Methodological Comparison of Cost-effectiveness of IECC Residential Energy Codes

Final Report

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Executive Summary

ICF was asked to conduct an analysis of building energy codes, comparing life-cycle cost analysis (LCC) – the predominant method used to evaluate the cost effectiveness of energy codes and other public policies – with two other cost-effectiveness methods: simple payback and mortgage cash-flow. Since a significant proposal before Congress would designate simple payback as the principal basis for energy code cost-effectiveness, representing a departure from decades of policy analysis practice, it is important to provide a robust comparison of simple payback to the LCC and mortgage cash-flow methods.

Simple payback is typically used in the private sector to evaluate discrete, low-to-moderate-cost energy retrofit projects in existing facilities. Mortgage cash-flow analysis is typically used to evaluate whole-building transactions involving financing. LCC analysis can incorporate mortgage cash flow calculations to the extent they account for the full useful life of energy efficiency measures. However, LCC is fundamentally incompatible with simple payback analysis; many measures that may "fail" a simple payback analysis can be cost-effective on an LCC basis.

A key issue in assessing cost-effectiveness of efficiency measures is capturing the value of savings over the full useful life of the measure or building. Both the LCC and mortgage cash-flow methods incorporate measures' useful lives, which can vary from 5 years (e.g., lighting measures) to more than 30 years (e.g., insulation measures). By contrast, simple payback fails to recognize useful life; this is a critical omission, and puts into question the appropriateness of simple payback for public policy analysis.

To help resolve these issues, this study provides a rigorous, consistent, quantified comparison of these three methodologies. In addition to detailing quantified results, it discusses the pros and cons of each method. The intent is to provide public policy analysts and policymakers additional clarity and insight into these important issues.

Pre-eminence of Life-Cycle Cost Approach for Energy Codes and other Policies

Policymakers take the life-cycle perspective because buildings can last over 100 years, and only the long view that accounts for all factors affecting the cost-effectiveness of efficiency improvements over the full life of the building can ensure sound public policy decisions. In addition, the International Energy Conservation Code (IECC) – which is the residential building code in 40 states, the District of Columbia, and numerous local jurisdictions in the remaining states – specifically requires that energy efficiency be considered "over the life of the building" (residential or commercial).

In conducting this life-cycle analysis, we employed widely-used and nationally-accepted National Institute of Standards and Technology (NIST) methodologies, and used:

- A nationally-accredited building simulation model to calculate energy savings,
- Recognized federal and industry sources for cost estimates, and
- Industry sources to quantify service life of efficiency measures.

Simple Payback

Simple payback is used principally by private investors to assess the time to recoup the cost of a single energy efficiency retrofit. Its primary attribute is calculation simplicity, but because simple payback fails to consider important financial elements – such as the full useful life of efficiency measures, the ways most Americans actually buy homes, changes in fuel costs and energy bills, discount rates, and tax implications – it is typically not used in public-policy cost-effectiveness assessments. In addition, because the great majority of American home buyers use mortgage financing to buy their homes, simple payback is not applicable to most home purchase transactions. Buyers who do pay cash are typically either investors seeking to rent or flip the property, or wealthy individuals for whom affordability is not an issue.

Mortgage Cash Flow

Building energy codes are developed and adopted to reduce homeowner and renter utility bills, which account for the largest share of home occupancy costs after mortgage payment (or rent) and are the least predictable cost of home ownership. To assess the cost-effectiveness of codes in the context of home occupancy costs, it is most appropriate to apply a mortgage cash flow analysis method, which projects the net occupancy costs associated with code-compliant homes. Tracking mortgage cash flow paints a clear and realistic picture of building energy efficiency to a typical homeowner or occupant, evaluating how quickly energy bill savings help the homeowner reach a break-even point with outlays for efficiency improvements.

Key Findings

All of the methodologies were used to calculate the cost-effectiveness of two IECC stringency increases: (1) the 2006 IECC to the 2012/2015[a] IECC, and (2) the 2009 IECC to the 2012/2015 IECC. Key findings that emerge from this analysis include:

- **The 2012/2015 IECC is cost-effective on a lifecycle basis.** Without exception, the LCC analysis shows net present dollar savings of the 2012/2015 IECC in all U.S. climate zones, whether the baseline code is the 2006 or 2009 IECC.
- **The 2012/2015 IECC delivers actual net savings to typical homeowners in the second year of home ownership.** The mortgage cash flow analysis shows positive cash flow in year 2, including points later in the mortgage term when replacement costs occur.
- **Simple paybacks average less than 10 years.** While paybacks exceed 10 years in some climate zones, on a national average basis, the payback is under 10 years. This contrasts sharply with other studies that show substantially longer paybacks, typically based on very high cost estimates that do not jibe with the recognized, transparent sources used in this analysis.

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[a] Because efficiency requirements of the 2015 IECC are virtually identical to those of the 2012 IECC, the energy savings attributed to the 2012 IECC in this analysis are also expected for homes built to the 2015 IECC. In its determination on the residential chapter of the 2015 IECC, the US Department of Energy found savings to be less than 1% greater than the 2012 IECC: "On June 11, 2015, DOE issued a determination that the 2015 IECC would achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in residential buildings of approximately:

- "0.73% energy cost savings
- "0.87% source energy savings
- "0.98% site energy savings"

A. Introduction

The intent of this study is to compare and contrast the multiple cost-effective methodologies for residential construction that have been discussed in the marketplace to date. These include: (1) Life-cycle Cost, (2) Simple Payback, and (3) Mortgage Cash Flow.

This study examines the pros and cons of each of these methodologies, provides examples their application to the same set of energy upgrades and costs, defines the three key common elements of cost-effectiveness analysis, and compare the differing results from these differing methods.

Life-cycle cost analysis has been the primary methodology used in public policy analysis for many decades, because policymakers take a long-term perspective that examines the full range of benefits and costs. For example, U.S. Department of Energy cost-effectiveness methods typically apply standardized life-cycle cost analysis methods developed by the National Institute of Standards and Technology (NIST). Simple payback is a private market metric that examines the time to recoup first costs of an investment. Mortgage cash flow analysis takes a homeowner perspective of the year-by-year balance of costs and benefits in a typical home mortgage context.

B. Pros and Cons of Each Cost-Effectiveness Methodology

i. Life-cycle Cost

Life-cycle Cost analysis calculates the sum of all benefits and costs over a specified time period, typically the service life of a building, technology, or project. In the context of this analysis, which examines the cost-effectiveness of building code-mandated efficiency measures for a typical homeowner, it calculates the net present value of the direct benefits and costs experienced by a typical homeowner, including increased purchase price, energy cost savings, tax implications, varying fuel prices, and increased property value. It brings back the stream of benefits and costs to a present value basis by applying a discount rate.

Pros

- Encompasses the full costs and benefits over the life of the building, as required in the IECC.
- Applies standardized NIST life-cycle cost methods that are widely used across the federal government.

Cons

- Requires somewhat more complex analysis than simple payback, typically involving spreadsheet calculations.

ii. Simple Payback

Simple payback is typically calculated the number of years required for energy cost savings to equal the initial cost of efficient measures, without addressing service life of measures, changes in fuel prices, discount rates, tax implications, resale value or other factors.

Pros

- Simple to calculate.
- Applied widely in private sector investment decision-making, where a single private entity is seeking to assess the time to recoup the cost of a specific investment.

Cons

- Does not address a policy perspective, which examines benefits and costs across the full lifetime of the building/technology/project, beyond the perspective of the initial investor.
- Does not capture the typical perspective of a homeowner, which involves mortgage financing. Cash buyers are typically investors seeking to rent or flip the property, or are wealthy individuals who are willing to pay full market value of the property.
- Does not encompass the full service life of the building, as required in the IECC, or of the individual efficiency measures in the building.

iii. Mortgage Cash Flow

Mortgage cash flow analysis calculates year-by-year annual net cash flow by comparing annualized cost mortgage payment increases to annual energy savings, while also factoring in added down payment, tax impacts and other factors. For example, if an efficient home's added construction costs increase mortgage payment by $350 per year and the annual energy savings are $400 per year, the annual cash flow is $50. These calculations can also be incorporated in a life-cycle cost analysis.

Pros

- Captures the most realistic perspective of the effect of energy codes on a typical homebuyer.
- Provides a more accurate indicator than simple payback of the time to recoup increased home construction costs.

Cons

- Typically requires spreadsheet calculations beyond simple math.

C. Key Elements of Sound Cost-Effectiveness Analysis

Three key inputs for cost-effectiveness calculations are required to achieve robust results:

1. **Accurate estimation of incremental cost**
   Determining reasonable incremental costs for building components can be difficult, because builders may not track incremental costs, or may be reluctant to divulge such cost details. Also, market dynamics typically drive costs down for the most commonly used products or materials; when energy codes shift standard specifications and practices, the new products and materials typically come down in price as they become the predominant market choice. To address these issues, ICF follows the common practice of policy analysts, consulting multiple robust sources to converge on reasonable cost estimates: these typically include the NREL Residential Energy Efficiency Measures Database, the PNNL Building Component Cost Community, and R.S. Means.

2. **Accurate estimation of energy savings**
   It is important to use accredited, field-verified energy simulation tools that are provide location-specific energy savings calculations, so that energy savings estimates are based on robust analysis. Using default national values or basic percent savings values can create a skewed picture or distort the policy implications of cost-effectiveness analyses.

3. **Accurate estimation of component useful life**
   Accounting for the realistic service life of a piece of equipment or efficiency upgrade savings is essential to assessing lifetime costs and benefits. For example an upgrade in shell insulation may add a one-time $500 to home construction costs, but delivers energy savings for the entire life of the home (30+ years). By contrast, high efficacy lighting may last approximately 5 years; while its initial incremental cost may be $100, over the 30-year period of analysis it would be replaced 6 times, with lifetime costs of $600 exceeding that of the insulation upgrade.

D. Scenario Analysis

i. Approach

Each of the cost-effectiveness methodologies outlined in Section A above were applied to a typical new single family home in locations across the country to compare the results using each methodology. These cost-effectiveness methodologies are calculated to estimate the cost-effectiveness of two code stringency increases: (1) the 2006 IECC to the 2012 IECC and (2) the 2009 IECC to the 2012 IECC.

ICF developed the following inputs for calculations using the three cost-effectiveness methodologies outlined in Section A:

1. Annual energy savings (kWh, Therms)
2. Incremental construction costs ($)
3. Building component useful life (Years)
4. Energy prices ($)
5. Economic Assumptions (e.g. mortgage interest rate, inflation rate, discount rate)

The first input, annual energy savings, was calculated through more than 3,000 simulations using ICF's RESNET-accredited Beacon Residential software. These simulations encompassed 119 weather locations, four foundation types, and two HVAC system types. Exhibit A4 of Appendix A displays the energy savings results.

The housing characteristics analyzed are shown displayed in Exhibit 1, below. This home is of a typical size for a new home in the United States, and aligns with the characteristics of the reference home contained in the U.S. DOE's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes. A more detailed view that includes HVAC system types and foundation types is contained in Exhibit A1 of Appendix A.

Exhibit 1: Housing Characteristics[b]

Parameter	Assumption
Conditioned Floor Area	2,400 ft^2
Stories	2
Bedrooms	3
Locations	119 Weather Locations across all IECC Climate Zones

The second set of inputs, the incremental costs for individual building component upgrades, was determined from the NREL National Residential Energy Efficiency Measures Database and R.S. Means. A full summary of incremental costs is contained in Exhibit A5 and A6 in Appendix A.

[b] U.S. DOE's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes

The third set of inputs, the building component useful life, was sourced from the National Association of Home Builders *Study of Life Expectancy of Home Components* report. These values are the median length of time in which a building component operates/functions within a home before needing to be replaced. A detailed summary of the useful life for each component is displayed in Exhibit A2 of Appendix A.

The fourth required input, energy prices, were obtained from the U.S. Energy Information Administration's Annual Energy Outlook and are outlined in Exhibit A3 in Appendix A.

Lastly, the assumptions required to perform an economic analysis are contained in Exhibit A3 of Appendix A. These values align with the assumptions contained in the U.S. DOE's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes.

Once all of these inputs were determined, they were input into ICF's Economic Metrics Calculator, which includes each of the three methodologies and is used to assess the cost-effectiveness of IECC code changes and above-code programs including the ENERGY STAR Certified Homes program.

ii. Results

Life-cycle Cost

The life-cycle cost analysis for each of these code upgrades results in net benefits across all Climate Zones, as shown in Exhibit 2, below. A negative life-cycle cost actually represents the positive net savings to the homeowner over the life of the mortgage; for example, in Exhibit 2, Zone 4 net savings are $1543. Exhibit 2 shows net savings for the 2012 IECC, compared to both the 2009 and 2009 versions, across all climate zones. Net savings range from $502 to $9,232; taking Climate Zone 4 as a median mixed climate, savings range from $1,543 to $2,975. The size of the net benefits increases when using the 2006 IECC as the basis, because total energy savings are larger in that scenario.

Exhibit 2: Life-Cycle Cost Results

Climate Zone	Present Value Costs	Present Value Benefits	Life-Cycle Net Savings
2009 to 2012 IECC			
1	$1,534	$2,036	$502
2	$1,660	$2,521	$861
3	$2,842	$4,412	$1,569
4	$2,674	$4,217	$1,543
5	$2,298	$3,572	$1,275
6	$1,808	$9,104	$7,295
7	$1,808	$9,627	$7,819
8	$1,808	$10,732	$8,923
2006 to 2012 IECC			
1	$2,957	$5,575	$2,618
2	$2,686	$4,863	$2,177
3	$5,011	$6,850	$1,839
4	$3,642	$6,617	$2,975
5	$3,209	$5,396	$2,187
6	$3,072	$10,926	$7,853
7	$3,072	$11,332	$8,260
8	$3,072	$12,304	$9,232

Simple Payback

In applying the simple payback methodology, we used a threshold of 10 years or less as a proxy for cost-effectiveness, as 10 years is often quoted as the maximum tenure of a first-time homebuyer, though in some markets this may be as low as 3-5 years. As displayed in Exhibit 3, the analysis shows that in several Climate Zones, the code upgrades do not meet either the 10-year or 3-5 year thresholds. However, national average simple paybacks are under 10 years for both code upgrade scenarios; this contrasts with sharply higher simple payback estimates developed by industry studies.

Exhibit 3: Simple Payback Results

Climate Zone	Incremental Upgrade Cost	Annual Energy Savings	Simple Payback (years)
2009 to 2012 IECC			
1	$970	$78	12.5
2	$1,073	$98	11.0
3	$2,058	$172	12.0
4	$1,964	$165	11.9
5	$1,651	$139	11.8
6	$1,255	$377	3.3
7	$1,255	$400	3.1
8	$1,255	$447	2.8
2006 to 2012 IECC			
1	$1,869	$219	8.5
2	$1,744	$191	9.1
3	$3,642	$262	13.9
4	$2,603	$261	10.0
5	$2,258	$212	10.7
6	$2,147	$448	4.8
7	$2,147	$465	4.6
8	$2,147	$506	4.2

Mortgage Cash Flow Analysis

Exhibit 4 displays the annual cash flow from the homeowner perspective over 30 years. This value varies year to year as building components reach the end of their useful life and replacement costs are incurred. For example, Exhibit 4 shows negative cash flow in years 10 and 20 as ductwork and other measures incur new costs. See the useful life values noted in Exhibit A2 in Appendix A for specifics.

The key finding from this analysis is that the typical homeowner sees positive cash flow by Year 2 of homeownership. Even when new costs are incurred later in the life-cycle, cash flow becomes positive again within two years. This means that in the real world of homeownership, energy code upgrades pay for themselves in less than two years.

For this analysis, ICF has aggregated these cash flow results into a single net present value number, and included it in the life-cycle cost analysis. While mortgage cash flow analysis comes closest to the real-world perspective of a typical homeowner, policymakers seeking guidance on building codes policy are best served by established life-cycle cost analysis.

Exhibit 4: Cash Flow Results

Year \ Climate Zone	2006 to 2012 IECC								2009 to 2012 IECC							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
0	-$106	-$112	-$371	-$192	-$181	$74	$92	$133	-$91	-$89	-$186	-$177	-$148	$159	$181	$228
1	$125	$103	$75	$129	$97	$346	$364	$406	$28	$43	$66	$64	$55	$321	$344	$393
2	$131	$109	$82	$137	$103	$359	$377	$421	$30	$46	$71	$69	$59	$333	$356	$406
3	$138	$114	$89	$144	$109	$373	$391	$437	$32	$49	$76	$73	$63	$344	$368	$420
4	$144	$120	$96	$152	$115	$387	$406	$452	$35	$51	$81	$78	$67	$356	$381	$434
5	$151	$126	$104	$160	$122	$401	$421	$469	$37	$54	$86	$83	$71	$368	$394	$449
6	$158	$132	$112	$168	$128	$416	$436	$486	$39	$57	$91	$88	$75	$381	$408	$464
7	$165	$138	$120	$176	$135	$431	$452	$503	$42	$61	$97	$93	$80	$394	$421	$479
8	$173	$145	$128	$185	$142	$447	$468	$521	$44	$64	$102	$99	$84	$407	$436	$495
9	$180	$151	$137	$194	$149	$463	$485	$539	$47	$67	$108	$104	$89	$421	$450	$511
10	-$42	-$72	-$84	-$26	-$73	$250	$273	$328	-$65	-$44	-$1	-$5	-$21	$321	$351	$414
11	$196	$165	$155	$213	$164	$496	$520	$577	$52	$74	$120	$116	$99	$450	$481	$546
12	$204	$172	$164	$222	$172	$514	$539	$597	$55	$78	$126	$122	$104	$465	$497	$564
13	$213	$180	$174	$232	$180	$532	$558	$618	$58	$81	$133	$128	$109	$481	$513	$582
14	$222	$187	$184	$243	$188	$551	$577	$639	$61	$85	$139	$134	$114	$497	$530	$601
15	$111	$76	$75	$134	$78	$451	$478	$542	-$55	-$30	$27	$22	$1	$394	$428	$501
16	$240	$203	$205	$264	$206	$590	$618	$684	$67	$93	$153	$148	$126	$530	$566	$641
17	$249	$211	$215	$275	$215	$610	$639	$707	$71	$97	$160	$155	$132	$547	$584	$662
18	$259	$220	$226	$287	$224	$631	$661	$731	$74	$102	$168	$162	$138	$565	$603	$683
19	$269	$229	$238	$299	$234	$653	$683	$755	$77	$106	$175	$169	$144	$584	$623	$705
20	-$634	-$364	-$308	-$17	-$66	$365	$396	$471	-$283	-$254	-$92	$42	-$11	$442	$482	$566
21	$290	$247	$261	$324	$254	$698	$730	$806	$85	$115	$191	$184	$157	$622	$664	$751
22	$301	$257	$274	$337	$264	$721	$754	$833	$88	$120	$199	$192	$163	$643	$685	$775
23	$313	$266	$287	$350	$275	$745	$779	$861	$92	$125	$208	$200	$170	$663	$707	$799
24	$324	$277	$300	$364	$286	$770	$805	$889	$96	$130	$217	$209	$177	$685	$730	$825
25	$336	$287	$313	$378	$297	$796	$832	$918	$100	$135	$226	$217	$185	$707	$753	$851
26	$349	$298	$327	$392	$309	$822	$860	$948	$104	$140	$235	$226	$192	$729	$777	$878
27	$361	$309	$341	$407	$321	$850	$888	$979	$109	$146	$244	$235	$200	$753	$802	$906
28	$374	$320	$356	$422	$333	$877	$917	$1,011	$113	$152	$254	$245	$208	$777	$827	$934
29	$388	$332	$370	$438	$345	$906	$947	$1,044	$118	$157	$264	$254	$216	$801	$853	$964
30	$402	$161	$178	$111	$5	$582	$624	$724	-$22	$19	$78	-$15	-$39	$563	$617	$730

iii. Comparison of Results and Key Findings

This section compares lifecycle cost and simple payback results using the methodology described above. Exhibit 5 summarizes this comparison; it shows divergent results, in that the life-cycle cost approach shows net cost savings across all Climate Zones, whereas the simple payback approach shows results that exceed 10 years in some Climate Zones. These differences can be explained by two factors:

- Life-cycle cost analysis takes into account the total stream of savings over the lifetime of the building's efficiency measures; simple payback does not.
- Life-cycle cost analysis spreads the costs of energy code upgrades over a 30-year mortgage term, which is the typical homebuyer experience; simple payback assumes all costs are incurred in the first year. In a life-cycle cost analysis, only the incremental down payment is included in first-year costs.

Exhibit 5: Methodology Results Comparison

Climate Zone	Simple Payback (years)	Life-Cycle Net Savings
2009 IECC		
1	12.5	$502
2	11.0	$861
3	12.0	$1,569
4	11.9	$1,543
5	11.8	$1,275
6	3.3	$7,295
7	3.1	$7,819
8	2.8	$8,923
2006 IECC		
1	8.5	$2,618
2	9.1	$2,177
3	13.9	$1,839
4	10.0	$2,975
5	10.7	$2,187
6	4.8	$7,853
7	4.6	$8,260
8	4.2	$9,232

Key findings that emerge from this analysis include:

- **The 2012 IECC is cost-effective on a lifecycle basis.** The LCC analysis shows net savings in all Climate Zones, whether the baseline code is the 2006 or 2009 IECC.
- **The 2012 IECC delivers net savings to typical homeowners in the second year of home ownership**. The mortgage cash flow analysis shows positive cash flow in year 2, even later in the mortgage term when replacement costs occur.
- **Simple paybacks average less than 10 years**. While paybacks exceed 10 years in some climate zones, on a national average basis the payback is under 10 years. This contrasts sharply with other studies that show substantially higher paybacks, typically based on very high cost estimates that do not jibe with the recognized, transparent sources used in this analysis.

Appendix A

Exhibit A1: Expanded Housing Configuration[c]

Parameter	Assumption
Housing Type	Single Family Detached
Conditioned Floor Area	2,400 ft2
Ceiling Height	8.5 ft
Perimeter	30 x 40 ft
Bedrooms	3
Window to Floor Area	15%
Window Destruction	Even
Locations	119 Weather Locations
Heating System Types	Natural Gas Furnace
	Heat Pump
Cooling System Types	Central AC
	Heat Pump
Domestic Hot Water System Types	Gas Tank Water Heater
	Electric Tank Water Heater
Foundation Types	Slab-on-grade
	Unconditioned basement
	Conditioned basement
	Vented crawlspace

Exhibit A2: Building Component Useful life

Component	Assumptions	Source
Insulation / Shell	30+ years	NAHB[d]
Framing Members	30+ years	NAHB
Windows	20 years	NAHB
Ventilation Systems	15 years	NAHB
Ductwork (sealing)	10 years	NAHB
High Efficacy Lighting	5.4 years	ENERGY STAR[e]

[c] U.S. DOE's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes

[d] NAHB Life Expectancy of Home Systems and Components

[e] ENERGY STAR lighting product calculator

Exhibit A3: Economic Analysis Assumptions

Economic Metric	Assumed Value	Source
Mortgage Interest Rate	5%	U.S. DOE[f]
Loan Term	30 years	U.S. DOE
Down Payment Rate	10%	U.S. DOE
Points and Loan Fees	0.7%	U.S. DOE
Discount Rate	5%	U.S. DOE
Period of Analysis	30 years	U.S. DOE
Property Tax Rate	0.9%	U.S. DOE
Income Tax Rate	25%	U.S. DOE
Home Price Escalation Rate	1.6%	U.S. DOE
Inflation Rate	1.6%	U.S. DOE
Fuel Price ($/kWh)	$0.13	U.S. EIA[g]
Fuel Prices ($/therm)	$1.26	U.S. EIA
Fuel Price Escalation Rate	3%	U.S. EIA

Exhibit A4: Energy Savings Results by IECC Climate Zone

	2006 to 2012 IECC		2009 to 2012 IECC	
IECC Climate Zone	kWh	Therms	kWh	Therms
1	1,723	1	613	0
2	1,309	21	628	15
3	1,636	44	1,057	30
4	1,386	68	848	46
5	558	112	315	79
6	1,342	221	1,207	179
7	1,458	223	1,285	188
8	1,498	252	1,321	222

[f] U.S. DOE's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes

[g] U.S. EIA Annual Energy Outlook

Exhibit A5: Incremental Cost Assumptions – 2006 IECC to 2012 IECC

	IECC Climate Zone							
Building Component	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ceiling Insulation	$0	$102	$102	$111	$111	$0	$0	$0
Wall Framing	$0	$0	$375	$375	$0	$0	$0	$0
AG Wall Insulation	$0	$0	$242	$242	$0	$0	$0	$0
Window	$469	$242	$210	$43	$30	$30	$30	$30
Infiltration	$960	$960	$1,392	$1,392	$1,392	$1,392	$1,392	$1,392
Vent	$94	$94	$94	$94	$94	$94	$94	$94
BG Wall Insulation	$0	$0	$881	$0	$286	$286	$286	$286
Ducts	$196	$196	$196	$196	$196	$196	$196	$196
HVAC Insulation	$50	$50	$50	$50	$50	$50	$50	$50
Lighting	$100	$100	$100	$100	$100	$100	$100	$100
Total	$1,869	$1,744	$3,642	$2,603	$2,258	$2,147	$2,147	$2,147

Exhibit A6: Incremental Cost Assumptions – 2009 IECC to 2012 IECC

	IECC Climate Zone							
Building Component	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ceiling Insulation	$0	$102	$102	$111	$111	$0	$0	$0
Wall Framing	$0	$0	$375	$375	$0	$0	$0	$0
AG Wall Insulation	$0	$0	$242	$242	$0	$0	$0	$0
Window	$167	$167	$102	$0	$19	$19	$19	$19
Infiltration	$528	$528	$960	$960	$960	$960	$960	$960
Vent	$94	$94	$94	$94	$94	$94	$94	$94
BG Wall Insulation	$0	$0	$0	$0	$286	$0	$0	$0
Ducts	$98	$98	$98	$98	$98	$98	$98	$98
HVAC Insulation	$50	$50	$50	$50	$50	$50	$50	$50
Lighting	$33	$33	$33	$33	$33	$33	$33	$33
Total	$970	$1,073	$2,058	$1,964	$1,651	$1,255	$1,255	$1,255