

Energy & Cost Savings Analysis of 2009 IECC Efficiency Improvements



*As Adopted by the ICC
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An Analysis Prepared for the Energy Efficient Codes Coalition (EECC) by ICF International

Executive Summary

Although it won't fully realize the 30% improvement sought by the Energy Efficient Codes Coalition, the recently-completed 2009 International Energy Conservation Code (IECC) represents a substantial – and some argue, unprecedented – boost in the energy efficiency of new home construction and renovations over the 2006 IECC. **ICF International's analysis estimates that homes built to the 2009 IECC standards will save 12.2% under the simple "prescriptive" method and could save 14.7% or more using the more complicated "performance-based" method.**

Perhaps as significant as the numerical results, a clear majority of International Code Council voting members present at the Final Action Hearing consistently supported energy efficiency improvements, including "The 30% Solution" (EECC's comprehensive package addressing virtually all energy-related aspects of home construction) and EECC's proposal to establish the IECC as the nation's *only* model energy code. Although both proposals fell a few votes shy of the two-thirds majority needed for final approval, **this impressive support suggests that future IECC efficiency improvements will enjoy substantial support from the ICC membership.**

How much energy will the improvements to the IECC save? How close does it come to the 30% goal sought by many government officials and the EECC for 2009?

Different experts' estimates of energy savings from the recent improvements vary, depending on the level of detail of their analysis and the assumptions made. For example, the US Department of Energy called ICC's Final Action Hearings "a home run," adding that "residential experts suggest the 2009 IECC will be at least 15 percent and possibly even 18-20 percent more energy efficient than its 2006 predecessor."

Because we felt a comprehensive assessment would add more clarity to this important question, EECC asked ICF International – a leading professional services firm – to conduct a thorough analysis of the energy cost savings that might reasonably be expected if the 2009 IECC were adopted and enforced. ICF's residential energy efficiency team combines building science and computer simulation expertise with home building industry field experience to calculate the

energy and economic impacts of advanced home design and construction technologies. The firm's methodology and assumptions are described below.

ICF estimates nationally-weighted “hard” savings of 12.2% under the 2009 IECC’s Prescriptive Path and savings that could exceed 14.7% or more for a new home using the Performance Path

Homeowner Energy Cost Savings Average \$235/Year

If the 2009 IECC were adopted and enforced for new homes constructed throughout the US, ICF's analysis estimates national energy cost savings of 12.2% and average weighted energy cost savings to the new homeowner of \$235 per year (using 2007/2008 EIA cost data by state). It should be noted that these costs likely substantially understate actual cost savings because they do not incorporate expected increases in energy prices over the life of the home. By Climate Zone, the estimated energy savings range from 9.5% -14.1% and the energy cost savings range from \$163-\$437 per home, as follows (ICF used energy cost savings as the metric to be consistent with how the IECC measures energy savings):

Nationally Weighted	By Climate Zone								
	1	2	3	4	4 Marine	5	6	7	8
12.2%	14.1%	13.2%	13.4%	11.6%	9.5%	10.0%	11.6%	13.1%	13.3%
\$ 235	\$ 437	\$ 223	\$ 242	\$ 238	\$ 163	\$ 221	\$ 276	\$ 337	\$ 419

In an effort to shorten the IECC, make it easier to use and employ a common map for both commercial and residential codes, the 2006 IECC reduced climate zones to eight in number. The simpler map replaced many pages of maps and commercial envelope tables and allowed IECC users to easily determine the requirements that apply anywhere in the US. The new IECC Climate Zone map is shown to the right (Hawaii, Guam, Puerto Rico and the Virgin Islands are in Climate Zone 1; Alaska is in Climate Zones 7 and 8).



What Are the 2009 IECC Improvements Included in ICF’s

Energy Cost Savings Estimates for the Prescriptive Path?

ICF included the following energy-saving provisions that adopted at the IECC Final Action Hearings in Minneapolis on September 21-22:

More Efficient Windows & Doors

- ✓ Vertical window U-factors reduced from 0.75 to 0.65 in climate zone 2, from 0.65 to 0.50 in Climate Zone 3, and from 0.40 to 0.35 in Climate Zone 4 (EC-18)
- ✓ Maximum allowable solar heat gain coefficient is reduced from 0.40 to 0.30 in Climate Zones 1, 2, and 3 (EC-26)
- ✓ Door U-factor exemption limited to one side-hinged opaque door assembly up to 24 square feet in area (EC-58)

More Efficient Lighting

- ✓ At least 50% of installed lighting fixtures to use technologies at least as efficient as compact fluorescent lights (EC-84)

Increased Insulation

For walls:

- ✓ R-20 wall insulation in Climate Zones 5 and 6 (EC-28)

For Foundations and Basements:

- ✓ Increased basement wall insulation in Climate Zones 6-8 to R-15/19 (EC-33)
- ✓ R-5/13 insulation for most Climate Zone 3 basements (EC-36)
- ✓ Heated slab insulation is lesser of 2 feet or depth of footing in Climate Zones 1-3 (EC-37)

For Floors:

- ✓ Increased floor insulation in Climate Zones 7-8 to R-38 (EC-35)

For Ceilings (with and without attics):

- ✓ Limit on cathedral ceiling exemption to 500 square feet or 20% of total insulated ceiling area, whichever is less (EC-46)

For Circulating Hot Water Systems:

- ✓ Increased insulation on mechanical system pipe distribution systems to R-3 (EC-74)

Envelope and Duct Air Leakage Testing

- ✓ Requires either a visual inspection of the thermal envelope components or a blower door test at 7 ACH at a pressure of 50 pascals (EC-64)
- ✓ Ensured limited air duct leakage, by requiring duct testing or location of the air handler and all ducts within the conditioned envelope (EC-71)

Performance Path Changes Add to Potential Savings

The IECC offers designers and builders both “prescriptive” and “performance” paths to comply. The prescriptive path prescribes specific energy efficiency levels that must be met for each component of the new home —insulation, windows, etc. While there are simple ways to trade efficiency among envelope components, the prescriptive path generally establishes a simple recipe (or prescription) for designers and builders to follow. The performance path, on the other hand, requires a more detailed analysis of the home’s energy use, but permits more choices for trading off various aspects of building performance to achieve the required level of energy

efficiency. Under the performance path, the proposed home is compared to a code-specified baseline standard reference design for a home of the same size to determine if the proposed home will have energy costs no higher than the reference design.

Buildings constructed under the 2009 performance path will achieve most of the same increased savings as under the 2009 prescriptive path, since the prescriptive path improvements generally also serve to improve the baseline reference home under the performance path. In addition, in the 2009 IECC, the performance path was specifically tightened up. As a result of these improvements, depending on the home design, homeowners may see savings over the previous code by 15% or more.

The 2009 IECC Lowers the Performance Path's Assumed Window Area to No More Than 15%

Previously, the performance path based the reference home on an assumption of a maximum 18% window area as a percentage of the home's conditioned floor area. By reducing the assumed maximum percentage to 15%, the energy usage of the reference home is reduced by about 2.5%. This means that any home designed in compliance with the performance path that would have used 18% or more windows will be required to use about 2.5% less energy (for homes with less than 15% window area, this change will have no effect; for homes between 15% and 18% the savings will be less than 2.5%).

The 2009 IECC Also Eliminates Trade-offs of Mechanical Equipment (Heating, Cooling and Hot Water) in the Performance Path

In the 2009 IECC, the ICC voted to eliminate trade-offs of building envelope efficiency (e.g. insulation and windows) for efficiency gains in heating and cooling equipment in the performance path. Such trade-offs were already prohibited under the prescriptive path.

For example, under previous IECC versions, builders could claim trade-off "credit" for installing high-efficiency furnaces or other more efficient equipment, by installing less insulation or less-efficient windows, even though those furnaces already account for a substantial part of the U.S. market, and a majority of the market in colder states. To make matters worse, states are preempted by federal law from requiring equipment efficiency that exceeds the federal minimum efficiencies. In other words, builders could build homes that were less efficient than they should be, by taking credit for the efficiency of equipment that would most likely have been installed anyway, while a state is powerless to set more reasonable equipment efficiencies suitable to its climate zone. Eliminating such tradeoffs effectively closed a major "loophole" in the IECC.

Example: How the Elimination of Mechanical Trade-Offs Boosts Energy Savings in the Performance Path

The elimination of mechanical equipment trade-offs is one of the most significant improvements made to the 2009 IECC. Here's one example of how this change will boost new home energy efficiency:

- Under the 2006 IECC, installing a 90% AFUE (Annual Fuel Utilization Efficiency) furnace in a home with 18% window area would give the builder using the Performance Path an average 7% trade-off allowance that could result in the installation of other less efficient insulation, windows or other measures (*the trade-off allowance ranges from 0.1% in Climate Zone 1 to 11.1% in Climate Zone 8*). The impact would be even greater for a more efficient furnace and there would also be a substantial trade-off allowance if more efficient air conditioning and hot water heating equipment were installed.
- Under the 2009 IECC, using a performance path home with 18% glazing, the average 7% boost in energy savings from the 90% AFUE furnace – rather than traded away with reduced insulation or other envelope features – would be added to the weighted average savings of 12.2% for the Prescriptive Path **AND** 2.5% for the reduced window area **to result in a new home that is 21.7% more energy efficient than an average home meeting the 2006 IECC.**

Energy and Cost Savings Estimates Necessarily Depend on Assumptions . . . The Vital Role Accurate and Thorough Assumptions Play in ICF's Building Code Analysis



In order to provide stakeholders with accurate, technically-credible estimates of energy cost savings from the efficiency improvements approved at the Final Action Hearings for the IECC (*the IECC uses energy cost as the metric for comparing energy efficiency*), IECC selected ICF International to conduct our analysis. A review of the extensive spectrum of factors listed below that ICF incorporated into its analysis attests to the firm's thoroughness and technical rigor.

Although the numbers included in the ICF analysis are precise, it should be kept firmly in mind that the numbers are simply estimates based on an extensive array of assumptions about energy prices, new home starts within climate zones, the physical details of an average home, owner operating practices and many other factors. Of course, specific home savings will vary substantially. ICF's modeling approach examines a broad array of house types, seeking to capture a reasonable representation of the varieties of home construction around the U.S., by examining home with the following range of characteristics:



- 239 TMY2 local climate locations in US
- Three types of foundations: slab, basement & crawl space
- Two building heights: One & two stories
- Two floor areas: 2,000 & 3,000 square ft.

- Four window orientations: northern, southern, eastern & western
- Energy Costs: 2007/2008 Energy Information Agency utility rates by state
- Regional and national results reflect weighting by number of housing starts

The ICF approach also makes the following assumptions regarding its baseline home:

- Three bedrooms
- R-Values, U-Values & SHGC from the 2006 IECC
- Home aspect (width:height) ratio of 2:1
- Insulation installation quality: Grade 3
- R-6 duct insulation
- Duct leakage of 15 cubic feet/minute for each 100 square feet of conditioned floor area
- Air infiltration of 8 ACH50
- Lighting with 10% high efficacy lamps
- Window area is 15% of floor area
- Thermostat settings: 72° heating, 75° cooling
- Interior Shade Fraction: 0.85 winter, 0.75 summer
- HVAC system is 15% over-sized
- Furnace with Average Fuel Utilization Efficiency (AFUE) of 78%
- Air conditioner with Seasonal Energy Efficiency Rating (SEER) of 13
- Heat pump meeting Heating Season Performance Factor (HSPF) of 7.7
- 40-gallon gas water heater with Energy Factor (EF) of 0.594
- Frame Fractions 23% wall, 11% ceiling and 10% floor
- Below-grade basement wall height 6'
- Roof & wall absorptivity of 0.75
- Ducts located in unconditioned space:
 - 100% in 1-story, slab
 - 100% in 1-story, crawlspace
 - 75% in 1-story, basement
 - 75% in 2-story slab
 - 75% in 2-story, crawlspace
 - 65% in 2-story, basement
- Factors: Shielding = .185; Horizontal = .40; Neutral level = .50.

Cost Savings Estimates Would Multiply if Societal Benefits Were Included

For various reasons, this analysis only includes energy cost savings. It does not attempt to include other cost savings (like savings from reduced equipment sizes), much less calculate the *societal* benefits achieved by boosting energy efficiency and reducing energy demand. These benefits are substantial and could significantly influence public policy priorities such as:

- Increasing America's energy security by reducing energy imports and reducing peak electric and gas demand
- Reducing the need for expensive new power plant capacity and gas rigs to meet rising electricity and gas demand
- Reducing emissions of greenhouse gases and other air pollutants
- Reducing or stabilizing energy prices for all Americans, by reducing energy demand in buildings
- Reducing the cost of building materials—moderating energy prices reduce materials manufacturers' energy costs and thus moderate future materials prices.

Conclusion

The energy efficiency of new homes will improve substantially under the nation's 2009 model energy code governing new home construction – the International Energy Conservation Code (IECC) – but will not achieve the 30 percent improvement sought by the U.S. Department of Energy, the U.S. Conference of Mayors, the National Association of State Energy Officials and the broad-based Energy Efficient Codes Coalition (EECC). But after two decades of only modest energy efficiency gains, it's clear that a growing number of building officials are embracing the need for much higher energy efficiency in our codes for new home construction.

Beginning with the new ICC code development cycle that kicks off in April 2009, the EECC will continue to advocate dynamic codes that will eventually take new home construction well beyond a 30 percent improvement. In the near term, the coalition will make its comprehensive package, called "The 30% Solution," available for state and local governments that want to go beyond the 2009 IECC today. In addition, EECC and will work with states to ensure that local elected officials, code officials and builders have the resources they need to do their jobs, and continue to expand our coalition.

About EECC

The Energy Efficient Codes Coalition is a unique, broad-based alliance of longstanding energy efficiency advocates that united to join a growing chorus supporting an ambitious step forward in the energy efficiency of American homes. Its supporters include government, national energy efficiency groups, regional energy efficiency alliances, environmental groups, utilities, affordable housing advocates, architecture, academia/think tanks, energy consumers and businesses, and labor. Together, in 2007/2008 the Coalition developed "The 30% Solution," a comprehensive code change proposal to boost energy efficiency in the 2009 model energy code by 30% over the current IECC, using fully achievable and affordable "state-of-the-shelf" technologies. The Coalition also opposes proposals that either weaken energy efficiency or include industry- or product-specific special exemptions.

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About ICF International

ICF International (NASDAQ: ICFI) partners with government and commercial clients to deliver consulting services and technology solutions in the energy, climate change, environment, transportation, social programs, health, defense, and emergency management markets. Since 1969, ICF has been serving government at all levels, major corporations, and multilateral institutions. ICF combines its expertise in energy policy, building science, and industry knowledge with its unique analytical capabilities to help clients successfully develop policies and programs. ICF has extensive experience assessing energy performance and savings for technologies and buildings. This experience ranges from providing simple assessments, such as spreadsheet calculations, to very detailed energy modeling simulations for the residential, commercial, and industrial buildings sectors. ICF also has extensive experience in creating sophisticated and easy to use software tools for clients to predict the energy and demand savings potential.