BCAP Dedicated to the adoption, implementation, and advancement of building energy codes

Virginia Residents Buying 2012 IECC Homes Will Save Thousands

An Analysis of Homeowner Profit after Paying Incremental Construction Costs For New Single Family Homes Meeting the Building Energy Code

HIGHLIGHTS

- **Energy cost savings for a 2012 IECC home are estimated to be $196-368 per year ($16-31 per month), when compared to homes meeting the current energy code.**
- **Break-even on investment—the additional down payment and slight mortgage payment increase—occurs in as little as 15 months.**
- **After the break-even point, homeowners achieve a net profit (energy savings less mortgage costs) of $97-$267 annually.**
- **2012 IECC homebuyers pocket $2,502 and $7,644 in net profits over the length of a 30 year mortgage term.**

SUMMARY

Virginia residents buying new single family homes meeting the 2012 International Energy Conservation Code (IECC) will pocket between $2,502 and $7,644 in net energy savings over a 30 year mortgage term, according to an analysis of energy savings and incremental construction costs by the Building Codes Assistance Project and ICF, International.

This report assesses energy savings and incremental construction cost increases of new, 2,400 square foot single family homes in Virginia that meet the latest model energy code, the 2012 IECC, compared to the current code in effect, the 2009 IECC. This analysis finds that an average new home meeting the 2012 IECC will add less than 1% to the cost of a new home, costing an additional $1,452 to $2,303 as compared to the costs of homes meeting the current energy code. **Annual energy savings for 2012 IECC homes are significant, and are estimated in this study at between $196-368 per year.**

The energy savings from the 2012 code are enough to pay back the buyer's additional down payment and slightly increased mortgage cost in as soon as fifteen months (*sooner if the homebuyer puts less than 20% down*). **After that date, the owner continues to pocket a profit (energy savings minus mortgage costs) of between $97 and $267 annually, depending on foundation and wall type—money that would otherwise go to pay higher utility bills.** These net savings will be even greater if energy costs rise over the next 30 years consistent with historical trends.

Stated differently, monthly **utility bill savings to the homeowner are as much as four times the additional mortgage payment** needed to cover the added first-cost of energy saving features included in the 2012 code.

ENERGY SAVINGS AND CONSTRUCTION COST METHODOLOGY

To calculate energy savings and incremental construction costs, this analysis defined a "typical" single family house to represent new residential development in Virginia. For this analysis, we modeled a two

story home, with exterior dimensions of 30 by 40 feet, wood-framed walls, and two alternative foundation types: a slab on grade foundation and a basement foundation. The model home's size and foundation type is based on regional construction practices, and it contains 2,400 square feet in floor area—which is also the approximate size of the average new home built nationwide.

For the purposes of this analysis we assume a baseline home that meets the requirements of the 2009 IECC, which is the basis of the state's current code. Although some leading builders are meeting or exceeding many elements of the 2012 IECC already, for purposes of this analysis we assume a baseline home that exactly meets the requirements of the 2009 IECC.

Energy savings were modeled by ICF International (ICFI), an international energy consulting firm with extensive experience in the use of hourly building energy simulation software to estimate energy performance and energy savings of alternative building codes and design concepts. Although the values included in the analysis represent a careful, independent technical judgment by ICFI staff, it should be kept in mind that – like any such analysis – the results depend on a number of assumptions about the physical features of a typical new home, operating practices, energy prices, and other factors.

Both the existing 2009 IECC and the new 2012 IECC codes allow a builder to choose among a number of alternatives to comply with the code. In this case, ICFI conservatively chose to compare the results from the prescriptive path of each version of the code. ICFI uses BeaconTM, an hourly simulation model that utilizes DOE-2 or EnergyPlus, and summarizes building performance in terms of estimated annual energy costs, based on long-term average weather conditions in a given climate zone (city), DOE/EIA state level energy costs. ICFI also estimates energy consumption by end-use, fuel type, electricity peak demand, and air conditioner size in each prototype home. More details of the modeling assumptions used in this analysis are available on request.

PART I. INCREMENTAL COSTS FOR SLAB ON GRADE HOMES

Using the 2,400 square foot model home as a baseline, we calculated incremental costs by identifying the building components that would have to be upgraded from the current 2009 IECC, according to the prescriptive requirements in the 2012 IECC. To estimate incremental costs, we rely on construction costs from the well-regarded *2012 RS Means Contractor's Pricing Guide* to approximate actual costs of new home construction. This resource is known to be conservative and is useful for this analysis because all estimated construction costs are inclusive of material costs, labor, and contractor overhead and

Figure 1: Slab on Grade Foundation. Credit flickr user US Forest Service

profit.[1] For this analysis, RS Means data is supplemented by additional calls to local building suppliers and experts.

Exterior Walls

The 2012 IECC would require builders in Virginia to make changes to a new home's exterior wall construction. At present, the 2009 IECC requires R-13 walls for exterior walls, while the 2012 IECC mandates an insulation upgrade to R-13+5 or R-20 walls.

Building the R-13+5 walls begins with the 2 x 4 walls currently by builders and would replace conventional OSB wall sheathing with structurally insulated sheathing (SIS)[2]—an engineered product that combines structural reinforcement of oriented strand board (OSB) with insulation equivalent to R-5, thus creating an R-13+5 wall.[3] The cost difference of the conventional OSB and R-5 insulation is estimated as $0.76 per square foot of wall area, for an estimated total of $1,813 per new home.

Builders also have to option to meet the wall requirements in the 2012 IECC by upgrading to R-20 walls. To build the R-20 wall, builders will have to upgrade conventional 2 x 4 framing with 2 x 6 framing. The larger framing allows for R-21 fiberglass batts to be placed between studs instead of the R-13 batts required in the 2009 IECC. This cost is estimated by RS Means as $0.68 per square foot of wall area, for a total of $1,618 per new home. It is important to note that this cost may in fact be significantly lower. In fact, due to the superior strength of 2 x 6 stud construction, builders can introduce a cost-saving variant of the R-20 wall that increases the space between wall studs from 16 inches apart to 24 inches known as O.V.E. framing—thus saving lumber and dramatically reducing incremental cost. With studs spaced 24 inches on center, the cost of upgrading the model home's walls drops to $928.

Window Extension Jambs

Builders in Virginia who intend to meet the 2012 wall requirements with R-20 walls may also incur an additional cost for window jamb extensions. These jamb extensions are required because the wall thickness increases with a change from 2 x 4 to 2 x 6 framing. While some window manufacturers offer jamb extensions as a factory-built option, most builders prefer to field-fabricate extension jambs, which are attached to the interior jamb of the window and create a consistent wood or drywall transition between the window and wall. These extensions, essentially four pieces of wood or drywall that "frame" the interior window jamb, are estimated at $300 after a brief survey of installers, who put costs at $10-12 per window.

Extension jambs are not assumed to be an added cost for builders using R-13+5 walls to meet the 2012 IECC, as the difference in wall thickness of OSB and SIS is less than ½ inch.

Whole House Air Leakage and Ventilation

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[1] RS Means also includes a location factor, which provides an estimate of local costs as a percentage of RS Means national average estimates. For this analysis, the location factor used was that of the state capital, Richmond. The location factor for Richmond is 94%, indicating that construction costs in the Richmond are approximately 6% lower than the national average.

[2] Please note, here SIS is used as a generic term for insulated sheathing products. It does not refer to DOW's SIS, which is currently not available to contractors.

[3] Incremental cost for 13+5 walls relies on local building supply estimates for R-5 or R-6 structurally insulated sheathing (SIS). Incremental costs for walls with SIS do not take into account savings from eliminating a housewrap, a function that is included in SIS panels. Thus, incremental costs for walls should be lower than projected in this analysis

We estimate that the additional required air sealing in the 2012 IECC and the required testing for whole house air leakage (commonly known as "blower door") and duct leakage will add about $350 per new home.[4] Because the resulting home will have fewer air and duct leaks to the outside, mechanical ventilation will have to be improved, a cost we estimate at $180 for upgrading one bathroom vent fan to a unit with an Energy Star rating along with the installation of a simple controller which is set to automatically exhaust indoor air.[5]

Hot Water Distribution Lines

An additional 2012 IECC code change will require builders to insulate hot water distribution lines to kitchens. We believe the cost impact of this change is small, as R-3 insulation costs less than 50 cents per linear foot and most insulation products can be "clipped" around supply pipes after the plumbing rough-in.[6] As a result, this cost is estimated at $100 per new home.

Lighting

Builders will have to install high-efficiency lamps in 75 percent of hard-wired fixtures, up from 50 percent in the 2009 IECC. Usually, this requirement is met with compact florescent lights (CFLs). Our analysis estimates that the upgrade of lamps in 25 percent of fixtures will cost no more than $25.

Attic Insulation

The 2012 IECC also requires builders to upgrade blown-in ceiling (attic) insulation from R-38 to R-49, which is estimated by RS Means to cost an additional $384 per new home.

Cost Savings

Fortunately, the 2012 IECC will also introduce cost savings for builders. While complying with the 2012 IECC increases first-cost in some areas, the new code also presents opportunities to **reduce** costs for HVAC equipment as a result of an improved building envelope. Among other possible savings, builders will be able to reduce the size of costly mechanical equipment. For the prototype house in Virginia's climate zone 2 with a slab foundation, builders will be able to reduce the cooling system capacity from an average of 4 to approximately 3 tons. This reduction in air conditioner capacity can result in first-cost savings of one ton, which is expected to save approximately $815 for the average new house.[7]

Total incremental costs for new homes in Virginia with slab foundations are estimated in Table 1, below:

[4] $350 is a commonly used as an expected air sealing and testing cost for new single-family detached homes nationwide.

[5] Ventilation system and costs are described in an August 2005 report from Lawrence Berkeley National Laboratory "Review of Residential Ventilation Technologies." Although the costs of these components have decreased in recent years, the 2005 estimate ($180 per new home) is quoted in this analysis.

[6] It is difficult to determine what combination of redesign, resizing, and/or partial insulation of hot water lines would be done in a typical new home. Insulating distribution lines to the kitchen and very long runs would add costs while downsizing lines would reduce costs; in any case we believe the net effect would be small.

[7] EPA conservatively estimates for their Energy Star Homes Version 3 that first-cost savings for downsizing a 13 SEER air conditioner are $815 per ton. By "right-sizing" the HVAC equipment, building occupants will also benefit from a reduction in equipment short-cycling (i.e., where equipment is too large for the cooling load and cycles on and off frequently, thus wasting energy and losing some of its ability to dehumidify indoor air). Please note that additional cost savings could be obtainable from downsizing heating equipment, but this study does not attempt to calculate those savings.

Table 1: Virginia 2012 IECC Incremental Costs for Slab Foundation Homes					
Building Component	Total Area	Incremental Cost/Square Ft	Total	Location Factor	Adjusted Total
Ceiling Insulation Upgrade from R-38 to R-49 (both blown-in)	1,200	$0.34	$ 408	94%	$ 384
Increased Air Sealing and Testing	N/A	N/A	N/A	N/A	$ 350
Insulating Hot Water Pipes	N/A	N/A	N/A	N/A	$ 100
75% CFLs in hardwired fixtures (from 50%)	N/A	N/A	N/A	N/A	$ 25
Bathroom Vent Fan Upgrade and Addition of Automatic Timer	N/A	N/A	N/A	N/A	$ 180
Wall Option 1: R13+5 Walls	N/A	N/A	N/A	N/A	$1,813
Wall Option 2: R-20 Walls, studs 16" on center	N/A	N/A	N/A	N/A	**OR** $1,618
Wall Option 3: R-20 Walls, Studs 24" on center	N/A	N/A	N/A	N/A	**OR** $ 928
Window Extension Jambs: *Applicable only to Walls Options 2 and 3, above*	N/A	N/A	N/A	N/A	$ 300
HVAC System Savings (downsizing cooling system 1 ton)					$ (815)
Incremental Cost (R-13+5 Walls)					**$2,036**
Incremental Cost (R-20 Walls, studs 16" on center) $2,142					
Incremental Cost (R-20 Walls, studs 24" on center) $1,452					

ENERGY COST SAVINGS: SLAB FOUNDATIONS

According to the model used in this analysis, **upgrading to the 2012 IECC will result in significant energy bill savings for Virginia homebuyers, resulting in utility bill savings of between $196 to $221 per year**. It is noteworthy that these savings assume constant energy prices; if energy prices continue to rise consistent with historical trends, savings will be greater in future years. These energy savings allow homebuyers to quickly recapture their incremental costs.

Table 2: 2012 IECC Energy Savings for Slab Foundation Homes	
Climate Zone and Wall Types	**Annual Energy Savings**
Houses with R-13+5 Walls	$221
Houses with R-20 Walls	$196

MORTGAGE PAYBACK FOR HOMEOWNERS: SLAB FOUNDATIONS

Homebuyers will be able to include the incremental first-costs of meeting the 2012 IECC in their mortgage, while benefiting from lower utility bills starting on day one. With estimated energy cost savings of between $196 and $221 per year, monthly utility bill savings for homes built using O.V.E.

framing are more than three times as much as the additional mortgage payment needed to cover the added first-cost of energy saving features required by the 2012 IECC.

This cash-flow difference is enough to pay back the buyer's added down payment within as soon as 27 months after purchase (or sooner if the loan allows a down payment below 20%). After that date, the owner continues to realize a profit of up to $129 annually due to lower utility bills – and even more if energy prices increase.

This payback analysis assumes that homebuyers purchase a new home with 20% down at the current nationwide interest rate of 4.03 percent. This scenario would result in an increased down payment of between $290 and $428 with an additional monthly mortgage cost of between $6 and $8 per month. Taking into account energy savings and lower utility bills, a cash flow analysis indicates that the homebuyer would break even within as soon as 27 months after purchase. After that break-even date, **homeowners would continue to realize a profit of up to $129 annually,** which is calculated by subtracting additional mortgage costs from energy savings. Homebuyers with a lower down payment—such as 5 or 10 percent—will realize payback more quickly. Mortgage payback to homeowners is presented below in Table 3, below.

Table 3: Mortgage Payback for Homeowners for Slab on Grade Homes

Home Exterior Wall Type	Incremental Costs	Energy Savings/Year and Month per home	Down Payment Increase (and Mortgage Increase per Month)	Breakeven Point	Annual Profit for Homeowner after Breakeven Point	Gross Profit over Mortgage Term (Energy Savings Minus Mortgage Costs)
Home with R13+5 Walls	$2,036	$221/year ($18 per month)	$407 (plus $8/month)	3 years and 2 months	$127	$3,419
Home with R20 Walls, studs 16" on center	$2,142	$196/year ($16 month)	$428 (plus $8/month)	4 years and 4 months	$97	$2,502
Home with R20 Walls, studs 24" on center	$1,452	$196/year $16/month	$290 (plus $6/month)	2 years and 3 months	$129	$3,591

PART II. INCREMENTAL COSTS FOR HOMES WITH BASEMENT FOUNDATIONS

In addition to those incremental costs incurred in building slab on grade homes, builders of homes with basement foundations may also incur costs for hard ducted returns in basement ceilings.

Hard Ducted Returns in Basement Ceilings
For builders currently using "panned" floor joists as return air ducts, meeting the 2012 IECC will require an upgrade to conventional "hard ducted" returns in basement ceilings. Many builders already use conventional ducts as returns, but this cost has been included in this analysis regardless. Calculating the cost change between panned and

Figure 2: Basement Foundation. Credit: flickr user chintanamin

conventional ducts is challenging, as panned ducts are not priced in RS Means and many construction cost sources. After consulting with HVAC contractors, who indicated the cost of panned ducts was roughly half of conventional ducts, incremental costs are estimated in this analysis as one-half of cost of flexible return ducts. We believe this cost is reasonable due to the significant amount of labor required for panned ducts, as contractors must screw sheet metal between two adjacent joists and seal the edges with mastic. RS Means estimates the installed cost of flexible, non-insulated, 6" diameter flexible ducts at $4.58 per linear foot.[8] As such, the cost to upgrade ducts is estimated at $2.15 per linear foot, or $161 for the estimated 75 feet of return duct which some builders will have to upgrade under the 2012 IECC.

Additionally, homes with conditioned basements will achieve cooling reductions of approximately 1.2 tons, which to be conservative is rounded down to 1 ton due to the availability of mechanical equipment, which is usually available in half ton increments. This reduction in air conditioner capacity will likewise result in first-cost savings of one ton, which is expected to save approximately $815 for the average new house. Total incremental costs for new homes in Virginia with basement foundations are estimated in Table 4, below:

Table 4: Virginia 2012 IECC Incremental Costs for Basement Foundation Homes

Building Component	Total Area	Incremental Cost/Square Ft	Total	Location Factor	Adjusted Total
Ceiling Insulation Upgrade from R-38 to R-49 (both blown-in)	1,200	$0.34	$ 408	94%	$ 384
Upgrade First Floor Panned Ducts to Flexible Ducts	75 linear feet	$2.29	$ 172	94%	$ 161
Increased Air Sealing and Testing	N/A	N/A	N/A	N/A	$ 350
Insulating Hot Water Pipes	N/A	N/A	N/A	N/A	$ 100
75% CFLs in hardwired fixtures (from 50%)	N/A	N/A	N/A	N/A	$ 25
Bathroom Vent Fan Upgrade and Addition of Automatic Timer	N/A	N/A	N/A	N/A	$ 180
Wall Option 1: R13+5 Walls	N/A	N/A	N/A	N/A	$1,813
Wall Option 2: R-20 Walls, studs 16" on center	N/A	N/A	N/A	N/A	**OR** $1,618
Wall Option 3: R-20 Walls, Studs 24" on center	N/A	N/A	N/A	N/A	**OR** $ 928
Window Extension Jambs: *Applicable only to Walls Options 2 and 3, above*	N/A	N/A	N/A	N/A	$ 300
HVAC System Savings (downsizing cooling system 1 ton)					$ (815)
Incremental Cost (R-13+5 Walls)					**$2,197**
Incremental Cost (R-20 Walls, studs 16" on center) $2,303					
Incremental Cost (R-20 Walls, studs 24" on center) $1,613					

ENERGY COST SAVINGS: BASEMENT FOUNDATIONS

[8] Less expensive duct options are available, but this product matches the modeling assumptions used by ICFI.

According to the model used in this analysis, **upgrading to the 2012 IECC will result in significant energy bill savings for Virginia homebuyers, resulting in utility bill savings of between $340 to $368 per year**. It is noteworthy that these savings assume constant energy prices; if energy prices continue to rise consistent with historical trends, savings will be greater in future years. These energy savings allow homebuyers to quickly recapture their incremental costs.

Table 5: 2012 IECC Energy Savings for Basement Foundation Homes

Climate Zone and Wall Types	Annual Energy Savings
Houses with R-13+5 Walls	$368
Houses with R-20 Walls	$340

MORTGAGE PAYBACK FOR HOMEOWNERS: BASEMENT FOUNDATIONS

Homebuyers will be able to include the incremental first-costs of meeting the 2012 IECC in their mortgage, while benefiting from lower utility bills starting on day one. With estimated energy cost savings of between $340 and $368 per year, monthly utility bill savings for homes built using O.V.E. framing are more than four and half times as much as the additional mortgage payment needed to cover the added first-cost of energy saving features required by the 2012 IECC.

This cash-flow difference is enough to pay back the buyer's added down payment within as soon as 15 months after purchase (or sooner if the loan allows a down payment below 20%). After that date, the owner continues to realize a profit of up to $267 annually due to lower utility bills – and even more if energy prices increase.

This payback analysis assumes that homebuyers purchase a new home with 20% down at the current nationwide interest rate of 4.03 percent. This scenario would result in an increased down payment of between $323 and $461 with an additional monthly mortgage cost of between $6 and $8 per month. Taking into account energy savings and lower utility bills, a cash flow analysis indicates that the homebuyer would break even within as soon as 15 months. After that break-even date, **homeowners would continue to realize a profit of up to $267 annually,** which is calculated by subtracting additional mortgage costs from energy savings. Homebuyers with a lower down payment—such as 5 or 10 percent—will realize payback more quickly. Mortgage payback to homeowners is presented below in Table 6, below.

Table 6: Mortgage Payback for Homeowners with Basement Homes

Home Exterior Wall Type	Incremental Costs	Energy Savings/Year and Month per home	Down Payment Increase (and Mortgage Increase per Month)	Breakeven Point	Annual Profit for Homeowner after Breakeven Point	Gross Profit over Mortgage Term (Energy Savings Minus Mortgage Costs)
Home with R13+5 Walls	$2,197	$368/year ($31 per month)	$440 (plus $8/month)	1 year and 8 months	$267	$7,579
Home with R20 Walls, studs 16" on center	$2,303	$340/year ($28 month)	$461 (plus $9/month)	2 years	$234	$6,555
Home with R20 Walls, studs	$1,613	$340/year $28/month	$323 (plus $6/month)	1 year and 3 months	$265	$7,644

24" on center

CONCLUSIONS

- As estimated in this analysis, incremental costs for new 2,400 square foot homes built to the 2012 IECC in Virginia range from $1,452 to $2,303 per new home, depending on foundation type.
- Annual energy savings for Virginia homeowners attributable to the 2012 IECC range from $196 to $368 per year.
- Assuming a conservative 20% down payment, new home buyers will break even on their initial investment in as little as 15 months after purchase.
- Gross profit for homebuyers over a 30 year mortgage term ranges from $2,502 to $7,644.

About BCAP

As an independent judge of the efficacy of energy codes, BCAP strives to use data to address energy code barriers, including the real or perceived construction costs incurred by code changes. To address concern in the building community that upgrading to the latest version of the residential energy code, the 2012 IECC, will result in cost prohibitive increases in construction cost for new single-family homes, BCAP has completed a nationwide incremental cost analysis as well as analysis for states on demand. BCAP is a project of the Alliance to Save Energy, a nonprofit organization that promotes energy efficiency worldwide through research, education, and advocacy.

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