

2012 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 cost savings, and percent energy cost savings associated with constructing a house compliant with the 2012 IECC relative to a 2006 IECC baseline. A methodology established by the NAHB Research Center was used to determine the incremental energy cost savings. A cost effectiveness analysis was also performed using both the 2006 and 2009 IECC as a baseline to illustrate incremental paybacks in an analysis with different baselines.

Background

A strong push was made by many advocacy groups, including the U. S. Department of Energy (DOE), to increase the stringency of the 2012 International Energy Conservation Code (IECC) to achieve a 30 percent energy savings relative to the 2006 IECC. This effort resulted in a number of major changes which impact both energy savings and construction costs for residential construction.

Energy Evaluation Methodology

A methodology was developed by the NAHB Research Center (NAHB Research Center 2012-1) to calculate energy savings with 2006 IECC as the primary 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 editions 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
1 st Floor CFA	1,780	1,776
2 nd 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
1 st Floor Wall Area	2,006	1,764
2 nd 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

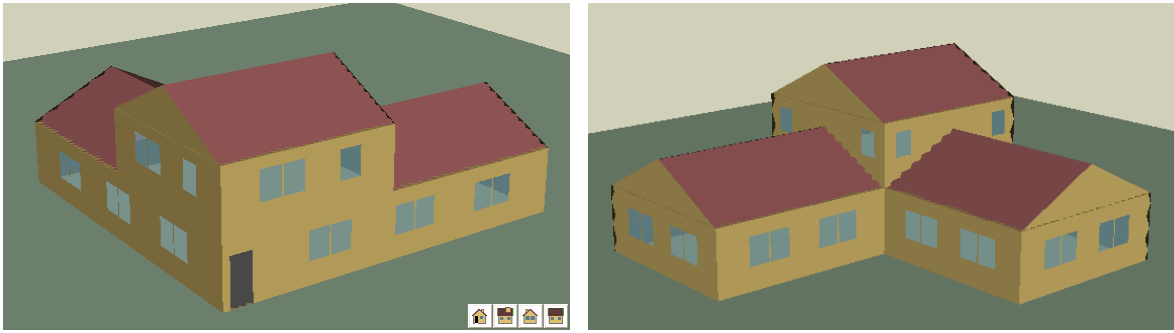


Figure 1: Simulation Model of Standard Reference House

Representative Cities

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

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

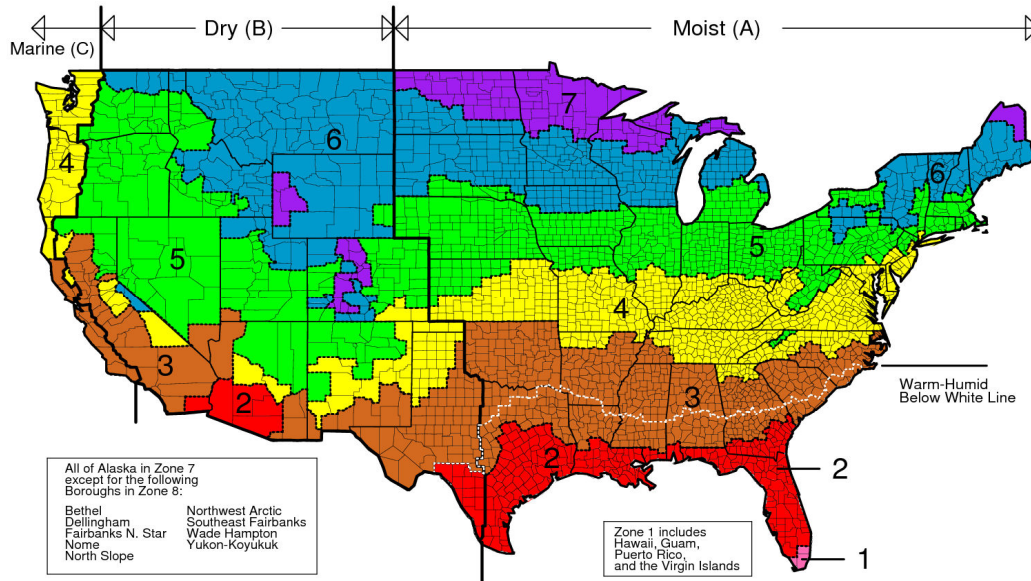


Figure 2: DOE Climate Zone Map

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 based on how new homes are constructed as determined by the NAHB Research Center's Annual Builder Practices Survey (ABPS). 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 2012 IECC

A number of major changes were made from the 2006 IECC to the 2012 IECC. For the first time, performance testing for whole building tightness is now mandated in the IECC. Lighting requirements were added to the scope of the IECC in 2009 and further increased in 2012. The largest cost increases have been due to the changes in wall insulation requirements which affected six of the eight climate zones. Also added was a prescriptive requirement mandating insulation on the hot water pipes for specific locations and on all pipes exceeding specified lengths.

Appendix A includes the baseline 2006 IECC prescriptive table and Appendices B and C contain the 2009 and 2012 IECC prescriptive tables, respectively, with highlighted changes from the 2006 edition. Table 3 shows the incremental cost for changes made between the 2006 and 2012 IECC specified by climate zone. All costs listed below are based on a unit basis and totals for the *Standard Reference House*. Costs from the ASHRAE RP-1481 have been escalated for inflation using RS Means adjustment factors.

Construction Costs Associated with 2012 IECC Changes

Each climate zone has different requirements; consequently, the resulting incremental construction costs to comply with the 2012 IECC vary between climate zones. The cost increases (Table 4) range from a high of \$8,871 in Climate Zone 3 to a low of \$4,499 in Climate Zone 2, with a national weighted average cost increase of \$7,034. Complete cost analysis details on the individual measures for each climate zone can be found in Appendix D.

Calculated Energy Usage

Table 4 summarizes the calculated energy usage for a house built to the minimum requirements of both the 2006 and 2012 IECC. The following nomenclature is used to categorize the energy use:

TEU_{2006} = Total Energy Usage using the 2006 IECC

TEU_{2012} = Total Energy Usage using the 2012 IECC

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

Energy cost savings are calculated using 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 multipliers to obtain source Btu's are 3.365 for electricity and 1.092 for natural gas (Hendron 2008).

Table 3: Itemized 2012 IECC Incremental Construction Cost over 2006 IECC

Affected Climate Zone(s)	Item	Code Requirement		Cost			Source
		2006 IECC	2012 IECC	Unit Cost	Unit	Per House	
1,2	Air Sealing	N/R	5 ACH 50	\$ 0.26	sq ft floor	\$ 610	ASHRAE 1481 RP
3,4,5,6,7,8	Air Sealing	N/R	3 ACH 50	\$ 0.41	sq ft floor	\$ 955	ASHRAE 1481 RP
ALL	Blower Door Testing	N/R	Required	\$ 165	per house	\$ 165	Southface
2,3	Ceiling Insulation	R-30	R-38	\$ 0.25	sq ft attic	\$ 441	ASHRAE 1481 RP
4,5	Ceiling Insulation	R-38	R-49	\$ 0.53	sq ft attic	\$ 941	ASHRAE 1481 RP
ALL	High Efficacy Lighting	10% (base)	75%	\$ 1.00	% cfl	\$ 65	Local Survey
ALL	Duct Sealing	15% (base)	4cfm/100sf	\$ 800	per house	\$ 800	Building America
ALL	Duct Testing	N/R	Required	\$ 165	per house	\$ 165	Southface
7,8	Floor Insulation	R-30	R-38	\$ 0.72	sq ft floor	\$ 1,282	ASHRAE 1481 RP
1, 2	Mass Wall	R-3	R-4	\$ 0.10	sq ft wall	\$ 258	ASHRAE 1481 RP
5	Mass Wall	R-13	R-17	\$ 0.41	sq ft wall	\$ 1,060	ASHRAE 1481 RP
ALL	Mechanical Ventilation	N/R	Required	\$ 382	per house	\$ 382	Russell (2005)
ALL	Prog Thermostat	N/R	Required	\$ 25	per house	\$ 25	Local Survey
ALL	R-3 Plumbing	N/R	R-3	\$ 1,034	per house	\$ 1,034	NAHB RC (2010)
3,4	Wall- Above Grade	R-13	R-20	\$ 1.33	sq ft AG wall	\$ 3,433	ASHRAE 1481 RP
5	Wall- Above Grade	R-19	R-20	\$ 0.20	sq ft AG wall	\$ 516	ASHRAE 1481 RP
6	Wall- Above Grade	R-19	R-20+5	\$ 1.52	sq ft AG wall	\$ 3,927	ASHRAE 1481 RP
7,8	Wall- Above Grade	R-21	R-20+5	\$ 1.32	sq ft AG wall	\$ 3,403	ASHRAE 1481 RP
3 (northern 1/2)	Wall- Basement	N/R	R-10	\$ 1.87	sq ft BM wall	\$ 2,932	ASHRAE 1481 RP
5,6,7,8	Wall- Basement	R-10	R-15	\$ 1.05	sq ft BM wall	\$ 1,644	ASHRAE 1481 RP
5,6,7,8	Wall- Crawl Space	R-10	R-15	\$ 1.05	sq ft CS wall	\$ 822	ASHRAE 1481 RP
1	Window	U-1.2	U-0.5	\$ 2.86	sq ft window	\$ 1,108	ASHRAE 90.1 ENV
	SHGC	0.40	0.25				
2	Window	U-0.75	U-0.4	\$ 2.00	sq ft window	\$ 774	Paquette (2010)
	SHGC	0.40	0.25				
3	Window	U-0.65	U-0.35	\$ 2.50	sq ft window	\$ 968	Paquette (2010)
	SHGC	0.4	0.25				
4	Window	U-0.4	U-0.35	\$ 0.50	sq ft window	\$ 194	Paquette (2010)
	SHGC	NR	0.40				
5,6,7,8	Window	U-0.35	U-0.32	\$ 0.45	sq ft window	\$ 174	ASHRAE 90.1 ENV
	SHGC	NR	NR				

Table 4: 2012 IECC Incremental Construction Cost over 2006 IECC

Climate Zone/City	Incremental Construction Cost
1 Miami	\$4,521
2 Phoenix	\$4,499
3 Memphis	\$8,871
4 Baltimore	\$8,072
5 Chicago	\$5,872
6 Helena	\$8,734
7 Duluth	\$8,403
8 Fairbanks	\$8,403
National Weighted Average	\$7,034

Table 5: Annual Energy Usage for House Built to the 2006 and 2012 IECC

Location		kWh	Therms	Site MBtu	Source MBtu	Energy Cost
Zone 1 Miami	TEU ₂₀₀₆	19,267	25	68.2	223.9	\$ 2,300
	TEU ₂₀₁₂	15,296	24	54.6	178.2	\$ 1,831
	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 ₂₀₁₂	16,292	94	65.0	197.3	\$ 2,024
	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 ₂₀₁₂	14,049	287	76.6	192.6	\$ 1,967
	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 ₂₀₁₂	13,302	537	99.1	211.4	\$ 2,150
	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 ₂₀₁₂	12,436	875	129.9	238.3	\$ 2,412
	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 ₂₀₁₂	10,251	1,085	143.5	236.2	\$ 2,382
	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 ₂₀₁₂	9,394	1,567	188.8	279.0	\$ 2,801
	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 ₂₀₁₂	9,547	2,112	243.8	340.3	\$ 3,408
	HCWU ₂₀₀₆	1,455	2,985	303.5	342.7	\$ 3,396
National Weighted Average	TEU ₂₀₀₆	17,499	715	131.2	279.0	\$ 2,837
	TEU ₂₀₁₂	13,723	505	97.3	212.7	\$ 2,164
	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. Percent savings in Table 6 were calculated using a formula consistent with the PNNL/DOE presentation in various forums including the 2010 RESNET Conference (Taylor 2010):

$$\% \text{ Savings} = 100 * (\text{TEU}_{2006} - \text{TEU}_{2012}) / \text{HCWU}_{2006}$$

Table 6: 2012 IECC Energy Savings above the 2006 IECC

Climate Zone	Site Btu Savings	Source Btu Savings	Energy Cost Savings
1	34.5%	35.8%	35.8%
2	33.3%	35.3%	35.3%
3	40.1%	43.0%	43.1%
4	33.6%	37.1%	37.2%
5	31.6%	35.6%	35.8%
6	30.8%	36.3%	36.6%
7	33.3%	37.6%	37.8%
8	31.3%	34.6%	34.8%
National Weighted Average	33.9%	37.8%	37.9%

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 building components, or fuel escalation rates. Table 6 summarizes the energy cost savings, construction cost, and resulting simple payback for each climate zone by climate zone and a weighted national average.

The simple paybacks in Table 7 are based on an overall average for all changes in the 2012 IECC relative to a 2006 IECC baseline. 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 2012 IECC.

Table 7: 2012 IECC Cost Effectiveness Relative to 2006 IECC

Climate Zone	Annual Energy Savings	Incremental Construction Cost	Simple Payback (yrs)
1	\$470	\$4,521	9.6
2	\$556	\$4,499	8.1
3	\$732	\$8,871	12.1
4	\$627	\$8,072	12.9
5	\$728	\$5,872	8.1
6	\$687	\$8,734	12.7
7	\$978	\$8,403	8.6
8	\$1,180	\$8,403	7.1
National Weighted Average	\$673	\$7,034	10.4

Cost Effectiveness Using a 2009 IECC Baseline

The above analysis focused on construction costs and energy reduction associated with the 2012 IECC relative to a 2006 IECC baseline; however, it is important to understand that cost effectiveness decreases as energy requirements become more stringent, presuming the codes advance in a rational manner. Decreasing cost effectiveness becomes evident when comparing a defined code edition to varying baselines.

An analysis was performed using the same methodology comparing the 2006 IECC to the 2009 IECC (NAHB Research Center 2012-2). When code comparison results of the 2009 IECC analysis are compared with this analysis; the resulting difference in both energy savings and incremental cost are listed in Table 8. A national average incremental simple payback of 13.3 years was calculated when going from the 2009 IECC to the 2012 IECC as compared to the 10.4 years when using the 2006 IECC baseline, thus decreasing the cost effectiveness when evaluating the payback over the latest code cycle.

Table 8: 2012 IECC Cost Effectiveness Relative to 2009 IECC

Climate Zone	Annual Energy Savings	Incremental Construction Cost	Simple Payback (yrs)
1	\$206	\$3,224	15.7
2	\$294	\$3,330	11.3
3	\$470	\$7,203	15.3
4	\$410	\$7,091	17.3
5	\$505	\$4,653	9.2
6	\$397	\$6,399	16.1
7	\$609	\$6,465	10.6
8	\$725	\$6,465	8.9
National Weighted Average	\$427	\$5,668	13.3

Conclusions

The energy savings calculation methodology used in this analysis provides detailed incremental construction cost, energy cost savings, percent energy savings, and a simple payback cost effectiveness analysis. The national average percent energy cost savings for the 2012 IECC over the 2006 IECC baseline is 37.9 percent (site energy savings 33.9 percent; source energy savings 37.8 percent). This result is significantly higher than many estimates which simply accept the 2012 IECC as 30 percent more efficient than the 2006 IECC.

The additional cost to construct to the 2012 IECC relative to the 2006 IECC is \$7,034 with the majority of the increase (\$5,668) associated with the changes between the 2009 and 2012 versions of the IECC.

Incremental simple payback from the 2006 to the 2012 IECC is 10.4 years; however, if the analysis only considers changes made from the 2009 edition of the IECC, the payback for adopting the 2012 IECC increases to 13.3 years.

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Appendix A: Prescriptive Requirements for 2006 IECC

2006 International 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 International 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 2006 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: Prescriptive Requirements for 2012 IECC

2012 International Energy Conservation Code

Climate Zone	Fenestration U-Factor ^b	Skylight U-Factor ^b	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	0.50	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 Less Marine	0.35	0.55	0.40	49	20 or 13+5 ^h	8/13	19	10/13	10/2	10/13
5 & 4 Marine	0.32	0.55	NR	49	20 or 13+5 ^h	13/17	30 ^g	15/19	10/2	15/19
6	0.32	0.55	NR	49	20+5 or 13+10 ^h	15/20	30 ^g	15/19	10/4	15/19
7 & 8	0.32	0.55	NR	49	20+5 or 13+10 ^h	19/21	38 ^g	15/19	10/4	15/19

2009 Alteration
2012 Alteration

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 D: Itemized Climate-Specific Incremental Construction Costs 2006-2012 IECC

Climate Zone 1, Light Frame and Mass Walls

Framed Walls		Cost		Code Requirement		Foundation Distribution					Cost Source
						0%	0%	90%	0%	10%	
35%	Unit Cost	Unit	2006 IECC	2012 IECC	Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace		
Window	U-Factor SHGC	\$ 2.86	sq ft window	1.20	0.50			\$ 1,108		\$ 1,108	ASHRAE 90.1 Env
				0.40	0.25						
Ceilings				0.035	0.035						
Frame Walls				0.082	0.082						
Mass Wall				N/A	N/A						
Floors				0.064	0.064						
Bsmt Walls				0.360	0.360						
Slab				0	0						
Crawl Wall				0.477	0.477						
CFL	\$ 1.00	% cfl	10% (base)	75%			\$ 65			\$ 65	Local Survey
Ducts	\$ 800	per house	15% (base)	4cfm/100sf			\$ 800			\$ 800	Building America
Blower Door	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
Air Sealing	\$ 0.26	sq ft floor	N/R	5 ACH 50			\$ 610			\$ 610	ASHRAE 1481 RP
Mechanical Ventilation	\$ 382	per house	N/R	Required			\$ 382			\$ 382	Russell (2005)
Duct Blaster	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
R-3 Plumbing	\$ 1,034	per house	N/R	R-3			\$ 1,034			\$ 1,034	NAHB RC (2010)
Prog Thermostat	\$ 25	per house	N/R	Required			\$ 25			\$ 25	Local Survey
Incremental Cost							\$ 4,354			\$ 4,354	\$ 4,354

Mass Walls		Cost		Code Requirement		Foundation Distribution					Cost Source
						0%	0%	90%	0%	10%	
65%	Unit Cost	Unit	2006 IECC	2012 IECC	Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace		
Window	U-Factor SHGC	\$ 2.86	sq ft window	1.20	0.50			\$ 1,108		\$ 1,108	ASHRAE 90.1 Env
				0.40	0.25						
Ceilings				0.035	0.035						
Frame Walls				N/A	N/A						
Mass Wall	\$ 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	0						
CFL	\$ 1.00	% cfl	10% (base)	75%			\$ 65			\$ 65	Local Survey
Ducts	\$ 800	per house	15% (base)	4cfm/100sf			\$ 800			\$ 800	Building America
Blower Door	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
Air Sealing	\$ 0.26	sq ft floor	N/R	5 ACH 50			\$ 610			\$ 610	ASHRAE 1481 RP
Mechanical Ventilation	\$ 382	per house	N/R	Required			\$ 382			\$ 382	Russell (2005)
Duct Blaster	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
R-3 Plumbing	\$ 1,034	per house	N/R	R-3			\$ 1,034			\$ 1,034	NAHB RC (2010)
Prog Thermostat	\$ 25	per house	N/R	Required			\$ 25			\$ 25	Local Survey
Incremental Cost							\$ 4,612			\$ 4,612	\$ 4,612

Climate Zone 1 Weighted Average Incremental Cost= \$ 4,521

Climate Zone 2, Light Frame and Mass Walls

Framed Walls	Cost		Code Requirement		Foundation Distribution					Cost Source	
					0%	0%	90%	0%	10%		
					Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace		
85%	Unit Cost	Unit	2006 IECC	2012 IECC							
Window U-Factor SHGC	\$ 2.00	sq ft window	0.75	0.40			\$ 774			\$ 774	Paquette (2010)
			0.40	0.25							
Ceilings	\$ 0.25	sq ft attic	0.035	0.030			\$ 441			\$ 441	ASHRAE 1481 RP
Frame Walls			0.082	0.082							
Mass Wall			N/A	N/A							
Floors			0.064	0.064							
Bsmt Walls			0.360	0.360							
Slab			0	0							
Crawl Wall			0.477	0.477							
CFL	\$ 1.00	% cfl	10%	75%			\$ 65			\$ 65	Local Survey
Ducts	\$ 800	per house	15.0%	4cfm/100sf			\$ 800			\$ 800	Building America
Blower Door	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
Air Sealing	\$ 0.26	sq ft floor	N/R	5 ACH 50			\$ 610			\$ 610	ASHRAE 1481 RP
Mechanical Ventilation	\$ 382	per house	N/R	Required			\$ 382			\$ 382	Russell (2005)
Duct Blaster	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
R-3 Plumbing	\$ 1,034	per house	N/R	R-3			\$ 1,034			\$ 1,034	NAHB RC (2010)
Prog Thermostat	\$ 25	per house	N/R	Required			\$ 25			\$ 25	Local Survey
Incremental Cost							\$ 4,460			\$ 4,460	\$ 4,460

Mass Walls	Cost		Code Requirement		Foundation Distribution					Cost Source	
					0%	0%	90%	0%	10%		
					Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace		
15%	Unit Cost	Unit	2006 IECC	2012 IECC							
Window U-Factor SHGC	\$ 2.00	sq ft window	0.75	0.40			\$ 774			\$ 774	Paquette (2010)
			0.40	0.25							
Ceilings	\$ 0.25	sq ft attic	0.035	0.030			\$ 441			\$ 441	ASHRAE 1481 RP
Frame Walls			N/A	N/A							
Mass Wall	\$ 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	0							
Crawl Wall			0.477	0.477							
CFL	\$ 1.00	% cfl	10% (est)	75%			\$ 65			\$ 65	Local Survey
Ducts	\$ 800	per house	15.0%	4cfm/100sf			\$ 800			\$ 800	Building America
Blower Door	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
Air Sealing	\$ 0.26	sq ft floor	N/R	5 ACH 50			\$ 610			\$ 610	ASHRAE 1481 RP
Mechanical Ventilation	\$ 382	per house	N/R	Required			\$ 382			\$ 382	Russell (2005)
Duct Blaster	\$ 165	per house	N/R	Required			\$ 165			\$ 165	Southface
R-3 Plumbing	\$ 1,034	per house	N/R	R-3			\$ 1,034			\$ 1,034	NAHB RC (2010)
Prog Thermostat	\$ 25	per house	N/R	Required			\$ 25			\$ 25	Local Survey
Incremental Cost							\$ 4,718			\$ 4,718	\$ 4,718

Climate Zone 2 Weighted Average Incremental Cost= \$ 4,499

Climate Zones 3 and 4

Framed Walls					Foundation Distribution									Cost Source
					Cost		Code Requirement		0%	0%	75%	15%	10%	
100%	Unit Cost	Unit	2006 IECC	2012 IECC	Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace					
Window U-Factor SHGC	\$ 2.50	sq ft window	0.65	0.35			\$ 968	\$ 968	\$ 968	Paquette (2010)				
Ceilings	\$ 0.25	sq ft attic	0.035	0.030			\$ 441	\$ 441	\$ 441	ASHRAE 1481 RP				
Frame Walls	\$ 1.33	sq ft wall	0.082	0.057			\$ 3,433	\$ 3,433	\$ 3,433	ASHRAE 1481 RP				
Mass Wall			N/A	N/A										
Floors			0.047	0.047										
Bsmt Walls	\$1.87	sq ft base wall	0.360	0.091				\$ 2,932		ASHRAE 1481 RP				
Slab			0	0										
Crawl Wall			0.136	0.136										
CFL	\$ 1.00	% cfl	10% (base)	75%			\$ 65	\$ 65	\$ 65	Local Survey				
Ducts	\$ 800	per house	15% (base)	4cfm/100sf			\$ 800	\$ 800	\$ 800	Building America				
Blower Door	\$ 165	per house	N/R	Required			\$ 165	\$ 165	\$ 165	Southface				
Mechanical Ventilation	\$ 382	per house	N/R	Required			\$ 382	\$ 382	\$ 382	Russell (2005)				
Air Sealing	\$ 0.41	sq ft floor	N/R	3 ACH 50			\$ 955	\$ 955	\$ 955	ASHRAE 1481 RP				
Duct Blaster	\$ 165	per house	N/R	Required			\$ 165	\$ 165	\$ 165	Southface				
R-3 Plumbing	\$ 1,034	per house	N/R	R-3			\$ 1,034	\$ 1,034	\$ 1,034	NAHB RC (2010)				
Prog Thermostat	\$ 25	per house	N/R	Required			\$ 25	\$ 25	\$ 25	Local Survey				
Incremental Cost							\$ 8,431	\$ 11,363	\$ 8,431	\$ 8,871				

Climate Zone 3 Weighted Average Incremental Cost= \$ 8,871

Framed Walls					Foundation Distribution									Cost Source
					Cost		Code Requirement		35%	0%	25%	20%	20%	
100%	Unit Cost	Unit	2006 IECC	2012 IECC	Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace					
Window U-Factor SHGC	\$ 0.50	sq ft window	0.40	0.35	\$ 194	\$ 194	\$ 194	\$ 194	\$ 194	Paquette (2010)				
Ceilings	\$ 0.53	sq ft attic	0.030	0.026	\$ 941		\$ 941	\$ 941	\$ 941	ASHRAE 1481 RP				
Frame Walls	\$ 1.33	sq ft wall	0.082	0.057	\$ 3,433		\$ 3,433	\$ 3,433	\$ 3,433	ASHRAE 1481 RP				
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)	75%	\$ 65		\$ 65	\$ 65	\$ 65	Local Survey				
Ducts	\$ 800	per house	15% (base)	4cfm/100sf	NR		\$ 800	\$ 800	\$ 800	Building America				
Blower Door	\$ 165	per house	N/R	Required	\$ 165		\$ 165	\$ 165	\$ 165	Southface				
Mechanical Ventilation	\$ 382	per house	N/R	Required	\$ 382		\$ 382	\$ 382	\$ 382	Russell (2005)				
Air Sealing	\$ 0.41	sq ft floor	N/R	3 ACH 50	\$ 1,676		\$ 955	\$ 955	\$ 955	ASHRAE 1481 RP				
Duct Blaster	\$ 165	per house	N/R	Required	NR		\$ 165	\$ 165	\$ 165	Southface				
R-3 Plumbing	\$ 1,034	per house	N/R	R-3	\$ 1,034		\$ 1,034	\$ 1,034	\$ 1,034	NAHB RC (2010)				
Prog Thermostat	\$ 25	per house	N/R	Required	\$ 25		\$ 25	\$ 25	\$ 25	Local Survey				
Incremental Cost					\$ 7,913		\$ 8,157	\$ 8,157	\$ 8,157	\$ 8,072				

Climate Zone 4 Weighted Average Incremental Cost= \$ 8,072

Climate Zone 5, Light Frame and Mass Walls

Framed Walls		Cost		Code Requirement		Foundation Distribution						Cost Source
						45%	5%	10%	35%	5%		
95%	Unit Cost	Unit	2006 IECC	2012 IECC	Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace			
Window U-Facto SHGC	\$ 0.45	sq ft window	0.35	0.32	\$ 174	\$ 174	\$ 174	\$ 174	\$ 174	\$ 174	ASHRAE 90.1 Env	
Ceilings	\$ 0.53	sq ft attic	0.030	0.026	\$ 941	\$ 941	\$ 941	\$ 941	\$ 941	\$ 941	ASHRAE 1481 RP	
Frame Walls	\$ 0.20	sq ft wall	0.060	0.057	\$ 516	\$ 516	\$ 516	\$ 516	\$ 516	\$ 516	ASHRAE 1481 RP	
Mass Wall			N/A	N/A								
Floors			0.033	0.033								
Bsmt Walls	\$ 1.05	sq ft base w/	0.059	0.050	\$ 1,644						ASHRAE 1481 RP	
Slab			10/2	10/2								
Crawl Wall	\$ 1.05	sq ft base w/	0.065	0.055		\$ 822					ASHRAE 1481 RP	
CFL	\$ 1.00	% cfl	10% (base)	75%	\$ 65	\$ 65	\$ 65	\$ 65	\$ 65	\$ 65	Local Survey	
Ducts	\$ 800	per house	15% (base)	4cfm/100sf	NR	NR	\$ 800	\$ 800	\$ 800	\$ 800	Building America	
Blower Door	\$ 165	per house	N/R	Required	\$ 165	\$ 165	\$ 165	\$ 165	\$ 165	\$ 165	Southface	
Mechanical Ventilation	\$ 382	per house	N/R	Required	\$ 382	\$ 382	\$ 382	\$ 382	\$ 382	\$ 382	Russell (2005)	
Air Sealing	\$ 0.41	sq ft floor	N/R	3 ACH 50	\$ 1,676	\$ 955	\$ 955	\$ 955	\$ 955	\$ 955	ASHRAE 1481 RP	
Duct Blaster	\$ 165	per house	N/R	Required	NR	NR	\$ 165	\$ 165	\$ 165	\$ 165	Southface	
R-3 Plumbing	\$ 1,034	per house	N/R	R-3	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	NAHB RC (2010)	
Prog Thermostat	\$ 25	per house	N/R	Required	\$ 25	\$ 25	\$ 25	\$ 25	\$ 25	\$ 25	Local Survey	
Incremental Cost					\$ 6,621	\$ 5,079	\$ 5,221	\$ 5,221	\$ 5,221	\$ 5,221	\$ 5,844	

Mass Walls		Cost		Code Requirement		Foundation Distribution						Cost Source
						45%	5%	10%	35%	5%		
5%	Unit Cost	Unit	2006 IECC	2012 IECC	Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace			
Window U-Facto SHGC	\$ 0.45	sq ft window	0.35	0.32	\$ 174	\$ 174	\$ 174	\$ 174	\$ 174	\$ 174	ASHRAE 90.1 Env	
Ceilings	\$ 0.53	sq ft attic	0.030	0.026	\$ 941	\$ 941	\$ 941	\$ 941	\$ 941	\$ 941	ASHRAE 1481 RP	
Frame Walls	\$ 0.20	sq ft wall	N/A	N/A								
Mass Wall	\$ 0.41	per house	R-13	R-17	\$ 1,060	\$ 1,060	\$ 1,060	\$ 1,060	\$ 1,060	\$ 1,060	ASHRAE 1481 RP	
Floors			0.033	0.033								
Bsmt Walls	\$ 1.05	sq ft base w/	0.059	0.050	\$ 1,644						ASHRAE 1481 RP	
Slab			10/2	10/2								
Crawl Wall	\$ 1.05	sq ft base w/	0.065	0.055		\$ 822					ASHRAE 1481 RP	
CFL	\$ 1.00	% cfl	10% (base)	75%	\$ 65	\$ 65	\$ 65	\$ 65	\$ 65	\$ 65	Local Survey	
Ducts	\$ 800	per house	15% (base)	4cfm/100sf	NR	NR	\$ 800	\$ 800	\$ 800	\$ 800	Building America	
Blower Door	\$ 165	per house	N/R	Required	\$ 165	\$ 165	\$ 165	\$ 165	\$ 165	\$ 165	Southface	
Mechanical Ventilation	\$ 382	per house	N/R	Required	\$ 382	\$ 382	\$ 382	\$ 382	\$ 382	\$ 382	Russell (2005)	
Air Sealing	\$ 0.41	sq ft floor	N/R	3 ACH 50	\$ 1,676	\$ 955	\$ 955	\$ 955	\$ 955	\$ 955	ASHRAE 1481 RP	
Duct Blaster	\$ 165	per house	N/R	Required	NR	NR	\$ 165	\$ 165	\$ 165	\$ 165	Southface	
R-3 Plumbing	\$ 1,034	per house	N/R	R-3	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	NAHB RC (2010)	
Prog Thermostat	\$ 25	per house	N/R	Required	\$ 25	\$ 25	\$ 25	\$ 25	\$ 25	\$ 25	Local Survey	
Incremental Cost					\$ 7,166	\$ 5,623	\$ 5,766	\$ 5,766	\$ 5,766	\$ 5,766	\$ 6,389	

Climate Zone 5 Weighted Average Incremental Cost= \$ 5,872

Climate Zones 6, 7 and 8

Framed Walls	Cost		Code Requirement		75%	5%	5%	10%	5%	Cost Source
	100%	Unit Cost	Unit	2006 IECC	2012 IECC	Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	
Window U-Factor SHGC	\$ 0.45	sq ft window	0.35	0.32	\$ 174	\$ 174	\$ 174	\$ 174	\$ 174	ASHRAE 90.1 Env
Ceilings			N/R	N/R						
Ceilings			0.026	0.026						
Frame Walls	\$ 1.52	sq ft of wall	0.060	0.048	\$ 3,927	\$ 3,927	\$ 3,927	\$ 3,927	\$ 3,927	ASHRAE 1481 RP
Mass Wall			N/A	N/A						
Floors			0.033	0.033						
Bsmt Walls	\$ 1.05	sq ft base w	0.059	0.050	\$ 1,644					
Slab			10.4	10.4						
Crawl Wall	\$ 1.05	sq ft base w	0.065	0.055		\$ 822				ASHRAE 1481 RP
CFL	\$ 1.00	% cfl	10% (base)	75%	\$ 65	\$ 65	\$ 65	\$ 65	\$ 65	Local Survey
Ducts	\$ 800	per house	15% (base)	4cfm/100sf	NR	NR	\$ 800	\$ 800	\$ 800	Building America
Blower Door	\$ 165	per house	N/R	Required	\$ 165	\$ 165	\$ 165	\$ 165	\$ 165	Southface
Mechanical Ventilation	\$ 382	per house	N/R	Required	\$ 382	\$ 382	\$ 382	\$ 382	\$ 382	Russell (2005)
Air Sealing	\$ 0.41	sq ft floor	N/R	3 ACH 50	\$ 1,676	\$ 955	\$ 955	\$ 955	\$ 955	ASHRAE 1481 RP
Duct Blaster	\$ 165	per house	N/R	Required	NR	NR	\$ 165	\$ 165	\$ 165	Southface
R-3 Plumbing	\$ 1,034	per house	N/R	R-3	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	NAHB RC (2010)
Prog Thermostat	\$ 25	per house	N/R	Required	\$ 25	\$ 25	\$ 25	\$ 25	\$ 25	Local Survey
Incremental Cost					\$ 9,091	\$ 7,548	\$ 7,691	\$ 7,691	\$ 7,691	\$ 8,734

Climate Zone 6 Weighted Average Incremental Cost= \$ 8,734

Framed Walls	Cost		Code Requirement		Foundation Distribution					Cost Source	
	100%	Unit Cost	Unit	2006 IECC	2012 IECC	75%	5%	5%	10%		5%
						Conditioned Basement	Conditioned Crawlspace	Slab on Grade	Unconditioned Basement	Vented Crawlspace	
Window U-Factor SHGC	\$ 0.45	sq ft window	0.35	0.32		\$ 174	\$ 174	\$ 174	\$ 174	\$ 174	ASHRAE 90.1 Env
Ceilings			N/R	N/R							
Ceilings			0.026	0.026							
Frame Walls	\$ 1.32	sq ft of wall	0.057	0.048		\$ 3,403	\$ 3,403	\$ 3,403	\$ 3,403	\$ 3,403	ASHRAE 1481 RP
Mass Wall			N/A	N/A							
Floors	\$ 0.72	sq ft floor	0.033	0.028					\$ 1,282	\$ 1,282	ASHRAE 1481 RP
Bsmt Walls	\$ 1.05	sq ft base w	0.059	0.050		\$ 1,644					ASHRAE 1481 RP
Slab			10.4	10.4							
Crawl Wall	\$ 1.05	sq ft base w	0.065	0.055			\$ 822				ASHRAE 1481 RP
CFL	\$ 1.00	% cfl	10% (base)	75%		\$ 65	\$ 65	\$ 65	\$ 65	\$ 65	Local Survey
Ducts	\$ 800	per house	15% (base)	4cfm/100sf		NR	NR	\$ 800	\$ 800	\$ 800	Building America
Blower Door	\$ 165	per house	N/R	Required		\$ 165	\$ 165	\$ 165	\$ 165	\$ 165	Southface
Mechanical Ventilation	\$ 382	per house	N/R	Required		\$ 382	\$ 382	\$ 382	\$ 382	\$ 382	Russell (2005)
Air Sealing	\$ 0.41	sq ft floor	N/R	3 ACH 50		\$ 1,676	\$ 955	\$ 955	\$ 955	\$ 955	ASHRAE 1481 RP
Duct Blaster	\$ 165	per house	N/R	Required		NR	NR	\$ 165	\$ 165	\$ 165	Southface
R-3 Plumbing	\$ 1,034	per house	N/R	R-3		\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	\$ 1,034	NAHB RC (2010)
Prog Thermostat	\$ 25	per house	N/R	Required		\$ 25	\$ 25	\$ 25	\$ 25	\$ 25	Local Survey
Incremental Cost						\$ 8,568	\$ 7,025	\$ 7,168	\$ 8,449	\$ 8,449	\$ 8,403

Climate Zones 7 & 8 Weighted Average Incremental Cost= \$ 8,403