Mississippi Energy Codes Economic Analysis

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Building Codes Assistance Project

Southface Energy Institute

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Building Codes Assistance Project (BCAP)
BCAP is a non-profit advocacy organization established in 1994 as a joint initiative of the Alliance to Save Energy, the American Council for an Energy-Efficient Economy, and the Natural Resources Defense Council. BCAP focuses on providing state and local governments in the United States, as well as stakeholder organizations, with support on code adoption and implementation through direct assistance, research, data analysis, and coordination with other activities and allies.

With over sixteen years of experience supporting numerous state energy offices and city building departments, along with tracking code activities across the country, BCAP is well-positioned to assist in local and statewide activity to advance codes. As a trusted resource, BCAP is able to identify and navigate past policy and programmatic pitfalls to help states and jurisdictions put the best possible strategy in place to improve efficiency in both new and existing buildings.

Our work pulls together local efforts, identifies national-scale issues, and provides a broad perspective, unbiased by corporate/material interests. BCAP also hosts OCEAN—an online international best practice network for energy codes—and is increasingly working abroad to gather and share best practices that provide value across organizations.

Southface Energy Institute
For more than 30 years, Southface has promoted sustainable homes, workplaces, and communities through education, research, advocacy, and technical assistance.

Today, Southface continues this important mission through offering a wide variety of programs and services including sustainability consulting, design reviews, LEED administration, building certifications and energy audits ; and through education programs, hands-on technical assistance, advocacy and research work.

Southface believes the marketplace is the greatest force for environmental change. As a result, it focuses on entrepreneurial initiatives that benefit the environment. Southface is proud to partner extensively with business, government and community leaders to deliver programs and services that support environmentally sound building practices.

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Executive Summary

This analysis seeks to quantify the manifold economic benefits of energy code adoption and implementation in the state of Mississippi. The report is organized into five sections: Statewide Energy Savings, Financial Benefits to Individual Homeowners and Businesses, Economic Benefits from Updated Energy Codes, Environmental Benefits from Update Energy Code, and Local and Regional Best Practices.

Sections I and II provide comprehensive residential and commercial construction energy savings analysis, both sector-wide and at the building level. The analysis estimates that if Mississippi adopted and implemented the 2009 International Energy Conservation Code (IECC) and the ASHRAE Standard 90.1-2007 statewide in 2012, by 2016, state energy use would decrease by approximately 609,593 MWh of electricity and 11,291,148 therms of natural gas over the five year period. Reduced demand for energy is estimated to decrease annual energy costs for Mississippi households and businesses by over $61 million. These savings also present positive cost-benefit scenarios for home buyers and commercial building owners and tenants, whereby they recoup their initial code-induced efficiency investments quickly and thereafter receive the long-term benefits of reduced utility bills.

Section III of the report describes attendant economic benefits of code adoption, including emerging trends regarding energy-efficient building valuation. As well, analysis examines increased consumer purchasing power and its impact on local and state economies. This spending has beneficial—but difficult to quantify –effects, through the reallocation of spending into high-value chain products, which multiply increased consumer spending throughout the larger economy. As well, Section III suggests that if updated codes were adopted on a statewide basis, moderate job creation would be spurred as a result of newfound job opportunities for building inspectors and HERS rating providers.

Section IV presents environmental benefits associated with code adoption. Reduced energy demands due to updated codes directly translate into reduced air pollution and carbon emissions from energy producers. Section V, Local and Regional Best Practices, draws on local stakeholder interviews and examples from its Compliance Planning Assistance (CPA) Program to compile an abbreviated list of best practices from jurisdictions within Mississippi and from states within the southeastern region.

Summary Findings, Total Potential Statewide Energy Savings								
Year	Commercial Energy Savings		Residential Energy Savings		Total Energy Savings, Statewide		Total Energy Cost Savings, Statewide	
	Electricity (MWh)	Natural Gas (therms)	Electricity (MWh)	Natural Gas (therms)	Electricity (MWh)	Natural Gas (therms)	Electricity	Natural Gas
2012	21,143	320,655	11,039	248,971	32,182	569,626	$2,915,784	$289,153
2013	47,016	738,201	23,918	539,437	70,934	1,277,638	$6,435,649	$652,990
2014	78,502	1,284,640	38,638	871,398	117,140	2,156,038	$10,549,421	$1,128,250
2015	113,662	1,904,971	54,277	1,224,107	167,939	3,129,0078	$15,107,974	$1,700,763
2016	150,532	2,561,204	70,836	1,597,564	221,368	4,158,768	$20,030,767	$2,308,499
5-Year Total	410,885	6,809,671	198,708	4,481,477	609,593	11,291,148	$61,119,250	

Section I: Statewide Energy Savings

Effective energy codes adopted at the state level have served as a proven tool to enhance the minimum energy performance of newly constructed and renovated building stock across the residential and commercial sectors. Energy code adoption has demonstrated economic and environmental benefits, while enhancing the comfort and durability of the built environment.

This section provides an incremental cost analysis of two energy codes, the 2009 IECC and the 2007 ASHRAE 90.1, within the residential and commercial building sectors, respectively. The analysis then estimates the associated energy savings across each sector. Using state-specific data, this study determines that statewide adoption of building energy codes would yield significant energy savings at a modest cost to the property owner.

Residential Energy Savings:

A major barrier to energy code adoption across the United States is the concern that mandatory energy code compliance will add to the retail cost of new homes and impede potential homebuyers from affording the homes they want. By assuming a statewide baseline of the 2003 IECC, this analysis concludes that that energy code compliance will actually reduce out-of-pocket expenses for Mississippi homeowners over time. According to this analysis, compliance with the 2009 IECC represents a nominal 0.6 percent increase (calculation shown in Section II) to the retail price of an average new home[1]—an incremental cost which is fully paid off in just 11 months from energy savings alone, while all future energy cost savings accrue to the homeowner.

For energy modeling and incremental cost estimates, the following specifications were used to model the average new home in Mississippi:

- 2-story, single-family home (25'x 40')
- Conditioned floor area: 2000 square feet
- 8- ft high ceilings
- Total ceiling area: 1000 square feet
- Unconditioned attic
- Gross exterior wall are: 2080 square feet
- Total window area: 312 square feet (15% of wall area, oriented equally to the north, south, east and west)

[1] For the purposes of modeling, this study has used a 2,000 square foot, two-story slab on grade home with three bedrooms as a benchmark for the "average" new residential building constructed in Mississippi. This assumption is consistent with current trends in construction measured by the U.S. Census Bureau and was confirmed by stakeolder interviews. The baseline retail price associated with this "average" new home (before added energy code cost) is assumed to be $176,000—and uses the average new home price per square foot of $80—a value suggested by stakeholders and confirmed by U.S. Census analysis for new home sales. Ten percent is added in addition to the baseline $80 per square foot to account for land costs.

Incremental Cost of Residential Energy Code Implementation:

After completing a side-by-side comparison of Mississippi's current practices in residential construction[2] with the 2009 IECC energy code, the following prescriptive measures have been identified as required upgrades to satisfy the 2009 IECC:

- A window performance upgrade, including enhanced insulating properties (U-factor) and lower thermal transfer from incident sunlight (solar heat gain coefficient, or SHGC). The baseline windows are assumed to be double pane aluminum windows with a U-factor of 0.65 and a SHGC factor of 0.66. Compliance with the 2009 IECC will require an upgrade to a U-factor of .50 and an SHGC factor of 0.30. Estimated window area is 312 square feet, and the cost increment is assumed to be $1 per square foot, or $312, total for the entire house.[3]

- Energy-efficient lighting, including the use of qualified compact fluorescent or L.E.D. fixtures. Estimated costs are $60 per new home.

- Baseline air sealing practice is assumed to be minimal, with an average number of 10 air changes per hour (ACH). For code compliance, this analysis assumes an incremental cost of $350 to conduct extensive air sealing of the building envelope and conduct "blower door" testing.

- Baseline duct sealing is also assumed to be minimal, with 15 percent estimated leakage to the outside. Code compliance is expected to require extensive duct sealing and diagnostic "duct blaster" testing of all duct work. Incremental cost is assumed to be $350 per new home.[4]

- Attic duct insulation in baseline homes is assumed to be R-6, while code compliance with the 2009 IECC requires ducts to be insulated with R-8 insullation.[5] Cost for the increased duct insulation is estimated at $120 per new home.

- Due to the improved building envelope, this analysis assumes that building equipment can be lowered in size from a 13 SEER, 8.1 HSPF 3.5 ton unit to a 13 SEER, 8.1 HSPF 3-ton unit. Reduction is estimated from interviews and confirmed using a Manual J calculation. Resulting savings are estimated at $100 per new home.

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[2] This analysis assumes current residential building practices in Mississippi align with the 2003 IECC energy code; therefore, 2003 IECC is used as the baseline of current construction practices. This assumption mirrors the determination used by the Department of Energy.

[3] Estimated incremental window costs are provided by the Efficient Windows Collaborative (EWC) and were confirmed by multiple window manufacturers.

[4] This analysis uses $350 as a nationwide average cost for the added duct sealing/testing costs. However, in many states, including Mississippi, blower door tests may be less expensive. Informal interviews suggested cost may be as low as $200 per new home.

[5] Based on a regional survey of design and construction professionals conducted by Southface in May 2011.

As a result, this study concludes that the average incremental cost to achieve 2009 IECC code compliance across the state of Mississippi is approximately $1,092 per home. See Figure 1, below, for a detailed breakdown of costs.

Figure 1: Incremental Cost Estimates for New 2,000-square-foot home in Mississippi			
Mississippi Climate Zones 2 and 3			
Features	Standard House	Code Compliant House	Cost Difference
Air Sealing	Minimal (10 ACH_{50})	Extensive and tested (7 ACH_{50})	$350
Wall Insulation	R-13[6]	R-13	$0
Ceiling Insulation	R-30 blown cellulose[6]	R-30 blown cellulose	$0
Windows	Double pane metal: U-factor (0.65), SHGC (0.66)	Double pane low-e: U-factor (0.5), SHGC (0.30)	$312
Duct Sealing	Minimal (15% leakage to outside)**Error! Bookmark not defined.**	Extensive and tested (8% leakage to outside)	$350
Duct Insulation	R-6 (attic) [6]	R-8 (attic)	$120
Equipment	13 SEER, 8.1 HSPF 3.5 ton[6]	13 SEER, 8.1 HSPF 3 ton (Manual J)	-$100
Water Heater	50 gallon electric (0.92 EF) [6]	50 gallon electric (0.92 EF)	$0
Lighting	10% efficient fixtures	50% efficient fixtures	$60[7]
Total Upgrade Cost			
Price of Home	$176,000	$177,092	+$1,092

Energy Savings for Individual Homeowners:

To determine the energy savings per average Mississippi home resulting from the implementation of the 2009 IECC, this study modeled energy savings using the National Renewable Energy Laboratory's Building Energy Optimization software (BEopt). Estimated energy savings per home in each of Mississippi's climate zones 2 and 3 are presented in Figure 2, below.[8]

Figure 2: Energy Savings Per Home Attributable to 2009 IECC9			
Climate Zone	Electricity (kWh)	Natural Gas (therms)	Estimated Percentage Energy Savings
Climate Zone 2 (Biloxi)	2285	49	17.9% electric, 11.2% gas
Climate Zone 3 (Jackson)	2108	78	17.9% electric, 13.3% gas

[6] Based on a regional survey of design and construction professionals conducted by Southface in May 2011.
[7] Department of Energy. Lighting Market Characterization: National Lighting Inventory and Energy Consumption Estimate, Volume I.. Retrieved from: http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/lmc_vol1.pdf
[8] http://energycode.pnl.gov/EnergyCodeReqs/index.jsp?state=Mississippi
[9] For simplicity, this analysis assumes that the model house uses only electric heating and cooling and does not model a gas furnace for heating needs.

Statewide Energy Savings, Residential Sector

This analysis estimates that statewide 2009 IECC adoption and implementation for newly constructed single-family homes will result in approximately 198,708 MWh of electricity and 4,481,477 therms of natural gas throughout its first five years. These savings, aggregated from a projected 42,340 housing starts by 2016, will reduce peak capacity constraints on Mississippi's power supply, save homeowners millions of dollars in energy expenses, and help to limit the environmental impacts associated with electric power generation.

To calculate a statewide projection of energy savings, this analysis uses a five-year rolling average of Mississippi housing starts (2005 to 2010) according to data published by the U.S. Census Bureau. Linear growth[10] in residential housing stock is assumed between the years 2012 and 2016.

Recognizing the challenges of comprehensive energy code implementation and subsequent code enforcement, a conservative code compliance factor was included in projected residential development. Assuming increased compliance over time, estimated code compliance begins at 60 percent in year one and improves to 90 percent by year five. In this instance, code compliance is treated as a proxy for the percentage of potential energy savings, as identified by DOE, that are achieved by new homes.

DOE-modeled energy savings per average home were then applied to the residential development scenario and aggregated over the first five years.

Figure 3: Projected Residential Energy Savings, 2012-2016

Year	Zone 2 Projected Housing Starts	Zone 3 Projected Housing Starts	Cumulative New Units	Estimated Code Compliance Rate	Estimated Electricity Savings (MWh)	Estimated Natural Gas Savings (therms)
2012	3,093	5,375	8,468	60%	11,039	248,971
2013	3,093	5,375	16,936	70%	23,918	539,437
2014	3,093	5,375	25,404	80%	38,638	871,398
2015	3,093	5,375	33,872	85%	54,277	1,224,107
2016	3,093	5,375	42,340	90%	70,836	1,597,564
				5-Year Total	**198,708**	**4,481,477**

[10] This analysis projects linear growth in residential housing stock to promote simplicity and transparency of residential development assumptions, while recognizing that actual housing starts are subject to significant market cycles and other externalities.

Statewide Energy Savings, Commercial Sector

To calculate the energy savings from implementing ASHRAE Standard 90.1-2007 for commercial buildings in Mississippi, this analysis employs the BCAP Code Savings Estimator. Savings in the first year of implementation are estimated to be 320,665 therms in 2012, rising to 2,561,204 therms saved annually by 2016. The five-year increase from 2012 to 2016 is attributable to increasing compliance rates and a greater cumulative number of buildings built under the updated code.

The Code Savings Estimator projections use data provided by the Energy Information Administration's (EIA) Commercial Building Energy Consumption Survey (CBECS) and the Energy Information Administration's 2010 Annual Energy Outlook (AEO). Leveraging these data sources, the Code Savings Estimator tool compares a business-as-usual scenario with an ASHRAE 90.1-2007 scenario for statewide commercial building energy use. Central assumptions for the modeled business-as-usual and 90.1-2007 adoption scenarios include:

Total new commercial floor space: CBECS provides estimates of commercial floor space construction by census region, not by state. This analysis assumes that Mississippi's share of commercial construction equals its share of residential construction within the Southeast census region (1.4 percent) based on U.S. Census data. Between 2010 and 2016, the model estimates an average increase of 12 million feet^2 of commercial floor space.

Baseline and projected reduction in energy use intensity: The analysis also assumes ASHRAE 90.1-1999-compliance building components (efficiency of the building envelope, lighting system, and code-regulated equipment) as a static baseline for the current building practice in Mississippi. As concluded by DOE, commercial buildings constructed to ASHRAE 90.1-2007 standards require, as a national average, 17.1 percent less energy than if constructed to meet 90.1-1999.

Upgrades to existing buildings: The model assumes that each year, 4 percent to 7 percent of equipment will be replaced, and 75 percent of this equipment is assumed to be covered by the code. 1.2 percent of lighting systems are assumed to be renovated each year, and therefore fall under the latest codes.

Compliance rates: The study assumes that in 2012, about half of commercial construction and renovations covered by the code actually comply with the requirements, consisting of 60 percent compliance in new construction and 40 percent compliance among renovations and equipment replacement. By 2016, compliance rates are assumed to improve to 90 percent for new construction and 75 percent for renovations/replacement.

Other factors affecting energy savings: The estimated energy savings are slightly lower than a 17.1 percent energy use intensity reduction due to an estimated energy efficiency "rebound effect" of 15 percent. Consistent with the Annual Energy Outlook, the model assumes that for each energy efficiency improvement that reduces energy use by 10 percent, the demand for energy services increases by 1.5 percent since energy users expect more convenience and performance from more efficient buildings.

Figure 4: Projected Commercial Energy Savings, Statewide, 2012-2016					
Year	Projected New Commercial Floorspace (million ft^2)	Cumulative New Commercial Floorspace (million ft^2)	Estimated Code Compliance Rate	Energy Savings	
				Electric (MWh)	Natural Gas (therms)
2012	10.05	10.05	60%	21,143	320,655
2013	10.90	20.95	70%	47,016	738,201
2014	11.94	32.89	80%	78,502	1,284,640
2015	12.85	45.74	85%	113,662	1,904,971
2016	13.44	59.18	90%	150,532	2,561,204
			5-Year Total	**410,885**	**6,809,671**

Energy Savings to Individual Commercial Property Owners

At the building level, individual commercial property owners and tenants will directly benefit from efficiency measures in buildings constructed to the latest commercial code, ASHRAE Standard 90.1-2007. The Department of Energy's recent report, *Impacts of Standard 90.1-2007 for Commercial Buildings at the State Level*, provides energy savings estimates for three major property types in Mississippi. The modeled building types are: medium size office buildings, mid-rise apartment buildings, and warehouse buildings.[11] Because Mississippi lacks a statewide code, to calculate savings DOE assumed an approximate statewide construction baseline, 90.1-1999. Energy savings for these product types are listed in Figure 5, below.

This study adjusts DOE's numbers to reflect local Mississippi prices for commercial consumers rather than a national average. After this change—which effectively lowered savings in light of the state's relatively low energy prices, annual energy savings to range from 0.7 percent (or $66 energy cost savings/year) for warehouse buildings in climate zone 3, to 14 percent ($10,809 energy cost savings/year) for office buildings built in climate zone 3.

[11] *Impacts of Standard 90.1-2007 for Commercial Buildings at State Level*. Pacific Northwest National Laboratory. Sepetember 2009.

Figure 5: Annual Energy Savings per Commercial Building Type Attributable to Upgrade to ASHRAE 90.1-2007					
Climate Zone	**Commercial Building Type**	**Energy Savings**		**Total Energy Savings (Percentage)**	**Total Annual Energy Savings, Current Rates**
		Electric (kWh/ ft^2/yr)	**Natural Gas (therms/ ft^2/yr)**		
2	Office Building	1.16	.0007	8.2%	$ 6,030.56
2	Apartment Building	0.25	.0118	5.7%	$ 1,172.98
2	Warehouse Building	0	.0016	0.8%	$ 75.23
3	Office Building	2.09	.0001	14.0%	$10,809.16
3	Apartment Building	0.33	.0151	6.8%	$ 1,533.82
3	Warehouse Building	0	.0014	0.7%	$ 65.82

Section II: Financial Benefits to Individual Homeowners and Businesses

Savings realized through lowered utility bills are the most meaningful economic benefits achieved by the adoption of an energy code, as these savings directly benefit homeowners and commercial tenants (or property owners) month after month throughout the lifetime of the building. Further, the incremental cost of component upgrades to enhance the energy performance of the building can be included in the overall project financing which significantly reduces the upfront expense to homeowners and commercial property developers alike.

Residential Energy Cost Savings to Individual Homeowners:

Individual homeowners are potentially the greatest beneficiaries of effective energy codes for Mississippi's buildings. Using energy savings estimates from Section I, this analysis provides a cost-benefit analysis of 2009 IECC adoption, from the perspective of Mississippi homeowners using localized energy prices and real estate lending data.

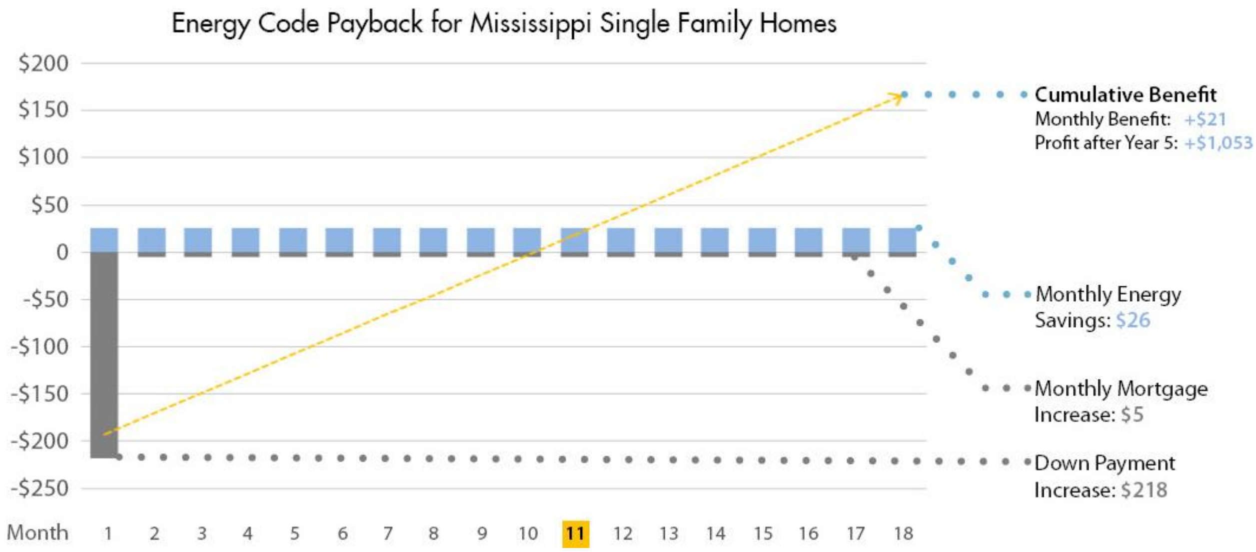
As outlined in the previous section, compliance with the 2009 IECC code comes with the added expense of increased insulation, higher efficiency lighting, and added sealing and diagnostic testing of duct work—an estimated incremental cost of $1,092 per new home.

To understand the impact of an added $1,092 to the cost of a new home, this analysis models a typical financing scenario under which a homeowner purchases a new home with energy efficieny improvements. For the purposes of this financing exercise, the payback analysis assumes the following:

- Retail price of $176,000 for the 2,000 ft^2 home modeled throughout this study
- 2009 IECC compliance adds $1,092 to the retail price
- New home is financed with a 30-year mortgage
- 20 percent down payment assumed
- Interest rate set according to the national average, 5.05 percent

Based on these assumptions, compliance with the 2009 IECC represents an estimated 0.6 percent increase to the retail price of an average new home in Mississippi. However, when this incremental cost is rolled into a 30-year mortgage, real costs to the homebuyer translate to an increase of $218.40 to the down payment, as well as $4.72 of added cost to monthly mortgage installments. This scenario is graphed and presented as a balance sheet in Figure 6, below.

Figure 6:



To evaluate the economic benefit resulting from 2009 IECC energy code adoption, this study applies average Mississippi energy prices to the estimated savings calculated in Section I. In support of accurate and relevant energy cost savings estimates, this analysis uses the most recent annual average energy prices available through the U.S. Energy Information Administration's (EIA) State Energy Profile of Mississippi, 9.97 cents per kWh.[12] Based on these calculations, the analysis concludes that the average Mississippi home can expect to save approximately $310 annually in energy expenditures as a result of 2009 IECC energy code adoption. See Figure 7, below, for energy savings estimates.

Month	Mortgage Increase	Monthly Energy Savings	Cumulative Cost/Benefit	
1	$218.40	$25.83	-$192.57	
2	$4.72	$25.83	-$171.46	
3	$4.72	$25.83	-$150.35	
4	$4.72	$25.83	-$129.24	
5	$4.72	$25.83	-$108.13	
6	$4.72	$25.83	-$87.02	
7	$4.72	$25.83	-$65.91	
8	$4.72	$25.83	-$44.80	
9	$4.72	$25.83	-$23.69	
10	$4.72	$25.83	-$2.58	
11	**$4.72**	**$25.83**	**$18.53**	**Break Even**
12	$4.72	$25.83	$39.64	$21 profit every month
13	$4.72	$25.83	$60.75	
14	$4.72	$25.83	$81.86	
15	$4.72	$25.83	$102.97	
16	$4.72	$25.83	$124.08	
17	$4.72	$25.83	$145.19	
18	$4.72	$25.83	$166.30	

Accounting for energy savings in real

[12] Energy Information Administration. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State. Retrieved from: http://www.eia.gov/cneaf/electricity/epm/table5_6_a.html

cost to the homebuyer, this study conservatively concludes that the incremental cost of 2009 IECC code compliance will be paid off in full by energy savings in month eleven[13]. After this date, additional energy savings will continue to accrue to the homeowner over their occupancy of the home at a rate of approximately $253.36 annually ($310 annual energy savings minus $56.64 annual incremental mortgage payment cost).

Figure 7: Estimated Annual Energy Savings Attributable to 2009 IECC Compliance					
Climate Zone	**Electricity Savings (kWh)**	**Natural Gas Savings (therms)**	**Electricity Cost Savings***	**Natural Gas Cost Savings****	**Weighted Average Annual Savings Per Home*****
Biloxi (2A)	2285	49	$228	$68	**$310**
Jackson (3A)	2108	78	$210	$108	
*Electricity cost savings are calculated using current EIA statewide estimates: 9.97 ¢/kWh.					
**Natural gas cost savings are calculated using EIA statewide residential prices for 2008: $1.39/therm					
***The weighted average projects energy savings between climate zones based on single family housing starts in 2008.					

Residential Statewide Financial Benefits

To better understand the macroeconomic impacts of the adoption of an energy code across Mississippi's residential sector, this analysis also applies local energy prices to statewide energy saving estimates from Section I. Based on these calculations, the model estimates the implementation of the 2009 IECC represents a cumulative total of over $26 million dollars in energy cost savings to Mississippi homeowners over its first five years. These savings directly benefit residential consumers, and savings will likely grow exponentially over time when considering continued residential development, increased code compliance, and rising energy prices.

Figure 8: Projected Residential Energy Cost Savings, Statewide, 2012-2016							
Year	**Zone 2 Projected Housing Starts**	**Zone 3 Projected Housing Starts**	**Cumulative New Units**	**Estimated Code Compliance Rate**	**Statewide Energy Cost Savings**		**Total Energy Cost Savings**
					Electricity*	**Natural Gas****	
2012	3,093	5,375	8,468	60%	$1,100,619	$346,070	$1,446,688
2013	3,093	5,375	16,936	70%	$2,384,674	$749,818	$3,134,492
2014	3,093	5,375	25,404	80%	$3,852,166	$1,211,244	$5,063,410
2015	3,093	5,375	33,872	85%	$5,411,376	$1,701,509	$7,112,885
2016	3,093	5,375	42,340	90%	$7,062,304	$2,220,613	$9,282,918
				5-Year Total	**$19,811,139**	**$6,229,253**	**$26,040,392**
*Electricity cost savings are calculated using an average residential rate, statewide: 9.97 ¢/kWh							
**Natural gas cost savings are calculated using an average residential rate, statewide: $1.39/therm							

[13] It is worth noting that this breakeven scenario is subject to significant fluctuations in input variables. For example, under prospects of rising energy costs, both payback and breakeven 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.

Commercial Statewide Financial Benefits

Using the BCAP Code Estimator described in Section I, this study estimates commercial sector-wide energy savings over the next five years. Savings are considerably higher for the commercial sector than for the residential sector and are estimated at a cumulative $41.3 million dollars within five years. This section also examines the cost-effectiveness of energy code improvements for commercial buildings by comparing incremental construction costs estimates and energy saving projections incurred in the construction of the three commercial buildings described in Section I.

As in Section I, this analysis compares the assumed statewide commercial code baseline, ASHRAE 90.1-1999, with the latest model code, ASHRAE 90.1-2007. The three building types modeled are medium office buildings, mid-rise apartment buildings, and semi-heated warehouses. In the case of each of these property types, incremental costs range from a cost reduction of 0.61 percent of final costs for apartment buildings[14] to a cost increase of 0.99 percent for new medium sized office buildings.

For all of these building types, the combination of low upfront costs and building utility savings demonstrate that code-compliant commercial buildings are a good investment for property owners, investors, and tenants. For two of the building types, incremental costs are negative—reflecting that code-mandated building component improvements actually reduce the cost of building the structure when compared to the existing energy code, ASHRAE 90.1-1999.

Figure 9: Projected Commercial Energy Cost Savings, Statewide, 2012-2016

Year	Projected New Commercial Floor space (million ft^2)	Cumulative New Commercial Floor space (million ft^2)	Estimated Code Compliance Rate	Statewide Energy Cost Savings		Total Energy Cost Savings
				Electricity*	Natural Gas**	
2012	10.05	10.05	60%	$1,815,165	$289,153	$2,104,318
2013	10.90	20.95	70%	$4,050,975	$652,990	$4,703,965
2014	11.94	32.89	80%	$6,697,255	$1,128,250	$7,825,505
2015	12.85	45.74	85%	$9,696,598	$1,700,763	$11,397,361
2016	13.44	59.18	90%	$12,968,463	$2,308,499	$15,276,962
			5-Year Total	**$35,228,457**	**$6,079,654**	**$41,308,111**

*Electricity cost savings for commercial buildings are calculated using current EIA statewide estimates: 9.64 ¢/kWh.

**Natural gas costs are are calculated using the EIA estimated statewide price of $9.26 per thousand cubic foot.

Commercial Building Cost-Benefit Methodology

To calculate baseline building costs, which serve as the basis for cost-benefit analysis, research began with the three building prototypes used in DOE's report *Impacts of Standard 90.1-2007 for Commercial Buildings at the State Level*. Detailed specifications of these buildings, which are described below, are matched with actual building costs outlined in *RS Means Square Foot Costs, 2011,*[15] a construction data cost reference source that includes square foot costs for

[14] This indicates that upfront costs could be lowered through technology upgrades.

[15] RS Means is a well-respected construction cost reference that includes square foot costs for hundreds of building types, including those used in the DOE study.

hundreds of building types, including those used in the DOE study. Using RS Means, this analysis is able to set an approximate baseline cost for buildings built under the existing and new codes.

Baseline construction costs, as estimated using RS Means, is inclusive of material costs, labor costs, and contractor overhead and profit for each building type. Each material cost is brand-agnostic, and represents an average component cost reflective of a nationwide average. Because standard construction materials and labor rates range widely across the United States, RS Means' national average prices are adjusted to reflect material and labor costs within Mississippi. For this adjustment, RS Means provides location factors that are geo-referenced to cities and towns. As this study seeks to find an average construction cost adjustment factor for each climate zone within Mississippi, the highest location factor available statewide, 83 percent is used in order to approximate statewide cost as a percentage of the national average. Before finalizing the baseline construction cost, five percent is added to the baseline costs to approximate the added cost of land acquisition.

Figure 10: Baseline Building Cost for Model Commercial Buildings

Building Type	Building Area (ft^2)	Per Ft^2	Location Factor	Adjusted Cost/ft2	Total Building Cost	Baseline Plus 5% Land Costs
Office	53,625	$ 155.50	83%	$ 129.07	$6,921,213	$7,267,275
Residential	33,744	$149.00	83%	$ 123.67	$4,173,226	$4,381,888
Semi-heated Warehouse	52,043	$96.40	83%	$ 80.01	$4,164,105	$4,372,311

Medium-Size Office Building

The prototype office building has a total building floor area of 53,626 $feet^2$ evenly divided between three floors. The model building is metal framed with a roof area of 17,879 $feet^2$. Curtain wall windows represent one-third of the building's exterior. To achieve compliance with ASHRAE 90.1-2007 in climate zone 2, the following construction adjustments to the office building are required: 1) increasing roof insulation from R15 to R20 continuous insulation; and 2) improvement of window U-factor from 1.22 to 0.72 in climate zone 2 and .62 in climate zone 3[16], requiring an upgrade from single-paned windows with a reflective coating to a double-paned low-E product. The total incremental cost of these energy efficiency improvements is estimated at $65,793, an increase of 0.91 percent over the baseline cost. In addition to the requirements in climate zone 2, climate zone 3 requires the following construction adjustment: an increase in wall insulation via the addition of R3.8 continuous insulation. For climate zone 3, total incremental costs were estimated at $75,972, an increase of 1.05 percent over the baseline cost.

Mid-Rise Apartment Building

The apartment building is modeled using a mid-rise, wood-framed four story building, containing 32 apartments and a encompassing a total building floor area of 33,745 $feet^2$. Roof

[16] Actual U-factor requirements are .75 and .65, respectively, but .72 and .62 were used in this analysis to reflect available product pricing.

area is 8,439 feet^2 and the window area represents slightly less than 15 percent of the exterior. In both climate zones 2 and 3, to achieve compliance with ASHRAE 90.1-2007, the following adjustments were made to the apartment building: 1) increasing the exterior insulation by adding R7.5 to the baseline R13; 2) upgrading the roof insulation from R15 to R20 continuous insulation; and 3) and improving installed windows from single-paned windows with a reflective coating to a double-paned low-E product, corresponding to a change in U-factor from 1.22 to 0.72 in climate zone 2 and .62 in climate zone 3. Total incremental costs in both climate zones are estimated at -$26,799, a decrease of 0.61 percent over the baseline cost.

Semi-Heated Warehouse Building

The semi-heated warehouse building simulated in this analysis is one story steel framed building with a total building floor area of 52,044 feet^2. The building contains a conditioned office space measuring 2,550 feet^2. This office space represents the majority of the additional cost. In climate zone 2, total incremental costs are estimated at $1,828, a decrease of 0.042 percent over baseline costs. In climate zone 3, total incremental costs are estimated at $191, an increase of 0.004 percent.

Results

As depicted in Figure 11, this study determines the weighted average (according to climate zone) percentage change in cost for each product type statewide, which is estimated to range from a decrease of 0.61 percent to an increase of 0.99 percent, dependant on building type. A detailed breakdown of incremental cost calculations is presented in Appendix A.

Figure 11: Weighted Average Incremental Cost for Model Commercial Buildings

Building Type	Total Building and Land Costs	Incremental Cost	Total Cost for 90.1-2007	% Change in Price
Office	$ 7,267,275	$72,255	$7,339,529	0.99%
Residential	$ 4,381,888	($26,799)	$4,381,888	-0.61%
Semi-heated Warehouse	$ 4,372,311	($546)	$4,371,764	-0.01%

First Cost Savings

Despite the increases in first cost required by the building envelope improvements, this study finds that many product types are also able to achieve a negative incremental cost, or incremental cost savings. Savings come chiefly from lighting power density reductions, attributable to improved lighting technology, which lowers the need for both the number and wattage of lighting fixtures. For many of the buildings modeled in this study, the incremental cost savings achieved through lighting power density reductions are significant enough to offset incremental increases in building envelope costs. To calculate lighting power density reductions, this analysis draws on the Pacific Northwest National Laboratory's (PNNL) 2006 study, *Analysis of Energy Savings Impacts of New Commercial Energy Codes for the Gulf Coast*.[17] In the report, PNNL researchers calculated lighting equipment cost savings per square foot of building area for the three DOE building models in this study. Savings are estimated at $0.65 per building foot^2 for office buildings, $2.29 per foot^2 for apartment buildings, and $0.10 per foot^2 for warehouse buildings.[18] As a result of these savings, apartment buildings in both climate zones, as well as warehouses in climate zone 2 are expected to cost less to build under the new code, ASHRAE 90.1-2007, than under the assumed baseline, ASHRAE 90.1-1999. A full list of lighting power density results for other commercial property types is presented in Appendix D. It should also be noted that the office building, the only product type with increased incremental costs at the statewide level, may in fact be cheaper to construct than this study projects. By reducing the size of HVAC equipment—which can be smaller due to a more efficient building envelope—builders are able to achieve significant cost savings that may substantially reduce or eliminate incremental cost.

Cost-Benefit Analysis for Office, Apartment, and Warehouse Buildings

In conducting a cost-benefit analysis for commercial buildings, this study compares upfront incremental cost increases (or savings) described above to projected energy savings provided by DOE. In order to present realistic cost-benefit analysis for building owners and operators, this study makes assumptions consistent with common commercial real estate finance practices. The study assumes that owners make 20 percent equity contributions to conventional 30-year mortgages, which is assumed to be set at a 5 percent interest rate. The analysis indicates that payback times for the model buildings range from immediate (in the case of buildings with negative incremental costs) to 5 years, in the case of the climate zone 2 office building.

For half of the buildings, first costs are negative, indicating that payback is immediate. Resulting energy savings accrue to commercial property owners—or tenants, if they have a single or double net lease that requires them to pay utilities in addition to rent. Figure 12 also presents the net present value (NPV) of all of the added costs and energy savings for each building type over a 30-year span.

[17] *Analysis of Energy Saving Impacts of New Commercial Energy Codes for the Gulf Coast*. Halverson, M.A., Gowri, K., and Richman, E.E. Pacific Northwest National Laboratory, 2006.

[18] It should be noted that the report compares 90.1-2001 to 90.1-2004. Although this study compares 90.1-1999 to 90.1-2007, the lighting power densities are the same for 2001 and 1999 versions of the code, as well as between 2004 and 2007 versions, thus suggesting that the increment changes are still valid. It should also be noted that the PNNL-estimated lighting savings for the office building were reduced by $1,400 to account for the added cost of room occupancy sensors in building common spaces.

Figure 12: Annual Energy Savings per Commercial Building Type Attributable to Upgrade to ASHRAE 90.1-2007					
Climate Zone	Commercial Building Type	Total Energy Savings (Percentage)	Total Annual Energy Savings, Current Rates	Mortgage Amortization Break-even Time	Net Present Value, 30 Year Cash Flow[19]
2	Office Building	8.2%	$ 6,030.56	**5 years**	$11,139
2	Apartment Building	5.7%	$ 1,172.98	**N/A- Immediate**	$28,949
2	Warehouse Building	0.8%	$ 75.23	**N/A- Immediate**	$1,042
3	Office Building	14.0%	$10,809.16	**2 years, 3 months**	$55,349
3	Apartment Building	6.8%	$ 1,533.82	**N/A- Immediate**	$19,332
3	Warehouse Building	0.7%	$ 65.82	**8 months**	$591

[19] Discount rate for commercial buildings is set at 10 percent

Section III. Economic Benefits from Updated Energy Code

Energy codes for residential and commercial buildings have broad economic impacts. Although energy codes' central benefit is delivered through energy cost savings, other co-benefits include enhanced building valuation, job creation, and quantifiable reductions in greenhouse gas emissions. Effective energy codes assist both homeowners and business owners by reducing their monthly energy expenditures thereby freeing up discretionary income—the result of which bolsters the purchasing power of individual families and businesses and also fosters the growth of local and state economies.

Economic Impact of Updated Energy Codes for Residential Construction for Homebuyers

According to calculations cited in Section II, assuming the 2009 IECC is adopted for residential buildings in 2012 and affects all building starts over the next five years (2012 through 2016), owners of new homes statewide would realize over $26 million of energy cost savings. For Mississippi residents burdened by the lowest median income in the United States[20], energy cost savings are particularly valuable as a means to increase disposable income and insulate against volatile energy prices. According to the U.S. Bureau of Labor Statistics[21], utility bills represent the fourth highest expense in Americans' family budgets. As such, significant reductions in energy expenses allows for more spending on other essentials including food, clothing, healthcare, and transportation.

Economic Impact of Updated Energy Codes for Commercial Construction

Based on commercial energy savings projections in Section II, this study estimates the application of commercial building energy codes will yield approximately $41.3 million in energy cost savings statewide over a the next five years. However, due the nature of commercial leasing (which often decouples a tenant's lease rates from utility bills) it is unclear what proportion of the savings will accrue to building owners versus commercial tenants. Nevertheless, this projection presents substantial savings to Mississippi businesses. Benefeciaries will include commercial tenants with leases that obligate them to pay utility bills, building owners with leases that require them to pay tenant utility bills (triple net) and building owners who successfully market and lease buildings for higher rates per square foot than comparable buildings.

Economic Impact of Increased Consumer Spending

The combined savings from updated residential and commercial energy codes will have a positive impact on Mississippi's economy through increased consumer spending attributable to averted energy costs. The increase in discretionary income achieved from lower energy bills over the next five years in the residential sector is considerable, but the expansionary effects of increased spending are difficult to quantify. Data from April 2011 shows that on average, Americans directed 95.1 percent of their personal disposable income back into local and state

[20] According to 2009 income statistics captured by the U.S. Census Bureau, Mississippi's median income is $35,078, nearly 30 percent below the national average. (http://www.census.gov/hhes/www/income/data/statemedian/index.html)
[21] Bureau of Labor Statistics, Consumer Expenditure Survey 2009 (http://www.bls.gov/cex/2009/Standard/income.pdf)

economies.[22] As a result, Mississippi homeowners and businesses are expected to spend the majority of energy savings ($61.1 million) on other goods and services, which will have expansionary economic effects, both direct and indirect, on a wide range of economic sectors.

Additional Jobs Created Through Building Inspection

In addition to indirect job growth driven by increased economic activity, statewide adoption and enforcement of upgraded energy codes will likely result in modest job growth for building sector professionals.

According to the U.S. Bureau of Labor Statistics (BLS) the state of Mississippi employs the least number of construction and building inspectors in the East South Central U.S. Census region, which includes Alabama, Kentucky, and Tennessee. In fact, nearly half of Mississippi's 82 counties do not employ a single building inspector. In contrast, Alabama boasts at least one building inspector in each of its 67 counties and a total of approximately 225 registered inspectors for the entire state. Adoption of a statewide energy code may increase the need for at least one building code inspector per county, resulting in an additional 40 jobs created[23].

Additional jobs may also be created as a result of duct testing requirements under the residential energy code. In order to achieve compliance with the 2009 IECC, builders may choose to either reroute ducts and install interior ductwork within conditioned spaces (inside the building envelope) or conduct pressure (or "duct blaster") testing to assure that ducts installed in unconditioned spaces (such as attics and crawlspaces) are well sealed. For ducts installed in unconditioned spaces, leakage results in a significant loss of energy, while moving ducts to within the building envelope assures that leakage occurs within the building envelope and thus minimizes energy loss.

At present, there are no performance requirements on installed ductwork and stakeholder interviews indicate that it is not common practice in the state. Stakeholders also indicate that it is more likely that builders would choose to not move ducts from unconditioned spaces and instead would instead elect to meet this requirement by paying a third party contractor to conduct duct blaster testing to assure that ducting is properly sealed to prevent leakage. Because of this expected tendency, adoption of the 2009 IECC would create an increased need for certified Home Energy Rating System (HERS) raters to conduct performance verification on all newly installed residential duct systems.

Currently, there are only 13 certified HERS raters registered in Mississippi, fewer than nearby states, Alabama and Georgia, with 18 and 33 certified raters[24], respectively. To meet the added demand for services under adoption of the 2009 IECC, BCAP estimates the need for an additional 14 full-time HERS raters at a minimum[25].

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[22] Bureau of Economic Activity, National Economic Accounts http://www.bea.gov/newsreleases/national/pi/pinewsrelease.htm

[23] Appendix B.

[24] RESNET database(http://www.resnet.us/)

[25] This estimate assumes 75 percent of housing starts elect the performance testing pathway for compliance. Appling this assumption to annual residential development projections, 6,259 units will require diagnostic testing. Assuming the average rater can cover 2 sites per day, for an average of 240 days yearly, 14 additional jobs would be created.

Economic Impact of Updated Energy Codes for Electric Utilities

Energy efficient building practices required under the new energy codes have the potential to measurably reduce end-use energy demand. For utilities in Mississippi, this translates into averted power generation needs, and therefore, avoided costs to utilities (and by extension, consumers – as these costs are often passed on).

Impact on Residential Building Valuation

At present, home appraisers and major mortgage-originating banks have not made significant progress in assigning added value to energy-efficient buildings during the appraisal process. Few banks presently offer mortgage products that expand borrowers' limits on their debt-to-income ratios for energy efficient homes. Despite this, promising efforts by the Federal Housing Administration (FHA) have helped alter debt-to-income calculations for some buyers. One of FHA's programs, Energy Efficient Homes (EEH) has been embraced by some small banks as a way to "stretch" conventional debt-to-income ratios for new single family homes by two percent—a change significant enough to cover incremental costs in Mississippi and in most states.

While appraisals currently do not commonly incorporate the value of energy-efficient features, opportunities exist to assign value to these features. Assigning a NPV to anticipated energy savings is one promising strategy that could be incorporated into the appraisal process. For example, for the new single-family home modeled in Section I, assuming level energy prices, utility savings over 30 years would yield a NPV[26] of $3,691.22—over three times the estimated incremental cost from IECC 2009 code compliance.

Impact on Commercial Building Leasing

While the real estate industry has only begun to value energy efficiency features in mainstream practice, emerging evidence suggests that energy efficient or "green" real estate may command a premium over conventional equivalents. Thus far, this study has examined conventional cost-benefit analysis, which compares initial incremental costs to subsequent energy savings. However, emerging research findings suggest that energy-efficient building attributes may positively affect other real estate metrics which convey value to developers and long-term operators, including lease-up rates, lease rates per square foot, and cap rates. The cap rate is the ratio between the net income and its cost or value. To date, research has not been performed that ties improved real estate fundamentals to code-compliant buildings, but positive findings do exist for buildings with certified energy-efficient attributes, including ENERGY STAR and LEED-certified buildings.[27]

A 2008 study completed by the CoStar Group, *Does Green Pay Off?,* provides an excellent data source on the issue. As the largest commercial real estate analysis firm in the United States, CoStar collects more data on individual buildings than any other firm nationwide, which allows the study to draw on data from the CoStar database's records of conventional buildings, LEED

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[26] Assuming a discount rate of 5 percent.

[27] The lack of research on code-compliant buildings is unsurprising, as all buildings are assumed (often incorrectly) to be compliant with local energy codes.

certified, and ENERGY STAR certified buildings across the country.[28] The study, which examined Class A office buildings in excess of 5 stories, demonstrated that within the CoStar database, buildings with ENERGY STAR and LEED certification achieved higher occupancy rates, rents, and sales prices.

The study's 2010 follow-up, *Does Green Still Pay?*[29], shows less separation for ENERGY STAR buildings compared to the market as a whole—although LEED status maintains its advantage over conventional equivalents. Additionally, the 2010 study shows significantly lower cap rates[30] for LEED properties compared to the remainder of the building stock. The authors caution this result is preliminary and based on limited transactions by mid-2010: 378 Class A buildings traded by the time of the report's publication in June, and only 5 were LEED certified and 12 ENERGY STAR Labeled. While the sample size is low, it does demonstrate that amidst tepid commercial real estate markets throughout the first half of 2010, LEED certified buildings presented the best values, as determined by lower cap rates at closing.

Cap rates have a significant impact on building value. As an example, if we assume annual pre-tax cash flows of $432,000 for the apartment building modeled in Section II, the difference in a cap rate of half a percent, 8 percent compared to 7.5 percent, represents $360,000 in value ($5,400,000 compared to $5,760,000). While CoStar's results are preliminary, they suggest that the commercial real estate sector should continue efforts to assess building energy performance attributes as they relate to higher rents, lease-up rates, and occupant satisfaction.

Apart from measures of sustainability, energy performance may in fact be the most important attribute of high-performance buildings, at least as it relates to building valuation. The Green Building Finance Consortium in its recent study, *Value Beyond Cost Savings: How to Underwrite Sustainable Properties*, points out that "environmental certifications and assessments cannot be the basis for financial analysis or valuation because…environmental certifications measure environmental performance, not financial performance." The consortium later concludes that energy is the most critical issue for sustainable property valuation due to "the substantial project energy savings of many sustainable properties."[31]

Impact of Updated Energy Codes on Occupant Comfort:

New homes and commercial buildings built in compliance to the 2009 IECC are not only more energy efficient but are also typically more comfortable. The building materials, testing, and design considerations that go into an energy code compliant home or building help to keep temperatures even, the air clean, and the living space dry, quiet, and draft-free. Some of the following building upgrades are incremental modifications required in order to attain compliance with the 2009 IECC:

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[28] It should be noted that Energy Star Buildings do not necessarily represent the latest in energy efficiency construction techniques. Within the CoStar database sample used in this study, the average structure certified through the Energy Star program was built in 1985.

[29] *Does Green Still Pay Off?* Miller, Norm. The Journal of Sustainable Real Estate, June 2010.

[30] Cap (or capitalization) rates are a measure of value when appraising real estate assets and reflect to a property's net operating income—both existing and projected. Lower cap rates indicate higher value; when applied to a given building's operating income, a lower cap rate yields a higher asset value.

[31] *Value Beyond Cost Savings: How to Underwrite Sustainable Properties*. Muldavin, Scott R. Green Building Finance Consortium, 2010.

- **Low-E glazed, double-pane windows** reduce ultraviolet light that can cause fading of carpets and furniture, and minimize solar heat gain, keeping window areas cooler and more comfortable.
- **Duct sealing and diagnostic testing** stops drafts, helps keep humidity and garage contaminants out of the house, and creates a barrier to rodents and insects.
- **Improved insulation measures** help maintain comfortable temperatures in conditioned spaces and assist with noise attenuation.
- **High-efficiency HVAC** with engineered duct systems, fresh air intakes, and programmable thermostats provide improved air quality, better dehumidification, quieter operation, enhanced air circulation and filtration, and more consistent temperature distribution.

Section IV: Environmental Benefits from Updated Energy Code

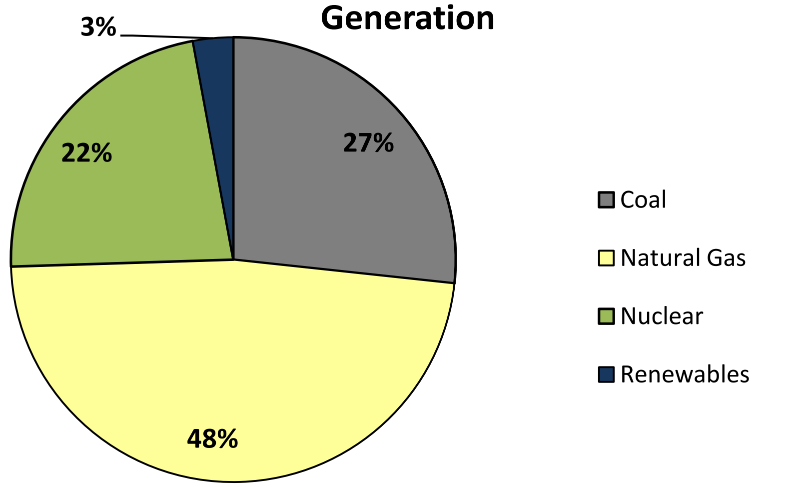
Energy savings resulting from the successful implementation of an energy code are accompanied by a series of co-benefits, including a reduction in emissions from averted energy needs. Emissions reductions of select air pollutants—sulfur dioxide, nitrogen oxides (nitrogen dioxide, nitrous acid and nitric acid) and carbon dioxide—based on the energy savings projections from Section I are significant.

For the purposes of this study, energy savings under a code implementation scenario are estimated by sector (commercial and residential), then further categorized by type of energy savings, electricity versus natural gas. As such, subsequent emissions reductions accrue from both electric power generation sources, as well as on-site combustion of natural gas for space and water heating.

Electric Power Profile, Averted Emissions

To determine the environmental benefits associated with the adoption of energy codes across the state's commercial and residential building sectors, this study profiles Mississippi's power generation sector and its historic emissions factors.[32] Today, Mississippi's electric power production features natural gas as a primary fuel, largely because of its proximity to natural gas reserves throughout the Gulf of Mexico, as well as recent reductions in delivered price relative to coal. Mississippi's electric portfolio also includes significant contributions from both coal-fired and nuclear thermoelectric generation, with limited representation from renewable sources (see Figure 13, above).

Figure 13. Mississippi, 2009, Electric Power Generation



Using Mississippi's current generation mix, this analysis applies the state's existing portfolio proportions to its energy savings projections calculated in Section I. As a result, this study approximates averted electricity production needs by fuel type between 2012 and 2016. See figure 14, below, for further detail.

[32] Historic emission factors were gathered from the U.S. EIA's 2009 Mississippi Electricity Profile.

Figure 14: Energy Code Implications on Mississippi's Power Sector							
Year	**Residential Electricity Savings (MWh)**	**Commercial Electricity Savings (MWh)**	**Total Electricity Savings (MWh)**	**Averted Power Generation**			
				Coal (MWh)	**Natural Gas (MWh)**	**Nuclear (MWh)**	**Renewables (MWh)**
2012	11,039	21,143	**32,182**	8,593	15,383	7,267	940
2013	23,918	47,016	**70,934**	18,939	33,906	16,017	2,071
2014	38,638	78,502	**117,140**	31,276	55,993	26,450	3,420
2015	54,277	113,662	**167,939**	44,840	80,275	37,921	4,904
2016	70,836	150,532	**221,368**	59,105	105,814	49,985	6,464
5-Year Total	**198,708**	**410,855**	**609,563**	**162,753**	**291,371**	**137,639**	**17,799**

As illustrated in Figure 15 below, electricity savings due to energy code adoption have a significant impact on Mississippi's emissions profile. The energy code has the potential to limit both SO_2 and NOx emissions, while reducing CO_2 emissions by 293,631 metric tons over 5 years.

Figure 15: Energy Code Impacts on Mississippi's Power Sector Emissions				
Primary Fuel, Electric Power Generation	Emission Type	Emission Density *(Thousand mt/MWh)*	5-Year Averted Power Generation, By Primary Fuel *(MWh)*	Associated Averted Emissions *(mt)*
Coal	SO_2	2.77×10^{-06}	162,753	452
	NOx	1.23×10^{-06}		201
	CO_2	1.02×10^{-02}		166,149
Natural Gas	SO_2	0	291,371	0
	NOx	3.87×10^{-07}		113
	CO_2	4.38×10^{-04}		127,482
Nuclear	SO_2	0	137,639	0
	NOx	0		0
	CO_2	0		0
Renewables	SO_2	5.62×10^{-06}	17,799	100
	NOx	1.40×10^{-06}		<1
	CO_2	0		0
Total Averted SO_2 Emissions (mt), 5 Years				**552**
Total Averted NOx Emissions (mt), 5 Years				**314**
Total Averted CO_2 Emissions (mt), 5 Years				**293,631**
Data gathered from U.S. EIA State Electricity Profiles, Mississippi, 2009.				

Projected Natural Gas Savings, Averted Emissions

According to this study's findings, statewide implementation of energy codes would also result in a significant reduction of natural gas, used primarily for space and water heating. Natural gas, although clean-burning with respect to criteria air pollutants, still emits significant quantities of CO_2 as a byproduct of combustion.

This study applies an average CO_2 factor[33] for natural gas to the study's projected natural gas savings under an energy code adoption scenario. These calculations, shown in Figure 16, conclude that effective code adoption would result in over 11 million therms of natural gas savings, in aggregate, over 5 years. Subsequently, these savings represent a CO_2 emission reduction of 56,456 metric tons—the equivalent of removing 10,042 passenger vehicles from Mississippi roadways[34].

		Figure 16: Energy Code Impacts on Mississippi Building Emissions, Natural Gas		
Year	**Natural Gas Reduction, Commercial (therms)**	**Natural Gas Reduction, Residential (therms)**	**Total Natural Gas Reduction (therms)**	**Total Averted CO_2 Emissions, Natural Gas (mt)**
2012	320,655	248,971	569,626	2,848
2013	738,201	539,437	1,277,638	6,388
2014	1,284,640	871,398	2,156,038	10,780
2015	1,904,971	1,224,107	3,129,078	15,645
2016	2,561,204	1,597,564	4,158,768	20,794
5-Year Total	**6,809,671**	**4,481,477**	**11,291,148**	**56,456**

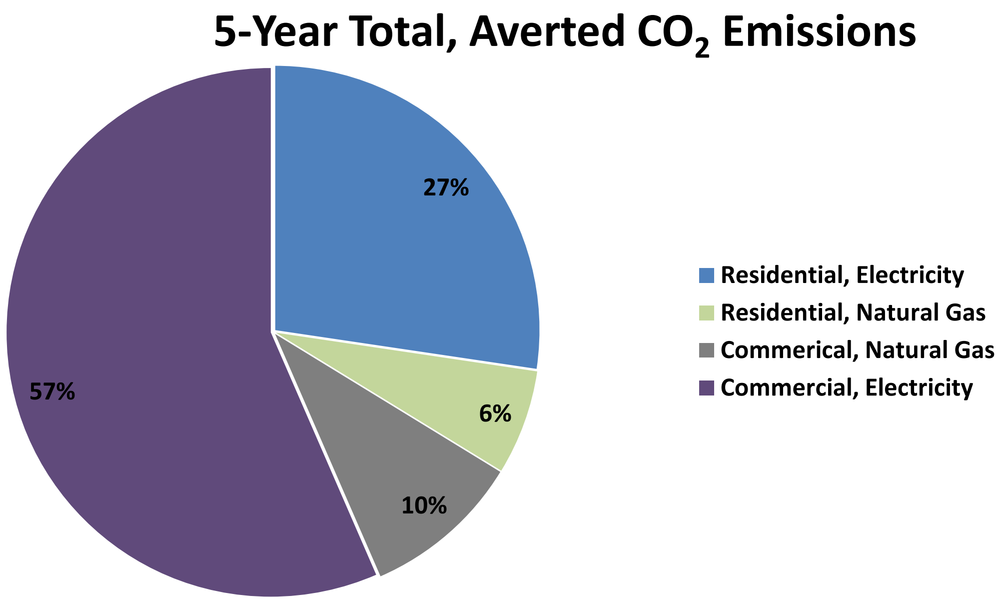
Averted Emissions Equivalents

In addition to a host of other economic benefits, energy codes are accompanied by measurable environmental benefits as a result of averted energy use. As states across the United States set ambitious targets for improved energy efficiency and greenhouse gas (GHG) emission reductions, energy codes serve as a valuable tool to limit the energy requirements of statewide building stock, as well as subsequent GHG emissions and other air pollutants.

In sum, this analysis concludes that energy code adoption across Mississippi's residential and commercial building sectors represents the following emissions reductions throughout the first 5 years: 350,086 metric tons of CO_2[35]; 552 metric tons of SO_2; and 314 metric tons of NOx.

[33] This study assumes 0.005 mt of CO_2/therm of natural gas.
[34] This equivalency was estimated using the U.S. EPA's Greenhouse Gas Equivalencies Caluculator.
[35] This figure includes both averted electric and natural gas needs.

Figure 17:



Cumulative avoided CO_2 emissions: 350,086 metric tons

By volume, averted CO_2 emissions are clearly the largest environmental impact of energy code adoption. To offer a sense of scale, see the list of CO_2 emission equivalents below.[36]

350,086 mt CO_2 Equivalents:

- 62,273 passenger vehicles
- 35,604,559 gallons of gasoline
- 738,588 barrels of oil
- 1,729 railcars of coal

[36] This equivalency was estimated using the U.S. EPA's Greenhouse Gas Equivalencies Caluculator.

Section V: Local and Regional Best Practices

As previous sections have demonstrated, a statewide energy code translates into financial benefits for state, local, and household economies by improving business competitiveness and buffering residents from volatile energy prices. In addition, the adoption and enforcement of the latest energy codes will, by default, "raise the bar" in residential and commercial construction quality, and open up more jobs in the building construction industry.

While seven local jurisdictions in Mississippi already support an updated energy code, the latest building energy codes - IECC 2009 and the ASHRAE Standard 90.1-2007 - are most effective and beneficial when implemented and enforced on a statewide level. In a statewide plan, the state has an opportunity to train state-level support officials and builders under a single standard for residential and commercial buildings. From both a workforce training and a construction efficiency perspective, this approach eliminates the design and building professionals' need to navigate local variances in energy codes between jurisdictions.

This study concludes by offering examples of best practices from local jurisdictions within Mississippi as well as from other states in the South that have implemented updated energy codes. BCAP encourages Mississippi to take heed of these in order to achieve policy aims and provide state-level assistance to local governments in adopting and enforcing these codes.

Mississippi—State-Level Adoption and Enforcement

Mississippi is a home rule state, which means it is the responsibility of each jurisdiction to adopt and enforce building and energy codes locally. Currently the state of Mississippi does not have a statewide energy code. The state-approved energy code for residential homes is voluntary and based on ASHRAE 90-1975, a code that is over thirty years out of date.

One of the major barriers to adopting and implementing updated residential energy codes on a state and local level is the public's unfamiliarity with building science and a corresponding lack of interest in energy-efficient features on the part of many homebuyers. Homebuyers do not know how to ask about energy efficient measures in new homes; some are not even aware which aspects of building technology help achieve energy efficiency at low cost.

Although Mississippi is currently without a statewide energy code, there are increasing efforts at the state-level to promote energy-efficient building:

- Several jurisdictions in Mississippi have already, voluntarily, adopted an updated energy code. Three jurisdictions have adopted the 2003 IECC and three jurisdictions have adopted the 2006 IECC. Nineteen jurisdictions in the state have adopted the 2003 International Building Code (IBC), and 12 have adopted the 2006 IBC. The 2003 and 2006 IBC contain an energy chapter that sets energy efficiency requirements above those required by the current state baseline code.[37]

[37] Appendix C.

- On June 10, 2009, Governor Barbour announced the creation of the Mississippi Energy Policy Institute (MEPI) in order to "promote policies supporting long term economic growth through reliable and affordable energy."[38]
- Mississippi's Public Service Commission is encouraging public awareness by hosting a series of meetings, or "Energy Expos", on energy saving opportunities. Partnering with the Tennessee Valley Authority (TVA) and local city leaders, TVA Commissioner Presley has already visited the cities of Aberdeen, Holly Springs and Pontotoc, and plans to continue the campaign to additional jurisdictions[39]. According to Presley, the meetings offer an opportunity for residents to find out what kind of energy efficiency services and products are available to help lower electric bills. Attendees who complete an online energy evaluation on site receive energy savings kits.
- The Mississippi Development Authority Energy Division promotes energy efficiency and renewable energy, and provides free online videos on a variety of building science issues, including an overview of the 2006 IECC[40].
- The Mississippi Development Authority Energy Division reciently provided Energy Code Training Seminars in the north, central and south regions of the state. The seminars are targeted, but not limited to: architects, engineers, contractors (residential and commercial), building code officials (state and local), building owners, building operators, building engineers, real estate managers, property managers, state using agencies, and other construction industry professionals.

Best Practices from States in the Southeast Region

Alabama

In the neighboring state of Alabama, the city of Homewood adopted the 2009 IECC energy code in 2008[41]. Homewood residents and builders faced their share of obstacles in the transition to the more stringent code: a lack of familiarity with Standard 90.1-2007 on the part of many mechanical and electrical engineers, code officials, residential contractors, and subcontractors; insufficient access to education on improved building practices; and elevated costs of conducting site plan reviews and on-site inspections. The city is addressing these challenges through the following actions:

- Arranging for training on energy code basics and proper enforcement.
- Organizing educational opportunities for key stakeholders in the construction industry on the provisions of the 2009 IECC[42].

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[38] http://www.governorbarbour.com/news/2009/jun/energy_institute.html
[39] Mississippi Public Service Commission, Northern District April 2011 newsletter http://www.psc.state.ms.us/commissioners/northern/newsletters/2011/Newsletter%20April%202011.pdf
[40] http://www.codecollegenetwork.com/ms/index.html
[41] http://www.bcap-ocean.org/resource/alabama-implementation-action-kit
[42] http://www.southface.org/learning-center/trainings/alabama-workshop-series#rec

- Evaluating and setting building permit fees to cover the increased costs resulting from the new code.
- Requiring design professionals to provide documentation demonstrating a new home's or major renovation's compliance with the code.
- Providing up-to-date information and reminding parties involved in new construction or renovation about the 2009 IECC requirements.

Arkansas

In October 2004, Arkansas adopted the 2003 IECC for its residential sector. For commercial buildings, Arkansas references ASHRAE Standard 90.1-2001, which is not equivalent with the latest national model energy codes. The Arkansas Energy Office (AEO) is the primary entity promoting energy codes in the state. Some of the AEO's successful practices and programs are outlined below[43]:

- The AEO provides a copy of the energy code free online as well as links to free compliance tools from DOE and AEO.
- The AEO has also come up with "Code Cards," or small quick-reference guides for the requirements of the Arkansas Energy Code, which have already become a major, visible educational resource.
- The state created a scholarship fund using support from the Recovery Act to subsidize $1,000 of the $1,500 total cost of a one-week HERS rater certification course for prospective students.

Louisiana

The state of Louisiana recently adopted the 2009 version of the International Residential Building Code, retaining Chapter 11 (which sets the energy criteria) from the 2006 IRC. For commercial buildings, Louisiana references the 2006 IECC. The general public can access online a new guide entitled *Energy Efficient Homes in Louisiana* that suggests various ways homeowners and building professionals can make Louisiana homes as energy efficient as possible.

Kentucky

Unlike Mississippi, Kentucky mandates a minimum-maximum building energy code that prohibits local jurisdictions from diverging from the state code (also known as Dillon's Rule). While this inhibits jurisdictions from implementing more stringent energy codes, it creates a strong uniform statewide mandatory code. Kentucky has made notable steps toward adopting updated energy codes that can serve as best practice examples for Mississippi[44]:

- The Commonwealth's Board of Housing, Construction and Buildings actively involved the building construction industry in the adoption process of the 2009 IECC for commercial buildings (pending final approval by the LRC)

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[43] http://www.bcap-ocean.org/resource/arkansas-gap-analysis-report
[44] http://www.bcap-ocean.org/resource/kentucky-gap-analysis-report

- Requiring stringent energy standards for state-funded buildings to reflect the Commonwealth's drive for fiscal responsibility, as tax dollars will be better-spent (through lower energy bills).
- The state has engaged and raised awareness of the importance of energy efficiency in school districts via the KEEPS program, whereby every school district develops an energy management program to reduce energy consumption.

Appendices

Appendix A. Detailed Climate Zone Specific Incremental Cost for Three Commercial Property Types

Incremental Cost for Commercial Buildings in Mississippi, Climate Zone 2						
Building Type	Wall Incremental Costs	Roof Incremental Costs	Window Incremental Costs	Total Envelope Change	First Cost Savings	Total Incremental Cost (or Savings)
Office	$0	$5,935.78	$93,314.31	$99,250.09	$33,456.77	**$65,793.32**
Apartment	$14,640.67	$2,801.72	$33,034.53	50,476.92	$77,275.73	**$(26,798.81)**
Semi-heated Warehouse	$0	$846.52	$2,530.11	3,376.63	$5,204.35	**$(1,827.73)**

Incremental Cost for Commercial Buildings in Mississippi, Climate Zone 3						
Building Type	Wall Incremental Costs	Roof Incremental Costs	Window Incremental Costs	Total Envelope Change	First Cost Savings	Total Incremental Cost (or Savings)
Office	$10,179.12	$5,935.78	$93,314.31	$109,429.21	$33,456.77	**$75,972.44**
Apartment	$14,640.67	$2,801.72	$33,034.53	50,476.92	$77,275.73	**$(26,798.81)**
Semi-heated Warehouse	$2,018.63	$846.52	$2,530.11	$5,395.25	$5,204.35	**$190.90**

Appendix B. State Licensed and Registered Building Inspectors in Mississippi

State Licensed and Registered Building Inspectors in Mississippi, 2010		
Counties with no state registered licensed building inspectors	**Counties with state registered licensed building inspectors**	**Number of Licensed Building inspectors**
Benton	Adams	1
Calhoun	Alcorn	3
Choctaw	Amite	1
Clay	Attala	1
Copiah	Bolivar	3
Franklin	Carroll	1
George	Chicksaw	1
Greene	Claiborne	1
Grenada	Clarke	1
Holmes	Coahoma	1
Humphreys	Covington	1
Issaquena	DeSoto	10
Itawamba	Forrest	8
Jasper	Hancock	2
Jefferson	Harrison	21
Jefferson Davis	Hinds	13
Lawrence	Jackson	9
Leake	Jones	2
Leflore	Kemper	2
Lincoln	Lafayette	3
Marshall	Lamar	2
Montgomery	Lauderdale	2
Neshoba	Lee	6
Perry	Lowndes	4
Prentiss	Madison	11
Quitman	Marion	1
Scott	Monroe	1
Sharkey	Newton	1
Smith	Noxubee	1
Tallahatchie	Okitibbeha	5
Tippah	Panola	2
Tishomingo	Pearl River	3
Tunica	Pike	2
Walthall	Pontotoc	2
Wayne	Rankin	14
Webster	Simpson	1
Wilkinson	Stone	1
Winston	Sunflower	1
Yalobusha	Tate	1
Yazoo	Union	3
	Warren	4
	Washington	3
Total: 40	**Total: 42**	**Total 156**

Appendix C. International Codes Adopted by Jurisdictions in Mississippi

International Codes-Adoption by Jurisdiction (Updated 04-01-2011)		
Jurisdiction	**IBC**	**IECC**
Batesville, City	2003	
Bay St. Louis	2003	
Biloxi	2006	2006
Clinton	2006	2006
De Soto County	2003	
Gulfport	2003	
Hancock County	2003	
Harrison County	2003	
Hattiesburg	2003	
Jackson	2003	2003
Jackson County	2003	
Long Beach	2003	
Madison	2006	
Magee	2003	
McComb	2003	
Natchez	2003	2003
Ocean Springs	2003	
Olive Branch	2003	2003
Oxford	2003	
Pascagoula	2006	
Pearl River County	2003	
Pearl River Valley Water Supply District	2006	
Philadelphia	2006	
Picayune	2003	2003
Raymond	2006	
Richland	2006	2006
Ridgeland	2006	
Southhaven	2003	
Tupelo	2006	
Vicksburg	2006	
West Point	2006	

Appendix D. Lighting Power Density and Cost Savings[45]

Table D- 6 Whole Building Model Comparison – 90.1-2001 to 90.1-2004-Mississippi

Building Type	Equipment Cost "Change" in $/sqft	LPD Energy "Change" in W/sqft
Automotive Repair	(0.96)	(0.60)
Convention Center	(0.26)	(0.20)
Courthouse	(0.61)	(0.20)
Dining-Bar Lounge/Leisure	(0.21)	(0.20)
Dining-Café/Fast Food	0.09	(0.40)
Dining-Family	0.32	(0.30)
Dormitory	(2.51)	(0.50)
Exercise Center	(0.08)	(0.40)
Fire Station	(0.52)	(0.50)
Gymnasium	(0.07)	(0.60)
Healthcare-Hospital	(0.83)	0.00
Hotel	(0.91)	(0.40)
Library	(1.90)	(0.70)
Manufacturing	(0.25)	(0.20)
Motel	(0.97)	(0.90)
Multi-Family	(2.29)	(1.00)
Museum	(0.33)	(0.30)
Office	(0.65)	(0.50)
Parking Garage	(0.76)	(0.30)
Penitentiary	(0.54)	0.00
Police Station	(1.54)	0.00
Post Office	(0.46)	0.00
Religious	0.04	0.00
Retail	(1.50)	(0.40)
School-College	(0.25)	(0.30)
Sports Arena	(0.89)	(0.40)
Theater-Performing Arts	0.03	0.10
Theatre-Motion Picture	(0.37)	(0.40)
Town Hall	(0.65)	(0.30)
Transportation	(0.10)	(0.20)
Warehouse	(0.10)	(0.40)
Workshop	(0.16)	(0.30)
Average	(0.63)	(0.34)

[45] *Analysis of Energy Saving Impacts of New Commercial Energy Codes for the Gulf Coast*. Halverson, M.A., Gowri, K., and Richman, E.E. Pacific Northwest National Laboratory, 2006.