Energy Myths and Energy Efficiency of Various Wall Systems

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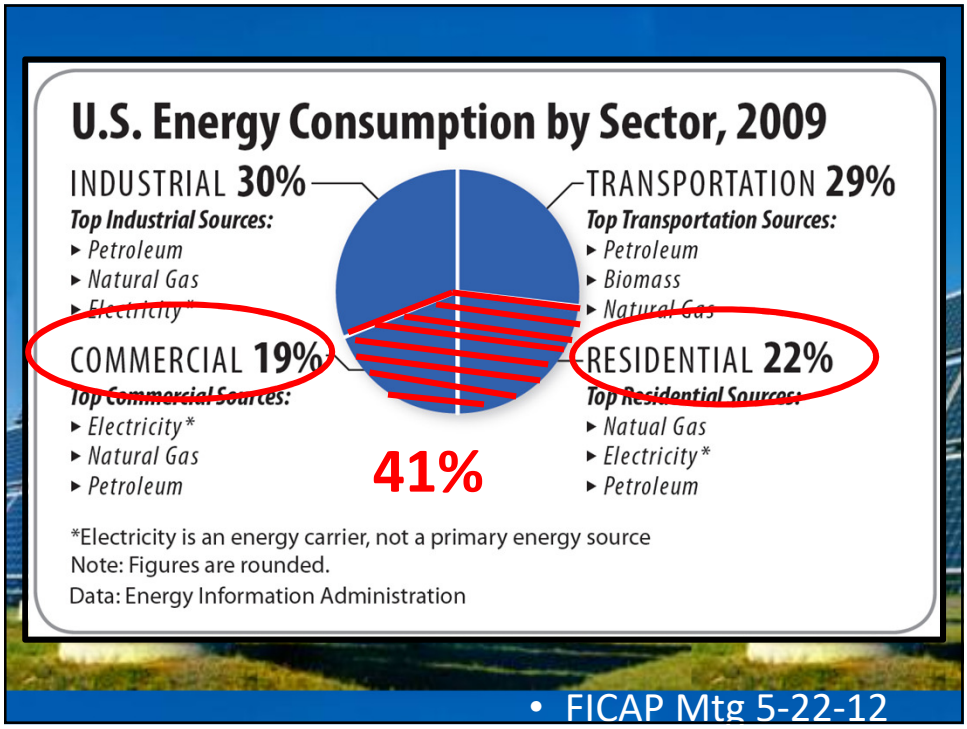
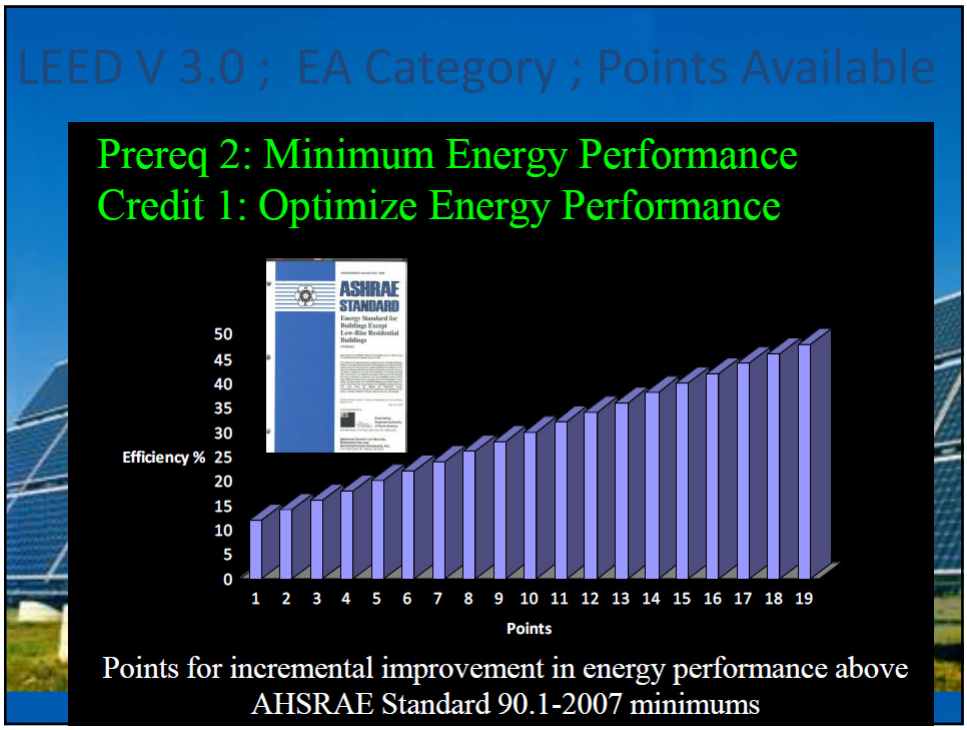
40%- of Exterior Residential Walls

VS

60%+ of Exterior Residential Walls


U.S. Energy Consumption by Sector, 2009
INDUSTRIAL 30%
Top Industrial Sources:
▸ Petroleum
▸ Natural Gas
▸ Electricity*
TRANSPORTATION 29%
Top Transportation Sources:
▸ Petroleum
▸ Biomass
▸ Natural Gas
COMMERCIAL 19%
Top Commercial Sources:
▸ Electricity*
▸ Natural Gas
▸ Petroleum
RESIDENTIAL 22%
Top Residential Sources:
▸ Natual Gas
▸ Electricity*
▸ Petroleum
41%
*Electricity is an energy carrier, not a primary energy source
Note: Figures are rounded.
Data: Energy Information Administration
• FICAP Mtg 5-22-12


LEED V 3.0 ; EA Category ; Points Available
Prereq 2: Minimum Energy Performance
Credit 1: Optimize Energy Performance
ASHRAE STANDARD
Efficiency %
0
5
10
15
20
25
30
35
40
45
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Points
Points for incremental improvement in energy performance above AHSRAE Standard 90.1-2007 minimums

Historic Problem

"R" Value

vs

"U" Value

vs

Thermal Mass

vs

Actual Energy Performance

Historic Problem

"R" Value

vs

"U" Value

vs

Thermal Mass

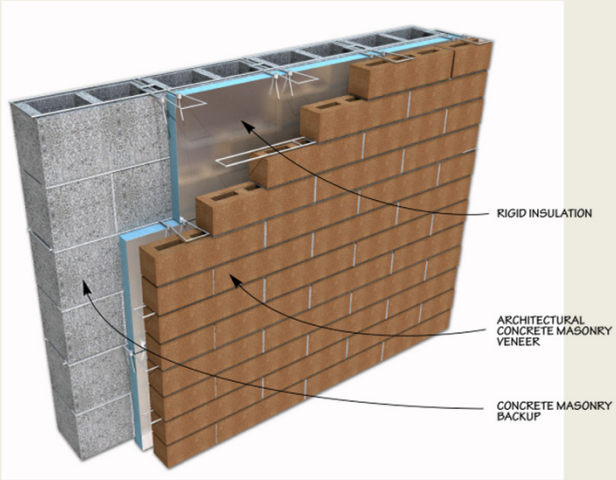
vs

Actual Energy Performance

Another Historic Problem

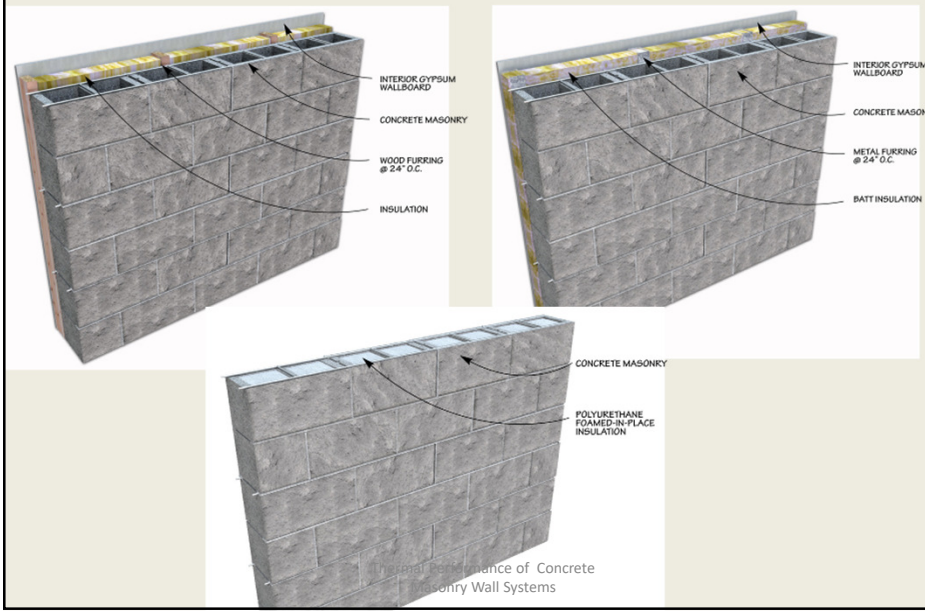
Continuous
VS
Integral
Insulation

Masonry Walls: Continuous Insulation



Thermal Performance of Concrete Masonry Wall Systems

Masonry Walls: NOT Continuous



Thermal Performance of Concrete Masonry Wall Systems

Yet Another Historic Problem

Prescriptive
VS
Performance

Prescriptive	Performance
• The simple way to figure out what to do • Required values are spelled out in black and white • Conservative because it covers a broad range of cases • Valuable in marketing because it is simple, visual and general	• More complicated to use but more accurate • The results are specific as opposed to general. This makes the results harder to use in describing general traits. • Relies on sophisticated computer programs and requires more input up front.

• FICAP Mtg 5-22-12

Mandatory Requirements in the Commercial 2014 FBC Energy

Mandatory Section Requirements

C402.4 – Air Leakage
C403.2 – Provisions Applicable to All Mech Sys
C404 – Service Water Heating
C405 –Elect Power and Lighting Sys

Conversion of R to U

(U=1/R)

(R=1/U)

Layers → • $R_{TOTAL} = R_1 + R_2 + R_3 + ...$

Whole Wall

Includes Air Films → • $U = 1/R_{TOTAL}$

Thermal Performance of Concrete Masonry Wall Systems

TABLE C402.2

OPAQUE THERMAL ENVELOPE REQUIREMENTS[a] *(By Added Continous Insulation R Value)*

CLIMATE ZONE	1		2	
	All Other	Group R	All Other	Group R
Mass[c]	R-5.7ci[c]	R-5.7ci[c]	R-5.7ci[c]	R-7.6ci
Metal building	R-13+ R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20

5th Edition Florida Building Code Masonry Changes

TABLE C402.1.2
OPAQUE THERMAL ENVELOPE REQUIREMENTS[a] *(By Through Wall U Value)*

CLIMATE ZONE	1		2	
	All Other	Group R	All Other	Group R
Mass	U-0.142	U-0.142	U-0.142	U-0.123
Metal building	U-0.079	U-0.079	U-0.079	U-0.079
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064
Wood framed and other	U-0.064	U-0.064	U-0.064	U-0.064

5th Edition Florida Building Code Masonry Changes

[redacted]

Per 5th Ed. FBC Energy

CLIMATE ZONE	1		2	
	All Other	Group R	All Other	Group R
Mass[c]	R-5.7ci[c]	R-5.7ci[c]	R-5.7ci[c]	R-7.6ci
Metal building	R-13+ R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20

Exterior Air Film	R=.25
8" CMU	R=1.3
1 ½ " Reflective Air Space	R=5.6
Int Gypboard	R=.45
Interior Air Film	R=.68
Tot R Value	**R=8.28**

[redacted]

CLIMATE ZONE	1		2	
	All Other	Group R	All Other	Group R
Mass	U-0.142	U-0.142	U-0.142	U-0.123
Metal building	U-0.079	U-0.079	U-0.079	U-0.079
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064
Wood framed and other	U-0.064	U-0.064	U-0.064	U-0.064

[redacted]

FBC 5th Ed. – Chapter 4
COMMERCIAL ENERGY EFFICIENCY

C402.1.2 *U*-factor alternative. An assembly with a *U*-factor, *C*-factor, or *F*-factor equal or less than that specified in Table C402.1.2 shall be permitted as an alternative to the *R*-value in Table C402.2.

5th Edition Florida Building Code

Where the Confusion Comes In

C402.2.3 Thermal resistance of above-grade walls. The minimum thermal resistance (*R*-value) of the insulating materials installed in the wall cavity between the framing members and continuously on the walls shall be as specified in Table C402.2, based on framing type and construction materials used in the wall assembly.

The *R*-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with Table C402.2.

5th Edition Florida Building Code Masonry Changes

FBC 5th Ed. – Chapter 4
COMMERCIAL ENERGY EFFICIENCY

C402.1.2 *U*-factor alternative. An assembly with a *U*-factor, *C*-factor, or *F*-factor equal or less than that specified in Table C402.1.2 shall be permitted as an alternative to the *R*-value in Table C402.2.

5th Edition Florida Building Code

Historic Problem

"R" Value

vs

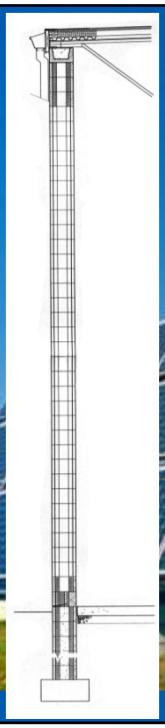
"U" Value

vs

Thermal Mass

vs

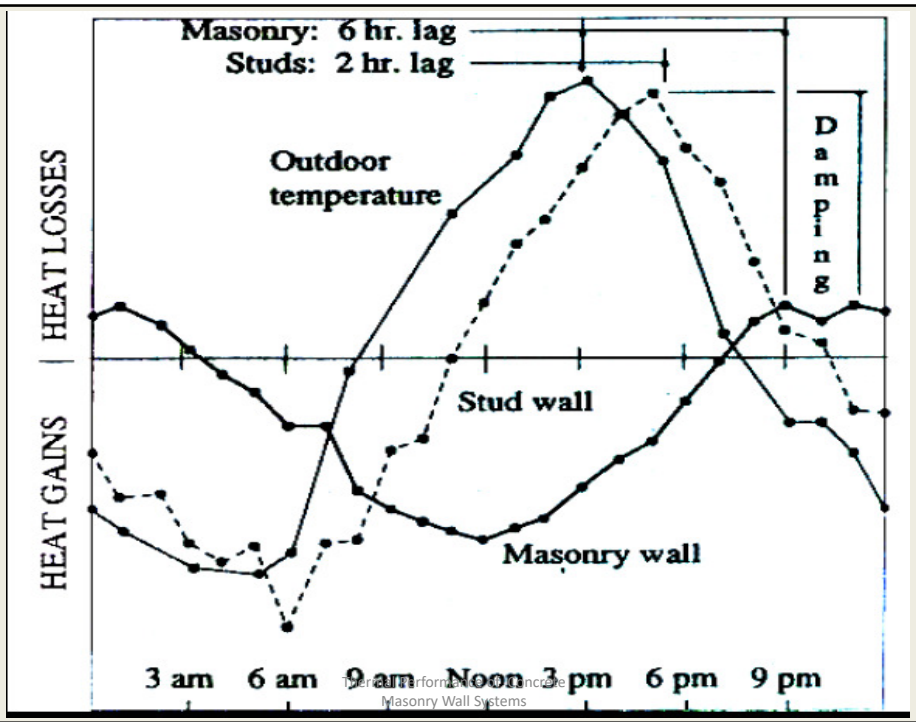
Actual Energy Performance



THERMAL MASS: Materials with mass heat capacity and surface area are capable of affecting building loads by storing and releasing heat as the interior and/or exterior temperature and radiant conditions fluctuate.

Thermal mass tends to decrease both heating and cooling loads in a given building.

PHOENIX



Thermal Performance Advantage
Masonry Wall Systems

TABLE C402.1.2
OPAQUE THERMAL ENVELOPE REQUIREMENTS[a]

CLIMATE ZONE	1		2		
	All Other	Group R	All Other	Group R	R Value
Mass	U-0.142	U-0.142	U-0.142	U-0.123	R-8.13
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	R-12.66
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	R-15.62
Wood framed and other	U-0.064	U-0.064	U-0.064	U-0.064	R-15.62

All of these walls are considered by the code to be equivalent in their energy efficiency

The difference is MASS

5th Edition Florida Building Code Masonry Changes

Options for Reducing 'U' Values of Concrete Masonry Walls

Due to it's mass factor, walls constructed of concrete masonry can meet the requirements of the Florida Energy Code without having to install a Continuous Insulation system to the exterior.

Opaque Thermal Envelop Assembly Requirements (Values from Energy Conservation, Table C402.1)	U Values
Through Wall 'U' Value Prescriptive Requirements (All of FL other than Dade, does not include Residential)	0.142
Plain Concrete Block Wall	0.770
Foamed Cells with Exposed Interior	0.206
Interior ¾" Reflective Insulation	0.174
Interior 1½" Reflective Insulation	0.121
Interior ¾" Polyisocyanurate Board + ¾" Reflective Air Space	0.101

This advantage enables the stucco to be applied directly to the block, thus avoiding the additional expense and maintenance of a metal plaster base to the outside of the building.

Historic Problem

"R" Value

vs

"U" Value

vs

Thermal Mass

vs

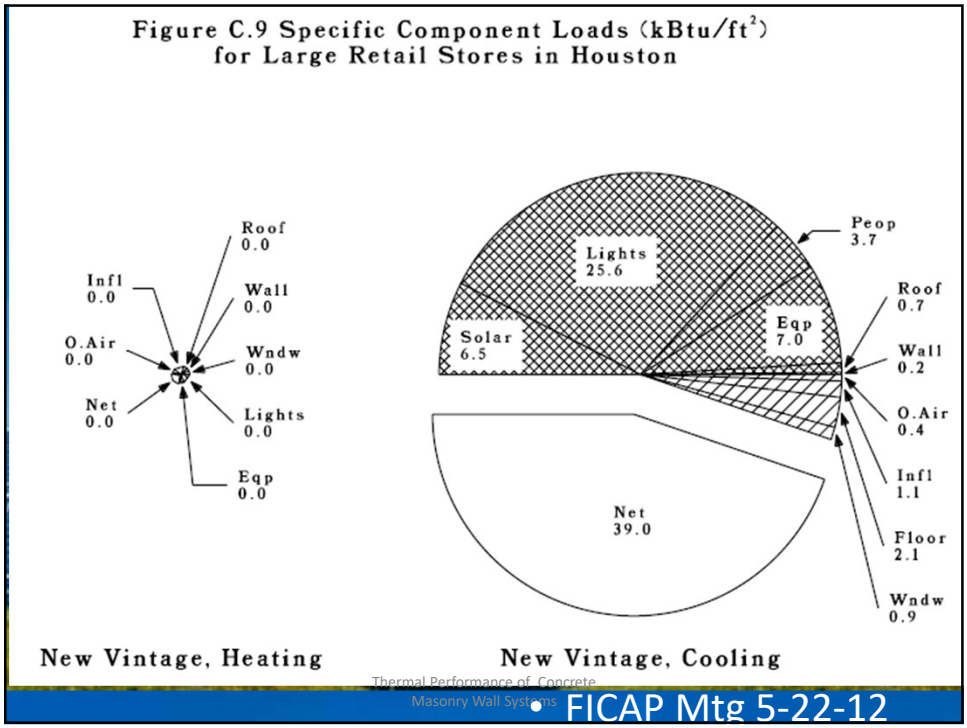
Actual Energy Performance

- FICAP Mtg 5-22-12

COMMERCIAL HEATING AND COOLING LOADS COMPONENT ANALYSIS

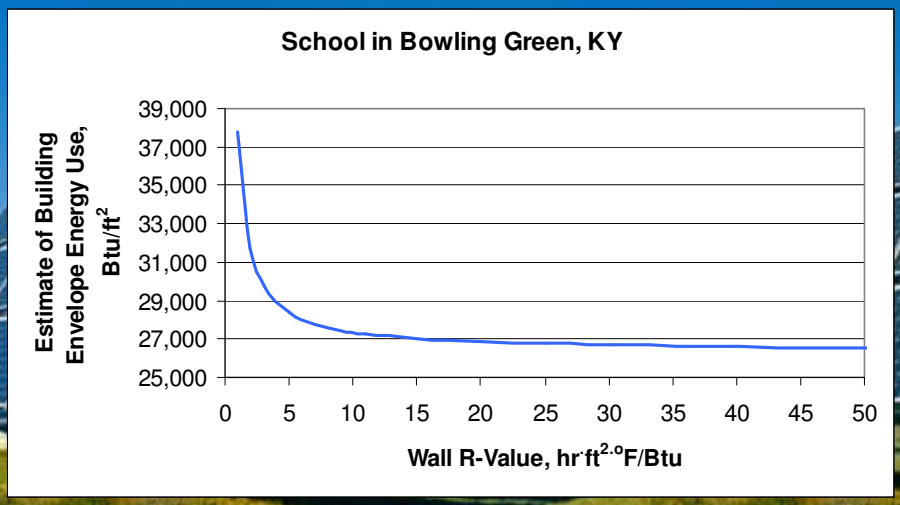
Building Technologies Department
Environmental Energy Technologies Division
Lawrence Berkeley National Laboratory
University of California
Berkeley, CA 94720

- FICAP Mtg 5-22-12



Diminishing Returns

School in Bowling Green Kentucky



Diminishing Returns

School in Bowling Green Kentucky

- Doubling insulation R-value from R7 to R14 drops building envelope energy use by 2.5%
- After R12 do not recover additional cost of insulation through energy savings during the lifetime of the building

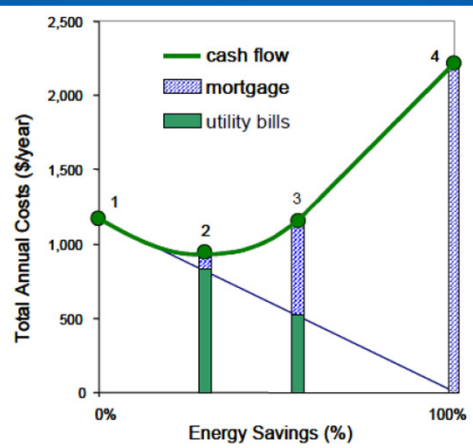


Figure 2.4 – Cost to reduce energy consumption from a base case (Christensen 2004). From a base case (point 1) there are initially cost-effective methods to reduce energy consumption, but those energy saving methods eventually become more costly (points 2, 3, and 4).

- FICAP Mtg 5-22-12

- FICAP Mtg 5-22-12

Carroll's BUILDING MATERIALS

BuildBlock INSULATING CONCRETE FORMS

Average Utility Cost Per Sq. Ft.	
Concrete Block Home	.10¢ to .13¢ per month
Wood Frame Home*	.08¢ to .12¢ per month
BuildBlock ICF Home	.03¢ to .04¢ per month

Claims from $1440 to $2400 Saving / yr over CMU construction

July 16th, 2014

Residential Wall Type Energy Impact Analysis

(Phase I)

Masonry Association of Florida
NCMA Foundation
Pacific NW National Laboratories

Who Are PNNL?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U.S. DEPARTMENT OF ENERGY
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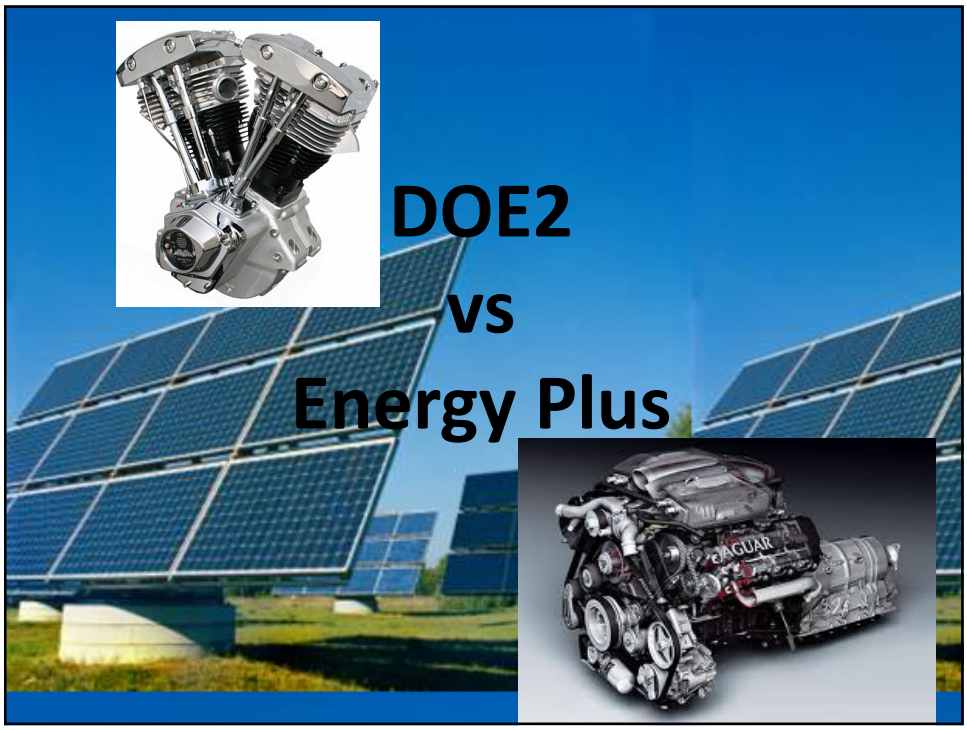
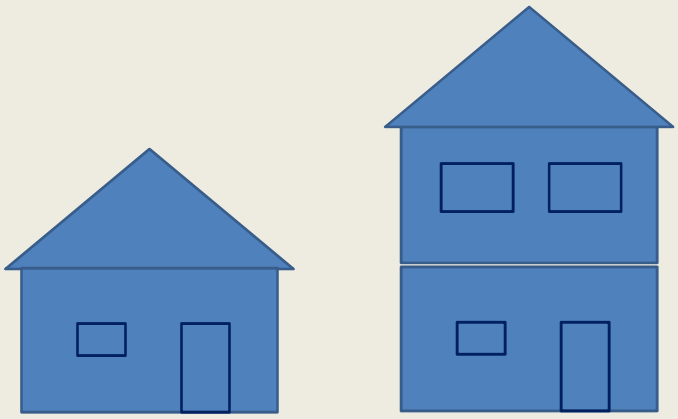

DOE2
vs
Energy Plus
JAGUAR

Project Goals

- Determine the difference in energy usage due **exclusively** to the exterior wall properties in residential structures.
- Evaluate both CMU and competing systems in one and two story structures across all US climate zones.

39

General Concept For PNNL Research



One and Two Story Homes Based on Standard Reference Design Criteria of Both the IECC and the FBC

Wall Combinations

Walls Designed from:

- **CMU;**
- **Wood and;**
- **ICF**

Building Parameters - National

- Building Types
  - 1 Story, 2000 square feet, slab on grade
  - 2 Story, 2200 square feet, crawl space
- Rectangular buildings
- Fenestration – 15% of floor area, equally distributed among cardinal directions
- Natural Gas Furnace, split system cooling with DC coil, natural gas water heat
- DOE Parameters for IECC analysis with 2012 IECC parameters

42

Building Parameters - Florida

- Building Types
  - 1 Story, 2000 square feet, slab on grade
  - 2 Story, 2200 square feet, slab on grade
- Rectangular buildings
- Fenestration – 15% of floor area, equally distributed among cardinal directions
- Electric heat pump for heating/cooling and electric water heater
- FSEC prototypes for 2010 Florida Energy Code (2009 IECC basis)

43

CMU Wall Variables

- **Types of CMU -** Standard Web or Reduced Web (ASTM C90-11b)
- **Unit Weights -** 85, 115 and 135
- **Grout Spacing -** Solid, 24, 48, 96 and no grout
- **Filled Cell Insulation -** Foam Fill or Empty
- **Insulation Location -** Interior or Exterior
- **Insulation Levels –** Zero to R24

Wood Wall Variables

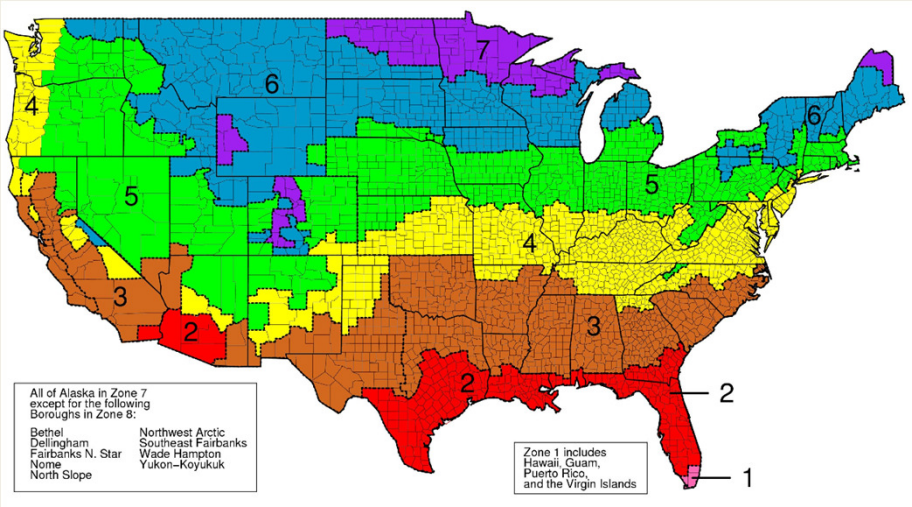
- **Stud Spacing -** Standard at 16” oc
- **Wall Stud Thickness -** 3 ½” or 5 ½”
- **Bat Insulation -** R13 (3 ½” Stud) or R19 (5 ½” Stud)
- **Board Insulation –** Zero to R7
- **Total Insulation Range –** R13 to R26
- **Exterior Finish –** Stucco on Lath

ICF Wall Variables

- **Core Width –** 4” or 6”
- **Concrete Density –** 120 pcf or 140 pcf
- **Insulation (Split) –** R16 to R24

Location	State	Climate Zone	Moisture Regime
Miami	FL	1A	Moist
Phoenix	AZ	2B	Dry
Houston	TX	2A	Moist
El Paso	TX	3B	Dry
San Francisco	CA	3C	Marine
Memphis	TN	3A	Moist
Albuquerque	NM	4B	Dry
Salem	OR	4C	Marine
Baltimore	MD	4A	Moist
Boise	ID	5B	Dry
Chicago	IL	5A	Moist
Helena	MT	6B	Dry
Burlington	VT	6A	Moist
Duluth	MN	7	---
Fairbanks	AK	8	----

Florida Climate Regions – Miami, Orlando, Jacksonville



Total Project Scope

Wall Type	Wall Combos	One or Two Sty	X 18 Climate Zones	Number of Runs
3 Web CMU	314	X 2	X 18	11,304
2 Web CMU	273	X 2	X 18	9828
ICF	12	X 2	X 18	432
Wood Frame	8	X 2	X 18	288
TOTAL	**607**	**X 2**	**X 18**	**21,852**

49

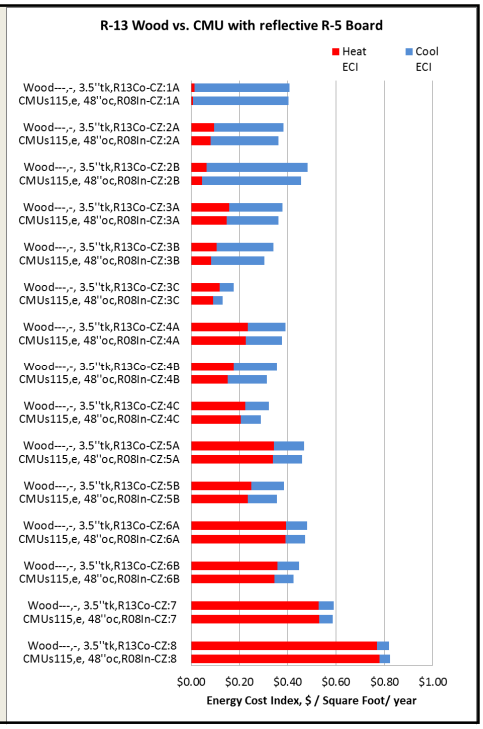
Results Summary

- EUI – Energy Use Intensity (Btu per square foot per year)
- **ECI – Energy Cost Index ($ per square foot per year)**

50

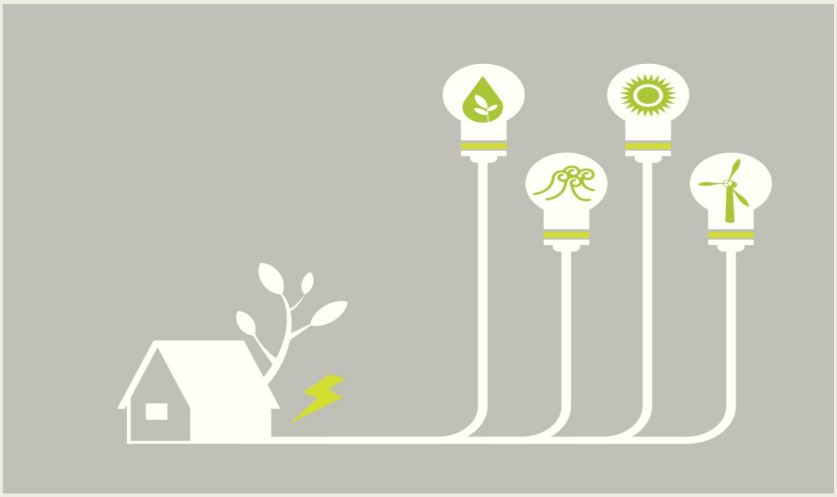
National – R13 Wood vs. R7.8 CMU

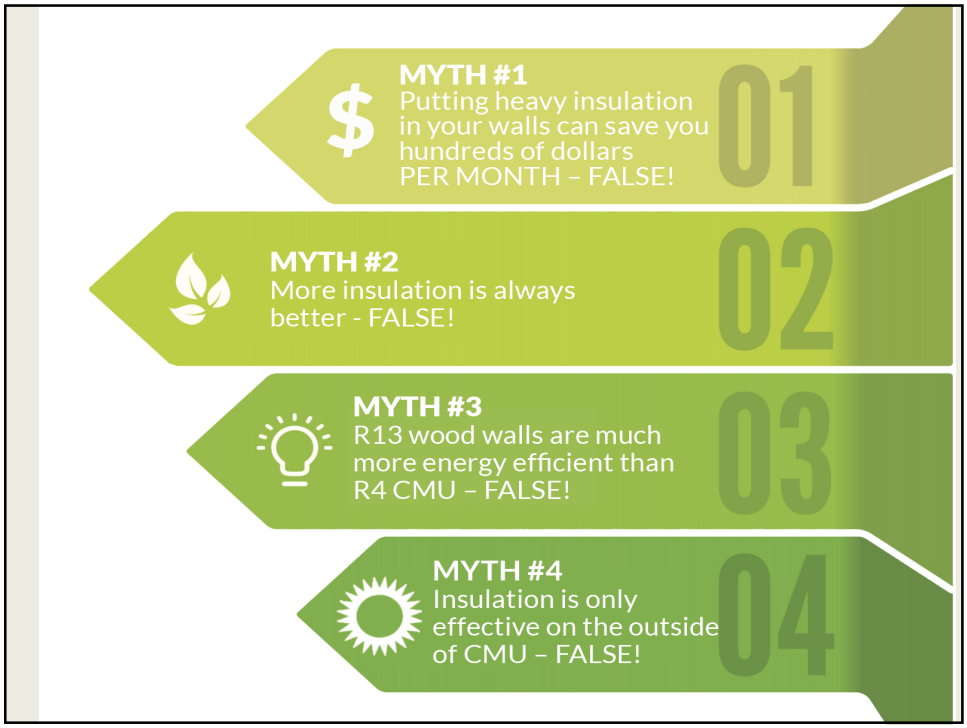
Masonry performers better in 7 of 8 climate zones and approximately equals R13 wood in CZ:8 (Fairbanks)

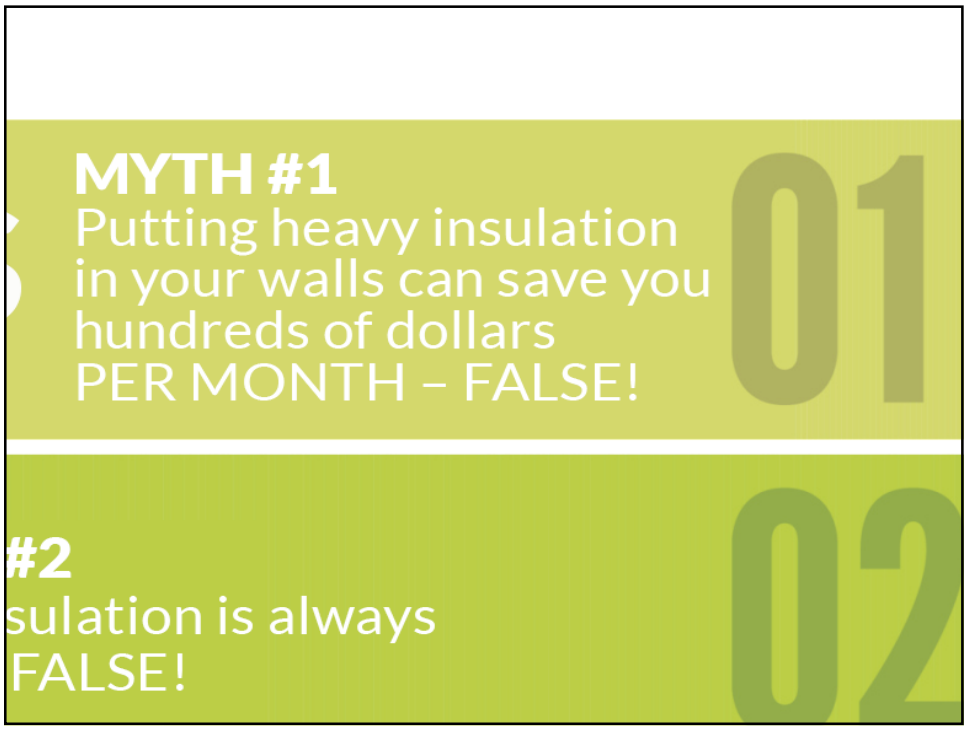


FLORIDA ENERGY RESEARCH REPORT

Initial Florida Report on Results of PNNL Residential Energy Study




MYTH #1
Putting heavy insulation in your walls can save you hundreds of dollars PER MONTH – FALSE!
01
MYTH #2
More insulation is always better - FALSE!
02
MYTH #3
R13 wood walls are much more energy efficient than R4 CMU – FALSE!
03
MYTH #4
Insulation is only effective on the outside of CMU – FALSE!
04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July 16th, 2014

Table 1: Comparison of Energy Savings of the Least and Most Insulated Walls in Florida

Total Energy $ Savings per Year Over Standard CMU w/R4 Added Insulation (2000 sf Single Story Home)

Wall#	Wall Disc	Overall R Value	$ Savings in Miami	$ Savings in Orlando	$ Savings in Jax	Cost of Energy Upgrade	Payback Period[6] for Mia
1	CMU R4	5.8	0	0	0	0	0
2	CMU R7	8.3	$38	$30	$36	$437[8]	11.5 yrs
3	ICF R20	21.7	$101	$79	$96	$4,207[5]	41.5 yrs

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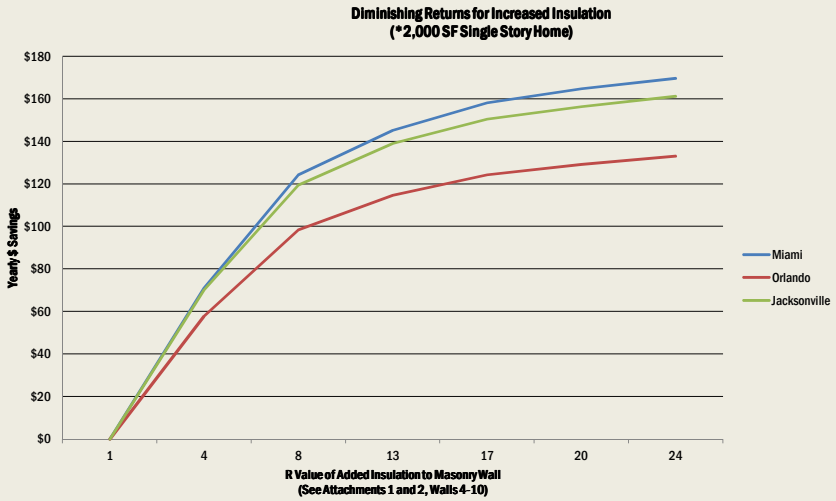
Figure 1 – Diminishing Returns of Added Insulation to Mass CMU Walls



etter - FALSE!

MYTH #3
R13 wood walls are much more energy efficient than R4 CMU – FALSE!

MYTH #4
Insulation is only effective on the outside

Table 2 - Energy Differences Between R4 CMU and R13 Wood Walls

Total Energy $ Savings per Year Over Standard CMU w/R4 Added Insulation					
Wall#	Wall Disc	Overall R Value	Miami	Orlando	Jax
11	CMU R4	5.8	0	0	0
12	Wood R13	10.9	$46	$15	$18

MYTH #4

Insulation is only effective on the outside of CMU – FALSE!

04

Table 3 - Comparison of Energy Savings of Interior vs. Exterior Insulation (FL CMU Walls)

Total Energy Savings per Year of Exterior Insulation over Interior Insulation							
Wall #	Wall Disc	Overall R Value	Mia	Orl	Jax	Cost of Exterior Insulation[1]	Payback Period[6] for Jax
13	CMU Int Insul	10	0	0	0	0	0
14	CMU Ext Insul	10	$14	$17	$22	$3366	153 yrs

Phase II
(Currently Contracted)

- Include Steel Frame
- Enhanced Documentation
- Cost Effectiveness Spreadsheet
- Heating System Selection
- Enhanced Spreadsheet Including:
  - Interpolation Between Analyzed Results
  - Analysis Increased from 5 to 10 walls

PNNL and Florida Report Available at www.floridamasonry.com

QUESTIONS?