2009 IECC Cost Effectiveness Analysis

Prepared for
National Association of Home Builders

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Objective

The objective of this analysis is to quantify the incremental construction cost, energy savings, and percent energy savings associated with constructing a house compliant with the 2009 IECC relative to the 2006 IECC baseline. A methodology established by the NAHB Research Center was used to determine the incremental energy savings. A simple payback cost effectiveness analysis was also performed using cost and savings estimates.

Background

A strong push was made by many advocacy groups, including the U. S. Department of Energy (DOE), to increase the stringency of the 2009 International Energy Conservation Code (IECC). This effort resulted in a number of major changes which impact both energy savings and construction costs for residential construction. As part of the federal effort to encourage state and local adoption of the more stringent code, provisions were also included in the American Recovery and Reinvestment Act (ARRA) to persuade states to adopt the 2009 IECC.

Energy Evaluation Methodology

A methodology was developed by the NAHB Research Center (NAHB Research Center 2012) to calculate energy savings with a 2006 IECC baseline. This methodology defines a Standard Reference House, including the building configuration and energy performance parameters. In addition, a calculation formula was included to determine a "percent energy savings" when comparing versions of the energy code. Energy performance parameters from the IECC were used where available. For parameters not defined in the IECC, DOE's Building America Benchmark (Hendron 2008) protocols were used.

Standard Reference House

The building geometry (Figure 1) used in this analysis is documented in the methodology paper and was developed using the NAHB Research Center's 2008 and 2009 Annual Builder Practices Survey (ABPS) results. The parameters represent the average (mean) values from the ABPS for building areas and features not dictated by the 2006 IECC. Table 1 lists floor, attic, wall, and window areas used in the *Standard Reference House*.

Table 1. Average Wall and Floor Square Footage

	Annual Builder Practices Survey (ABPS)	Standard Reference House
1st Floor CFA	1,780	1,776
2nd Floor CFA	572	576
Total CFA (w/o Conditioned Basement)	2,352	2,352
Slab/Basement/Crawl Floor Area		1,776
Total CFA (with Conditioned Basement)		4,128
Attic Floor Area		1,776
1st Floor Wall Area	2,006	1,764
2nd Floor Wall Area	586	816
Total Above-Grade Wall Area	2,592	2,580
Basement Wall Area (8ft wall height)		1,568
Crawlspace Wall Area (4ft wall height)		784
Window Area (18%/15%)		464/387

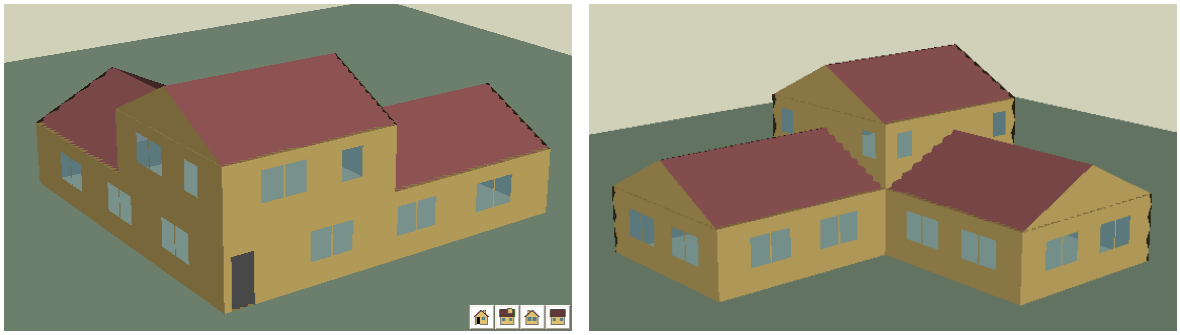

Figure 1: Simulation Model of Standard Reference House

Representative Cities

Eight cities (Table 2) representing each of the DOE Climate Zones (Figure 2) were selected to quantify energy savings for their respective climate.

Table 2: Representative Climate Zone Cities

Climate Zone	Moisture Region	State	City	HDD(65)	CDD(65)
1	Moist	Florida	Miami	120	4,396
2	Dry	Arizona	Phoenix	977	4,790
3	Moist	Tennessee	Memphis	2,851	2,221
4	Moist	Maryland	Baltimore	4,460	1,314
5	Moist	Illinois	Chicago	6,174	911
6	Dry	Montana	Helena	7,474	353
7	N/A	Minnesota	Duluth	9,371	185
8	N/A	Alaska	Fairbanks	12,818	49

Note: HDD and CDD data from TMY3 Dataset

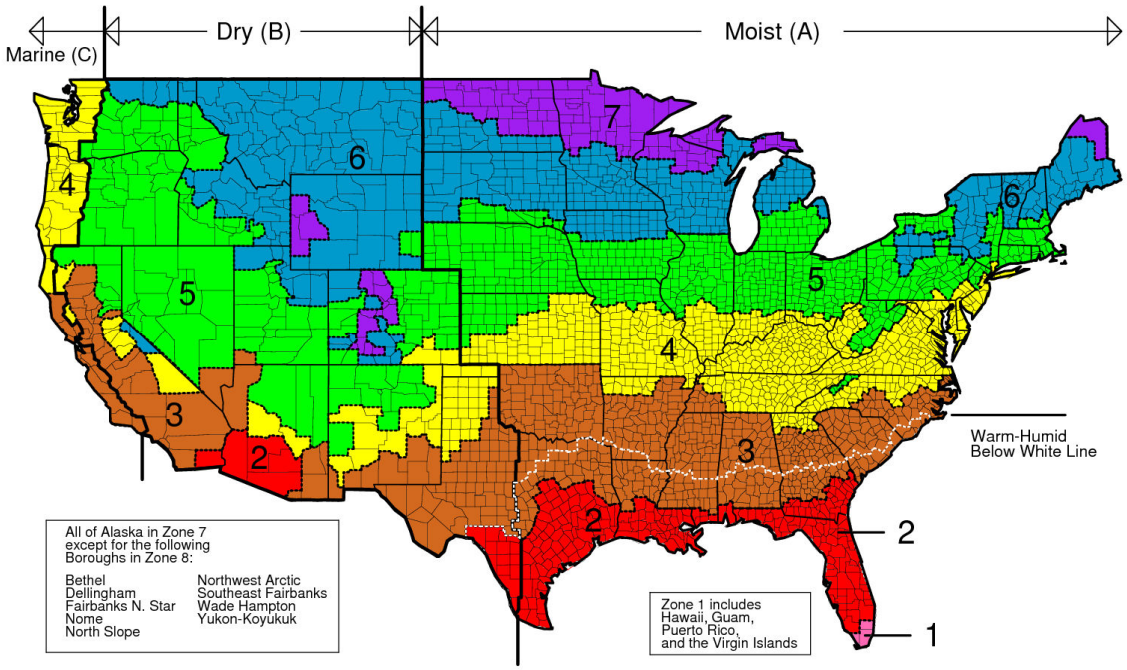

Figure 2: DOE Climate Zone Map

Weighted Averaging

Weighted averaging was applied both within and across climate zones. Within climate zones, wall construction factors for light-framed and mass walls as well as various foundation types (slab, crawlspaces, and basements) were applied. Once the savings within a climate zone were determined, a weighted calculation according to building starts (Briggs 2002) for each climate zone was performed in order to obtain a national average.

Changes and Cost Impacts of the 2009 IECC

A number of major changes were made from the 2006 IECC to the 2009 IECC. For the first time, performance testing of a whole building tightness and duct tightness testing are now part of the IECC. In addition, lighting has been added to the scope along with updates of R-value and U-factor requirements. Appendix A includes the baseline 2006 IECC prescriptive table and Appendix B contains the 2009 IECC prescriptive table with highlighted changes from the 2006 version. All costs listed below are based on the Standard Reference House.

Incremental Cost Impact Changes:

- **Windows:** Window requirements were changed in the southern climates. The SHGC was reduced from 0.40 to 0.30 in Climate Zones 1 through 3 and reductions were made in the U-factor in Climate Zones 2 through 4. Based on incremental cost estimates from a 2010 Building Codes Assistance Project study (Paquette 2010), the changes resulted in a $\$0.50/ft^2$ cost increase for all window changes except Climate Zone 3 where the cost increase was $\$1.00/ft^2$.

- **Window Area:** The window to conditioned floor area percentage was reduced from 18 to 15 percent in the 2009 IECC. This change will result in either reduced window area or additional requirements that will need to be traded off against the more conductive windows. It is assumed that no construction cost change will result from this code modification.

- **Frame Walls:** The wood-frame wall R-values changed from R-19 to R-20 in the prescriptive table. The lowest incremental cost to go from R-19 to R-20 is $\$0.20/ft^2$ (ASHRAE 1481 RP).

- **Mass Walls:** Although the mass wall U-factors did not change in the 2009 IECC, the assumed location of the insulation moved to the outside of the structure. Since the majority of mass walls in southern climates have insulation installed on the inside surface of a block wall, this change effectively increased the requirement. The cost increase associated with this change included the increase in insulation required for insulation located on the inside walls. Cost increase was $\$0.10/ft^2$ in Climate Zone 1 and 2, and $\$0.41/ft^2$ in Climate Zone 5 (ASHRAE 1481 RP).

- **Basement/Crawlspace Insulation:** Basement insulation was not previously required in Climate Zone 3. The new requirement is now R-5 continuous insulation or R-13 when installed within framing when a home is north of the Hot-Humid line in Climate Zone 3 (see Figure 2). Based on the foundation distribution by climate zone, it is believed that very few basements exist south of the Hot-Humid line; therefore, the calculation assumes all homes in Climate Zone 3 with basements will either need floor insulation or basement wall insulation. The incremental cost for basement wall insulation is $2,932 per house ($\$1.87/ft^2$ of basement wall). Basement and conditioned crawlspace insulation levels increased in Climate Zones 6 through 8 from R-10 to R-15 at a cost of $\$1.05/ft^2$ of wall. This resulted in a cost increase of $1,644 for basements and $822 for conditioned crawlspaces (ASHRAE 1481 RP).

- **Duct Systems:** Ducts are required to be either entirely within conditioned space or sealed and tested. The assumption for the energy simulation model is that ducts are outside conditioned space and

additional sealing and testing is required when the house has a slab foundation or vented crawlspace. The associated cost is $259 to seal (Building America) the ducts and $165 to test (Southface).

- **Air Sealing:** Building air sealing special inspection or testing to 7 ACH_{50} was introduced in the 2009 IECC. The majority of new homes would meet the 2009 IECC tightness requirement, but to avoid having to re-test, it is expected that additional air sealing will be performed. The associated cost is $0.12/$ft^2$ to seal (ASHRAE 1481 RP) the house and $165 to test (Southface).

- **Lighting:** The 2009 IECC introduced a new, mandatory 50 percent high-efficacy lighting requirement. The baseline assumption is that 10 percent of hard-wired lighting is already high efficacy. The cost to increase lighting to 50 percent is $1 per percent change, or $40.

- **Thermostats:** The 2009 IECC has a new programmable thermostat requirement for gas furnaces. Nearly all thermostats are now electronic, however, there is still a cost added for the programmable feature. A survey of a big box retailers indicated that the additional cost to upgrade to programmable is roughly $25 per thermostat (Research Center local survey).

Construction Costs Associated with 2009 IECC Changes

Each climate zone has different requirements (except zones 7 and 8); consequently, the resulting incremental construction costs to comply with the 2009 IECC vary between climate zones. The cost increases (Table 3) range from a high of $1,867 in Climate Zone 6 to a low of $1,151 in Climate Zone 2, with a national weighted average cost increase of $1,441. Complete cost analysis details on the individual measures for each climate zone can be found in Appendix C.

Table 3: 2009 IECC Incremental Construction Cost

Climate Zone/City	Incremental Construction Cost
1/Miami	$1,297
2/Phoenix	$1,168
3/Memphis	$1,667
4/Baltimore	$981
5/Chicago	$1,218
6/Helena	$2,336
7/Duluth 8/Fairbanks	$1,938
National Weighted Average	**$1,365**

Calculated Energy Usage

Table 4 summarizes the calculated energy usage for a house built to the minimum requirements of both the 2006 and 2009 IECC. The following nomenclature is used to identify the energy use:

TEU_{2006} = Total Energy Usage using the 2006 IECC
TEU_{2009} = Total Energy Usage using the 2009 IECC
$HCWU_{2006}$ = Heating, Cooling, and Water heating energy Usage using the 2006 IECC

Energy costs savings are calculated using energy prices reported in the Energy Information Administration's calendar year 2011 consumer price data for electricity ($0.118/kWh) and natural gas ($1.08/therm).

It is necessary to convert electric (kWh) and natural gas (Therm) energy usage into Btu's in order to determine the site and source energy usage. The site to source multiplier to obtain source Btu's for electricity is 3.365 and for natural gas is 1.092 (Hendron 2008).

Table 4: 2009 IECC Energy Usage for House Built to the 2006 and 2009 IECC

Location		kWh	Therms	Site MBtu	Source MBtu	Cost
Zone 1 Miami	TEU_{2006}	19,267	25	68.2	223.9	$ 2,300
	TEU_{2009}	17,030	25	60.6	198.2	$ 2,036
	$HCWU_{2006}$	10,919	23	39.6	127.9	$ 1,313
Zone 2 Phoenix	TEU_{2006}	20,782	118	82.7	251.5	$ 2,580
	TEU_{2009}	18,599	114	74.9	226.0	$ 2,318
	$HCWU_{2006}$	12,289	115	53.4	153.6	$ 1,574
Zone 3 Memphis	TEU_{2006}	18,855	440	108.3	264.5	$ 2,700
	TEU_{2009}	17,061	393	97.5	238.8	$ 2,438
	$HCWU_{2006}$	10,415	434	79.0	167.0	$ 1,698
Zone 4 Baltimore	TEU_{2006}	16,527	766	133.0	273.4	$ 2,777
	TEU_{2009}	15,213	708	122.7	252.0	$ 2,560
	$HCWU_{2006}$	7,340	757	100.8	167.0	$ 1,684
Zone 5 Chicago	TEU_{2006}	15,413	1,224	175.0	310.6	$ 3,141
	TEU_{2009}	14,187	1,151	163.5	288.6	$ 2,918
	$HCWU_{2006}$	6,051	1,222	142.9	202.9	$ 2,034
Zone 6 Helena	TEU_{2006}	12,316	1,496	191.6	304.7	$ 3,069
	TEU_{2009}	11,119	1,359	173.8	276.0	$ 2,779
	$HCWU_{2006}$	2,318	1,482	156.1	188.5	$ 1,874
Zone 7 Duluth	TEU_{2006}	11,238	2,271	265.4	377.0	$ 3,779
	TEU_{2009}	10,117	2,052	239.8	340.3	$ 3,410
	$HCWU_{2006}$	1,261	2,257	230.0	260.9	$ 2,586
Zone 8 Fairbanks	TEU_{2006}	11,432	2,999	338.9	458.8	$ 4,588
	TEU_{2009}	10,300	2,701	305.3	413.2	$ 4,133
	$HCWU_{2006}$	1,455	2,985	303.5	342.7	$ 3,396

		kWh	Therms	Site MBtu	Source MBtu	Cost
National Weighted Average	TEU_{2006}	17,499	715	131.2	279.0	$ 2,837
	TEU_{2009}	15,899	662	120.5	254.9	$ 2,592
	$HCWU_{2006}$	8,537	710	100.1	175.6	$ 1,774

Calculated Energy Savings

Energy savings are presented in three formats: 1) percent of site energy savings; 2) percent of source energy savings; and 3) percent of energy cost savings. The percent savings in Table 5 were calculated using a formula consistent with the PNNL/DOE presentation in various forums including the 2010 RESNET Conference (Taylor 2010):

$$\% \text{ Savings} = 100*(TEU_{2006} - TEU_{2009})/HCWU_{2006}$$

Table 5: 2009 IECC Energy Savings above the 2006 IECC

Climate Zone	Site Btu Savings	Source Btu Savings	Energy Cost Savings
1	19.3%	20.1%	20.1%
2	14.7%	16.6%	16.6%
3	13.7%	15.4%	15.4%
4	10.2%	12.8%	12.9%
5	8.0%	10.8%	11.0%
6	11.4%	15.2%	15.4%
7	11.2%	14.1%	14.2%
8	11.1%	13.3%	13.4%
National Weighted Average	**10.7%**	**13.8%**	**13.9%**

Cost Effectiveness

While various cost-effectiveness evaluation criteria can be used, this analysis employs the simple payback method. The simple payback analysis is easy to understand and it does not make future assumptions such as general inflation rates, life expectancy of the building component, or fuel escalation rates. Table 5 summarizes the energy cost savings, construction cost, and resulting simple payback for each climate zone and weighted national averages.

Table 6: Cost Effectiveness Calculation

Climate Zone	Annual Energy Savings	Incremental Construction Cost	Simple Payback (yrs)
1	$264	$1,297	4.9
2	$262	$1,168	4.5
3	$262	$1,667	6.4
4	$217	$981	4.5
5	$223	$1,218	5.5
6	$289	$2,336	8.1
7	$368	$1,938	5.3
8	$456	$1,938	4.3
National Weighted Average	**$246**	**$1,365**	**5.6**

The simple paybacks in Table 6 are an overall average for all changes made in the 2009 IECC. Consequently, some changes result in shorter paybacks than the average simple payback and some in longer paybacks. This analysis did not calculate the individual payback period for each modification to the 2009 IECC.

Conclusions

The Energy Savings Calculation Methodology used in this analysis provides detailed energy cost savings, percent energy savings, and a simple payback cost effectiveness analysis. The national average percent energy cost savings for the 2009 IECC over the 2006 Baseline is 13.9 percent, site energy savings is 10.7 percent, and source energy savings 13.8 percent. This result is slightly lower than some other estimates making similar comparisons (14.7% ICF 2008).

Although the overall payback period is relatively low (average 5.6-year payback), there are changes that are significantly more cost effective (e.g., high-efficacy lighting, duct tightness) than others (e.g., additional wall and/or floor insulation in Climate Zones 7-8). Additional analysis will be necessary to quantify the savings and payback periods for individual changes.

This analysis also does not take into account the learning curve associated with new requirements or potential liability associated with techniques or technologies necessary to meet the requirements of the 2009 IECC. It does provide a reasonable cost estimate and energy savings based on typical construction practices for an average size house by both climate zone and on a national basis.

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Appendix A: Prescriptive Requirements for 2006 IECC

2006 Internation Energy Conservation Code

Climate Zone	Fenestration U-Factor	Skylight U-Factor	Glazed [b] Fenestration SHGC	Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall R-Value	Floor R-Value	Basement [c] Wall R-Value	Slab [d] R-Value & Depth	Crawl [c] Space Wall R-Value
1	1.20	0.75	0.40	30	13	3	13	0	0	0
2	0.75	0.75	0.40	30	13	4	13	0	0	0
3	0.65	0.65	0.40 [e]	30	13	5	19	0	0	5/13
4 Less Marine	0.40	0.60	NR	38	13	5	19	10/13	10/2	10/13
5 & 4 Marine	0.35	0.60	NR	38	19 or 13+5 [g]	13	30 [f]	10/13	10/2	10/13
6	0.35	0.60	NR	49	19 or 13+5 [g]	15	30 [f]	10/13	10/2	10/13
7 & 8	0.35	0.60	NR	49	21	19	30 [f]	10/13	10/2	10/13

R-Values are mins. U-Factors are max. R19 permitted in 2x6 cavity

b Applies to all Fenestration

c First is continuous, second is framing cavity

d R-5 shall be added to slab edge for heated slabs

e No SHGC for Marine zones

f Or insulation to fill the framing cavity, R-19 minimum

g First is cavity, second is sheathing

Appendix B: Prescriptive Requirements for 2009 IECC

2009 Internation Energy Conservation Code

Climate Zone	Fenestration U-Factor	Skylight U-Factor	Glazed b,e Fenestration SHGC	Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall i R-Value	Floor R-Value	Basement c Wall R-Value	Slab d R-Value & Depth	Crawl c Space Wall R-Value
1	1.20	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 Less Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10/2	10/13
5 & 4 Marine	0.35	0.60	NR	38	20 or 13+5 h	13/17	30 g	10/13	10/2	10/13
6	0.35	0.60	NR	49	20 or 13+5 h	15/19	30 g	15/19	10/2	10/13
7 & 8	0.35	0.60	NR	49	21	19/21	38 g	15/19	10/2	10/13

Highlighted cells represent modifications to the 2009 IECC

b Applies to all Fenestration

c First is continuous, second is framing cavity

d R-5 shall be added to slab edge for heated slabs

e No SHGC for Marine zones

f Not required in warm humid locations per table 301.1

g Or insulation to fill the framing cavity, R-19 minimum

h First is cavity, second is sheathing

i Second value applies when more than half the insulation is on the interior

j For impact Rated - U-Factors shall be 0.75 for zone 2 and 0.65 for 3

Appendix C: Climate-Specific Cost Breakdown

Climate Zone 1, Light Frame and Mass Walls

Framed Walls	Cost		Code Requirement		Foundation Distribution										Cost Source
35%					0% Conditioned Basement		0% Conditioned Crawlspace		90% Slab on Grade		0% Unconditioned Bsmt		10% Vented Crawlspace		
	Unit Cost	Unit	2006 IECC	2009 IECC											
Window U-Factor	$ 0.50	sq ft window	1.20	1.20											
SHGC			0.40	0.30						$ 194				$ 194	Paquette (2010)
Ceilings			0.035	0.035											
Walls			0.082	0.082											
Mass Wall			N/A	N/A											
Floors			0.064	0.064											
Bsmt Walls			0.360	0.360											
Slab			0.000	0.00											
Crawl Wall			0.477	0.477											
CFL	$ 1.00	% cfl	10% (base)	50%						$ 40				$ 40	Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf						$ 259				$ 259	Building America
Blower Door		per house	N/R	7 ACH 50						$ 165				$ 165	Southface
Air Sealing	$ 0.12	sq ft floor		Required						$ 282				$ 282	ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required						$ 165				$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required						$ 25				$ 25	Local Survey
Incremental Cost										**$ 1,130**				**$ 1,130**	**$ 1,130**

Mass Walls	Cost		Code Requirement		Foundation Distribution										Cost Source
65%					0% Conditioned Basement		0% Conditioned Crawlspace		90% Slab on Grade		0% Unconditioned Basement		10% Vented Crawlspace		
	Unit Cost	Unit	2006 IECC	2009 IECC											
Window U-Factor	$ 0.50	sq ft window	1.20	1.20											
SHGC			0.40	0.30						$ 194				$ 194	Paquette (2010)
Ceilings			0.035	0.035											
Walls			N/A	N/A											
Mass Wall (R-3->R-4)	$ 0.10	sq ft wall	R-3	R-4						$ 258				$ 258	ASHRAE 1481 RP
Floors			0.064	0.064											
Bsmt Walls			0.360	0.360											
Slab			0.000	0.00											
Crawl Wall			0.477	0.477											
CFL	$ 1.00	% cfl	10% (base)	50%						$ 40				$ 40	Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf						$ 259				$ 259	Building America
Blower Door	$ 165	per house	N/R	7 ACH 50						$ 165				$ 165	Southface
Air Sealing	$ 0.12	sq ft floor		Required						$ 282				$ 282	ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required						$ 165				$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required						$ 25				$ 25	Local Survey
Incremental Cost										**$ 1,388**				**$ 1,388**	**$ 1,388**

Climate Zone 1 Weighted Average Incremental Cost=	**$ 1,297**

Climate Zone 2, Light Frame and Mass Walls

Framed Walls	Cost		Code Requirement		Foundation Distribution												Cost Source
85%					0% Conditioned Basement		0% Conditioned Crawlspace		90% Slab on Grade		0% Unconditioned Basement		0% Vented Crawlspace				
	Unit Cost	Unit	2006 IECC	2009 IECC													
Window U-Factor	$ 0.50	sq ft window	0.75	0.65													
SHGC			0.40	0.30						$ 194						$ 194	Paquette (2010)
Ceilings			0.035	0.035													
Walls			0.082	0.082													
Mass Wall			N/A	N/A													
Floors			0.064	0.064													
Bsmt Walls			0.360	0.360													
Slab			0.000	0.00													
Crawl Wall			0.477	0.477													
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Duct Blaster	$ 165	per house	N/R	Required						$ 165						$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required						$ 25						$ 25	Local Survey
Incremental Cost										$ 1,130						$ 1,130	**$ 1,130**

Mass Walls	Cost		Code Requirement		Foundation Distribution												Cost Source
15%					0% Conditioned Basement		0% Conditioned Crawlspace		90% Slab on Grade		0% Unconditioned Basement		0% Vented Crawlspace				
	Unit Cost	Unit	2006 IECC	2009 IECC													
Window U-Factor	$ 0.50	sq ft window	0.75	0.65													
SHGC			0.40	0.30						$ 194						$ 194	Paquette (2010)
Ceilings			0.035	0.035													
Walls			N/A	N/A													
Mass Wall (R-3->R-4)	$ 0.10	sq ft wall	R-3	R-4						$ 258						$ 258	ASHRAE 1481 RP
Floors			0.064	0.064													
Bsmt Walls			0.360	0.360													
Slab			0.000	0.00													
Crawl Wall			0.477	0.477													
CFL	$ 1.00	% cfl	10% (base)	50%						$ 40						$ 40	Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf						$ 259						$ 259	Building America
Blower Door		per house	N/R	7 ACH 50						$ 165						$ 165	Southface
Air Sealing	$ 0.12	sq ft floor		Required						$ 282						$ 282	ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required						$ 165						$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required						$ 25						$ 25	Local Survey
Incremental Cost										$ 1,388						$ 1,388	**$ 1,388**

Climate Zone 2 Weighted Average Incremental Cost=	**$ 1,168**

Climate Zones 3 and 4

Framed Walls	Cost		Code Requirement		Foundation Distribution												Cost Source
					0% Conditioned Basement		0% Conditioned Crawlspace		75% Slab on Grade		15% Unconditioned Basement		10% Vented Crawlspace				
	Unit Cost	Unit	2006 IECC	2009 IECC													
Window U-Factor	$ 1.00	sq ft window	0.65	0.50													
SHGC			0.40	0.30						$ 387		$ 387		$ 387			Paquette (2010)
Ceilings			0.035	0.035													
Walls			0.082	0.082													
Mass Wall			N/A	N/A													
Floors			0.064	0.064													
Bsmt Walls	$1.87	sq ft wall	0.360	0.091								$ 2,932					ASHRAE 1481 RP
Slab			0	0													
Crawl Wall			0.477	0.477													
CFL	$ 1.00	% cfl	10% (base)	50%						$ 40		$ 40		$ 40			Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf						$ 259		$ 259		$ 259			Building America
Blower Door	$ 165	per house	N/R	7 ACH 50						$ 165				$ 165			Southface
Air Sealing	$ 0.12	sq ft floor		Required						$ 282				$ 282			ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required						$ 165				$ 165			Southface
Prog Thermostat	$ 25	per house	N/R	Required						$ 25				$ 25			Local Survey
Incremental Cost										**$ 1,323**		**$ 3,618**		**$ 1,323**			**$ 1,667**

Climate Zone 3 Weighted Average Incremental Cost=	$ 1,667

Framed Walls	Cost		Code Requirement		Foundation Distribution												Cost Source
					35% Conditioned Basement		0% Conditioned Crawlspace		25% Slab on Grade		20% Unconditioned Basement		20% Vented Crawlspace				
	Unit Cost	Unit	2006 IECC	2009 IECC													
Window U-Factor	$ 0.50	sq ft window	0.40	0.35													
SHGC			N/R	N/R		$ 194				$ 194		$ 194		$ 194			Paquette (2010)
Ceilings			0.030	0.030													
Walls			0.082	0.082													
Mass Wall			N/A	N/A													
Floors			0.047	0.047													
Bsmt Walls			0.059	0.059													
Slab			10\2	10\2													
Crawl Wall			0.065	0.065													
CFL	$ 1.00	% cfl	10% (base)	50%		$ 40				$ 40		$ 40		$ 40			Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf		N/R				$ 259		$ 259		$ 259			Building America
Blower Door	$ 165	per house	N/R	7 ACH 50		$ 165				$ 165		$ 165		$ 165			Southface
Air Sealing	$ 0.12	sq ft floor		Required		$ 282				$ 282		$ 282		$ 282			ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required		N/R				$ 165		$ 165		$ 165			Southface
Prog Thermostat	$ 25	per house	N/R	Required		$ 25				$ 25		$ 25		$ 25			Local Survey
Incremental Cost						**$ 706**				**$ 1,130**		**$ 1,130**		**$ 1,130**			**$ 981**

Climate Zone 4 Weighted Average Incremental Cost=	$ 981

Climate Zone 5, Light Frame and Mass Walls

Framed Walls	Cost		Code Requirement		Foundation Distribution										Cost Source
95%	Unit Cost	Unit	2006 IECC	2009 IECC	45% Conditioned Basement		5% Conditioned Crawlspace		10% Slab on Grade		35% Unconditioned Basement		5% Vented Crawlspace		
Window U-Factor			0.35	0.35											
SHGC			N/R	N/R											
Ceilings			0.030	0.030											
Frame Walls	$ 0.18	sq ft wall	0.060	0.057		$ 464		$ 464		$ 464		$ 464		$ 464	ASHRAE 1481 RP
Mass Wall			N/A	N/A											
Floors			0.033	0.033											
Bsmt Walls			0.059	0.059											
Slab			10\2	10\2											
Crawl Wall			0.065	0.065											
CFL	$ 1.00	% cfl	10% (base)	50%		$ 40		$ 40		$ 40		$ 40		$ 40	Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf		N/R		N/R		$ 259		$ 259		$ 259	Building America
Blower Door	$ 165	per house	N/R	7 ACH 50		$ 165		$ 165		$ 165		$ 165		$ 165	Southface
Air Sealing	$ 0.12	sq ft floor		Required		$ 282		$ 282		$ 282		$ 282		$ 282	ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required		N/R		N/R		$ 165		$ 165		$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required		$ 25		$ 25		$ 25		$ 25		$ 25	Local Survey
Incremental Cost						**$ 977**		**$ 977**		**$ 1,401**		**$ 1,401**		**$ 1,401**	**$ 1,189**

Mass Walls	Cost		Code Requirement		Foundation Distribution										Cost Source
5%	Unit Cost	Unit	2006 IECC	2009 IECC	45% Conditioned Basement		5% Conditioned Crawlspace		10% Slab on Grade		35% Unconditioned Basement		5% Vented Crawlspace		
Window U-Factor			0.35	0.35											
SHGC			N/R	N/R											
Ceilings			0.030	0.030											
Frame Walls			N/A	N/A											
Mass Wall	$ 0.41	per sq ft wall	R-13	R-17		$ 1,060		$ 1,060		$ 1,060		$ 1,060		$ 1,060	ASHRAE 1481 RP
Floors			0.047	0.047											
Bsmt Walls			0.059	0.059											
Slab			10\2	10\2											
Crawl Wall			0.065	0.065											
CFL	$ 1.00	% cfl	10% (base)	50%		$ 40		$ 40		$ 40		$ 40		$ 40	Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf		N/R		N/R		$ 259		$ 259		$ 259	Building America
Blower Door	$ 165	per house	N/R	7 ACH 50		$ 165		$ 165		$ 165		$ 165		$ 165	Southface
Air Sealing	$ 0.12	sq ft floor		Required		$ 282		$ 282		$ 282		$ 282		$ 282	ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required		N/R		N/R		$ 165		$ 165		$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required		$ 25		$ 25		$ 25		$ 25		$ 25	Local Survey
Incremental Cost						**$ 1,572**		**$ 1,572**		**$ 1,996**		**$ 1,996**		**$ 1,996**	**$ 1,784**

Climate Zone 5 Weighted Average Incremental Cost=	**$ 1,218**

Climate Zones 6, 7 and 8

Framed Walls	Cost		Code Requirement		Foundation Distribution										Cost Source
					75% Conditioned Basement		5% Conditioned Crawlspace		5% Slab on Grade		10% Unconditioned Basement		5% Vented Crawlspace		
	Unit Cost	Unit	2006 IECC	2009 IECC											
Window U-Factor			0.35	0.35											
SHGC			N/R	N/R											
Ceilings			0.026	0.026											
Frame Walls	$ 0.18	sq ft of wall	0.060	0.057		$ 464		$ 464		$ 464		$ 464		$ 464	ASHRAE 1481 RP
Mass Wall			N/A	N/A											
Floors			0.033	0.033											
Bsmt Walls	$ 1.05	sq ft wall	0.059	0.050		$ 1,644									ASHRAE 1481 RP
Slab			10\4	10\4											
Crawl Wall	$ 1.05	sq ft wall	0.065	0.055				$ 822							ASHRAE 1481 RP
CFL	$ 1.00	% cfl	10% (base)	50%		$ 40		$ 40		$ 40		$ 40		$ 40	Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf		N/R		N/R		$ 259		$ 259		$ 259	Building America
Blower Door	$ 165	per house	N/R	7 ACH 50		$ 165		$ 165		$ 165		$ 165		$ 165	Southface
Air Sealing	$ 0.12	sq ft floor		Required		$ 282		$ 282		$ 282		$ 282		$ 282	ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required		N/R		N/R		$ 165		$ 165		$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required		$ 25		$ 25		$ 25		$ 25		$ 25	Local Survey
Incremental Cost						**$ 2,621**		**$ 1,799**		**$ 1,401**		**$ 1,401**		**$ 1,401**	**$ 2,336**

Climate Zone 6 Weighted Average Incremental Cost=	**$ 2,336**

Framed Walls	Cost		Code Requirement		Foundation Distribution										Cost Source
					75% Conditioned Basement		5% Conditioned Crawlspace		5% Slab on Grade		10% Unconditioned Basement		5% Vented Crawlspace		
	Unit Cost	Unit	2006 IECC	2009 IECC											
Window U-Factor			0.35	0.35											
SHGC			N/R	N/R											
Ceilings			0.026	0.026											
Frame Walls			0.057	0.057											
Mass Wall			N/A	N/A											
Floors	$ 0.25	sq ft floor	0.033	0.028								$ 443		$ 443	ASHRAE 1481 RP
Bsmt Walls	$ 1.05	sq ft wall	0.059	0.050		$ 1,644									ASHRAE 1481 RP
Slab			10\4	10\4											
Crawl Wall	$ 1.05	sq ft wall	0.065	0.055				$ 822							ASHRAE 1481 RP
CFL	$ 1.00	% cfl	10% (base)	50%		$ 40		$ 40		$ 40		$ 40		$ 40	Local Survey
Ducts	$ 259	per house	15% (base)	8cfm/100sf		N/R		N/R		$ 259		$ 259		$ 259	Building America
Blower Door	$ 165	per house	N/R	7 ACH 50		$ 165		$ 165		$ 165		$ 165		$ 165	Southface
Air Sealing	$ 0.12	sq ft floor		Required		$ 282		$ 282		$ 282		$ 282		$ 282	ASHRAE 1481 RP
Duct Blaster	$ 165	per house	N/R	Required		N/R		N/R		$ 165		$ 165		$ 165	Southface
Prog Thermostat	$ 25	per house	N/R	Required		$ 25		$ 25		$ 25		$ 25		$ 25	Local Survey
Incremental Cost						**$ 2,156**		**$ 1,334**		**$ 936**		**$ 1,379**		**$ 1,379**	**$ 1,938**

Climate Zones 7 &8 Weighted Average Incremental Cost=	**$ 1,938**