U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

National Energy and Cost Savings for New Single- and Multifamily Homes:

A Comparison of the 2006, 2009, and 2012 Editions of the IECC

Building Energy Codes

National Energy and **Cost Savings** for New Single- and Multifamily Homes: A Comparison of the **2006, 2009,** and **2012 Editions** of the **IECC**

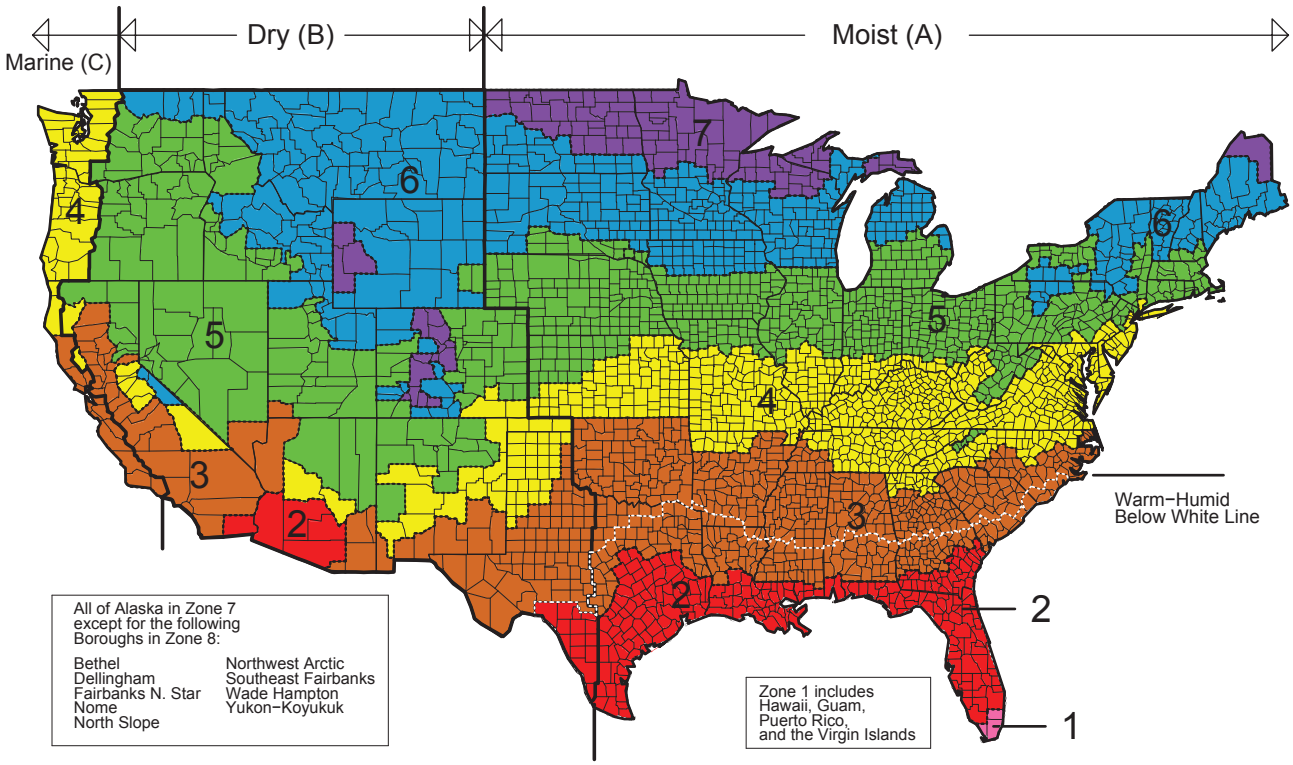

Figure 1. National Climate Zones

The 2009 and 2012 International Energy Conservation Codes (IECC) yield positive benefits for U.S. homeowners and significant energy savings for the nation.

Moving from a baseline of the 2006 IECC to the 2009 IECC reduces average annual energy costs by 10.8%, while moving from the same baseline to the 2012 IECC reduces them by 32.1%.

Highlights

National average energy savings against a 2006 IECC baseline:

- The 2009 IECC saves 10.8% of energy spent for heating, cooling, water heating, and lighting
- The 2012 IECC saves 32.1%

Long-term cost-effectiveness for consumers:

- Life-cycle cost savings over a 30-year period, averaged across all building types and configurations, are significant in all climate zones
- Average consumer savings range from $1,944 in Climate Zone 3, to $9,147 in Climate Zone 8 when comparing the 2009 IECC to the 2006 IECC
- Life-cycle cost savings for the 2012 IECC, as compared with the 2009 IECC average $2,280 in Climate Zone 2 and up to $23,900 in Climate Zone 8
- When comparing the 2012 and 2006 IECC, life-cycle costs savings average $4,763 in Climate Zone 2 and $33,105 in Climate Zone 8

Cost-Effectiveness

The U.S. Department of Energy (DOE) evaluates energy codes based on two measures of cost-effectiveness:

- **Life-Cycle Cost**: Full accounting over a 30-year period of the cost savings, considering energy savings, the initial investment financed through increased mortgage costs, tax impacts, and residual values of energy efficiency measures
- **Cash Flow**: Net annual cost outlay (i.e., difference between annual energy cost savings and increased annual costs for mortgage payments, etc.)

Life-cycle cost is the primary measure by which DOE assesses the cost-effectiveness of the IECC. These savings assume that initial costs are mortgaged, that homeowners take advantage of the mortgage interest deductions, and that long-lived efficiency measures retain a residual value after the 30-year analysis period. As shown in Table 1, life-cycle cost savings are substantial in all climate zones.

Table 1. Life-Cycle Cost Savings Compared to the 2006 and 2009 IECC

IECC Climate Zone	30-Year Life-Cycle Savings ($US)		
	IECC 2009 vs. 2006	IECC 2012 vs. 2009	IECC 2012 vs. 2006
1	$2,877	$5,347	$8,256
2	$2,443	$2,280	$4,763
3	$1,944	$3,613	$5,621
4	$2,259	$5,320	$7,625
5	$2,466	$6,717	$9,189
6	$3,094	$8,183	$11,307
7	$3,622	$9,502	$13,166
8	$9,147	$23,900	$33,105

Consumer Savings

Annual consumer cash flows impact the affordability of energy-efficient homes. This analysis has calculated, by climate zone, the net annual cash outlay consumers will experience under the three codes. The net annual cash flow savings, computed as the sum of the energy cost savings and tax benefits minus the sum of incremental mortgage payments and property taxes, are positive in all cases. Even accounting for the incremental up-front costs of mortgage fees and down payment, consumers' cumulative cash flows become positive within a year or two in all regions. Table 2 summarizes these results.

Table 2. Impacts to Consumers' Cash Flow from Compliance with 2009 and 2012 IECC

IECC Climate Zone	IECC 2009 vs. 2006		IECC 2012 vs. 2009		IECC 2012 vs. 2006	
	Net Annual Cash Flow Savings (Year 1)	Years to Cumulative Positive Cash Flow	Net Annual Cash Flow Savings (Year 1)	Years to Cumulative Positive Cash Flow	Net Annual Cash Flow Savings (Year 1)	Years to Cumulative Positive Cash Flow
1	$137	2	$257	1	$393	1
2	$115	2	$102	2	$218	2
3	$91	2	$163	2	$253	2
4	$110	1	$249	1	$359	1
5	$116	1	$320	1	$436	1
6	$146	1	$378	1	$524	1
7	$176	1	$444	1	$620	1
8	$447	1	$1,142	1	$1,588	1

The U.S. Department of Energy (DOE) provides estimates of energy and cost savings from code adoption:

- **National**: Energy cost savings (only)
- **Climate Zone**: Energy cost savings, life-cycle cost savings, and consumer cash flows
- **State**: Energy cost savings, life-cycle cost savings, consumer cash flows, and simple paybacks

For more information on how these estimates were developed, visit the DOE Building Energy Codes website: **www.energycodes.gov/development/residential**

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

EERE Information Center
1-877-EERE-INFO (1-877-337-3463)
www.eere.energy.gov/informationcenter

April 2012 PNNL-21329

Building Energy Codes
For information on Building Energy Codes, visit **www.energycodes.gov**

Technical Appendix A

Methodology

An overview of the methodology used to calculate these impacts is provided below. Further information as to how these estimates were developed is available at the U.S. Department of Energy's (DOE) Building Energy Codes website.[1]

Cost-Effectiveness

Pacific Northwest National Laboratory (PNNL) calculated two cost-effectiveness metrics in comparing the 2006, 2009, and 2012 International Energy Conservation Codes (IECC). These are:

- Life-Cycle Cost (LCC): Full accounting over a 30-year period of the cost savings, considering energy savings, the initial investment financed through increased mortgage costs, tax impacts, and residual values of energy efficiency measures
- Cash Flow: Net annual cost outlay (i.e., difference between annual energy cost savings and increased annual costs for mortgage payments, etc.)

LCC is a robust cost-benefit metric that sums the costs and benefits of a code change over a specified time period. LCC is a well-known approach to assessing cost-effectiveness. DOE uses LCC for determining the cost-effectiveness of code change proposals, and for the code as a whole, because it is the most straightforward approach to achieving the desired balance of short- and long-term perspectives.

The financial and economic parameters used for these calculations are as follows:

- New home mortgage parameters:
  - 5.0% mortgage interest rate (fixed rate)
  - Loan fees equal to 0.7% of the mortgage amount
  - 30-year loan term
  - 10% down payment
- Other rates and economic parameters:
  - 5% nominal discount rate (equal to mortgage rate)
  - 1.6% inflation rate
  - 25% marginal federal income tax and state-specific income tax
  - 0.9% property tax
  - Insulation has 60-year life with linear depreciation resulting in a 50% residual value at the end of the 30-year period
  - Windows, duct sealing, and envelope sealing have a 30-year life and hence no residual value at the end of the analysis period
  - Light bulbs have a 6-year life and are replaced four times during the 30-year analysis period

[1] www.energycodes.gov/development/residential

Energy and Economic Analysis

This analysis calculated the energy savings and economic impacts of the 2009 and 2012 IECC compared to the 2006 IECC, as well as the 2012 IECC compared to the 2009 IECC. Energy usage was modeled using the DOE's EnergyPlus™ software for two residential building types:

1. Single-Family: A two-story home with a 30-ft by 40-ft rectangular shape, 2,400 ft^2 of floor area excluding the basement, and windows that cover 15% of the wall area, equally distributed on all sides of the house
2. Multifamily: A three-story building with 18 units (6 units per floor), each having conditioned floor area of 1,200 ft^2 and window area equal to approximately 10% of the conditioned floor area, equally distributed on all sides of the building

Each building type, single-family and apartment/condo in a multifamily building, has four unique foundation types:

1. Slab on grade
2. Heated basement
3. Unheated basement
4. Crawlspace

Each building type also has four unique heating system types:

1. Natural gas
2. Heat pump
3. Electric resistance
4. Oil

This results in 32 unique scenarios (2 x 4 x 4) for each of the IECC climate zones depending on construction practice (e.g., basement or slab) and heating system type prevalent in each zone.

PNNL incorporated the prescriptive requirements of the 2006, 2009, and 2012 IECC when modeling the impacts of changes to the code. Whenever possible, PNNL uses DOE's EnergyPlus model software to simulate changes to code requirements. However, in some cases, alternative methods are employed to estimate the effects of a given change. As an example, in order to give full consideration of the impacts of the 2012 IECC requirement for insulating hot water pipes (or shortening the pipe lengths), a separate estimate was developed for hot water pipe insulation requirements in the 2012 IECC, which results in a 10% savings in water heating energy use (Klein 2012).

Energy and economic impacts were determined separately for each unique scenario, including the single-family and multifamily building, the four unique foundation types, and the four unique heating system types. The cost-effectiveness results were aggregated to a single average for each climate zone. In addition, energy savings results were aggregated to a national average. In computing these averages, results were first combined across foundation types and heating system types for single-family and multifamily prototypes, based on weights derived from Table A.1, Table A.2, and Table A.3 (single-family and multifamily have the same foundation shares). For example, the primary heating system type in new residential units in the East North Central division is a natural gas furnace. Therefore, the combined average energy usage calculations were proportionally weighted to account for the predominance of natural gas heating. Then single-family and multifamily results were combined to determine climate zone and national averages weighted by building permits from 2010 U.S. Census data shown in

Table A.4. The building permits are available from every county in the United States, which allows the new construction in the county based climate zones shown in Table A.4 to be determined.

Table A.1. Heating Equipment Shares – Single-Family (percent)

Census Division	Electric Heat Pump	Gas Heating	Electric Furnace	Oil Heating
New England	10.8	57.0	1.1	31.1
Middle Atlantic	24.5	69.2	1.7	4.6
East North Central	22.5	76.2	0.7	0.5
West North Central	39.6	56.7	3.4	0.2
South Atlantic	78.9	19.0	2.0	0.1
East South Central	68.9	28.9	2.1	0.0
West South Central	37.5	48.1	14.5	0.0
Mountain	19.4	77.8	2.6	0.2
Pacific	34.0	62.9	2.9	0.2

Table A.2. Heating Equipment Shares – Multifamily (percent)

Census Division	Electric Heat Pump	Gas Heating	Electric Furnace	Oil Heating
New England	3.0	66.0	0.7	30.4
Middle Atlantic	39.5	49.6	4.9	6.1
East North Central	3.3	96.5	0.1	0.1
West North Central	24.8	68.0	4.3	3.0
South Atlantic	74.9	24.2	1.1	0.0
East South Central	94.1	1.8	4.1	0.0
West South Central	14.6	21.4	64.1	0.0
Mountain	2.8	97.2	0.0	0.0
Pacific	14.9	84.2	0.8	0.2

Table A.3. Foundation Type Shares (percent)

State	Slab on Grade	Heated Basement	Unheated Basement	Crawlspace
Connecticut, Rhode Island, Vermont, New Hampshire, Maine	16.8	23.8	45.5	13.9
Massachusetts	15.8	21.2	51.9	11.2
New York	20.4	25.9	41.7	12.0
New Jersey	26.9	18.3	30.6	24.2
Pennsylvania	28.9	24.6	32.8	13.7
Illinois	22.5	39.4	14.1	24.1
Ohio and Indiana	27.5	29.9	21.2	21.4
Michigan	15.7	36.2	27.3	20.8
Wisconsin	14.9	45.0	29.7	10.4
Minnesota, Iowa, North Dakota, South Dakota	22.1	46.9	15.5	15.5
Kansas and Nebraska	29.8	32.7	14.9	22.5
Missouri	24.8	36.4	20.8	17.9
Virginia	33.2	24.2	9.8	32.8
Maryland, Delaware, and West Virginia	28.0	30.7	18.3	23.0
Georgia	57.1	6.6	9.7	26.7
North Carolina and South Carolina	38.7	2.3	4.1	54.9
Florida	87.7	0.0	0.4	11.8
Alabama, Mississippi, Kentucky	44.1	8.6	10.6	36.7
Tennessee	35.3	7.2	9.0	48.4
Arkansas, Louisiana, and Oklahoma	66.9	0.6	2.9	29.7
Texas	79.6	0.3	0.4	19.8
Colorado	30.7	28.2	9.9	31.2
Utah, Wyoming, Montana, Idaho	26.7	36.6	11.0	25.6
Arizona	90.7	0.6	3.1	5.6
Nevada and New Mexico	86.1	2.5	0.8	10.7
California	59.0	1.2	4.9	34.9
Washington, Oregon, Alaska, Hawaii	37.0	8.9	3.1	51.0

Table A.4. Construction by Building Type and Climate Zone

Climate Zone	Building Permits			Percent of National Total
	Single-Family	Multifamily	Total	
1	4,248	2,195	6,443	1.2
2	96,420	13,715	110,135	20.5
3 – south of warm-humid line	30,769	5,830	36,599	6.8
3 – north of warm-humid line	83,269	20,276	103,545	19.3
4	100,716	24,048	124,764	23.2
5	93,068	18,842	111,910	20.8
6	30,065	6,872	36,937	6.9
7	5,479	1,280	6,759	1.3
8	65	0	65	0.0

Differences Between the 2006 IECC, the 2009 IECC, and the 2012 IECC

All versions of the IECC have requirements that apply uniformly to all climate zones, and other requirements that vary by climate zone. Highlights of the mandatory requirements across all buildings include:

- Building envelope must be caulked and sealed. The 2012 IECC adds a requirement that the building must be tested and a level of leakage that is no more than a maximum limit must be achieved.
- Ducts and air handlers must be sealed. Testing against specified maximum leakage rates is required in the 2009 and 2012 IECC if any ducts pass outside the conditioned space (e.g., in attics, unheated basements). The 2012 IECC leakage requirements are more energy efficient.
- Supply and return ducts in attics and all ducts in crawlspaces, unheated basements, garages, or otherwise outside the building envelope must be insulated.
- For the 2009 and 2012 IECC, a minimum percentage of the lighting bulbs or fixtures in the dwelling must be high-efficacy lighting.
- A certificate listing insulation levels and other energy efficiency measures must be posted on or near the electric service panel.

A comparison of significant IECC requirements that do not vary by climate zone is contained in Table A.5. Of these, the most significant changes in the 2009 and 2012 IECC compared to the 2006 IECC are the requirements for pressure testing of the building envelope and ducts/air handlers, and for insulating service hot water pipes (2012 IECC only). The requirement for high-efficacy lamps, while significant, is somewhat abated by a superseding federal regulation banning the manufacture or import of less efficient lamps at common watt levels that takes effect in 2012 to 2014.

Requirements such as insulation levels and fenestration (window, door, and skylight) U-factors vary by the eight climate zones in the United States. Table A.6 shows these requirements.

Table A.5. Comparison of Major Requirements That Do Not Vary by Climate Zone

Requirement	2006 IECC	2009 IECC	2012 IECC
Building envelope sealing	Caulked and sealed verified by visual inspection	Caulked and sealed verified by visual inspection against a more detailed checklist	Caulked and sealed verified by visual inspection and a pressure test against a leakage requirement
Ducts and air handlers	Sealed verified by visual inspection	Sealed, verified by visual inspection, and pressure tested or all ducts must be inside building envelope	Sealed, verified by visual inspection, and pressure tested against a leakage requirement or all ducts must be inside building envelope
Supply ducts in attics	R-8	R-8	R-8
Return ducts in attics and all ducts in crawlspaces, unheated basements, garages, or otherwise outside the building envelope	R-8	R-6	R-6
Insulation on hot water pipes for service water heating systems	None	None	R-3 except where pipe run length is below a diameter-dependent threshold
Insulation on hot water pipes for hydronic (boiler) space heating systems	R-3	R-3	R-3
High-efficacy lamps (percent of lighting in the home)	None	50% of lamps	75% of lamps or 75% of fixtures
Certificate of insulation levels and other energy efficiency measures	Yes	Yes	Yes

While exemptions or allowances in the code are not included in this analysis, the code does allow for some of these depending on the compliance path. Examples include the following:

- One door and 15 ft^2 of window area are exempt
- Skylight U-factors are allowed to be higher than window U-factors
- Five hundred square feet or 20% of ceiling area of a cathedral ceiling, whichever is less, is allowed to have R-30 insulation in climate zones where more than R-30 is required for other ceilings

Incremental First Costs

Table A.7 shows the national average costs of implementing the prescriptive measures of the new codes. Costs are provided for both the reference home and apartment/condo, and for the cost of moving from the 2006 to the 2009 IECC, as well as from the 2006 IECC and 2009 IECC to the 2012 IECC. The costs derive from estimates assembled by Faithful + Gould (2012) and a number of other sources.[2]

[2] The Faithful + Gould cost data and other cost data for energy efficiency measures are available on the "BC3" website at http://bc3.pnnl.gov/.

Table A.6. Comparison of Major Requirements That Vary by Climate Zone

Climate Zone	IECC	Components										
		Ceiling (R-value)	Skylight (U-factor)	Fenestration (Windows and Doors)		Wood Frame Wall (R-value)	Mass Wall* (R-value)	Floor (R-value)	Basement Wall** (R-value)	Tested Max Air Leakage Rate (air changes per hour)	Slab*** (R-value and depth)	Crawl Space** (R-value)
				U-factor	SHGC							
1	2006	30	0.75	NR	0.4	13	3/4	13	NR	NR	NR	NR
	2009				0.3					NR		
	2012				0.25					5		
2	2006	30	0.75	0.75	0.4	13	4/6	13	NR	NR	NR	NR
	2009	30	0.75	0.65	0.3					NR		
	2012	38	0.65	0.4	0.25					5		
3	2006	30	0.65	0.65	0.4	13	5/8	19	0	NR	NR	5/13
	2009	30	0.65	0.5	0.3	13	5/8		5/13****	NR		
	2012	38	0.55	0.35	0.25	20	8/13		5/13****	3		
4	2006	38	0.6	0.4	NR	13	5/13	19	10/13	NR	10, 2 ft	10/13
	2009	38	0.6	0.35		13	5/10		10/13	NR		10/13
	2012	49	0.55	0.35	0.4	20	8/13		10/13	3		10/13
5	2006	38	0.6	0.35	NR	19	13/19	30	10/13	NR	10, 2 ft	10/13
	2009	38	0.6	0.35		20	13/17		10/13	NR		10/13
	2012	49	0.55	0.32		20	15/19		15/19	3		15/19
6	2006	49	0.6	0.35	NR	19	10/13	30	10/13	NR	10, 4 ft	10/13
	2009		0.6	0.35		20	15/19		15/19	NR		10/13
	2012		0.55	0.32		20+5	15/19		15/19	3		15/19
7 and 8	2006	49	0.6	0.35	NR	21	19/21	38	10/13	NR	10, 4 ft	10/13
	2009		0.6	0.35		21			15/19	NR		10/13
	2012		0.55	0.32		20+5		38	15/19	3		15/19

* The second number applies when more than half the insulation is on the interior side of the high mass material in the wall.

** The first number is for continuous insulation (e.g., a board or blanket directly on the foundation wall) and the second number is for cavity insulation (i.e., if there is a furred-out wall built against the foundation wall). Only one of these two has to be met.

*** The first number is R-value. The second value refers to the vertical depth of the insulation around the perimeter.

**** Basement wall insulation is not required in the warm-humid region of Zone 3 in the southeastern United States.

NR = not required

SHGC = solar heat gain coefficient

Table A.7. Total Construction Cost Increase for the 2009 and 2012 IECC Compared to the 2006 IECC and 2009 IECC

	2,400 ft² House			1,200 ft² Apartment/Condo		
	Unheated Basement or Crawlspace	Heated Basement	Slab	Unheated Basement or Crawlspace	Heated Basement	Slab
2006 to 2009 IECC						
Zone 1	$1,514	$1,514	$1,514	$660	$660	$660
Zone 2	$1,514	$1,514	$1,514	$660	$660	$660
Zone 3 – south of warm-humid line	$1,514	$1,514	$1,514	$660	$660	$660
Zone 3 – north of warm-humid line	$1,514	$2,014	$1,514	$660	$733	$660
Zone 4	$629	$629	$629	$367	$367	$367
Zone 5	$939	$939	$939	$482	$482	$482
Zone 6	$939	$1,194	$939	$482	$519	$482
Zone 7	$813	$780	$525	$429	$370	$333
Zone 8	$813	$780	$525	$429	$370	$333
2009 to 2012 IECC						
Zone 1	$1,659	$1,659	$1,659	$867	$867	$867
Zone 2	$1,995	$1,995	$1,995	$979	$979	$979
Zone 3 – south of warm-humid line	$2,528	$2,528	$2,528	$1,170	$1,170	$1,170
Zone 3 – north of warm-humid line	$2,528	$2,528	$2,528	$1,170	$1,170	$1,170
Zone 4	$2,035	$2,035	$2,035	$1,007	$1,007	$1,007
Zone 5	$1,566	$1,821	$1,566	$837	$874	$837
Zone 6	$2,797	$2,797	$2,797	$1,287	$1,287	$1,287
Zone 7	$2,797	$2,797	$2,797	$1,287	$1,287	$1,287
Zone 8	$2,797	$2,797	$2,797	$1,287	$1,287	$1,287
2006 to 2012 IECC						
Zone 1	$3,173	$3,173	$3,173	$1,527	$1,527	$1,527
Zone 2	$3,509	$3,509	$3,509	$1,639	$1,639	$1,639
Zone 3 – south of warm-humid line	$4,042	$4,042	$4,042	$1,830	$1,830	$1,830
Zone 3 – north of warm-humid line	$4,042	$4,542	$4,042	$1,830	$1,903	$1,830
Zone 4	$2,664	$2,664	$2,664	$1,374	$1,374	$1,374
Zone 5	$2,505	$2,760	$2,505	$1,319	$1,356	$1,319
Zone 6	$3,736	$3,991	$3,736	$1,769	$1,806	$1,769
Zone 7	$3,610	$3,577	$3,322	$1,716	$1,657	$1,620
Zone 8	$3,610	$3,577	$3,322	$1,716	$1,657	$1,620

Life-Cycle Cost

Table A.8 shows the life-cycle cost savings (discounted present value) of the new codes over the 30-year analysis period. These savings assume that initial costs are mortgaged, that homeowners take advantage of the mortgage interest tax deductions, and that efficiency measures retain a residual value at the end of the 30 years.

Table A.8. Life-Cycle Cost Savings Compared to the 2006 and 2009 IECC

IECC Climate Zone	30-Year Life-Cycle Savings		
	IECC 2009 vs. 2006	IECC 2012 vs. 2009	IECC 2012 vs. 2006
1	$2,877	$5,347	$8,256
2	$2,443	$2,280	$4,763
3	$1,944	$3,613	$5,621
4	$2,259	$5,320	$7,625
5	$2,466	$6,717	$9,189
6	$3,094	$8,183	$11,307
7	$3,622	$9,502	$13,166
8	$9,147	$23,900	$33,105

Cash Flow

Because most houses are financed, consumers will be very interested in the financial impacts of buying a home that complies with the 2009 or 2012 IECC requirements compared to the 2006 or 2009 IECC. Mortgages spread the payment for the cost of a house over a long period of time (the simple payback fails to account for the impacts of mortgages). In this analysis, a 30-year fixed-rate mortgage was assumed. It was also assumed that homebuyers will deduct the interest portion of the payments from their income taxes.

Table A.9, Table A.10, and Table A.11 show the impacts to consumers' cash flow resulting from the improvements in the 2009 and 2012 IECC. Up-front costs include the down payment and loan fees. The annual values shown in the table are for the first year.

The savings from income tax deductions for the mortgage interest will slowly decrease over time while energy savings are expected to increase over time because of escalating energy prices. These tables also include increases in annual property taxes because of the higher assessed house values. The net annual cash flow includes energy costs, mortgage payments, mortgage tax deductions, and property taxes but not the up-front costs. The time to positive cash flow includes all costs and benefits, including the down payment and other up-front costs.

As shown in Table A.9, there is a net positive cash flow to consumers across all eight climate zones ranging from an average of $91 in Climate Zone 3 to $447 in Climate Zone 8 beginning in year one for the 2009 IECC. Positive cumulative savings, including payment of up-front costs, are achieved in 1 or 2 years. The positive cash flow is more significant with the 2012 IECC ranging from an average of $102 to $1,142 for the 2009 to 2012 IECC improvement, with again only 1 or 2 years to positive cumulative savings after covering up-front costs (see Table A.10). Table A.11 shows the combined impacts of moving from the 2006 all the way to the 2012 IECC.

Table A.9. Impacts to Consumers' Cash Flow from Compliance with 2009 IECC Compared to the 2006 IECC

	Cost/Benefit	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
A	Down payment and other up-front costs	$140	$130	$134	$59	$93	$98	$72	$101
B	Annual energy savings (year one)	$213	$186	$164	$143	$166	$199	$215	$502
C	Annual mortgage increase	$76	$70	$73	$32	$50	$53	$39	$54
D	Net annual cost of mortgage interest deductions, mortgage insurance, and property taxes (year one)	$0	-$1	$0	-$1	$0	$0	$0	-$1
E = [B-(C+D)]	Net annual cash flow savings (year one)	$137	$115	$91	$110	$116	$146	$176	$447
F = [A/E]	Years to positive savings including up-front cost impacts	2	2	2	1	1	1	1	1

Table A.10. Impacts to Consumers' Cash Flow from Compliance with 2012 IECC Compared to the 2009 IECC

	Cost/Benefit	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
A	Down payment and other up-front costs	$159	$172	$224	$187	$162	$264	$272	$400
B	Annual energy savings (year one)	$344	$197	$285	$351	$409	$523	$592	$1,360
C	Annual mortgage increase	$86	$93	$121	$102	$88	$143	$147	$217
D	Net annual cost of mortgage interest deductions, mortgage insurance, and property taxes (year one)	-$1	-$2	-$1	$0	-$1	-$2	-$1	-$1
E = [B-(C+D)]	Net annual cash flow savings (year one)	$257	$102	$163	$249	$320	$378	$444	$1,142
F = [A/E]	Years to positive savings, including up-front cost impacts	1	2	2	1	1	1	1	1

Table A.11. Impacts to Consumers' Cash Flow from Compliance with 2012 IECC Compared to the 2006 IECC

	Cost/Benefit	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
A	Down payment and other up-front costs	$299	$302	$359	$246	$255	$362	$344	$500
B	Annual energy savings (year one)	$557	$383	$449	$494	$575	$722	$807	$1,862
C	Annual mortgage increase	$162	$164	$194	$134	$138	$196	$186	$271
D	Net annual cost of mortgage interest deductions, mortgage insurance, and property taxes (year one)	-$2	-$1	-$2	-$1	-$1	-$2	-$1	-$3
E = [B-(C+D)]	Net annual cash flow savings (year one)	$393	$218	$253	$359	$436	$524	$620	$1,588
F = [A/E]	Years to positive savings, including up-front cost impacts	1	2	2	1	1	1	1	1

Energy Cost Savings

All fuel prices were obtained from the DOE Energy Information Administration and are recent residential prices specific to each state (DOE 2012a, 2012b, 2012c). Energy prices are assumed to escalate at the rates published in DOE's *Annual Energy Outlook* (DOE 2012d).

Table A.12 shows the estimated annual energy costs, including heating, cooling, water heating, and lighting per home that result from meeting the requirements in the 2006, 2009, and 2012 IECC. Table A.13 shows the total energy cost savings as both a net dollar savings and as a percentage of the total energy use[3]. Results are averaged across home type (single- and multifamily), foundation type, and heating system types.

[3] The percent savings is the annual energy cost savings for heating, cooling, water heating, and lighting divided by the total baseline annual energy cost for heating, cooling, water heating, and lighting.

Table A.12. Annual Energy Costs for Different Versions of IECC

	2006 IECC					2009 IECC					2012 IECC				
Zone	Heating	Cooling	Water Heating	Lighting	Total	Heating	Cooling	Water Heating	Lighting	Total	Heating	Cooling	Water Heating	Lighting	Total
1	$24	$1,504	$380	$314	$2,222	$21	$1,345	$380	$263	$2,009	$11	$1,087	$342	$225	$1,665
2	$252	$758	$237	$209	$1,456	$228	$630	$237	$175	$1,270	$155	$557	$213	$148	$1,073
3	$427	$432	$259	$206	$1,324	$369	$360	$259	$172	$1,160	$184	$309	$233	$149	$875
4	$710	$311	$298	$192	$1,511	$611	$299	$298	$160	$1,368	$350	$262	$268	$137	$1,017
5	$997	$259	$274	$216	$1,746	$878	$247	$274	$181	$1,580	$535	$235	$247	$154	$1,171
6	$1,289	$197	$293	$215	$1,994	$1,134	$188	$293	$180	$1,795	$674	$181	$264	$153	$1,272
7	$1,546	$106	$300	$196	$2,148	$1,366	$103	$300	$164	$1,933	$827	$104	$269	$141	$1,341
8	$3,911	$115	$500	$340	$4,866	$3,467	$112	$500	$285	$4,364	$2,187	$122	$449	$246	$3,004

As can be seen from Table A.13, energy cost savings per year average from $143 in Zone 4 to $502 in Zone 8 for the 2009 IECC compared to the 2006 IECC. Annual energy cost savings rise significantly with the 2012 IECC compared to the 2009 IECC, ranging from an average $197 per year for Zone 2, up to $1,360 per year in Zone 3. On a percentage basis, energy cost savings range from about 25% to 38% with the 2012 IECC compared to the 2006 IECC depending on climate zone.

Table A.13. Total Energy Cost Savings

Climate Zone	2009 IECC vs. 2006 IECC		2012 IECC vs. 2009 IECC		2012 IECC vs. 2006 IECC	
	Savings ($/yr)	Percent Savings	Savings ($/yr)	Percent Savings	Savings ($/yr)	Percent Savings
1	$213	9.6	$344	17.1	$557	25.1
2	$186	12.8	$197	15.5	$383	26.3
3	$164	12.4	$285	24.6	$449	33.9
4	$143	9.5	$351	25.7	$494	32.7
5	$166	9.5	$409	25.9	$575	32.9
6	$199	10.0	$523	29.1	$722	36.2
7	$215	10.0	$592	30.6	$807	37.6
8	$502	10.3	$1,360	31.2	$1,862	38.3

References

Faithful + Gould. 2012. *Residential Energy Efficiency Measures – Prototype Estimate and Cost Data*. Portland, Oregon. http://bc3.pnnl.gov/wiki/index.php/Downloads

Faithful + Gould. 2011. *Residential Energy Efficiency Measures – Locations Factors*. Portland, Oregon. http://bc3.pnnl.gov/wiki/index.php/Downloads

Klein, G. 2012. *Cost Estimation for Materials and Installation of Hot Water Piping Insulation*. Affiliated International Management, LLC, Newport Beach, California.

U.S. Department of Energy (DOE). 2012a. *Electric Power Monthly*. DOE/EIA-0226. Washington, D.C. http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html

U.S. Department of Energy (DOE). 2012b. *Natural Gas Monthly*. DOE/EIA-0130. Washington, D.C. http://www.eia.gov/oil_gas/natural_gas/data_publications/natural_gas_monthly/ngm.html

U.S. Department of Energy (DOE). 2012c. *Petroleum Marketing Monthly*. DOE/EIA-0380. Washington, D.C. http://www.eia.gov/petroleum/marketing/monthly/

U.S. Department of Energy (DOE). 2012d. *Annual Energy Outlook*. DOE/EIA-0383. Washington, D.C.