New Residential Energy Codes for the Gulf Coast

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Summary

At the request of the Government Accountability Office (GAO), DOE's Building Energy Codes Program (BECP) undertook an analysis of the energy savings and cost impacts associated with the use of more efficient residential building energy codes in the states of Louisiana and Mississippi. The intent of this analysis was to determine the potential energy and economic impacts from improved energy efficiency for residential buildings during the Katrina reconstruction process. The focus is on new construction.

This analysis showed that going to an energy efficiency standard saved energy. Energy cost savings of 24% to 28% could be achieved by moving from estimated current practice for new construction to the 2006 International Energy Conservation Code (IECC). Furthermore, energy cost savings of 44% to 45% over current practice could be achieved by meeting Energy Star Home specifications. The energy efficiency provisions in the 2003 IECC and 2006 IECC are essentially identical for the purposes of this analysis.

The whole building analysis examines energy used for space heating and air conditioning only. Although there is additional potential to save energy used for water heating and appliances, those devices are preemptively regulated by Federal law and are not subject to state/local codes.

The house design considered was a 2000 ft^2, two-story house, 25x40 ft, with a slab-on grade foundation. The window area is 332 ft^2 (15% window–to-wall area ratio) equally oriented north, south, east, and west. Window U-factors were obtained from the Efficient Windows Collaborative. There are two doors with a total area of 40 ft^2.

Central electric air conditioning and a natural gas furnace are assumed. Heating, ventilating, and air conditioning (HVAC) equipment and ducts are assumed to be in the attic.

Additional estimates are generated for a house with a raised crawl space foundation (on piers).

This analysis uses the New Orleans climate. There is little variation in climate across the region affected by Katrina.

Five building level energy efficiency alternatives are examined:

Two baselines were established; the first is an approximation of measures in typical *existing* housing in the rebuilding region. This baseline is heavily influenced by the older vintage housing in the area. The Energy Information Administration (EIA) estimates in the South Census Region, 81% of the housing was built before 1989. The second baseline is estimated *current practice* for new construction (assuming no code in place) approximately equal to the 1995 Model Energy Code (MEC) (International Code Council 1995). The third level is the 2006 IECC. The fourth efficiency level is Energy Star Homes which requires a 15% improvement over the IECC for all energy used in a house. Finally, the efficiency level necessary to qualify for the $2000 Federal tax credit (EPAct 2005) which requires a 50% reduction in space heating and air conditioning energy use compared to the 2003 IECC.

The Energy Star Home program gives credit for improved lighting and appliances, but for comparison purposes it is assumed here that all the houses use the same lights and appliances.

Table 1. Comparison of the Baseline and other Energy Efficiency Alternatives

Selected Energy Features	Existing Housing Baseline	New Housing Baseline	IECC 2006	Energy Star	Tax Credit
Insulation-Wall	R-13	R-13	R-13	R-13	R-13
Insulation-Floor **1**	None	None	R-13	R-13	R-19
Insulation-Roof	R-19	R-19	R-19 **2**	R-30	R-30
Windows **3**	Single[3]	Double[3]	Double	Double	Double
Frame Mat'l	Aluminum	Aluminum	Vinyl with	Vinyl with	Vinyl with
Insulation Value	U-1.16	U-0.79	U-0.34/low-E	U-0.34/low-E	U-0.32/low-E
SHGC **4**	0.76	0.68	0.30	0.30	0.28
Doors	U-0.40	U-0.40	U-0.40	U-0.40	U-0.40
Heating System	Same for all - Gas Furnace				
AFUE **5**	80%	80%	80%	80%	90%
Cooling-System **6**	SEER-10	SEER-13	SEER-13	SEER-13	SEER-15
Duct-Insulation	R-4.0	R-4.0	R-8.0	R-8.0	R-8.0
Programmable Thermostat	No	No	No	Yes **7**	Yes **7**
Air-Sealing	Standard	Standard	Standard	0.30 ACH (tested)	0.30 ACH (tested)
Duct-Sealing	Standard	Standard	Standard	Max. 50 cfm leaks (tested)	Max. 50 cfm leaks (tested)

1. Floor insulation is applicable to crawlspace foundations, **not** slab-on-grade foundations.
2. The prescriptive requirement in the 2006 IECC for ceiling/roof R-value is R-30. A lower ceiling insulation R-value was traded off for higher window performance.
3. Single and double, with reference to windows throughout this report, means single and double glazing.
4. SHGC is solar heat gain coefficient, ratio of energy passing through glazing to unobstructed sunlight
5. The Federal minimum Annual Fuel Utilization Efficiency (AFUE) requirement is 78%. Most are 80%
6. SEER 10 was the most common before Federal minimum increased to 13 SEER in January 2006.
7. EnergyGauge assumes thermostat settings to save energy are entered if a programmable thermostat is used. There is no evidence to support this assumption.

Energy Costs

The latest available costs for natural gas and electricity were obtained from the DOE Energy Information Administration. Natural gas prices averaged above $12 per thousand cubic feet (approximately equal to a million Btus) in the residential market last winter in Louisiana. The electricity price for air conditioning was assumed to be 9.2 cents/kWh in Louisiana based on June 2006 prices in (DOE/EIA http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html).

Table 3. Annual Costs (Space Heating and Cooling Energy Only) of Alternatives Slab-on-Grade Foundation*

Efficiency Alternative	Cooling Cost	Heating Cost	Total Cost	Savings over New Housing Baseline $/year	Savings over New Housing Baseline %	Use Electricity (kWh) & Natural Gas (MBtu) (kWh)	Use Electricity (kWh) & Natural Gas (MBtu) (MBtu)
Existing Housing Baseline	$674	$206	$880	+$195	+28%	7436	16.3
New Housing Baseline	$520	$165	$685	-0-	-0-	5742	13.1
IECC	$379	$139	$518	-$167	-24%	4193	11.0
Energy Star	$291	$84	$375	-$310	-45%	3214	6.7
EPAct 05 Tax Credit	$239	$75	$314	-$371	-54%	2627	6.0

*Building a house on piers to the same levels adds an average of 20% to all the energy costs.

Table 4. Annual Heating Costs by Fuel/Equipment Type

Efficiency	Natural	Electric	Electric	Difference

Alternative	Gas	Resistance	Heat Pump	between Gas & Heat Pump
Existing Housing Baseline	$206	$297	$155	**-$51**
New Housing Baseline	$165	$238	$128	**-$37**
IECC	$139	$201	$107	**-$32**
Energy Star	$84	--	$69	**-$15**
EPAct 05 Tax Credit	$75	na	--	

Note the diminishing returns where the improved heating system saves less for the more efficient building alternative (and vice-versa). EPAct 05 tax credit does not permit electric heat.

In addition to the five whole-building efficiency levels, two isolated efficiency measures in new homes are briefly examined:

Advantageous solar orientation of walls/windows can save **6%** at no added cost.

Sealed and tested air distribution ducts (low cost) should cost about $235 extra, but will save over $160 per year (1 ½ year pay back) for the life of the system.

NOTES:

Comments on this analysis

The choice of house configuration, while not the most typical, is built to some degree in the area. A one story house would be more typical, but would place more emphasis on the ceiling/roof insulation requiring a higher level (R-30 typically) to meet the efficiency standards. There would be less wall area reducing the window area (1512 / 227 vs the 2210 / 332 sq. ft. modeled) and shading would be more easily accommodated.

Actual operating costs would be considerably more than the amounts shown due to all the electrical equipment in a typical house that was not considered. This additional cost would be the same for any given family no matter the house construction level. Personal temperature levels desired would also effect the cost, possibly substantially as a one degree increase or decrease can effect energy used by the HVAC equipment as much as 3%.

Air sealing is hard to control as it is as much related to the contractor's diligence as it is to equipment. It is very difficult to seal a house after it is completed, but relatively easily accomplished during construction. Every contractor being required to meet a national standard makes it easier to get most contractors to comply.

Supplemental Information:

Buying a more energy efficient house can be looked at as "financing" future energy use through a home mortgage and once the initial pay back period is over the saving are available for discretionary spending. FHA and VA take this into account when approving home loans which allows a family to qualify for a larger home.

Table 7. Incremental Construction Costs

Base Measure	Improved Measure	Unit Cost	Total Cost	Source for Cost Data
Double pane Aluminum Windows	Double pane Vinyl Windows with Low-E	$1/ft^2	$332	Estimate from various sources. Cost increase is primarily from addition of low-E coating.
R-4 Duct Insulation	R-8 Duct Insulation	0.68/ft^2	$286	California DEER Database (Itron 2005)
R-19 Ceiling Insulation	R-30 Ceiling Insulation	0.33/ft^2	$330	R. S. Means Cost Data
Standard duct sealing	Improved Duct Sealing	$235	$235	California EnergyCommission(2000)
Standard envelope sealing	Improved envelope sealing	--	$500	www.powerhousetv.com/stellent2/groups/public/documents/pub/phtv_se_we_gs_000530.hcsp
No Testing	Home Energy Rating	$450*	$450*	http://www.nbnnews.com/NBN/issues/2006-05-22/Research/index.html http://www.hud.gov/offices/hsg/sfh/eem/eemhog96.cfm
Standard Thermostat	Programmable Thermostat	$65	$65	www.fypower.org/res/tools/products_results.html?id=100133
13 SEER Air Conditioner	15 SEER Air Conditioner	$556	$556	California DEER database, 3.5 ton system
80% efficient Gas Furnace	90% Efficient Gas Furnace	$600	$600	California DEER database and other sources

* It is not known how much or even if raters will charge extra if certification for the tax credit is included in their rating. Qualification for the tax credit requires little extra effort beyond entering the information needed for a home energy rating in the rating software (printing out a form).

Table 8. Incremental Construction Costs for Energy Efficiency Alternatives

Scenario	Improvements Over New Housing Baseline	Cost Increase	Total vs. Baseline	Total vs. IECC	Total vs. Energy Star
IECC	Double vinyl low-E windows R-8 Ducts	$332 $286	$618	na	na
Energy Star	R-30 ceiling insulation Improved duct sealing improved envelope sealing Home Energy Rating Programmable thermostat	$330 $235 $500 $450 $65	$2,198	$1,580	na
Tax Credit	14 SEER efficient air conditioner 90% efficient furnace U-0.32/SHGC-0.28 windows Tax credit	$556 $600 0(a) **-$2000** (b)	$3,354 -2000 $1,354	$2736 -2000 $736	($844)

(a) These windows are the same type (materials and technology) as used in the Energy Star house, but would require the builder to be more selective in finding more energy efficient windows of that window type.

(b) Expires December 31, 2008

Air Conditioning Equipment Standards

The 2006 standards raise the energy efficiency standards to 13 SEER for new central air conditioners and to 13 SEER/7.7 HSPF for new central air conditioning heat pumps. The standards will apply to products *manufactured* for sale in the United States as of January 23, 2006; the former standard is 10. Equipment in stock before this date may still be sold and installed.

The standard for split-system air conditioners, the most common type of residential air conditioning equipment, represents a 30 percent improvement in energy efficiency. For split-system heat pumps, the new standard would represent a 30 percent improvement in cooling efficiency and a 13 percent improvement in heating efficiency.

SEER stands for Seasonal Energy Efficiency Ratio, the Department of Energy's (DOE) measure of energy efficiency for the seasonal cooling performance of central air conditioners and central air conditioning heat pumps.

HSPF stands for Heating Seasonal Performance Factor, the DOE's measure of energy efficiency for the seasonal heating performance of central air conditioning heat pumps.

The "lifespan" of a central air conditioner is about 15 to 20 years. A change in the standard does not require replacement of equipment nor does it mean that an existing system will be obsolete or impossible to maintain.