Nebraska Incremental Cost Analysis

New Single Family Homes

Nebraska Compliance Toolkit

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Prepared by the Building Codes Assistance Project for the Nebraska Energy Office as part of the American Recovery and Reinvestment Act of 2009

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

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Summary

This analysis indicates that incremental costs to build new homes to the 2009 International Energy Conservation Code (IECC) in Nebraska will be approximately $400 for a new home—although this figure could increase or decrease depending on local practices.

Model House Specifications

To determine the incremental construction costs for new homes in Nebraska resulting from the implementation of the 2009 IECC, this study relies on model home specifications (and estimated energy savings) provided by a 2009 U.S. Department of Energy (DOE) report, *Impacts of the 2009 IECC for Residential Buildings*.[1]

For the purposes of completing statewide energy modeling analysis for an "average" home statewide, the house model selected by DOE has the following construction specifications:

- 2-story, single-family colonial style home
- Conditioned floor area: 2,400 ft^2
- 8.5-ft high ceilings
- Total ceiling area: 1,200 ft^2
- Unconditioned attic
- Gross exterior wall area: 2,380 ft^2
- Total window area: 357 ft^2 (15% of wall area, oriented equally to the north, south, east and west)
- Perimeter: 140 linear feet

The 2,400 square foot model home was initially used by DOE in its analysis because this approximates the size average new home built nationwide. This analysis acknowledges that all new homes in Nebraska will not be 2,400 square feet, however this size provides a starting point for analysis. Homes that are either smaller or larger than the model home used in this study should expect incremental costs (and energy savings) that are roughly proportional to the change in size from the average home size—although some fixed costs, such as duct testing, would skew savings toward larger homes.

[1] *Impacts of the 2009 IECC for Residential Buildings in the State of Nebraska (BECP Report, Sept. 2009)* http://www.energycodes.gov/publications/techassist/residential/Residential_Nebraska.pdf

Data Sources

To calculate baseline construction costs which serve as the basis for cost-benefit analysis, the Building Codes Assistance Project (BCAP) relied on a construction data source, *RS Means Residential Cost Data 2011,* in order to approximate baseline cost and the costs of specific building component changes.[2]

The study used this resource to approximate a baseline construction cost, inclusive of material costs, labor costs, and contractor overhead and profit for each building type. Each material cost is not product-specific, and represents an average component cost that contractors use throughout the country. Because standard construction materials and labor rates range widely across the United States, the *RS Means* national average prices were modified to reflect building costs and labor for Nebraska. To make this adjustment, *RS Means* provides location factors that are georeferenced to cities and towns. As this study sought an average construction cost adjustment factor for each within Nebraska, the study uses the highest location factor available statewide – 91%, the location factor for Omaha – in order to approximate statewide cost as a percentage of the national average.

Baseline Scenario Incremental Cost Estimate

These incremental cost estimates for Nebraska are low, at an estimated statewide average of $400 for a new 2,400 ft^2 single family home. To calculate incremental cost, this analysis draws on prescriptive building requirements in the current statewide code, the 2003 IECC[3] and the current model code, the 2009 IECC. Prescriptive building changes are presented below in Figure 1. As highlighted in Figure 1, prescriptive building requirements for single-family homes in Nebraska change little between the 2003 and 2009 IECC. In fact, many requirements become less stringent in some climate zones, including ceiling R values and wood frame wall insulation requirements.

Walls

In a change from the 2003 to the 2009 IECC, wood frame wall requirement increase from R-18 and R-21 in the 2003 climate zones to R-20 or R-13+5 (fiberglass batts plus R-5 continuous sheathing) statewide. This change is largely insignificant, as both R-20 walls required in the 2009 IECC are equivalent to R-21, 2003 IECC-mandated walls in terms of construction. Both wall assemblies require 2’ x 6’ wall construction with 5-½” R-19 fiberglass batts plus ½ inch isocyanurate rigid exterior insulation or an equivalent assembly. Similarly, the R-18 required in 2003 IECC Climate Zone 13B is nearly equivalent to the R-13+5 requirement in the 2009 edition. The R-18 can be achieved via 2’ x 4’ stud construction with 3-½” R-15 plus ½” isocyanurate rigid

[2] RS Means is a well-respected construction cost reference that includes square foot costs for thousands of building products, including those used in this study.

[3] *Energy Impact Study of the 2003 IECC, 2006 IECC, and 2006 IRC Energy Codes for Nebraska.* Amy Musser. September 19, 2006.

insulation or a 2’ x 6’ wall with R-19 high density batts, whereas the R-13+5 insulation required in the 2009 IECC can be achieved with a 3-½” R-13 plus 3/4” isocyanurate rigid insulation.

Figure 1: Nebraska Climate Zone 5 Prescriptive Incremental Cost Estimates

Components	2003 IECC	2009 IECC	Change Per Ft^2	Current Practice Price	2009 IECC Price	Ft^2	Location Factor	Total Change
Ceiling (R-Value)[4]	38-49	38	$0 or cost savings	N/A	N/A	1,200	$0.91	$0.00
Window (U/SHGC Factor)	.35/NR	.35/NR	No Change	N/A	N/A	357	$0.91	$0.00
Wood Frame Wall (R-Value)	18, 21, 21	20 or 13+5	No Change	N/A	N/A	2,380	$0.91	$0.00
Floor (R-Value)[5]	21	30	N/A	N/A	N/A	1,200	$0.91	$0.00
Basement (R-Value)	10/13	10/13	No Change	N/A	N/A	140	$0.91	$0.00
Slab (R-Value)	10, 2 ft depth	10, 2 ft depth	No Change	N/A	N/A	1,200	$0.91	$0.00
Crawlspace (R-Value)[6]	20	10/13	$0 or cost savings	N/A	N/A	1,200	$0.91	$0.00
Improved Duct Sealing/Testing								$350.00
Lighting (50% high efficacy fixtures)								$50.00
Total								**$400.00**

Wall and Equipment Efficiency Tradeoffs

As this study relies on prescriptive energy code requirements, the analysis of tradeoffs is limited. Current practice in Nebraska indicates that many builders use RESCheck's tradeoff feature to tradeoff lower exterior insulation requirements for more efficient mechanical equipment. The 2009 IECC eliminates this tradeoff, which may affect builders working under the new code. Prior BCAP analysis in New York, Ohio, and other states indicates that in these states this tradeoff is unnecessary and may in some cases cause builders to incur additional costs. According to these studies, improvements in envelope efficiency allow downsizing (or, right-sizing to smaller) equipment that creates a cost-neutral scenario. Expecting a cost increment also discounts the potential for marketing the home based on its higher efficiency and expected improvement in occupant comfort.

Despite these findings, when using a conservative scenario in which builders are assumed to lose a tradeoff of downgrading from R-20 walls (the highest required statewide) to R-15 walls, the *RS Means* estimated cost increase would be $0.43 per square foot between the R-20 and R-15 wall assemblies. At 2,380 square feet of exterior wall area in the modeled home, the incremental cost would equal $1,017.93 in incremental costs. However, by eliminating the tradeoff builders would no longer be required to purchase more efficient equipment, lowering the incremental cost. In prior BCAP analysis in New York and Ohio, cost analysis found it more advantageous to lower equipment size to account for envelope improvements. ICF analysis for

[4] While the 2009 IECC lowers the cost of R-value (and cost) of ceiling insulation, this analysis does not calculate these savings or recommend lowering insulation levels.

[5] This analysis assumes that basement walls, rather than basement ceilings are insulated, negating the incremental cost of basement ceilings.

[6] Basement foundations are modeled in this analysis in lieu of other foundation types, including crawlspaces.

Ohio (for Climate Zone 5) demonstrates the cost savings of equipment size reductions in conjunction with envelope improvements:

Figure 2: Ohio Climate Zone 5 Right-Sizing Estimates

Feature	2006 IECC		2009 IECC (2x4)	
Cooling Equipment	13 SEER Central AC, 3.7 tons	$3,016	13 SEER Central AC, 3.2 tons	$2,608
Heating Equipment	80 AFUE gas furnace, 67.5 kBTUh	$1,620	80 AFUE gas furnace, 62.5 kBTUh	$1,500
Ceiling Insulation	R-38, 1875 Sq.Ft.	$2,194	R-38, 1875 Sq.Ft.	$2,194
Ceiling Insulation Installation	Grade III, 1875 Sq.Ft.	$0	Grade II, 1875 Sq.Ft.	$56
Above-Grade Wall Framing	2x6, 2150 Sq.Ft.	$5,784	2x4, 2150 Sq.Ft.	$4,924
A-G Wall Cavity Insulation	R-19, 1750 Sq.Ft.	$1,173	R-13, 1750 Sq.Ft.	$1,050
A-G Wall Sheathing	100% OSB, 1750 Sq.Ft.	$1,435	20% OSB, 80% R-5, 1750 Sq.Ft.	$1,393
A-G Wall Insulation Installation	Grade III, 2150 Sq.Ft.	$0	Grade II, 2150 Sq.Ft.	$65
Floor Insulation	R-19, 1875 Sq.Ft.	$1,819	R-19, 1875 Sq.Ft.	$1,819
Floor Insulation Installation	Grade III, 1875 Sq.Ft.	$0	Grade II	$56
Infiltration	8.0 ACH50	$625	8.0 ACH50	$625
Windows	U: 0.35 / SHGC: 0.45, 375 Sq.Ft.	$9,844	U: 0.35 / SHGC: 0.45, 375 Sq.Ft.	$9,844
Water Heater	Standard DHW	$500	Standard DHW	$500
Thermostat	Manual Thermostat	$25	Programmable Thermostat	$75
Duct Sealing	8 CFM per 100 ft² of floor area	$100	8 CFM per 100 ft² of floor area	$100
Lighting	0% Fluorescent Lighting	$10	50% Fluorescent Lighting	$80
	Total Cost:	$28,143	Total Cost:	$26,888
	Incremental Cost:	$0	Incremental Cost:	-$1,255
	Annual Energy Cost Savings:	$0	Annual Energy Cost Savings:	$232.04
	Simple Payback (years):	N/A	Simple Payback (years):	(5.4)

Basement Insulation: Wall versus Floor

Our analysis currently assumes that basements in new Nebraska homes are primarily insulated on basement walls. Under this scenario, no additional insulation requirements would be incurred in the basement. By conditioning the basement, additional basement ceiling insulation (which increases from R-20 to R-30 under the 2009 IECC) is not required. In a worst-case scenario, the incremental cost of upgrading to the R-30, 9" thick fiberglass batt is estimated by *RS Means* as $404.04.

Duct Testing and Lighting Requirements

This analysis assumes $350 for duct tightness tests required by the 2009 IECC. This cost can be avoided if builders reroute HVAC ducts through the building envelope, but this analysis assumes the majority will elect to keep ducts in non-conditioned space. This study also assumes $50 across the board for the installation of 50% high efficacy fixtures, which builders can accomplish via the installation of compact fluorescent or other qualified high-efficiency lights.

Estimated Payback

According to BCAP analysis, compliance with the 2009 IECC represents a nominal 0.1% increase to the retail price of an average new home[7]—an incremental cost which is fully paid off in just five months from energy savings alone, while all future energy cost savings accrue to the homeowner. This analysis is based on the following assumptions:

- $236 estimated energy savings, as estimated by DOE
- Mortgage particulars: 20% down payment, 30 year term, 5.05% interest rate

Under this scenario, homeowners would pay an additional $80 on their down payment and $1.73 on monthly mortgage payments. Energy savings of $19.67 per month, however, would reach the break-even point in Month 5, after which homeowners would reap $18 every month in profit, for a total of $215 annually.

It is worth noting that this conservative break-even scenario is subject to significant fluctuations in input variables. For example, under prospects of rising energy costs, both payback and break-even on the incremental cost of code improvements would be accelerated significantly. Similarly, variations in lending interest rates and required money down would each alter this projection. Increases in incremental cost would also increase payback time.

[7] For the purposes of modeling, this study has used a 2,400 square foot home as a benchmark for the "average" new residential building constructed in Nebraska. This assumption is consistent with a 2009 study, *Impacts of the 2009 IECC for Residential Buildings at the State Level*, commissioned by the U.S. Department of Energy (DOE). The baseline retail price associated with this "average" new home (before added energy code cost) is assumed to be $266,677. This amount was derived from the 2009 average home sale prices. This square foot cost was applied to the 2,400 foot model home to approximate baseline cost.