



PNNL-18455

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Analysis of 2009 International Energy Conservation Code Requirements for Residential Buildings in Utah

PC Cole

BG Lucas

May 2009



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Pacific Northwest National Laboratory
Richland, Washington 99352

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Pacific Northwest National Laboratory - May 27, 2009

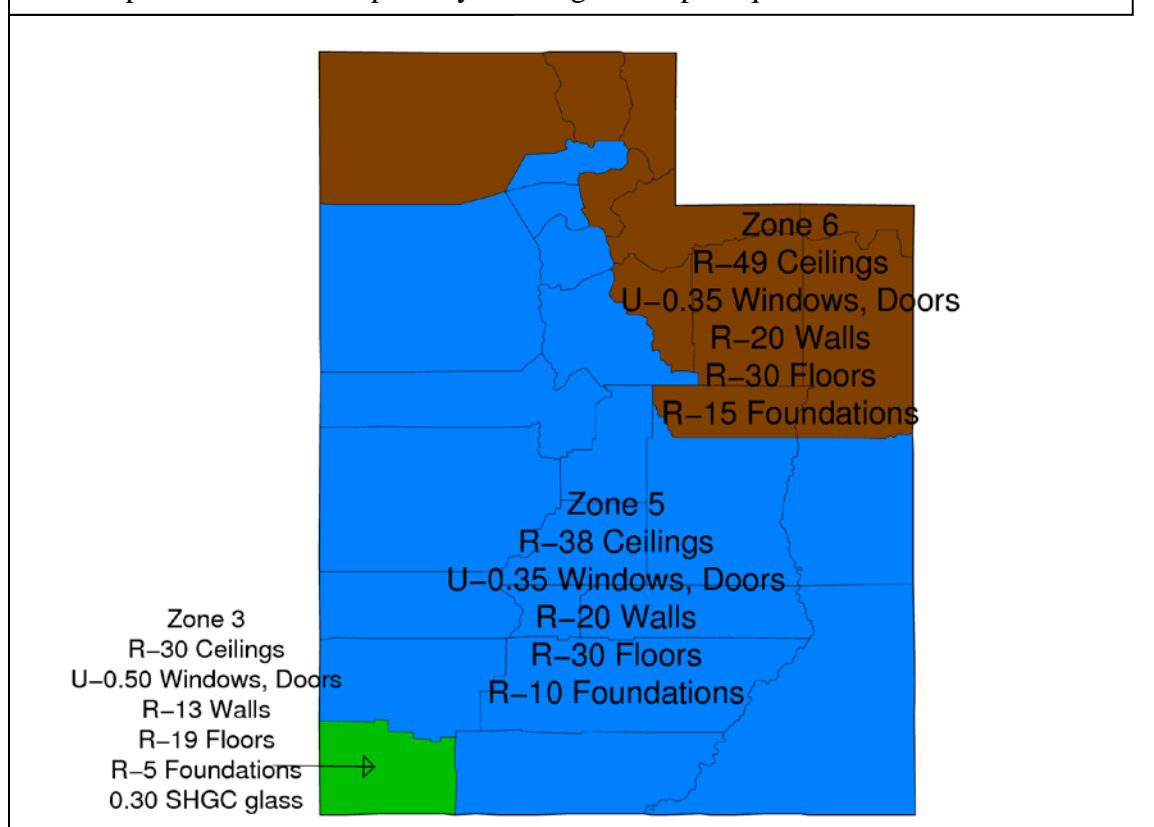
Summary

The 2009 International Energy Conservation Code (IECC) contains several major improvements in energy efficiency over the current Utah code, the 2006 IECC. The most notable changes are improved duct sealing and efficient lighting requirements. A limited analysis of these changes resulted in estimated savings of \$168 to \$188 for an average new house in Utah at recent fuel prices.

Details

IECC Scope : Residential includes single-family housing and multifamily housing three stories or less above-grade intended for permanent living (hotel/motel is not “residential”). The code applies to new buildings and additions/alterations/renovations/repairs.

The map below shows the primary building envelope requirements for all residential



Notable requirements in the 2009 IECC:

- Building envelope must be caulked and sealed.
- Slab-on-grade insulation is R-10 to a depth of 2 feet in Zones 5 and 6. Slab insulation is not required in Zone 3.
- Supply ducts in attics must be insulated to R-8. Return ducts in attics and all ducts in crawlspaces, unheated basements, garages, or otherwise outside building envelope must be insulated to R-6.
- All ducts must be sealed and either:
 - *verified by pressure testing* – the duct system has to be tested and the air leakage out of ducts must be kept to an acceptable maximum level.
 - *installed entirely within the building thermal envelope* – testing is not required if all ducts are inside the building thermal envelope (for example in heated basements), though the ducts still have to be sealed.
- Piping for hydronic (boiler) heating systems must be insulated to R-3.
- Although vapor retarders are not required by the IECC, the I-codes do set wall vapor retarder requirements in Section R601.3 of the 2009 IRC, and vapor retarders are required in Utah Zones 5 and 6.
- Less insulation is allowed for mass walls and more insulation required for steel framing.
- 50% of the lighting “lamps” (bulbs, tubes, etc.) in a building must be high efficacy. Compact fluorescents qualify, standard incandescent bulbs do not.
- Standard I-code administrative requirements (inspections, documentation) apply.
- A certificate must be posted near the electrical panel listing insulation levels and other energy efficiency measures.

Exemptions/Allowances from prescriptive measures:

- One door and 15 ft² of window area are exempt
- Skylight U-factors are allowed to be U-0.60
- 500 ft² or 20% of ceiling area of cathedral ceiling, whichever is less, is allowed to have R-30 insulation

Mandatory Requirements:

Windows, can never exceed an area-weighted U-factor of 0.48 in Zone 5 and 0.40 in Zone 6. The 2009 IECC also identifies a set of other requirements that are strictly “mandatory” that must be done in all buildings, such as building envelope and duct sealing.

Compliance Paths:

The IECC effectively contains three alternative compliance paths.

- 1) Prescriptive measures. This is considered the simplest path. These requirements do not vary by building size, shape, window area, or other features. The IECC has a single table of requirements for insulation R-values and window and door U-factors and SHGC. There is a corresponding U-factor table that permits

- compliance of less common component types (e.g., structural insulated panels), albeit without any cross-component trade-offs.
- 2) Total building envelope UA (U-factor multiplied by area). This is the path predominantly used by the REScheckTM software. Based on the prescriptive U-factor table, it allows trade-offs whereby some energy efficiency measures can fall below code requirements if balanced by other measures that exceed code requirements.
 - 3) Simulated performance (requires software programs). This path allows compliance if the home has a calculated annual energy consumption (or energy cost) equal to or less than that of a standard reference design that just meets the code's prescriptive requirements. This path allows for crediting energy efficiency measure not accounted for in the other paths, such as renewable energy measures. The 2009 performance path differs from previous editions of the IECC in that it allows no tradeoff credit for the use of high efficiency space heating, space cooling, or water heating equipment.

Main Differences between the Utah code and the 2009 IECC

Utah adopted the 2006 IECC on January 1, 2007. The 2006 IECC has the same format (including the same climate zones) and many of the same requirements as the 2009 IECC. The major differences are listed below:

- The current state code requires ducts to be sealed but not to a specific leakage rate verified by testing as is required in the 2009 IECC (if any ducts are outside the building envelope).
- 50% of the lighting “lamps” (bulbs, tubes, etc.) in a building have to be high efficacy in the 2009 IECC; the 2006 IECC has no lighting requirement. Compact fluorescents qualify, standard incandescent bulbs do not.
- Trade-off credit can no longer be obtained for high efficiency HVAC equipment. For example, if a high efficiency furnace is used, no reduction in wall insulation is allowed. (This will have a substantial impact on the flexibility allowed by the REScheck software and other energy performance analysis tools.)
- A number of thermal envelope requirements have improved. These are highlighted in Table 1.

Table 1: Comparison of Envelope Requirements

<i>Components</i>	Climate Zone 3B		Climate Zone 5B		Climate Zone 6B	
	IECC 2006	IECC 2009	IECC 2006	IECC 2009	IECC 2006	IECC 2009
Ceiling	30	30	38	38	49	49
Skylights	.65	.65	.60	.60	.60	.60
Fenestration (U-factor)	.65	.50	.35	.35	.35	.35
Fenestration (SHGC)	.40	.30	NR	NR	NR	NR
Wood Frame Wall	13	13	19	20	19	20
Mass Wall*	5/8	5/8	13/13	13/17	15/15	15/19
Floor	19	19	30	30	30	30
Basement Wall	0	5/13	10/13	10/13	10/13	15/19
Slab	0	0	10, 2ft	10, 2ft	10, 4ft	10, 4ft
Crawl Space	5/13	5/13	10/13	10/13	10/13	10/13

*When more than 50% of the insulation is placed on the interior of the wall, 2006 IECC requires R-value of 13 in Zone 5, the 2009 IECC requires R-value of 17.

Other changes in the 2009 IECC compared to the Utah code:

- R-3 pipe insulation on hydronic distribution systems (increased from R-2)
- Stricter area limits on door exemptions
- Improved (more detailed) air-sealing language
- Snow melt controls
- Pool covers are required for heated pools

Assumptions Used in Energy Analysis

A brief energy analysis was conducted comparing the current Utah code to the 2009 IECC. The EnergyGauge™ software was used to determine the energy impacts of changes in envelope requirements. EnergyGauge™ is based on the DOE-2 energy simulation software developed by DOE (Lawrence Berkeley National Laboratory 1981).

Two sets of buildings were simulated: one with energy efficiency levels set to the prescriptive requirements of the current state code, and one with energy efficiency levels set to the prescriptive requirements of the 2009 IECC. All inputs other than the changes in energy efficiency levels were identical in the two sets of simulations.

The analysis assumed a two-story, single-family house with a conditioned floor area of 2,400 ft² excluding the basement. It was assumed that the house had 8.5-ft high ceilings, a ceiling area (bordering the unconditioned attic) of 1,200 ft², a gross exterior above-grade wall area of 2,380 ft², a basement ceiling area of 1,200 ft², a basement wall area of 1,120 ft², and a window area of 357 ft² (15% of the above-grade wall area) equally oriented north, south, east, and west. Heating with a natural gas furnace (\$1.20/therm) and central electric air conditioning (10 cents/kWh) were assumed.

High-efficacy lighting was assumed to increase from 10% to 50% of all lighting within the building, reducing lighting energy use by 26%. Improved duct sealing was assumed to save 10% of the heating and cooling costs. Actual savings will vary depending on many factors, including how well ducts are currently sealed in the absence of any testing requirements.

Tables 2 through 4 show the estimated annual energy savings per house that result from meeting the improved requirements in the 2009 IECC in the three Utah climate zones.

Table 2: Annual Energy Cost Savings for the 2009 IECC – Climate Zone 3 (St. George)

Code improvement	Savings
Lighting	\$62
Improved duct sealing	\$88
Window U-factor and SHGC	\$38
Total	\$188

Table 3: Annual Energy Cost Savings for the 2009 IECC – Climate Zone 5 (Salt Lake City)

Code improvement	Savings
Lighting	\$62
Improved duct sealing	\$106
Total	\$168

Table 4: Annual Energy Cost Savings for the 2009 IECC – Climate Zone 6 (Salt Lake City)

Code improvement	Savings
Lighting	\$62
Improved duct sealing	\$119
Total	\$181



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