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FLORIDA ENERGY RESEARCH REPORT

Florida Report on Results of PNNL Residential Energy Study

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Executive Summary

The Pacific Northwest National Laboratory (PNNL) Research results reviewed in this brief Florida report and the more detailed PNNL report are ground breaking – but not astounding. The masonry industry would certainly have preferred it showed wild increases in the value of thermal mass across all climate zones. However, it did confirm the value of mass that researchers have verified over the past 40 years on energy use in residential structures. This is, in essence, a very good thing as it also means the research over the past 40 years validates this recent research. Combined with the technical force of PNNL; the proven validity of Energy Plus™ software; and the carefully documented research development, there is little room for doubt or dissension. In other words the results are rock solid – and favorable to high mass wall systems.

The results are groundbreaking in the breadth and scope of the walls compared - 607 different combinations of CMU, wood and ICF. Almost every conceivable arrangement of standard building products compared "apples to apples" across every climate zone in the US. It leaves nowhere to hide.

Additionally, the research is leading edge in that it moves us past discussions of "R" value to the ability to see the actual kWhs (and thus $$) differences between walls with varying mass, insulation levels and insulation arrangements. It brings all discussions on insulation levels into clear monetary focus, putting it in the correct perspective. Quadrupling the insulation in your walls sounds great until you find out that it only saves you a mere $100 a year and will never give you payback for the first cost of the higher R value!

Our Florida takeaways covered in this limited report are:

1. Super high R value wall systems don't pay for themselves anywhere in the Florida climate. The maximum dollar savings that can be achieved by changing the insulation of the exterior walls in a 2000 sf one story home is roughly $100 per year. That's it.
2. As you continue to add insulation to a mass wall in Florida your returns start to diminish rapidly. We always knew this was generally true – but we now know EXACTLY how it is true.
3. The energy efficiency of CMU with R4 insulation and wood walls with R13 bat insulation is neck and neck across Florida. Wood edges out CMU in Miami at $46/year but this lead reduces to $15/year in Orlando. We were surprised that mass did not perform better in Miami but elated at how close CMU came to wood in Jacksonville - $18/year difference – nearly a dead heat! When you factor in the moisture/mold degradation of wood's batt insulation over time we are back to what we always knew – CMU with a minimum of insulation is very energy efficient everywhere in Florida! In addition, insurance for wood frame homes costs $150 to $575 (10-20%) more annually[11] than CMU masonry homes, more than offsetting any incremental energy savings.
4. The last takeaway concerns exterior vs. interior insulation for mass walls. As we knew from past research, exterior insulation is more efficient; however, this research allowed us to look at the actual cost savings of $22/year in Jacksonville for R10 mass walls. At this small savings of cost exterior insulation is just not feasible. The interior insulation location currently being used in almost all CMU walls looks very cost effective. This is a 40-year discussion item solved for Florida – keep the insulation on the inside of the wall.

Respectfully Submitted,

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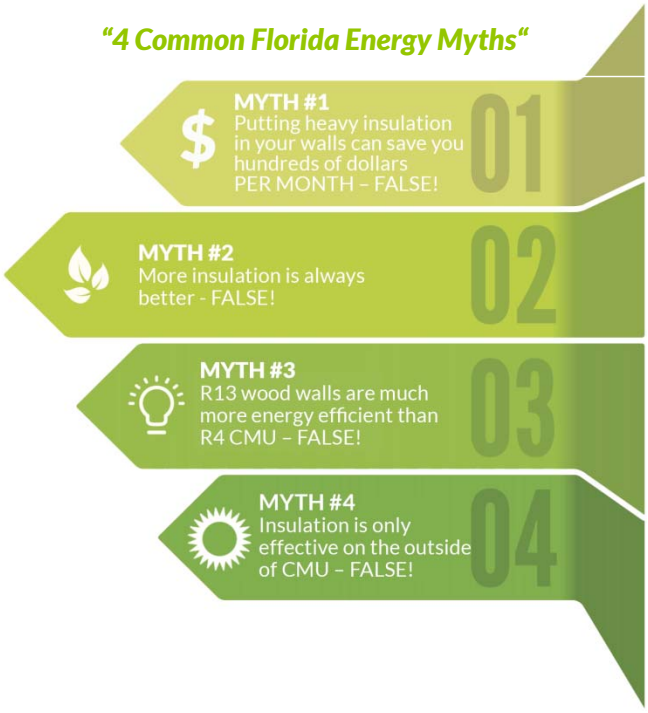
Introduction



In late 2012 the Florida Masonry Apprenticeship and Education Foundation (FMA&EF)[3], in joint cooperation with the National Concrete Masonry Association Education and Research Foundation[2], contracted with Pacific Northwest National Laboratory (PNNL)[1] to study the effects of various wall systems on the annual energy usage by one- and two-story residential homes in all climate zones across Florida and the United States.

The study's objective was to obtain a direct comparison of the actual energy and dollars[7] expended using different types of walls in a typical residential home while keeping all other aspects of the house EXACTLY the same.

This research was done using EnergyPlus™, a simulation software developed by the Department of Energy and acknowledged as one of the most accurate and powerful energy simulation tools available today.

Standard or "Prototype" homes were used in the computer modeling. These prototypes were developed using both Florida and National standards. Once established, all aspects of the prototype were kept identical except for the exterior wall system.

The basic output from the research is the total "whole house" annual energy usage. This usage includes only heating, cooling and ceiling fan energy (referred to as HVAC) and does not reflect all other household energy usage, such as hot water, lighting, electronic equipment, cooking, etc. As previously stated, all other HVAC variables are held equal so that differences in annual energy usage reflect exterior wall changes only.

In all, 607 different wall systems were modeled for both one- and two-story prototypes in 18 different Florida and National climate zones. A total of 21,852 separate wall system analyses were made. Of these, 3,642 wall system analyses were made specifically for Florida. For those wishing a more in-depth review of the research, please go to www.FloridaMasonry.com and click on the PNNL Research Report under the Resources tab.

The PNNL research provides valuable information for Florida. The research confirms the superior performance of thermal mass and the diminishing returns of over-insulation. It also gives us a better understanding of where in Florida mass performs best.

This report is limited in scope to 14 different wall systems prevalent in Florida and is not meant to be exhaustive in comparing the energy usage of all 3,642 analyses. It is intended to use the PNNL research, the most complete residential energy information currently available, to address four common misconceptions regarding residential energy usage. *See "4 Common Energy Myths" above.*

Effect of the Exterior Wall R Value on Your Energy Bill

Residential wall component manufacturers have heatedly discussed the effect of added insulation since the late 1960s. Although it may seem like the walls of a house would constitute a major component of energy efficiency - in reality they do not. The answer is clear cut from past research. Study after study over the past 30 years has shown that the energy savings resulting from wall insulation diminishes rapidly as more is added. Unfortunately, it always seems the research doesn't apply to the exact wall system being discussed, so there has always been "wiggle room" for inflated saving claims from unique wall insulation products.

The current PNNL study confirms what we already knew – heavy insulation in the walls in Florida is a waste of money. This research, however, has the scope and breadth to haul in all of the current wall types being constructed and compare them on an apples per apples basis.

As a pointed example, three walls were picked to compare the difference in annual energy usage. The first wall is a typical CMU with interior R4 foil insulation. The overall R value for the entire wall, including exterior finish and drywall, is R=5.8. This is the lowest R value for any standard wall used in Florida. This wall was compared to a masonry wall with interior R7 foil insulation and to a highly insulated ICF wall with R20 insulation split between the interior and exterior. The overall R value for the masonry wall with R7 foil is R8.3. The overall R value for the ICF wall is R=21.7. This would be one of the highest R values for any Florida wall system[4]. The results are in ***Table 1***.

[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

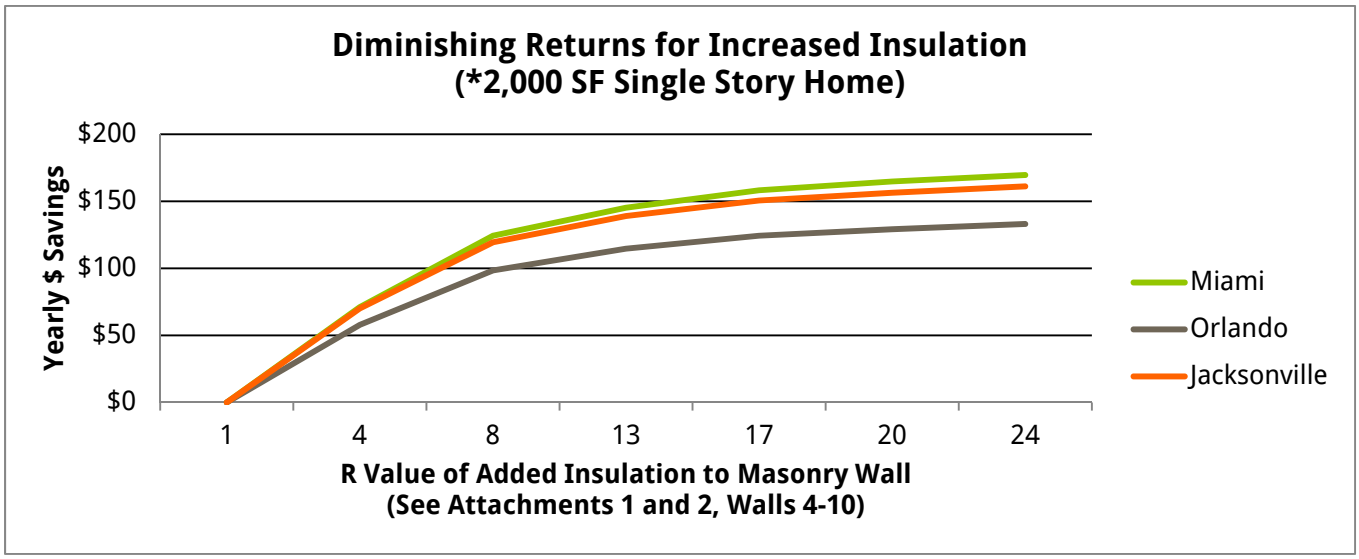
The annual savings achieved by going from a wall with an overall R value of 5.8 to a wall with an overall R value of 21.7 is $101 – that's it. This represents the absolute maximum yearly payback that you can obtain by changing the insulation value of the exterior walls in a typical 2000 sf single story home. In order to get that $101 you had to invest $4207.[5.] Your return on investment at 41.5 years far exceeds a reasonable 20 year payback period[6] and is simply a poor investment.

As an alternative, you could upgrade your interior insulation on the CMU to an R7 for approx. $463[8] with a payback in Miami of 11.5 years.

The bottom line is that CMU, with a small amount of R4 insulation, combined with the thermal mass of concrete makes for an extremely cost effective and hard to beat wall system anywhere in Florida. Upgrading insulation slightly from R4 to R7 is somewhat cost effective in Miami but any additional insulation becomes a waste of money.

The Chart in Figure 1 gives the $ savings per year as you increase insulation from R1 to R24 on a typical CMU wall in the three Florida climate zones. As you can see from the chart, putting SOME insulation on the wall is really essential. Your R4 foil insulation at around $360 pays back $71 in Miami in the first year and gives you an approximate five-year payback. This makes perfect sense. On the other hand, that same R4 added to R20 gives you a payback of only $5 per year. This money would be better invested in some other component of energy efficiency.

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



The bottom line is that your heavy energy costs, in Southern climate zones, do not come from heat or cold making their way through the exterior walls. Once you have added some moderate insulation to the wall system, the rest of your energy cost is from air infiltration through windows/doors/ walls, thermal and solar gain through windows, hot water, lighting, electronic equipment, cooking and particularly thermal gain through the roof and ceiling.

The PNNL Report proves that if someone states you will save substantially more than $100 per year on your energy bill in Florida by heavily insulating the walls of a 2000sf single story home – they are mistaken or simply trying to sell you something using misleading information.

R4 CMU vs. R13 Wood Frame

CMU with R4 foil insulation added to the interior wall between the furring strips and 4" nominal wood frame construction with R13 batt insulation between the studs are by far and away the two main wall systems used in Florida residential construction. In a discussion strictly focused on energy, it would seem that a wood frame wall with an R value of 10.9 is twice the energy efficiency of a CMU wall with an R value of 5.8. This is not accurate. The PNNL research shows the difference in energy efficiency is very minor and furthermore relies on the premise that the insulation in the wood frame structure stays dry and in good condition.

However, the "dry and in good condition" is not the reality for millions of square feet of Florida wood frame walls. Wood wall leakage and condensation can dampen the batt insulation and drastically reduce the insulation value. Additionally, CMU has the advantage of thermal mass where energy is "absorbed" by the wall rather than letting it pass through.

What the PNNL Research gives us is the exact $/year energy difference, across the State, between these two wall systems. The EnergyPlus™ software is powerful enough to accurately model the benefits of thermal mass, which has been difficult to exactly quantify in previous research done with less powerful modeling tools. No reduction in the energy efficiency of wood walls for problems due to damp and moldy batt insulation was factored into the PNNL research. The energy comparison is between the two wall system, properly constructed and maintained. The comparison results are shown in Table 2.

[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	4" Wood R13	10.9	$46	$15	$18

The effectiveness of thermal mass can be clearly seen in the above table and it is reversed from what we, in the construction industry, have always thought. Past research, using less powerful tools, indicated that thermal mass had the best advantage in Miami, then Orlando and finally Jacksonville. As it turns out, thermal mass has the best advantage in Orlando and Jacksonville, virtually eliminating any energy cost difference between wood frame and CMU walls in the Central and Northern portions of the State.

The construction cost difference between CMU and Wood homes is generally around $1.00 to $1.50 per sf of wall area or roughly $2530 for a typical 2000 sf home with 1530 sf of wall [9]. Since approximately 60% of all residential exterior walls are CMU in Florida there must be some advantages that outweigh the added construction costs.

Indeed, CMU has tremendous advantages. Unlike wood walls, CMU is unaffected by water and is not a food source for mold – no rot, no mold and no deterioration over time. Because it does not burn, your home insurance rates for CMU are 10 - 20% lower than for wood homes. Generally, this results in a savings of $150-$575 per year[11] for insurance alone. Structurally, CMU has proven far superior to wood in hurricanes and wind storms. CMU is unaffected by the catastrophic termite damage to wood structures in Florida. And, getting back to energy, the minor differences in Table 2 are quickly reversed with moisture deterioration of batt insulation over time (the average rainfall in South Florida is 60 inches per year).

The real eye-opener from the PNNL Research is not the slight energy use difference between Wood and R4 CMU in Miami. The eye opener is that the thermal mass in R4 insulated CMU performs extremely well in all of Central and North Florida, virtually identical to R13 wood frame construction in energy efficiency.

Interior vs. Exterior Insulation of CMU Walls

An age old discussion on proper insulation of CMU pitted the standard interior insulation against exterior insulation. From past research it was felt that insulation on the outside of the block was much more effective than insulation on the interior. The PNNL research has given us the answer but also the $$ difference made by the interior vs. exterior insulation placement.

Table 3 shows that for two CMU walls insulated to R10, placement of insulation on the exterior saves a small amount of money, but not enough to pay back the difference in construction costs.

Clearly the standard interior insulation on CMU walls that we have always used is by far and away the most cost effective placement.

[Table 3 - Comparison of Energy Savings of Interior vs. Exterior Insulation - Florida CMU Walls]

Total Energy Savings per Year of Exterior Insulation over Interior Insulation							
Wall#	**Wall Disc**	**Overall R Value**	**Miami**	**Orlando**	**Jax**	**Cost of Exterior Insulation[10]**	**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

Closing

This Florida-specific report only scratches the surface of the vast number of comparisons that can be done using the output of the PNNL Research. For those wishing a more in-depth review of the Research, please go to www.FloridaMasonry.com and click on the PNNL Research Report under the Resources tab.

The comparisons presented in this report were chosen to highlight the amount of bad information and confusion associated with them. When it comes to energy it seems like everyone has a product to sell or a personal "green" perspective to promote. The real value of this research is being able to quickly and easily get to the cost vs value relationship between virtually all wall systems. Not having the actual yearly dollar differences between walls leaves too much room for exaggeration and the imagination. "If no one knows - then anything goes" and myths on energy efficiency abound:

- Putting heavy insulation in your walls can save you hundreds of dollar PER MONTH – FALSE!
- More insulation is always better – FALSE!
- R13 wood walls are much more energy efficient than R4 CMU – FALSE!
- Insulation is only effective on the outside of CMU – FALSE!

The energy data from the PNNL research will certainly be dissected by those depending on exaggerated claims of energy savings.

The force of this research is that there is no better information currently available – anywhere.

> ***Please note:*** *In Attachments 1 and 2, I have provided additional technical information on the wall systems reviewed in this report. Since the "whole house" energy usage is given on a square footage(sf) basis, homes slightly larger or smaller than the 2000sf for single story and 2200sf for two story can be analyzed with reasonable accuracy by applying the per SF cost to the actual conditioned floor area.*

Sources

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[1] Pacific Northwest National Laboratory (PNNL) is located in Richland, Washington. PNNL is one among ten U.S. Department of Energy (DOE) national laboratories managed by DOE's Office of Science. For more information: http://www.pnnl.gov/

[2] The National Concrete Masonry Association (NCMA) is located in Herndon, Virginia. Contact: Robert Thomas 703.713.1900 www.ncma.org

[3] The Florida Masonry Apprenticeship and Education Foundation (FMA&EF) is headquartered in Boca Raton, Florida and was created in 2002 to add new and expand existing apprenticeship programs and offer education to the masonry industry. The Mission of the Foundation is: "To coordinate and provide education of the masonry trade" For more information: www.masonryeducation.org

[4] All walls used in this report are numbered consecutively as they appear and a complete description with technical information is provided in Attachments 1 and 2.

[5] Across Florida basic ICF costs range from $2/sf of wall to $4/sf more than CMU construction. A lower average would be $2.5/sf x1530sf = $3825. Including a 10% contractor markup brings that to 1.1 x $3825 = $4207 difference. $5000 is the standard upgrade figure used by many contractors across the State which falls in the same range as the above analysis.

[6] Where discussions of payback occur a straight 20-year comparison is used to determine if a particular investment makes sense. As an example, if you are intending to spend $3000 to upgrade the energy efficiency of a home you would want to see at least $3000/20=$150 per year savings to make it worthwhile.

A straight 20-year payback is an extremely conservative analysis. Most businesses are looking for a 3-7 year payback and are including the compound interest from the initial investment. For our purposes suffice it to say that if you cannot save enough energy over 20 years to pay for the initial investment then it is simply not worth investing in.

[7] All tables, charts and graphs in this report are based exclusively on dollars per year for a 2000sf, single story residential home. The output of the actual EnergyPlus™ software is in energy units calculated for both heating and cooling. A conversion factor of $0.11109/kWh was used across the state.

[8] Standard Fi-Foil AA2 installed at $.16/sf compared to VR+Shield on 1 ½"x1 ½" furring at $.42/sf for 1530sf of wall with 10% contractor markup is ($.42/sf - $.16/sf) x 1530sf x 1.1 = $437.

[9] The cost difference between wood and CMU varies widely across Florida depending on the location, the available subcontractors and the builder. There are enough builders in the State that build both wood and CMU that we know the range of $1500 for a tract builder to $2300 for a small but experienced builder is as close as you can get for a broad, State wide number. Using the higher number and applying our 10% contractor mark-up you get $2300 x 1.1 = $2530.

[10] Exterior insulation is usually combined with stucco on lath with would be an approx. $2.00/sf upcharge from direct applied stucco. For a 2000sf home with 1530sf of solid wall, including contractor mark-up, that would be $2/sf x 1530sf x 1.1 = $3366.

[11] *Masonry Association Survey of Florida Insurance Costs www.floridamasonry.com/resources*

Attachment 1

Wall #	Wall Case	Energy Use Index (EUI)(kBtu/sf-yr)			Energy Cost Index (ECI)($/sf-yr)					
	Wall Type & Block Density; Cell Fill; Grout o.c. or Wall thickness; Nominal Insulation R-Value & Location; Climate Zone	Heat EUI	Cool EUI	HVAC EUI	Heat ECI	Cool ECI	HVAC ECI	Yearly HVAC Bill for 2000sf 1 sty Home	Wall Uo	Wall R
1	CMUs115,e, 96''oc,R04In-CZ:Miami	0.305669987	9.614400522	9.920070509	0.0099494	0.312943	0.322892	645.78	0.174	5.75
2	CMUs115,e, 96''oc,R07In-CZ:Miami	0.283162958	9.055062724	9.338225682	0.0092168	0.294737	0.303954	607.91	0.121	8.26
3	ICF-145,-, 6.0''tk,R20Sp-CZ:Miami	0.233708588	8.114859723	8.348568311	0.0076071	0.264134	0.271741	543.48	0.046	21.74
4	CMUs115,e, 48''oc,R01In-CZ:Miami	0.346033831	10.65431091	11.00034474	0.0112632	0.346792	0.358055	716.11	0.279	3.58
5	CMUs115,e, 48''oc,R04In-CZ:Miami	0.296354203	9.612146236	9.908500439	0.0096462	0.31287	0.322516	645.03	0.175	5.71
6	CMUs115,e, 48''oc,R08In-CZ:Miami	0.269676489	8.820227846	9.089904334	0.0087778	0.287093	0.295871	591.74	0.100	10.00
7	CMUs115,e, 48''oc,R13In-CZ:Miami	0.257794129	8.512469103	8.770263232	0.008391	0.277076	0.285467	570.93	0.074	13.51
8	CMUs115,e, 48''oc,R17In-CZ:Miami	0.252097832	8.318047558	8.57014539	0.0082056	0.270748	0.278953	557.91	0.057	17.54
9	CMUs115,e, 48''oc,R20In-CZ:Miami	0.249288933	8.220230978	8.469519911	0.0081142	0.267564	0.275678	551.36	0.049	20.41
10	CMUs115,e, 48''oc,R24In-CZ:Miami	0.245408352	8.150121132	8.395529484	0.0079879	0.265282	0.27327	546.54	0.043	23.26
11	CMUs115,e, 96''oc,R04In-CZ:Miami	0.305669987	9.614400522	9.920070509	0.0099494	0.312943	0.322892	645.78	0.174	5.75
12	Wood---,-, 3.5''tk,R13Co-CZ:Miami	0.356632903	8.851112083	9.207744985	0.0116082	0.288098	0.299707	599.41	0.092	10.87
13	CMUs115,e, 48''oc,R08In-CZ:Miami	0.269676489	8.820227846	9.089904334	0.0087778	0.287093	0.295871	591.74	0.100	10.00
14	CMUs115,e, 48''oc,R09Ex-CZ:Miami	0.220595842	8.654318503	8.874914345	0.0071803	0.281693	0.288873	577.75	0.100	10.00
1	CMUs115,e, 96''oc,R04In-CZ:Orlando	1.258552283	7.041099206	8.299651488	0.0409651	0.229184	0.270149	540.30	0.174	5.75
2	CMUs115,e, 96''oc,R07In-CZ:Orlando	1.160694747	6.681304159	7.841998905	0.0377799	0.217472	0.255252	510.50	0.121	8.26
3	ICF-145,-, 6.0''tk,R20Sp-CZ:Orlando	0.993022589	6.079798745	7.072821334	0.0323223	0.197894	0.230216	460.43	0.046	21.74
4	CMUs115,e, 48''oc,R01In-CZ:Orlando	1.440504432	7.709002828	9.14950726	0.0468876	0.250923	0.297811	595.62	0.279	3.58
5	CMUs115,e, 48''oc,R04In-CZ:Orlando	1.238854153	7.022488117	8.26134227	0.040324	0.228578	0.268902	537.80	0.175	5.71
6	CMUs115,e, 48''oc,R08In-CZ:Orlando	1.111810348	6.524864184	7.636674532	0.0361888	0.21238	0.248569	497.14	0.100	10.00
7	CMUs115,e, 48''oc,R13In-CZ:Orlando	1.060245037	6.328034768	7.388279805	0.0345103	0.205974	0.240484	480.97	0.074	13.51
8	CMUs115,e, 48''oc,R17In-CZ:Orlando	1.031819867	6.208134371	7.239954238	0.0335851	0.202071	0.235656	471.31	0.057	17.54
9	CMUs115,e, 48''oc,R20In-CZ:Orlando	1.017736122	6.147799357	7.165535479	0.0331267	0.200107	0.233234	466.47	0.049	20.41
10	CMUs115,e, 48''oc,R24In-CZ:Orlando	1.003817908	6.101718738	7.105536646	0.0326737	0.198607	0.231281	462.56	0.043	23.26
11	CMUs115,e, 96''oc,R04In-CZ:Orlando	1.258552283	7.041099206	8.299651488	0.0409651	0.229184	0.270149	540.30	0.174	5.75
12	Wood---,-, 3.5''tk,R13Co-CZ:Orlando	1.314923097	6.752821867	8.067744964	0.0428	0.2198	0.2626	525.20	0.092	10.87
13	CMUs115,e, 48''oc,R08In-CZ:Orlando	1.111810348	6.524864184	7.636674532	0.0361888	0.21238	0.248569	497.14	0.100	10.00
14	CMUs115,e, 48''oc,R09Ex-CZ:Orlando	1.01895115	6.363007779	7.381958929	0.0331663	0.207112	0.240278	480.56	0.100	10.00
1	CMUs115,e, 96''oc,R04In-CZ:Jacksonville	2.938976963	6.168615244	9.107592207	0.095662	0.200785	0.296447	592.89	0.174	5.75
2	CMUs115,e, 96''oc,R07In-CZ:Jacksonville	2.721379441	5.833590045	8.554969486	0.0885793	0.18988	0.278459	556.92	0.121	8.26
3	ICF-145,-, 6.0''tk,R20Sp-CZ:Jacksonville	2.375929233	5.238738275	7.614667508	0.0773351	0.170518	0.247853	495.71	0.046	21.74
4	CMUs115,e, 48''oc,R01In-CZ:Jacksonville	3.34450109	6.79453726	10.13903835	0.1088615	0.221158	0.33002	660.04	0.279	3.58
5	CMUs115,e, 48''oc,R04In-CZ:Jacksonville	2.911369206	6.149777191	9.061146396	0.0947633	0.200172	0.294935	589.87	0.175	5.71
6	CMUs115,e, 48''oc,R08In-CZ:Jacksonville	2.619322209	5.685145023	8.304467231	0.0852574	0.185048	0.270305	540.61	0.100	10.00
7	CMUs115,e, 48''oc,R13In-CZ:Jacksonville	2.504688071	5.499650179	8.00433825	0.0815261	0.17901	0.260536	521.07	0.074	13.51
8	CMUs115,e, 48''oc,R17In-CZ:Jacksonville	2.438137984	5.388425629	7.826563613	0.0793599	0.17539	0.25475	509.50	0.057	17.54
9	CMUs115,e, 48''oc,R20In-CZ:Jacksonville	2.405265675	5.332152085	7.737417759	0.07829	0.173558	0.251848	503.70	0.049	20.41
10	CMUs115,e, 48''oc,R24In-CZ:Jacksonville	2.377036752	5.286675566	7.663712318	0.0773711	0.172078	0.249449	498.90	0.043	23.26
11	CMUs115,e, 96''oc,R04In-CZ:Jacksonville	2.938976963	6.168615244	9.107592207	0.095662	0.200785	0.296447	592.89	0.174	5.75
12	Wood---,-, 3.5''tk,R13Co-CZ:Jacksonville	2.926929073	5.905715267	8.83264434	0.0952698	0.192228	0.287497	574.99	0.092	10.87
13	CMUs115,e, 48''oc,R08In-CZ:Jacksonville	2.619322209	5.685145023	8.304467231	0.0852574	0.185048	0.270305	540.61	0.100	10.00
14	CMUs115,e, 48''oc,R09Ex-CZ:Jacksonville	2.515217176	5.449168496	7.964385672	0.0818688	0.177367	0.259236	518.47	0.100	10.00

Attachment 2

Characteristic	Wall # 1	Wall # 2	Wall # 3	Wall # 4	Wall # 5	Wall # 6	Wall # 7	Wall # 8	Wall # 9	Wall # 10	Wall 11	Wall 12	Wall 13	Wall 14
Case: Wall Type & Block Density; Cell Fill; Grout or Stud spacing; Nominal Insulation R-Value & Location	CMUs115,e, 96"oc,R04In	CMUs115,e, 96"oc,R07In	ICF-145,-, 6.0"tk,R20S	CMUs115,e, 48"oc,R01In	CMUs115,e, 48"oc,R04In	CMUs115,e, 48"oc,R08In	CMUs115,e, 48"oc,R13In	CMUs115,e, 48"oc,R17In	CMUs115,e, 48"oc,R20In	CMUs115,e, 48"oc,R24In	CMUs115,e, 96"oc,R04In	Wood---,-, 3.5"tk,R13C	CMUs115,e, 48"oc,R08In	CMUs115,e, 48"oc,R09Ex
Prototype	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily	singlefamily
Code Basis	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012	IECC_2012
Stories	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Heating fuel	electricity	electricity	electricity	electricity	electricity	electricity	electricity	electricity	electricity	electricity	electricity	electricity	electricity	electricity
ext_wall_type	CMUs	CMUs	ICF-	CMUs	CMUs	CMUs	CMUs	CMUs	CMUs	CMUs	CMUs	Wood	CMUs	CMUs
Structural thickness	7.6	7.6	6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	3.5	7.6	7.6
Grout or stud spacing, inches	96	96	na	48	48	48	48	48	48	48	96	16	48	48
Concrete density	115	115	145	115	115	115	115	115	115	115	115	---	115	115
Assembly unit weight lbs/sf	44.5	44.5	77.3	48.8	48.8	48.9	49.8	49.9	49.9	50.4	44.5	6.5	48.9	45.3
Cell fill for CMU	empty	empty	-	empty	empty	empty	empty	empty	empty	empty	empty	-	empty	empty
Overall Wall U-Factor	0.174	0.121	0.046	0.28	0.175	0.101	0.073	0.057	0.049	0.043	0.174	0.092	0.101	0.101
Overall Wall R-Value equiv	5.747126437	8.26446281	21.73913043	3.584229391	5.714285714	10	13.51351351	17.54385965	20.40816327	23.25581395	5.747126437	10.86956522	10	10
Insulation Nominal R-Total	4	7	20	1	4	8	13	17	20	24	4	13	8	9
R-value of cavity insulation	4	7	0	1	4	3	13	13	13	19	4	13	3	1
R-value of continuous insul.	0	0	20	0	0	5	0	4	7	5	0	0	5	8
Continuous insul. location	Interior	Interior	Split	Interior	Interior	Interior	Interior	Interior	Interior	Interior	Interior	Core	Interior	Exterior
Interior airspace	none	none	none	plain_airspace	none	reflective_airs	none	none	none	none	none	none	reflective_airs	plain_airspace
Interior finish	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum	Gypsum
Exterior Finish	cementitious_	cementitious_	synthetic_stuc	cementitious_	cementitious_	cementitious_	cementitious_	cementitious_	cementitious_	cementitious_	cementitious_	OSB_7/16in	cementitious_	synthetic_stucc
Case Sequence No. (CZ 1A)	18736	17656	21400	20212	18880	16612	14884	13228	12076	10744	18736	21832	16612	16756
Full Case ID: WallType_Uo_Rboard_Rcav_ BoardLoc_Thk_Dns_fill_ spacing_ExtFnsh_airSpace_ IntFnsh_Story_CZ	CMUs_0.174_ R00_R04_In_ 7.6_115_e_96 _Ce_n_G_1_F 1	CMUs_0.121_ R00_R07_In_ 7.6_115_e_96 _Ce_n_G_1_F 1	ICF- _0.046_R20_ R00_Sp_6.0_1 45_- _na_Sy_n_G_	CMUs_0.279_ R00_R01_In_ 7.6_115_e_48 _Ce_p_G_1_F 1	CMUs_0.175_ R00_R04_In_ 7.6_115_e_48 _Ce_n_G_1_F 1	CMUs_0.100_ R05_R03_In_ 7.6_115_e_48 _Ce_R_G_1_F 1	CMUs_0.074_ R00_R13_In_ 7.6_115_e_48 _Ce_n_G_1_F 1	CMUs_0.057_ R04_R13_In_ 7.6_115_e_48 _Ce_n_G_1_F 1	CMUs_0.049_ R07_R13_In_ 7.6_115_e_48 _Ce_n_G_1_F 1	CMUs_0.043_ R05_R19_In_ 7.6_115_e_48 _Ce_n_G_1_F 1	CMUs_0.174_ R00_R04_In_ 7.6_115_e_96 _Ce_n_G_1_F 1	Wood_0.092_ R00_R13_Co_ 3.5_n-a_- _16_Sh_n_G_ 1_F1	CMUs_0.100_ R05_R03_In_ 7.6_115_e_48 _Ce_R_G_1_F 1	CMUs_0.100_ R08_R01_Ex_ 7.6_115_e_48 _Sy_p_G_1_F 1
R-Values by Wall Layer:														
Esterior Surface finish	0.06443299	0.06443299	0.200320513	0.06443299	0.06443299	0.06443299	0.06443299	0.06443299	0.06443299	0.06443299	0.06443299	0.200320513	0.06443299	0.200320513
Exterior board insulation	0	0	10	0	0	0	0	0	0	0	0	0	0	6.256654618
Face shell or sheathing	0.199171447	0.199171447	0	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0.62	0.199171447	0.199171447
Core wall consolidated layer	0.88107701	0.88107701	0.375	0.843663513	0.843663513	0.843663513	0.843663513	0.843663513	0.843663513	0.843663513	0.88107701	8.708633989	0.843663513	0.843663513
Inner face shell	0.199171447	0.199171447	0	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0.199171447	0	0.199171447	0.199171447
Interior Board Insulation	0	0	10	0	0	5	0	4	7	5	0	0	5	0
Interior Cavity Insulation	3.112059021	5.612260169	0	0	3.112059021	0	10.96851347	10.96851347	10.96851347	15.62575465	3.112059021	0	0	0
Interior Airspace	0	0	0	0.96684936	0	2.359391502	0	0	0	0	0	0	2.359391502	0.96684936
Interior wall board	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455	0.454545455