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

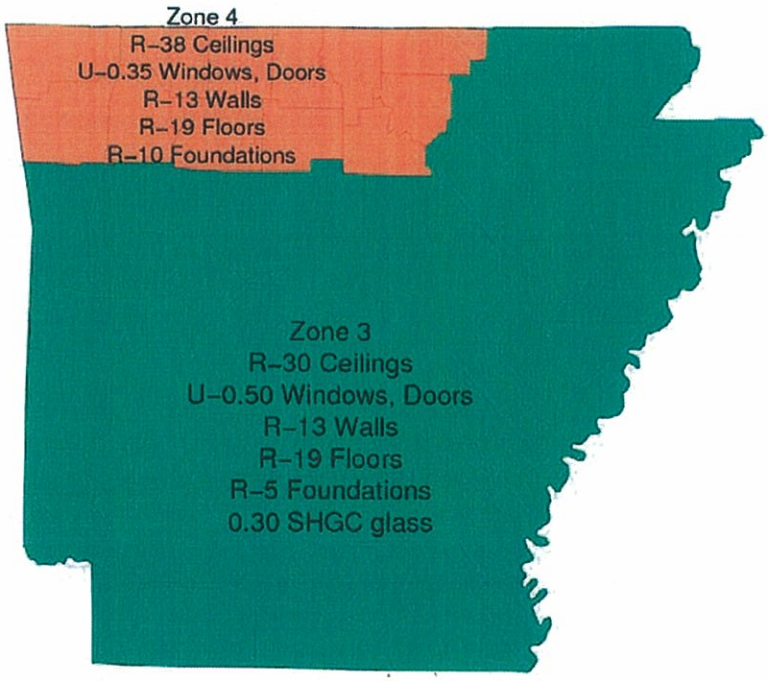
Summary

The 2009 International Energy Conservation Code (IECC) contains several major improvements in energy efficiency over the current state code, the 2003 IECC with amendments. The most notable changes are improved duct sealing and efficient lighting requirements. A limited analysis of these changes resulted in estimated savings of $242 to $245 a year for an average new house at recent fuel prices.

Overview of the 2009 IECC

The IECC scope includes residential 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 buildings in the 2009 IECC.



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 Zone 4. Insulation is not required for slab-on-grade foundations 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. However, vapor retarders are not required in Arkansas.
- Less insulation is allowed for mass walls and more insulation is 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 ft^2 of window area are exempt
- Skylight U-factors are allowed to be U-0.65 in Zone 3 and U-0.60 in Zone 4
- 500 ft^2 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 4 and cannot exceed an area-weighted SHGC of 0.50 in Zone 3. 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 RES*check*™ 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 measures 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 Difference between the Current Arkansas Code and the 2009 IECC

Arkansas has adopted the 2003 IECC with amendments, including:

- No glazed fenestration SHGC requirement. The 2003 IECC requires a maximum SHGC of 0.40 in south and central Arkansas.
- Duct insulation is set to R-5.6. The 2003 IECC duct insulation values vary from R-2 to R-8.

Major differences between the 2009 IECC and the Arkansas code 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 2003 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 in the 2009 IECC. 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 RES*check*™ software and other energy performance analysis tools.)
- The format of the 2003 IECC and 2009 IECC are substantially different. The 2009 IECC has new climate zones that cover larger geographic regions than the zones in the 2003 IECC. The envelope insulation and window requirements in the 2003 IECC vary by window-to-wall area percentage, but not in the 2009 IECC. This change in format makes a simple comparison of the envelope requirements in the two codes impossible.

Energy Analysis

A brief energy analysis was conducted comparing the current state 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 ft^2. It was assumed that the house had 8.5-ft high ceilings, a ceiling area (bordering the unconditioned attic) of 1,200 ft^2, a gross exterior wall area of 2,380 ft^2, and a window area of 357 ft^2 (15% of the wall area) equally oriented north, south, east, and west. Heating with a natural gas furnace ($1.20/therm) and central electric air conditioning ($.12/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%, or $74 a year. Savings attributable to the lighting requirements in the IECC will decrease as Federal law requires improved light bulbs in 2012 to 2014. 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.

Table 9 shows the estimated annual energy savings per house that result from meeting the improved requirements in the 2009 IECC. Total savings includes heating, cooling, and lighting and is shown as a percentage of the end-uses covered by the 2009 IECC (heating, cooling and water heating).

Table 9. Energy End Use and Percentage Savings

Climate Zone	*Annual Energy Cost ($)*				*Savings 2009 IECC vs. Arkansas Code*	
	Arkansas Code		*2009 IECC*			
	Heating	Cooling	Heating	Cooling	Savings ($/yr)	Percent Savings
Little Rock (CZ 3A)	965	300	853	244	242	15
Springfield MO (CZ 4A)	1185	213	1034	193	245	14