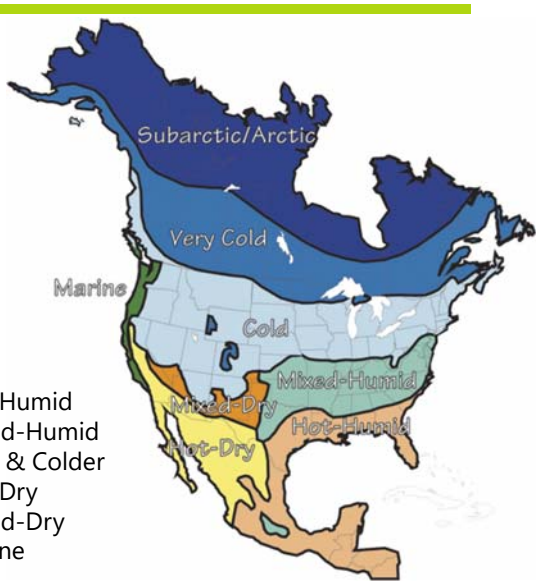
A house is a system made up of interrelated parts:

- The site and neighboring homes
- The weather barrier
- The building thermal envelope
- Space conditioning
- Ventilation
- Lighting & appliances & plumbing

- All efficiency measures should take occupants into account (e.g., air sealing & ventilation)

Building Science:

- Employ scientific principles from a variety of fields that govern building performance
- Optimize building performance and understand, predict, prevent and correct building failures
- Systems approach to houses
- Physics of:
  - **Heat:**
    Flows from hot to cold
  - **Air:**
    Flows from high pressure to low
  - **Moisture:**
    Flows from wet to dry
    (liquid and vapor)



A. Hot-Humid
B. Mixed-Humid
C. Cold & Colder
D. Hot-Dry
E. Mixed-Dry
F. Marine

Question 1

With a full set of plans and complete specifications, how long does it take to create and run an energy model?

- A. < 20 minutes
- B. Between 30 to 90 minutes
- C. At least 2 hours

Convection Heat Flow

- Heat transfer through a fluid (liquid or gas) – usually air.
  For air, the formula for calculating convective heat transfer is

$$q = 1.08 \times CFM \times \Delta T$$ = convective heat flow (Btu/hr)

- CFM = Cubic Feet per Minute of air being transported
- ΔT = temperature difference of entering air and ambient air (°F)

Example:
A supply fan delivers 50 cfm of OA into a 75°F home when the ambient is 90°F.
Sensible heat added is q = 1.08 x 50 x (15) = 810 Btu / hr

Conduction Heat Flow – Recap

- Heat transfer through a solid object: the formula for calculating transmission heat loss is:

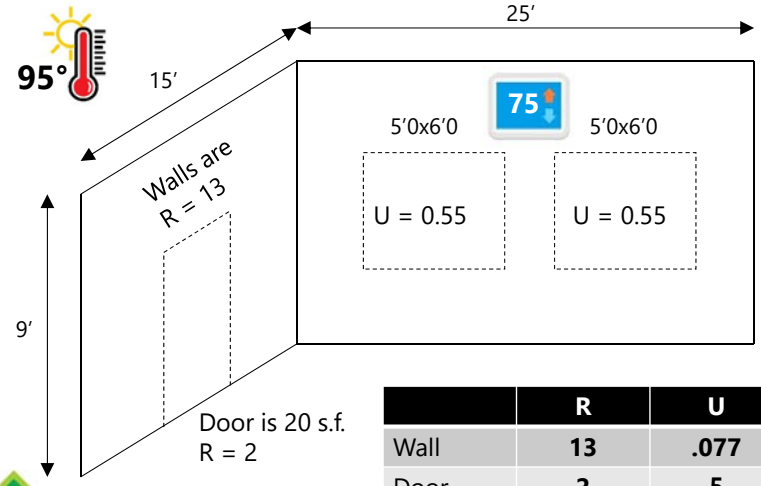
$$q = U \times A \times \Delta T$$

- q = heat flow (Btu/hr)
- U = inverse of R-Value [U=1/R, R=1/U] (Btu/hr ft^2°F)

  U is referred to as the *Conductance* or *Thermal Transmittance*
- A = area (square feet)
- ΔT = temperature difference across component (°F)

Btu = British Thermal Unit

Net Wall Area Example



(1/13) x 360 x 20 = **554**

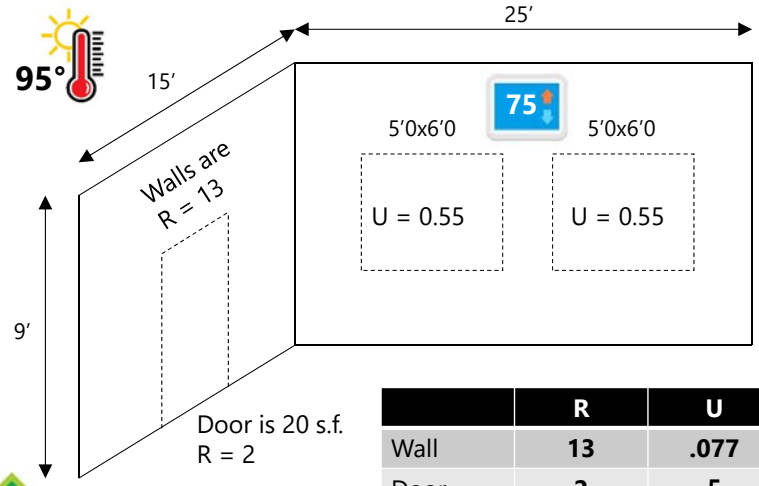
$$q = U \times A \times \Delta T$$

	R	U	Area	Delta T	q
Wall	13	.077	280	20	431Btu/hr
Door	2	.5	20	20	200Btu/hr
Window		.55	60	20	660Btu/hr

1291 Btu/hr

Net Wall Area Example

$$U_{avg} = \frac{U_1 \times A_1 + U_2 \times A_2 + U_3 \times A_3}{A_{total}}$$



$$U_{avg} = \frac{0.077x280 + 0.5x20 + 0.55x60}{360}$$

U_{avg} = **0.1793** **R = 5.6**

	R	U	Area	Delta T	q
Wall	13	.077	280	20	431Btu/hr
Door	2	.5	20	20	200Btu/hr
Window		.55	60	20	660Btu/hr
					1291 Btu/hr

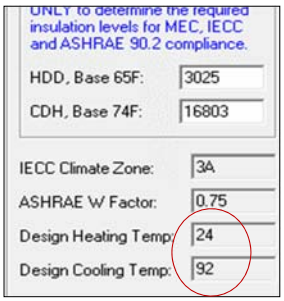
HVAC Sizing & Selection Process

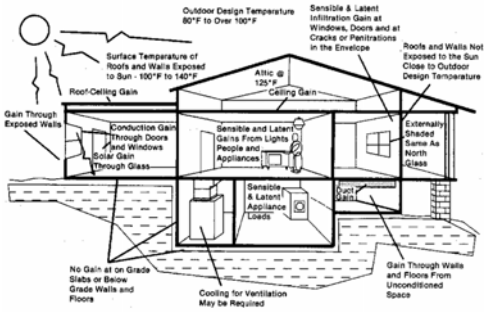
- ACCA Manual J & S are the code required methods used to size and select heating & cooling equipment
  - Manual J – used to determine heating & cooling loads of home
  - Manual S – used to select equipment based upon Manual J

Air Conditioning Contractors of America

How Does Manual J work?

- Location
- Orientation
- Envelope
- Duct & envelope tightness
- Internal gains
- Ventilation





Climate and Energy Efficiency

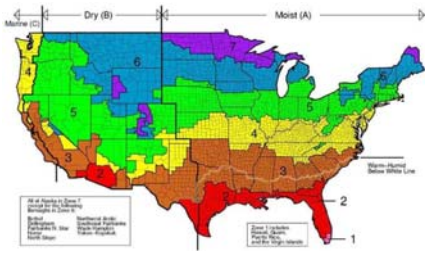
Design Temps	W / S
Atlanta	24/92
St. Louis	14/91
Fairbanks	-40/78
Miami	51/90

Design Temperatures

- Heating, for 99% of the season the outdoor temperature is above this value
- Only 1% of the Cooling season is hotter than this temperature

Design Temp Example

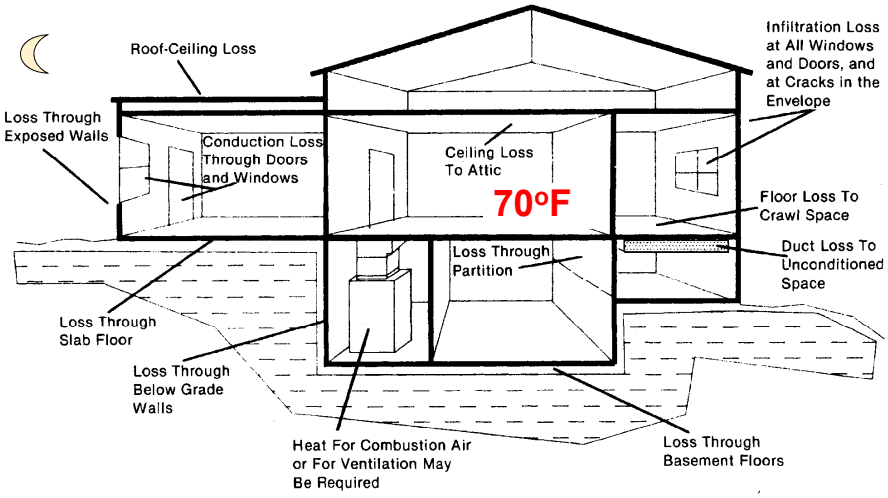
- Atlanta Winter 70 – 24 = 46 F ΔT
- Atlanta Summer 92 – 75 = 17 F ΔT



Load Calcs & Energy Code

- IECC 2009 Section 302.1: Interior design temperatures (72°F heating, 75°F cooling)
- "Heating and cooling equipment shall be sized in accordance with Section M1401.3"
- "Heating and cooling equipment shall be sized in accordance with **ACCA Manual S** based on building loads calculated in accordance with **ACCA Manual J** or other approved heating and cooling calculation methodologies."- 2015/18 IECC R403.7

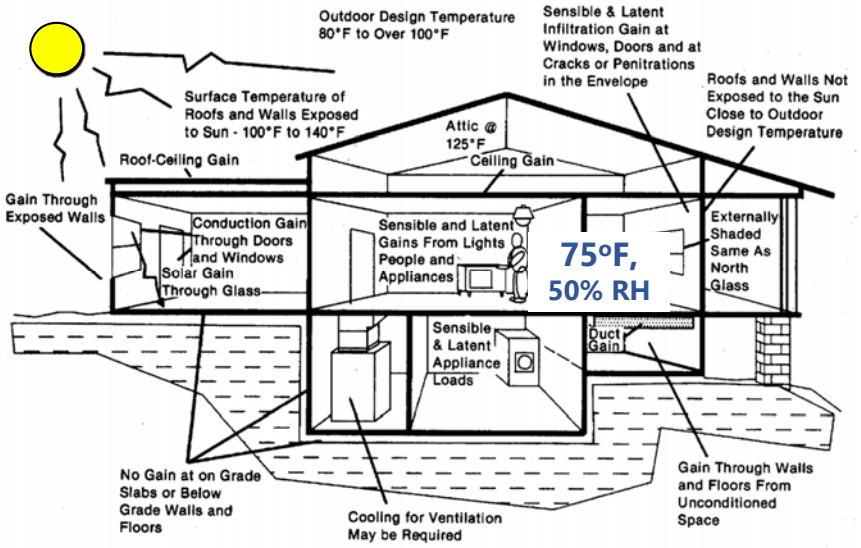
Manual J - Winter Loads



Winter Outdoor Design Temp

24°F

Manual J - Summer Loads



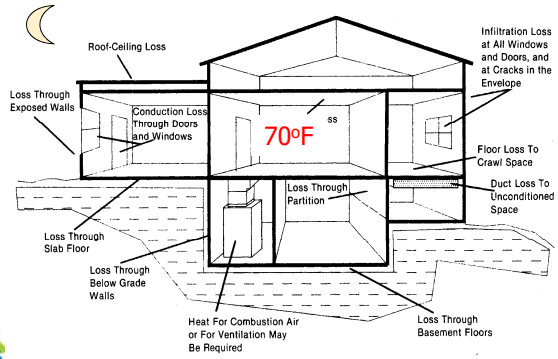
Summer Outdoor Design Temp

92°F

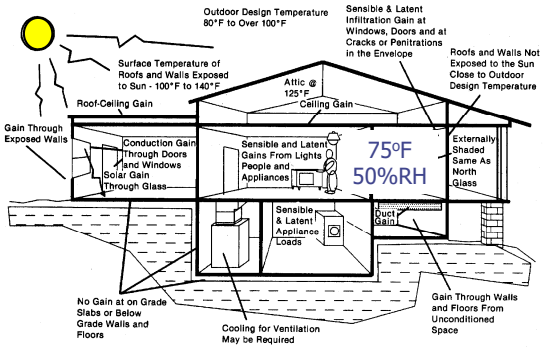
Manual J – Load Calculations

Load calcs are required, but there are no details about who is qualified to perform them Enforcement varies greatly!!

Winter Outdoor Design Temp

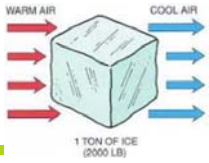


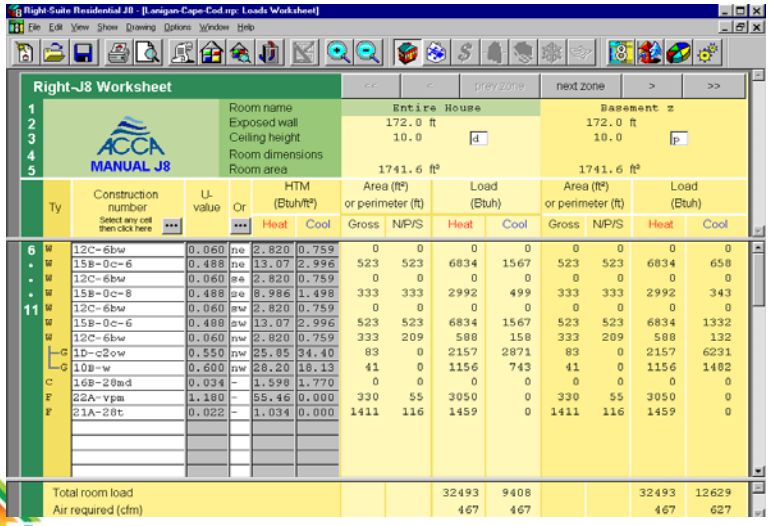
Summer Outdoor Design Temp



Manual J Software

1 ton = 12,000 Btu/hr

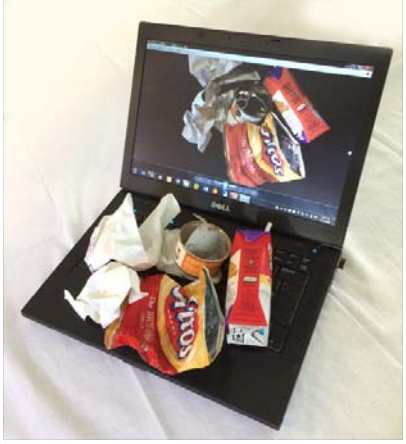




Why is sizing important?

- Equipment first-cost
- Longer/more efficient run times
- Limits equipment cycling
- Better dehumidification

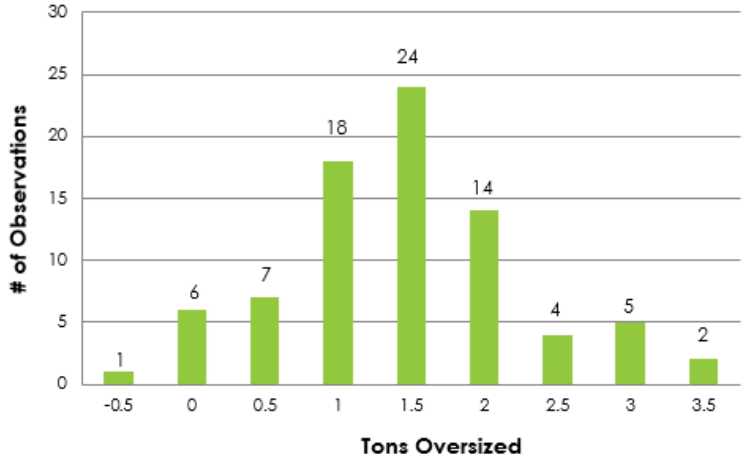
Common Problems with Manual J Inputs



- Manual Js are often not correct – both intentionally & unintentionally
- The results of a Manual J are only as meaningful as the input data ("GIGO")
- Several common input errors are often found
  - Design temperatures
  - Building orientation
  - Number of occupants
  - Window area, U-value, Solar Gain
  - Air leakage

Installed AC units

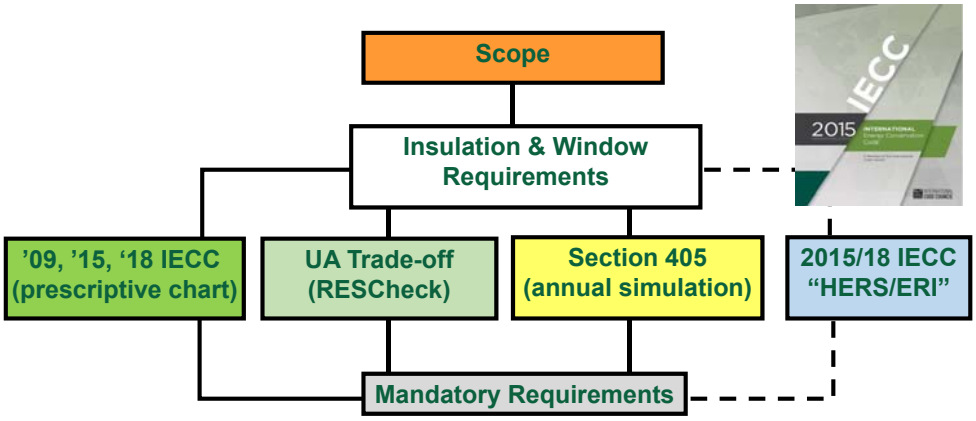
Tons Oversized



MO Equipment Sizing Study

UA Analysis

COMPLIANCE PATHS FOR INSULATION & WINDOWS

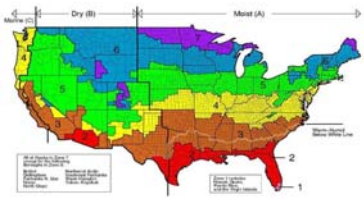


- The new ERI path gives the most design flexibility – such as credit for mechanical equipment efficiency
- It also credits items not covered by the code (e.g., appliance efficiencies)

The 2015/18 IECC: Prescriptive R-value Table

INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

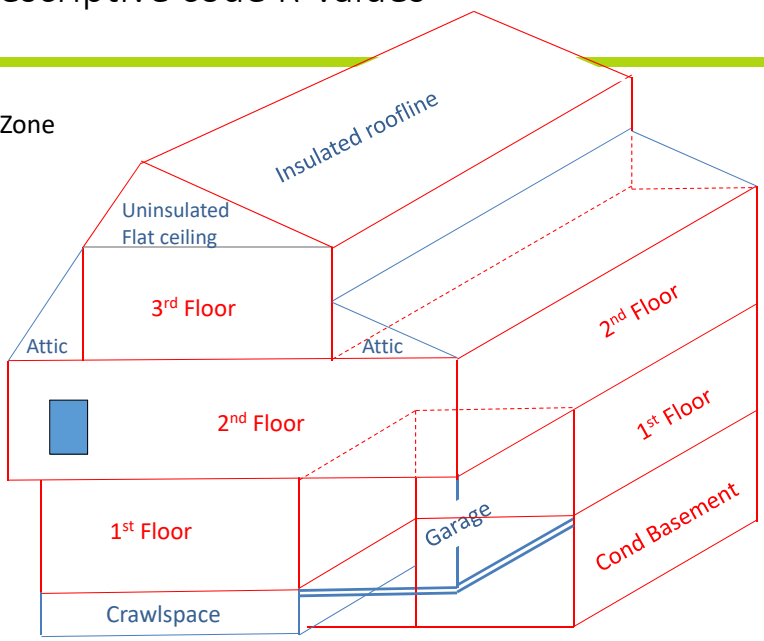
CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35 0.32	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35 0.32	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 0.30	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32 0.30	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 0.30	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19



Only changes In 2018 code

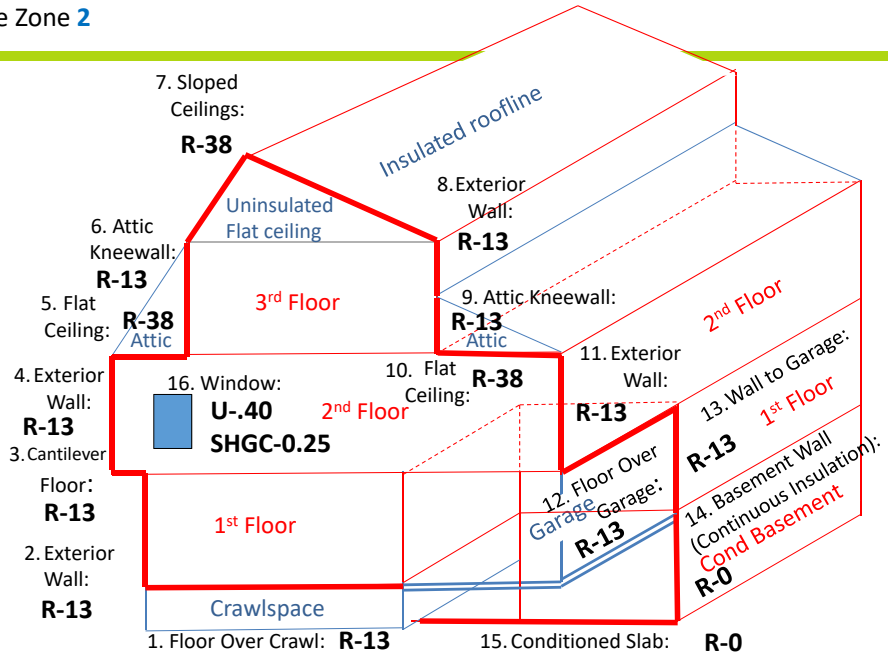
Fill in the prescriptive code R-values

Determine Climate Zone



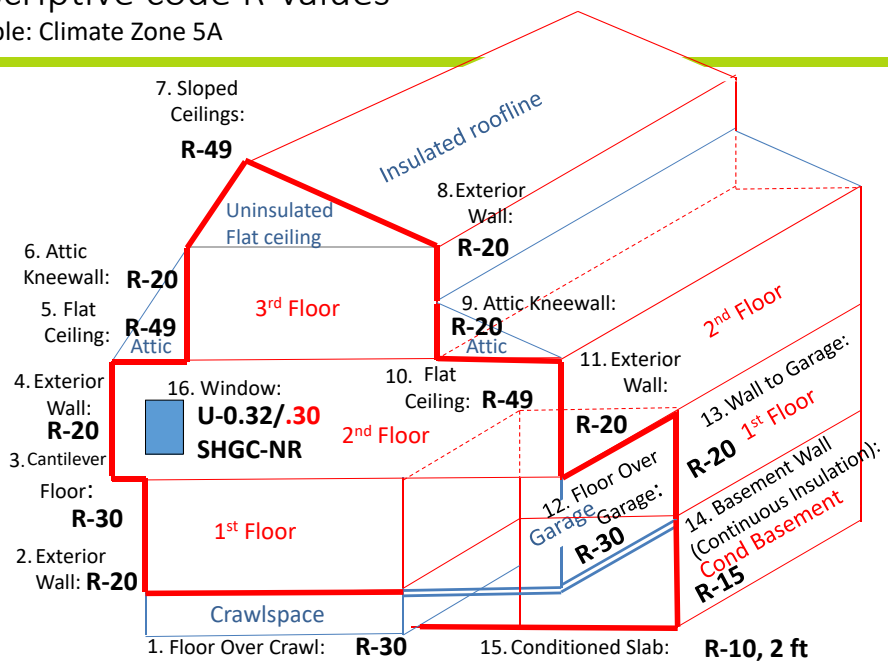
Prescriptive code R-values

Climate Zone **2**



Prescriptive code R-values

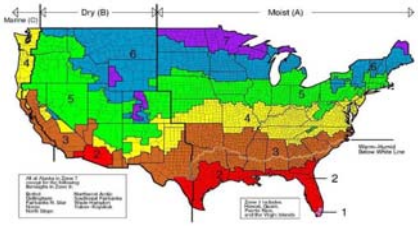
Example: Climate Zone 5A



The 2015/18 IECC: Prescriptive Ufactor Table

TABLE R402.1.4
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.084	0.165	0.064	0.360	0.477
3	0.35 0.32	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35 0.32	0.55	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32 0.30	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32 0.30	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32 0.30	0.55	0.026	0.045	0.057	0.028	0.050	0.055



Only changes
In 2018 code

UA Analysis

$$\mathbf{U}_{avg} \times \mathbf{A}_{total} = U_1 \times A_1 + U_2 \times A_2 + U_3 \times A_3$$

- The UA for a house is determined by the surfaces and the amount of insulation
- Against a version of the house built exactly to the U-factor prescriptive code, the as-built or as-proposed version can be compared
- As long as the proposed UA is no worse than the code UA, the envelope is in compliance

GEORGIA ENERGY CODE HELP DESK

www.southface.org

2020 Georgia Energy Code Resources

Energy Code Resources

2020 Georgia Energy Code Overview and Certificate
2020 Southface Presentation Slides Georgia Residential Energy Code
2020 Georgia Supplements and Amendments
Appendix RA Air Sealing and Insulation Key Points
2015 IECC Excerpt_Chap4

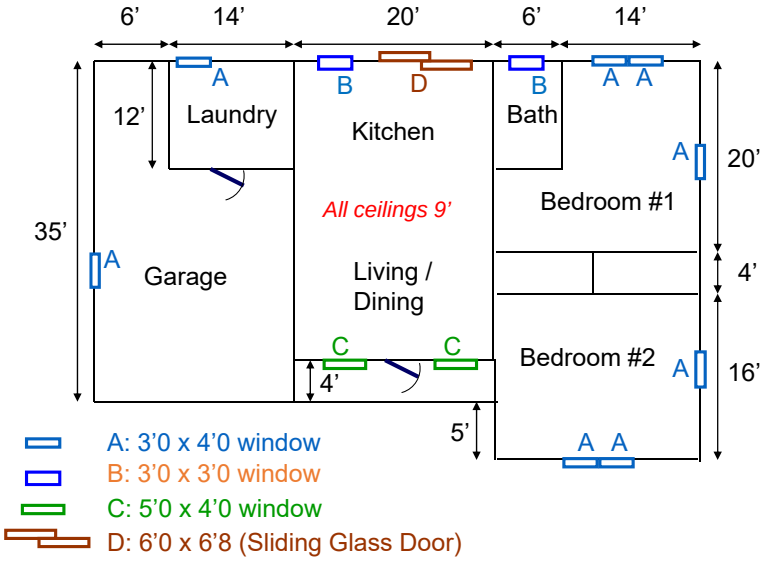
Tools and Support

Appropriate Ventilation Strategies White Paper
Southface Weighted Average Calculator (U and SHGC)
UA Trade Off Tool
2020 Georgia Commercial Field Guide
2020 Georgia Residential Field Guide

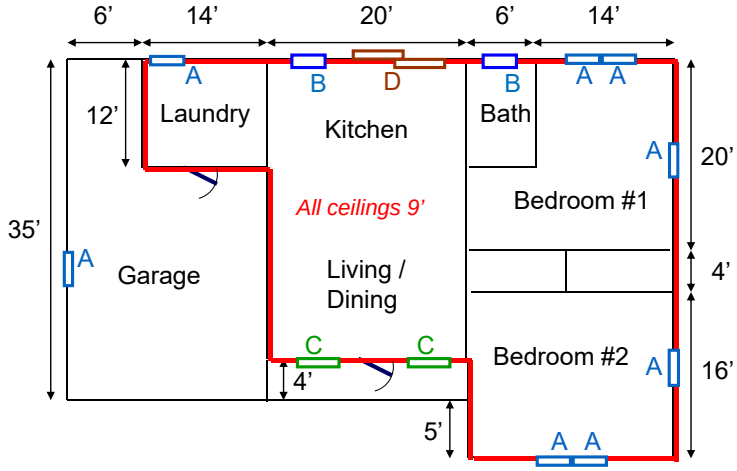
REScheck for UA Compliance

- www.energycodes.gov
- Software evaluates specific designs quickly
- Demonstrates SHGC compliance
- Allows trade-offs
  - Building envelope components
  - No trade-offs for better heating & cooling equipment efficiencies

Simple House



Simple House



- Perimeter: 54x2 + 40x2 = *188* ft.
- Gross Wall: 188 x 9 = *1,692* sq. ft.
- Floor Area:
  12x14 +
  20x31 +
  20x40 =
  1,588 sq. ft.
- Ceiling Area: *1,588* sq. ft.
- Windows
  - A: 12 x 7 = 84 sq. ft.
  - B: 9 x 2 = 18 sq. ft.
  - C: 20 x 2 = 40 sq. ft.

  Windows: *142* sq. ft.
- Glass Doors: 20 x 2 = *40* sq. ft.
- Solid Doors: *40* sq. ft. (R-3)

A: 3'0 x 4'0 DP low-e (U.31, SHGC.24)
B: 3'0 x 3'0 DP low-e (U.33, SHGC.26)
C: 5'0 x 4'0 DP low-e (U.32, SHGC.25)
D: 6'0 x 6'8 DP Sliding Glass Door with tint (U.47, SHGC.30)

RESCHECK FOR UA TRADEOFF

- www.energycodes.gov
- Software evaluates specific designs quickly
- Demonstrates SHGC compliance
- Allows trade-offs
  - Building envelope components
  - No trade-offs for better heating & cooling equipment efficiencies

Project Simple House

Energy Code:	**2015 IECC**
Location:	**Nashville, Tennessee**
Construction Type:	**Single-family**
Project Type:	**New Construction**
Conditioned Floor Area:	**1,588 ft2**
Glazing Area	**11%**
Climate Zone:	**4 (3729 HDD)**
Permit Date:	
Permit Number:	

Construction Site: Owner/Agent: Designer/Contractor:

Compliance: Passes using UA trade-off

Compliance: **0.9% Better Than Code** Maximum UA: **350** Your UA: **347** Maximum SHGC: **0.40** Your SHGC: **0.26**

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.

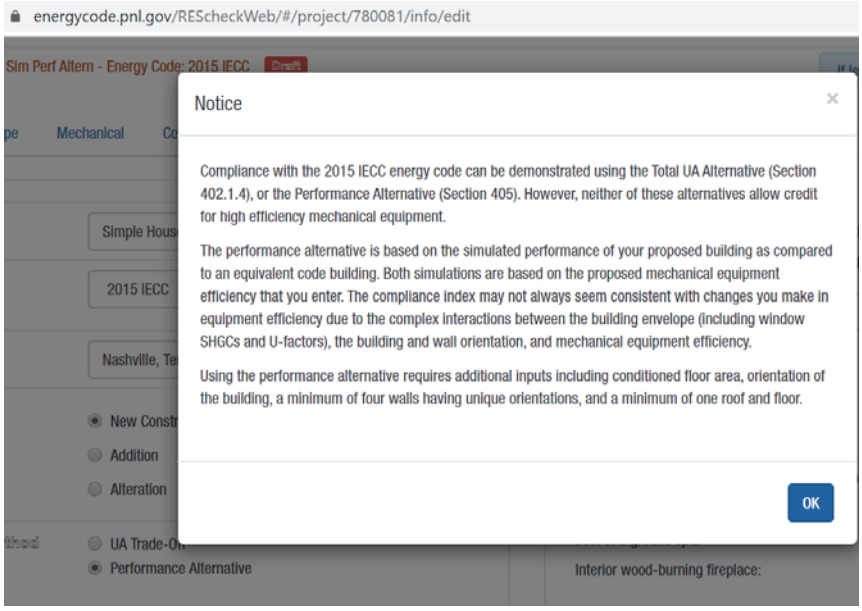
Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	U-Factor	UA
Ceiling: Flat Ceiling or Scissor Truss	1,588	49.0	0.0	0.026	41
Wall: Wood Frame, 16" o.c.	1,692	13.0	6.0	0.053	78
Front + Gar Door: Solid Door (under 50% glazing)	40			0.330	13
Door slider: Glass Door (over 50% glazing) SHGC: 0.30	40			0.470	19
WindowA: Vinyl Frame SHGC: 0.24	84			0.310	26
WindowB: Vinyl Frame SHGC: 0.26	18			0.330	6
WindowC: Vinyl Frame SHGC: 0.25	40			0.320	13
Floor: Slab-On-Grade (Unheated) Insulation depth: 2.0'	188		5.0	0.804	151

2015 IECC – Section 405

Simulated Performance Alternative

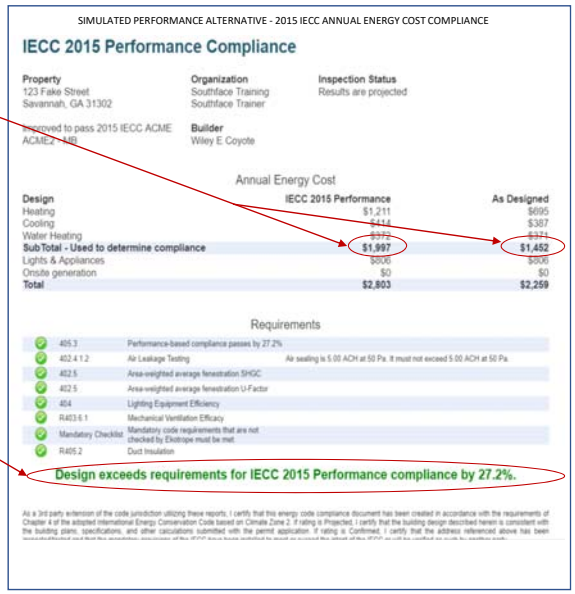
- Annual energy usage simulation demonstrates that the proposed building's energy costs are ≤ "standard code" building
- No credit for mechanical efficiencies
- Likely to involve a HERS rater ***www.resnet.us***
- Ekotrope, REMrate & Energy Gauge are acceptable
- "Crude" version in REScheck



2015 IECC – Section 405

Simulated Performance Alternative – Sample Report

- Compares total annual energy costs
  - Window U-factor and SHGC
  - Envelope and duct testing
  - Lighting, duct insulation
- Compares energy costs of actual home being built against 2015 IECC reference home's energy cost



SIMULATED PERFORMANCE ALTERNATIVE - 2015 IECC ANNUAL ENERGY COST COMPLIANCE

IECC 2015 Performance Compliance

Property	Organization	Inspection Status
123 Fake Street Savannah, GA 31302	Southface Training Southface Trainer	Results are projected

Approved to pass 2015 IECC ACME
ACME2-149

Builder
Wiley E Coyote

Annual Energy Cost

Design	IECC 2015 Performance	As Designed
Heating	$1,211	$695
Cooling	$414	$387
Water Heating	$372	$371
SubTotal - Used to determine compliance	**$1,997**	**$1,452**
Lights & Appliances	$806	$806
Onsite generation	$0	$0
Total	**$2,803**	**$2,259**

Requirements

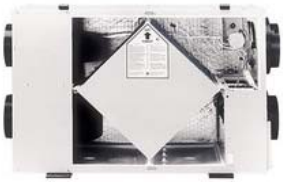
✓	405.3	Performance-based compliance passes by 27.2%	
✓	402.4.1.2	Air Leakage Testing	Air sealing is 5.00 ACH at 50 Pa. It must not exceed 5.00 ACH at 50 Pa.
✓	402.5	Area-weighted average fenestration SHGC	
✓	402.5	Area-weighted average fenestration U-Factor	
✓	404	Lighting Equipment Efficiency	
✓	R403.6.1	Mechanical Ventilation Efficacy	
✓	Mandatory Checklist	Mandatory code requirements that are not checked by Ekotrope must be met	
✓	R405.2	Duct Insulation	

Design exceeds requirements for IECC 2015 Performance compliance by 27.2%.

As a 3rd party extension of the code jurisdiction utilizing these reports, I certify that this energy code compliance document has been created in accordance with the requirements of Chapter 4 of the adopted International Energy Conservation Code based on Climate Zone 2. If rating is Projected, I certify that the building design described herein is consistent with the building plans, specifications, and other calculations submitted with the permit application. If rating is Confirmed, I certify that the address referenced above has been

The Energy Rating Index (ERI) path

The ERI may allow more options in materials choice, technologies and innovative strategies than the simulated performance path



- The new Energy Rating Index (ERI) path gives the most design flexibility (e.g., credit for mechanical equipment efficiency)
- It also credits items not covered by the code (e.g., appliance efficiencies)

How is the ERI determined?

- The ERI is a numerical integer value
- Lower numbers indicate lower energy usage
- The HERS Index is currently accepted for use as the ERI
- A HERS Index is generated from a HERS Rating using modeling software
- HERS stands for *Home Energy Rating System*

- The ERI path can be cost-effective & beneficial to builders
- Choosing the ERI can offer benefits compared to the prescriptive, UA trade-off and simulated performance approaches

HERS was developed by the Residential Energy Services Network (RESNET)

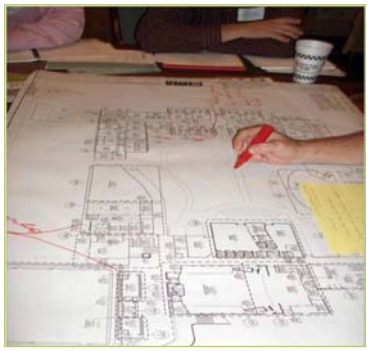
Determining the Energy Rating Index

1. Simulate two homes

- ***Rated*** Home – what will be built
- ***Reference*** Home – same home but exactly meets '06 code

2. Compare Annual Energy

- Space Heating & Cooling, Hot Water, Lighting and some Appliances
- Multiply by 100 (lower w/ renewables)



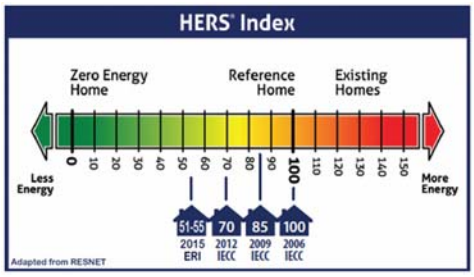
Index = 100 x $PE_{fraction}$ x $\frac{[\textit{Rated}\text{ Home's Htg + Clg + WtrH + L.A.}]}{[\textit{Refer}\text{. Home's Htg + Clg + WtrH + L.A.}]}$ **= 75**

40 30 30 50

70 20 30 80

HERS Index – What does it mean?

- HERS **Index** (lower is better)
- Rated home with Index of 100 = Reference home exactly meeting 2004/06 IECC
- Net Zero Energy Home = HERS Index of 0



Index = $PE_{fraction}$ x 100 x $\frac{[\text{Rated Home's Htg + Clg + WtrH + L.A.}]}{[\text{ Ref. Home's Htg + Clg + WtrH + L.A.}]}$ **= 75**

40 30 30 50

70 20 30 80

$PE_{fraction}$ is ratio of renewables to purchased energy

(e.g, a home that produces 20% of its annual energy would have a $PE_{fraction}$ of 0.8)

In this example, 0.8 x 75 = **60**

ERI Target Values


- The 2015/18 IECC sets a maximum ERI for each climate zone
- The ERI is not a "magic bullet" or "easy cakewalk"
- However, it opens more options and allows builders more credit for innovative strategies ("*the ERI shall consider all energy used in the residential building*")

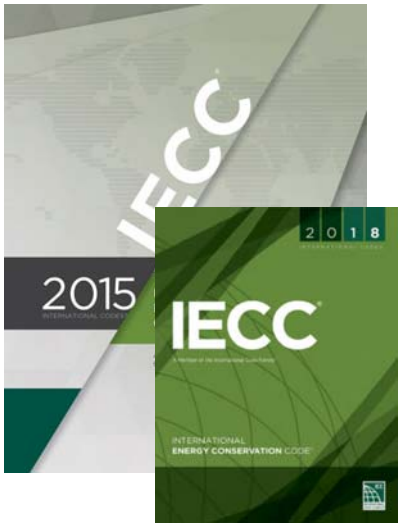
TABLE R406.4
MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX	ENERGY RATING INDEX[a]
1	~~52~~	57
2	~~52~~	57
3	~~51~~	57
4	~~54~~	62
5	~~55~~	61
6	~~54~~	61
7	~~53~~	58
8	~~53~~	58

The rated design must have an ERI less than or equal to the above table to comply with 2015/18 IECC

NOTE: The 2018 calculations were adjusted so the thresholds were amended!

The 2015/18 IECC: Overview



- Regardless of compliance path, must satisfy all the mandatory requirements of the 2015/18 IECC
- Like previous versions, the 15/18 IECC provide prescriptive and trade-off performance options
- The 2015 IECC introduced this new compliance option: the Energy Rating Index (ERI)

Benefits of choosing the ERI

Stringent prescriptive envelope requirements make the 2015 IECC prescriptive and tradeoff paths more difficult than previous codes!

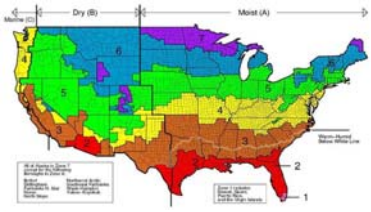
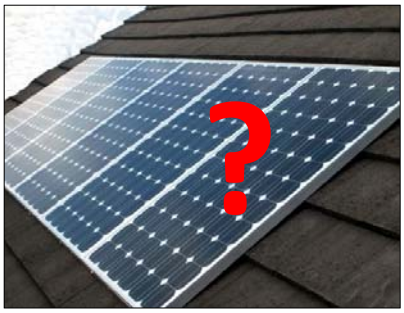


TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] 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	0.40	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

Benefits of choosing the ERI

The ERI may allow more options in materials choice, technologies and innovative strategies than the simulated performance path



Renewable energy is credited (with some constraints)

Better appliances are credited in ERI

High efficiency furnace (plastic flue pipe) is credited

Efficient lighting > 75 or 90% benefits the energy index

Which of these technologies are credited in the ERI path?

Check any of the following strategies that receive credit in the ERI pathway:

- ❑ 95% furnace (PVC flue pipe & combustion intake) in basement
- ❑ High efficiency mini split heat pump for bonus room
- ❑ The home features 95% LED lighting
- ❑ ENERGY STAR Washer, Dryer and Dishwasher supplied by builder
- ❑ Energy/Heat Recovery Ventilator provides fresh air for home
- ❑ Adaptive learning thermostat is used for HVAC control
- ❑ Minimum efficiency direct vent gas water heater in basement
- ❑ Solar powered clothes line is strung between house and garage

Explaining the Energy Rating Index

1. 2015/18 IECC targets

- **50's to Low 60's**

2. Who Can Do This?

- 3rd party – HERS Rater
- Approved software

3. Benefits

- Greater design flexibility
- High efficiency equipment & appliances credited

4. Backstops

- Envelope cannot be traded to be worse than 2009 IECC
- Must meet Mandatory Requirements (air sealing, duct insulation and sealing, duct and house testing, etc.)

TABLE R406.4
MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX	ENERGY RATING INDEX[a]
1	52	57
2	52	57
3	51	57
4	54	62
5	55	61
6	54	61
7	53	58
8	53	58

The rated design must have an ERI ≤ to the above table to comply with 2015 / 18 IECC

NOTE: Some states have amended these numbers!

Pros and Cons?

1. Concerns

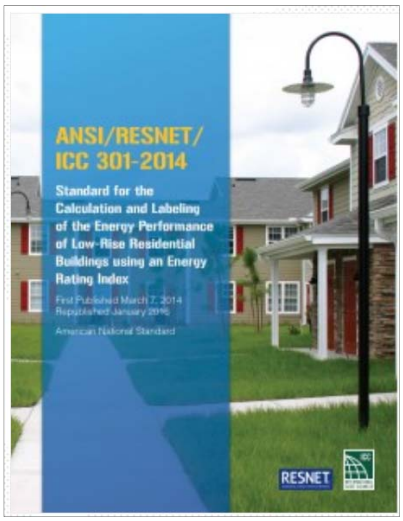
- **Conflict of interest** because rater works for the builder
- **Size Bias** against small houses
  - **Code** – because it uses the antiquated ACH50 term for air tightness (which favors larger, high volume homes)
  - **ERI** –small homes have less envelope load and are hindered in trade-offs
- **Credit for unregulated items** not in the Prescriptive code
  "Should the dishwasher be allowed to trade down insulation R-values?"

2. Benefits

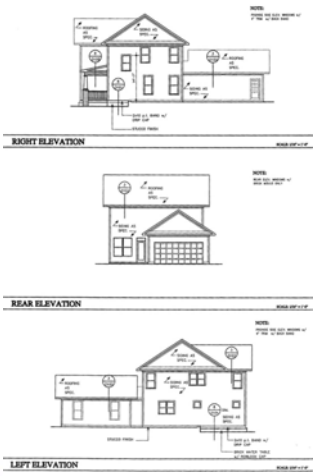
- **Professional** (HERS Rater) who understands energy efficiency is now involved and energy code isn't ignored
- **Marketing** – Builders can market their index and guarantee performance

Approved modeling software

- Software meets requirements of the ANSI/RESNET/ICC 301 Standard
- Software must be capable of generating reports as described in R406.6.2



ERI: Rated home vs. reference



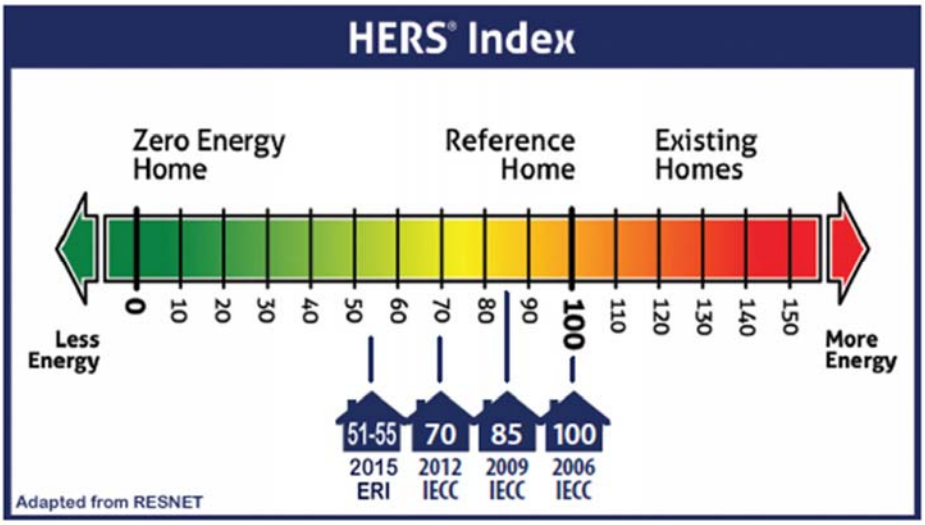
The software compares the projected energy use of the ***rated*** home against a ***reference*** home that is:

- The same shape and size, building structure, and # people (bedrooms)
- Constructed to meet the 2006 IECC

The ERI rates the house, not the behavior of people living in the house

…"the ERI shall consider all energy used in the residential building"

How does the ERI compare to previous codes versions?



A word about renewables…

- The 2015 IECC does not directly address renewables in the ERI pathway
- There are differing opinions on how renewables should be handled with the ERI
- States handle this differently
- 2018 IECC allows but penalizes renewables with a harder 2015 prescriptive backstop

"The ERI shall consider all energy used in the *residential building*."

- TX – no solar credit
- VT, MA (2012) – cap
- AL, IL, MD, NJ, NV, UT, WA – as written in 2015 IECC
- FL, 2018 IECC – harder backstop for renewables

ERI mandatory requirements

- Home must meet mandatory requirements of sections R401.2 and R403.5.3
- The building thermal envelope shall be greater than or equal to levels of efficiency of the 2009 IECC
- Software & rating procedure must comply with specifications in section R406
- Compliance must be verified by approved 3rd party (e.g. HERS Rater)

ERI mandatory requirement
Backstop is 2009 IECC Envelope

TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

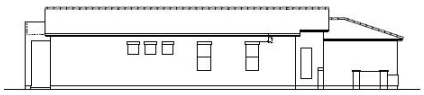
CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	1.2	0.75	0.30	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13+5[h]	15/19	30[g]	15/19	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	38[g]	15/19	10, 4 ft	10/13

2009 IECC insulation and window efficiencies table

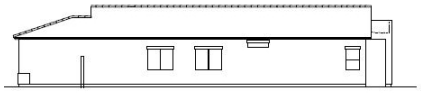
HERS Rating demonstration

FRONT ELEVATION

REAR ELEVATION



LEFT ELEVATION

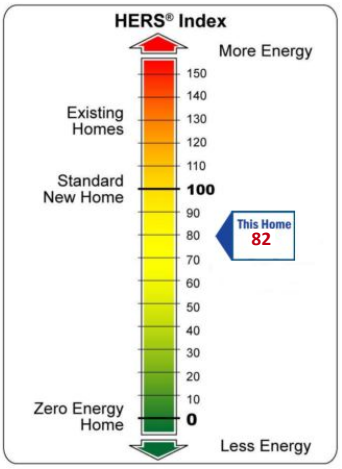


RIGHT ELEVATION

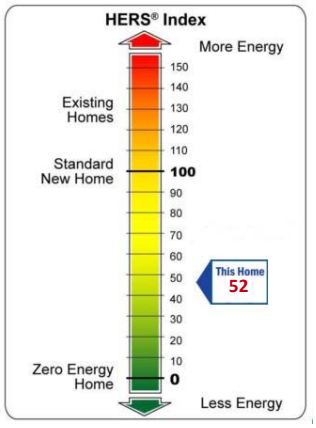
HERS Rating demonstration

Example home – CZ2:

- 1400 ft^2, single story
- Slab foundation
- Vented attic
- 1 HVAC system
- Building envelope meets 2009 IECC prescriptive requirements
- Mechanicals and appliances typical for area

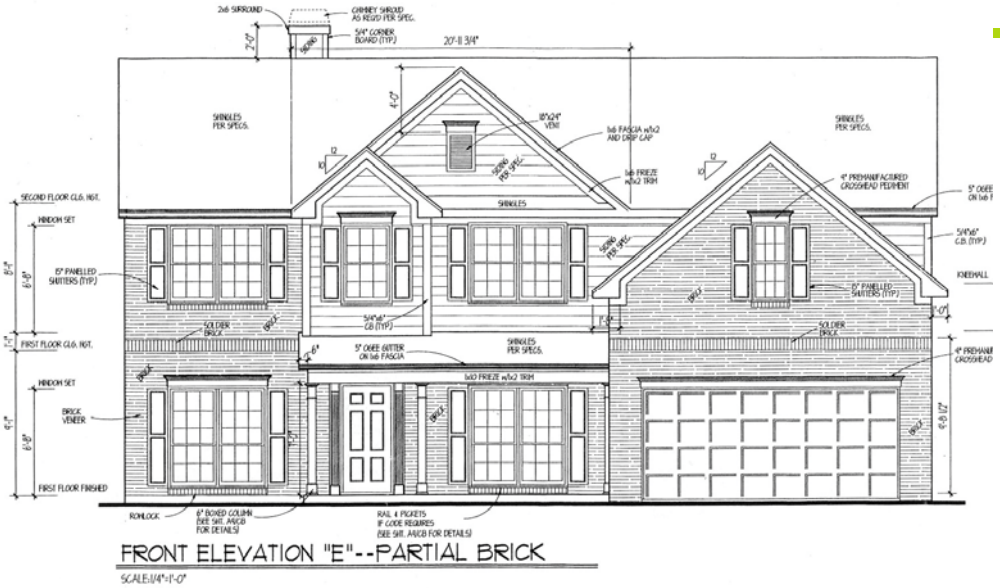


HERS Rating demonstration

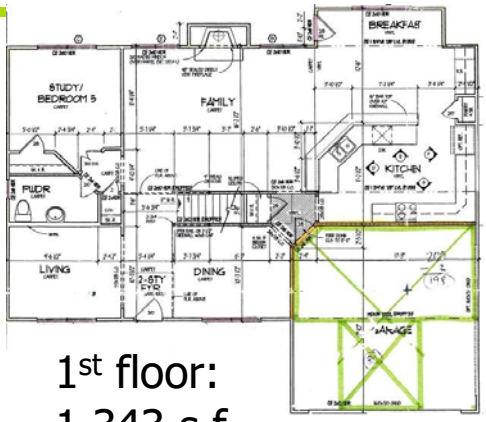


- Radiant barrier roof decking
- Install more efficient appliances (refrigerator, dishwasher, laundry)
- 100% high efficacy lighting
- High efficiency HVAC & water heater

“Acme” base case 2816 s.f home



Acme Home



1st floor:
1,343 s.f.

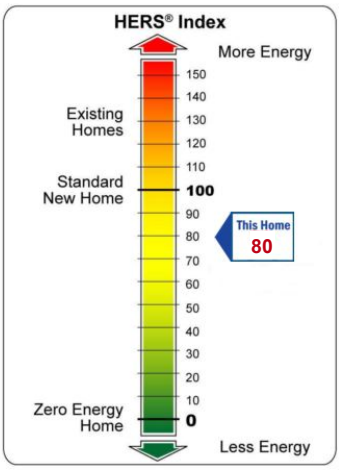
2nd floor:
1,473 s.f.

Acme Base - 2816 s.f. home

- Two mechanical systems – both in the vented attic
- 75% of 1st floor ducts inside; all others plus 2nd floor ducts in attic
- 80% furnaces, 14 SEER A/C's, no mechanical ventilation, 50 gal gas DHW
- Basic 2009 energy code compliant R-values (assume Grade III)
  - R-30 flat ceiling, R-19 vault
  - R-13 + OSB walls
  - R-19 floor over garage; no slab insulation

- Typical DP low-e windows: U-0.35 SHGC-0.30; poor orientation
- Duct leakage is 12% Total; 8% To Outside
- Envelope Leakage is 7 ACH_{50}, 0.45 ELR_{50}, 3009 cfm_{50}
- Elec rate 12.5¢/kWh + $10 base fee; Gas rate 75¢/therm + $20 base fee

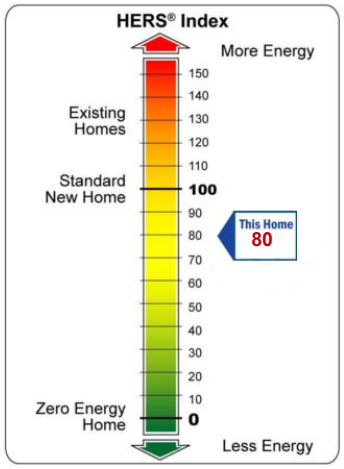
HERS Rating demonstration



- Results for Atlanta
- Index drops to **71** when 2012/15 IECC prescriptive envelope values are entered
- Index drops to **67** when 2012 IECC prescriptive 75% efficient lighting values are entered

- Index drops to **mid-50's** when condensing furnace, 16 SEER AC, and more efficient appliances are entered
- House load drops (4 tons to 3 tons)

ERI–Impact of Renewables on Index



- Results for Atlanta

- **80** => 70 with 2 kW
- => 56 with 5 kW
- => 32 with 10 kW

- **57** => 49 with 2 kW
- => 36 with 5 kW
- => 13 with 10 kW

Compliance Options

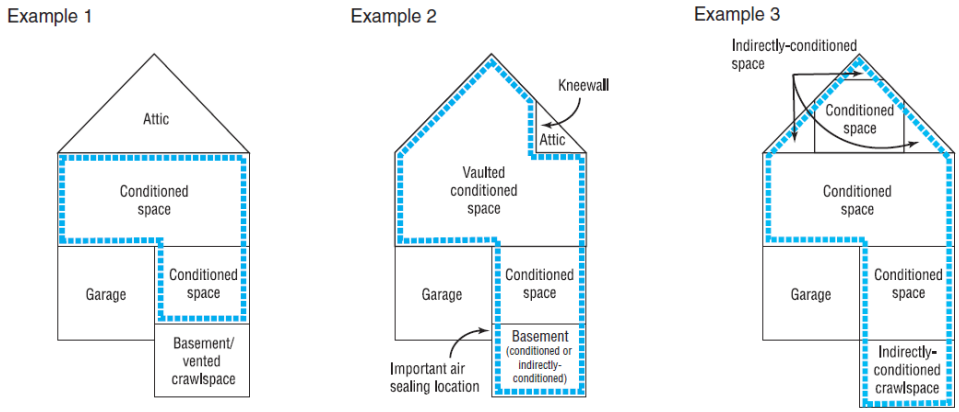
2015/18 IECC compliance options

TABLE R402.1.4
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.084	0.165	0.064	0.360	0.477
3	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	0.55	0.026	0.045	0.057	0.028	0.050	0.055

- Prescriptive (tables for R-, U-values)
- Total UA Alternative (REScheck)
- 405 - Simulated Performance Alternative (computer simulation using the *standard reference* and *proposed design*)
- 405 - Energy Rating Index ("HERS Rating")

Building Thermal Envelope



- Although these three homes look identical from the outside, each has defined the building thermal envelope differently

Question: Summarize Results

1. What is the basic conduction heat flow equation?
2. How does a load calculation differ from an hourly simulation?
3. What is a key difference between the IECC Simulated Performance Alternative compliance option and the Energy Rating Index?

Thoughts / Questions?

- June 4: It All Begins with Building Science
- June 11: Cracking the Building Energy Code
- June 18: Demystifying Energy Modeling
- June 25: Healthy Homes Matter - Understanding IAQ & Ventilation
- July 2: An Industry That Puts It All Together: The World of HERS Raters

Thank you!
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- **July 16th -** HVAC Load Calcs
- **Aug 20th -** High Performance Design

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