ENERGY EFFICIENCY IN THE SOUTH

Marilyn A. Brown,[1] Etan Gumerman,[2]
Xiaojing Sun,[2] Youngsun Baek,[1] Joy Wang,[1] Rodrigo Cortes,[1]
and Diran Soumonni[1]

April 12, 2010

Sponsored by:
Energy Foundation
Kresge Foudation
Turner Foundation

Published by:
Southeast Energy Efficiency Alliance
Atlanta, GA

[1]Georgia Institute of Technology
[2]Duke University

EXECUTIVE SUMMARY

The economic recession, climate change concerns and rising electricity costs have motivated many states to embrace energy efficiency as a way to create new local jobs, lower energy bills, and promote environmental sustainability. With this surge of interest in energy efficiency, policymakers are asking how much wasted energy can be eliminated by expanding investments in cost-effective technologies and practices.

This report describes the results of primary in-depth research focused on the size of the South's energy-efficiency resources and the types of policies that could convert this potential resource into reality over the next 20 years. We limit the scope of our analysis to energy-efficiency improvements in three sectors: residential and commercial buildings and industry (RCI). Our rigorous modeling approach – applied uniformly across the multi-state region and accompanied by a detailed documentation of assumptions and methods – separates this study from many previous assessments of energy-efficiency potential.

The major findings are listed below.

1. **Aggressive energy-efficiency initiatives in the South could prevent energy consumption in the RCI sectors from growing over the next twenty years.**

   The initiatives would involve actions at multiple levels (state and local, national, utility, business, and personal). In the absence of such initiatives, energy consumption in these three sectors is forecast to grow by approximately 16% between 2010 and 2030.

2. **Fewer new power plants would be needed with a commitment to energy efficiency.**

   Our analysis of nine illustrative policies shows the ability to retire almost 25 GW of older power plants – approximately 10 GW more than in the reference case. The nine policies would also avoid over the next twenty years the need to construct 49 GW of new plants to meet a growing electricity demand from the RCI sectors.

3. **Increased investments in cost-effective energy efficiency would generate jobs and cut utility bills.**

   The public and private investments stimulated by the nine energy-efficiency policies would deliver rapid and substantial benefits to the region. In 2020, energy bills in the South would be reduced by $41 billion, electricity rate increases would be moderated, 380,000 new jobs would be created, and the region's economy would grow by $1.23 billion.

The cost/benefit ratios for the modeled policies range from 4.6 to 0.3, with only two showing costs greater than benefits. When the value of saved CO_2 is included, only one policy is not cost effective, and it could be tailored to reduce the amount of subsidy.

4. **Energy efficiency would result in significant water savings.**

   The electricity generation that could be avoided by the nine energy-efficiency policies in the South could in turn conserve significant quantities of freshwater consumed for cooling. In the North American Electric Reliability Council (NERC) regions in the South, 8.6 billion gallons of freshwater could be conserved in 2020 (56% of projected growth in cooling water needs) and in 2030 this could grow to 20.1 billion gallons of conserved water (or 45% of projected growth).

Methodology and Background

The research team used a modified version of the National Energy Modeling System (NEMS) for its analysis, which is referred to as "SNUG-NEMS" (SNUG is short for the Southeast NEMS Users Group). By employing a hybrid approach using both the "bottom-up" and "top-down" modeling features of SNUG-NEMS and Global Insight's macroeconomic model, we are able to characterize a host of complicated interactive effects that are important, but often overlooked consequences of energy and climate policies. These include:

- the interaction of multiple energy efficiency policies on one another and their effect on the final demand for energy;
- the interaction of demand-side policies on supply-side trends;
- the feedback of energy efficiency policies on energy prices, and the subsequent (i.e., second-order) effect of prices on energy demand; and
- the interaction of energy-efficiency policies with the implementation of a carbon constrained future that puts a price on carbon.

We do not examine the impact of energy-efficiency investments on peak demand reductions. While clipping system peaks is critical to improving electric system performance, we treat this as an ancillary benefit of energy efficiency. Nor do we examine the role of demand-response or load-management programs aimed strictly at shifting on-peak consumption to off-peak hours.

The geographic scope covered by this report is defined by the U.S. Census Bureau's

definition of the South, composed of the District of Columbia and 16 States stretching from Delaware down the Appalachian Mountains, including the Southern Atlantic seaboard and spanning the Gulf Coast to Texas. The South is the largest and fastest growing region in the United States, with 36% of the nation's population and a considerably larger share of the nation's total energy consumption (44%) and supply (48%). It produces a large portion of the nation's fossil fuels, and the vast majority of the energy it consumes is derived from fossil resources.

Relative to the rest of the country, the South consumes a particularly large share of industrial energy, accounting for 51% of the nation's total industrial energy use. In addition, the region has a higher-than-average per capita energy consumption for each of the end-use sectors covered in this report: the South consumes 43% of the nation's electric power, 40% of the energy consumed in residences, and 38% of the energy used in commercial buildings. This energy-intensive lifestyle may be influenced by a range of factors including:

- the South's historically low electricity rates,
- the significant heating and cooling loads that characterize many southern states,
- its relatively weak energy conservation ethic (based on public opinion polls),
- its low market penetration of energy-efficient products (based on purchase behavior) and
- its lower than average expenditures on energy-efficiency programs.

If the South could achieve the substantial energy-efficiency improvements that have already been proven effective in other regions and other nations, carbon emissions across the South would decline, air quality would improve, and plans for building new power plants to meet growing electricity demand could be downsized and postponed, while saving ratepayers money.

Magnitude of the Energy-Efficiency Resource in the South

The U.S. Energy Information Administration projects energy consumption in the RCI sectors of the South to increase over the next 20 years, expanding from approximately 30,000 TBtu in 2010 to more than 35,000 TBtu in 2030 (Figure ES.1).

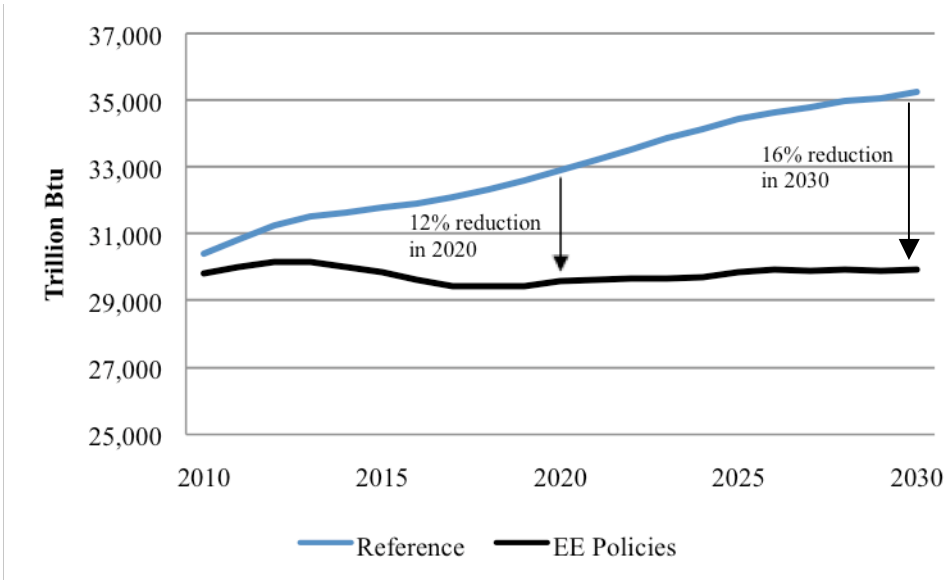

Figure ES.1 Primary Energy Consumption Projections (RCI Sectors) in the South

With the nine energy-efficiency policies, energy consumption does not grow over the next 20 years. This flat consumption trajectory represents a 16% reduction in energy consumption in 2030 relative to the reference forecast, or a savings of 5,600 trillion Btu (that is, 5.6 quads) in that year.

Energy-Efficiency Potential, by End-Use Sector. Among the three energy demand sectors in the South, the potential for improved energy efficiency is greatest in the commercial building sector in terms of percent energy reductions (Figure ES.2), while industrial sector has the largest absolute energy saving.

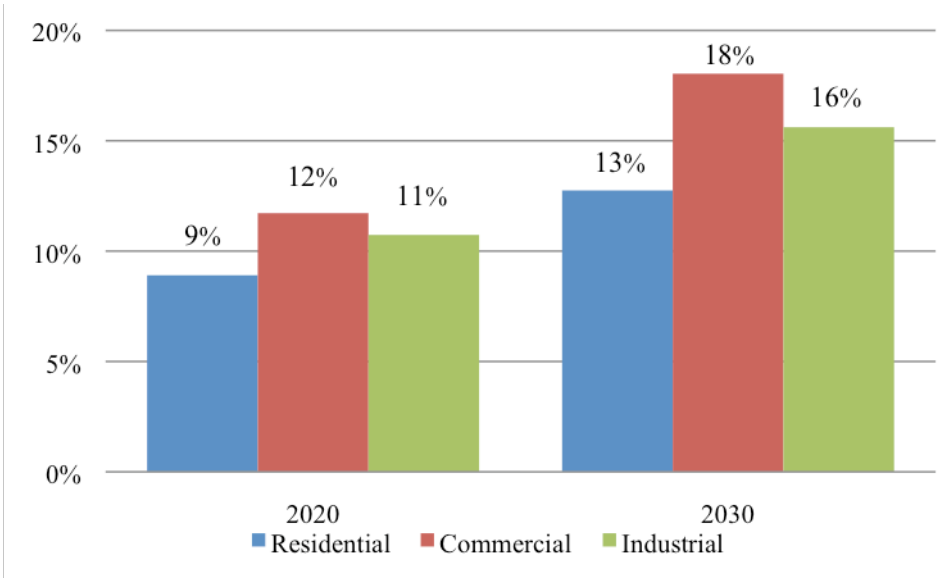

Figure ES.2 Energy-Efficiency Potential by Sector, in 2020 and 2030

Energy-Efficiency Potential, by Policy. Figure ES.3 portrays the energy-efficiency potential of each of the nine policies evaluated in this study.

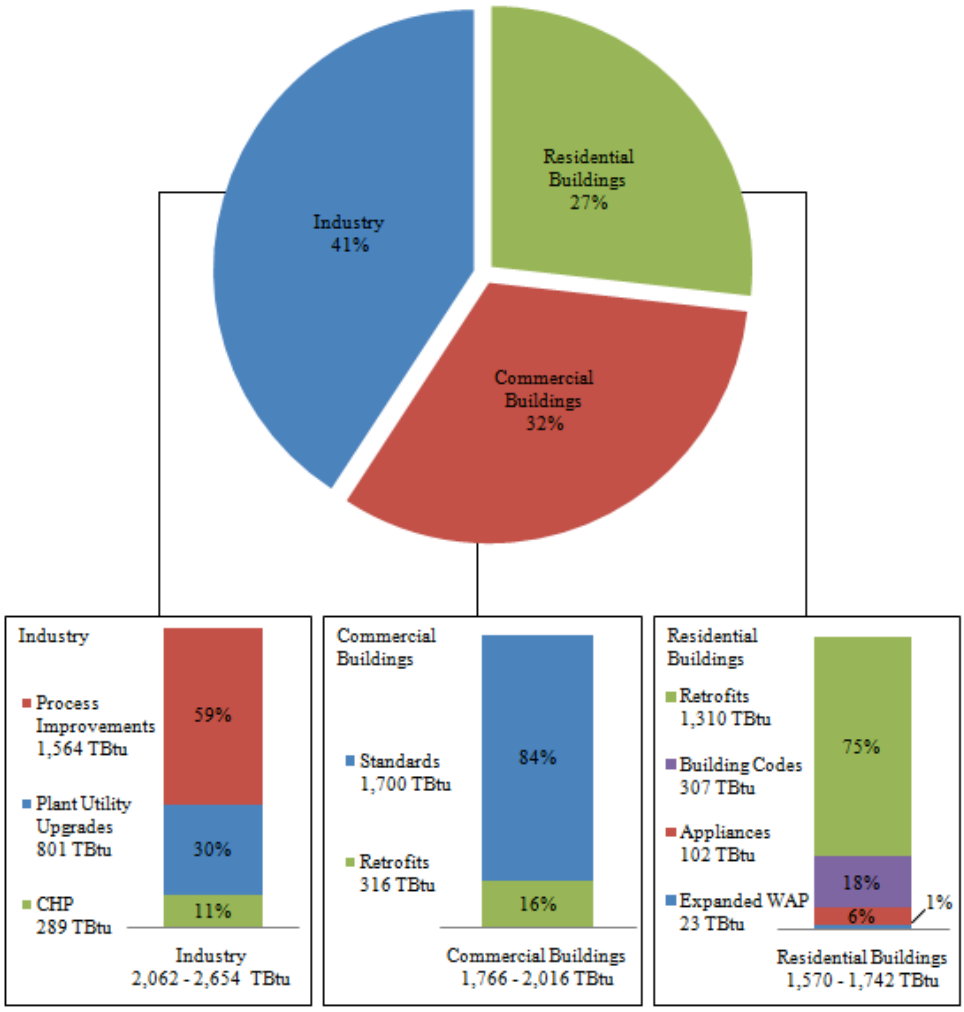

Figure ES.3 Energy-Efficiency Potential by Sector and Policy, in 2030*
(*The range of energy-efficiency potential shown for each sector reflects differences from summing individual policy estimates, SNUG-NEMS modeling of specific sectors, and economy-wide modeling estimates.)

- Of the nine policies, commercial appliance standards are estimated to have the greatest energy-savings potential in both 2020 and 2030. Commercial retrofit incentives account for additional cost-effective energy savings potential.
- In the industrial sector, process improvements could save significant quantities of natural gas and other fossil fuels. Significant industrial savings are also possible through policies that promote plant utility upgrades and incentives for combined heat and power systems.

- In the residential sector, retrofit incentives combined with equipment standards for heating, cooling, and water heating, is the dominant policy in terms of estimated energy-savings potential. It accounts for more than the other three residential policies combined (building codes, appliance standards, and expanded weatherization).

Impact on Power Plant Construction

By 2030, the Reference Scenario forecasts the need for an increase of 49 GW of electricity capacity in the southern National Electricity Reliability Council (NERC) regions above the capacity in operation in 2010 (Figure ES.4). This growing demand is expected to be met primarily by the addition of new combined cycle natural gas plants and new combined natural gas/diesel plants, along with some additional nuclear power, coal plants, and renewable power generation. Some oil and natural gas steam plants are retired during this period, as well. This is represented by the part of the bar in Figure ES.4 that is below the zero axis.

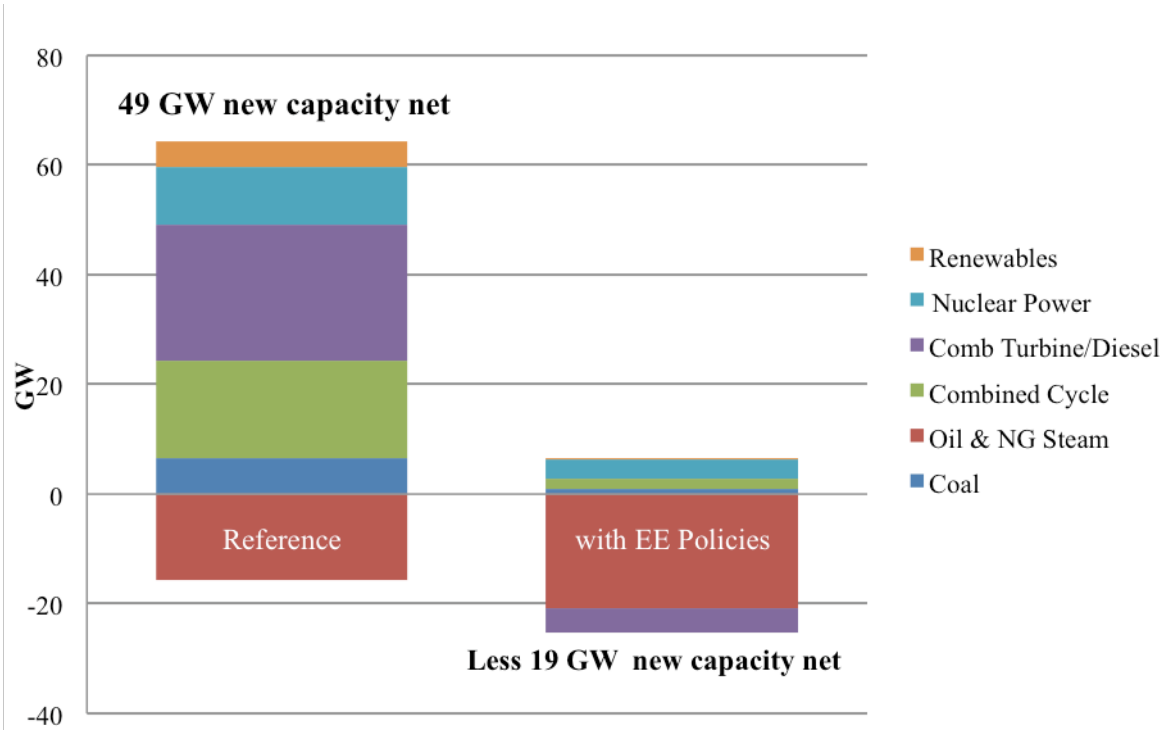

Figure ES.4 Incremental Generating Capacity in 2030 Beyond 2010 -- Southern NERC Regions

In contrast, implementation of vigorous energy-efficiency policies could eliminate the need to expand overall capacity between 2010 and 2030; in fact, the electricity capacity

in the Southern NERC regions could decrease over the 20-year period by 19 GW. While new plants are needed, their capacity is more than offset by plant retirements. In addition to retiring more than 20 GW of oil and natural gas steam plants and some natural gas capacity, the energy-efficiency policies eliminate the need for all but 7 GW of new capacity, most of which is expected to be nuclear and natural gas powered, based on the SNUG-NEMS model. Very little new renewable capacity is added in this Energy-Efficiency scenario because the addition of new capacity of any type is minimized, and most renewable power options exceed the cost of power production by new combined cycle natural gas plants.

Economic Impacts

The public and private investments stimulated by the energy-efficiency policies outlined in this study could reduce energy bills in the South, moderate electricity rate increases, create new employment opportunities, and expand the region's level of economic activity (i.e., Gross Regional Product) (Table ES.1).

Table ES.1 Economic and Employment Impacts of Energy-Efficiency Policies in the South

	2020	2030
Annual Energy Savings (billion $2007)	$40.9	$71.0
Annual Public and Private Investment (billion $2007)	$15.8	$22.4
Annual Increased Employment (From Productive Investment and Energy Savings) (in full-time-equivalents)	380,000	520,000
Impact on Gross Regional Product (GRP) (billion $2007)	$1.23	$2.12

Energy Bill Savings. Consumers in the South could save $41 billion in reduced energy bills in the year 2020 as a result of the portfolio of nine energy-efficiency policies. These energy bill savings increase to $71 billion in 2030. For example, a typical household in the South would save $26 on its monthly electricity bill in 2020, and would save $50 each month in 2030. In addition to directly benefiting the consumers who make energy-efficiency investments, these policies benefit all consumers because the reduction in overall energy consumption causes energy prices to rise more moderately than would otherwise occur.

Electricity Rate Impacts. The portfolio of nine energy-efficiency policies modeled together would lead to a moderation of the energy price escalation that is otherwise

forecast to occur over the next two decades (Table ES.2). For example, residential electricity rates in 2030 would be 17% lower in the Energy-Efficiency scenario than in the Reference Scenario. The reduced prices resulting from improved energy efficiency occur for both electricity and natural gas and across all sectors. The moderating impact on electricity rates grows over time as electricity consumption declines relative to the Reference case.

Table ES.2 The Effect of Energy-Efficiency Policies on Expected Southern Electricity Rates

	2015	2020	2025	2030
Residential	-3%	-8%	-11%	-17%
Commercial	-1%	-6%	-8%	-13%
Industrial	-3%	-8%	-11%	-16%

Employment Impacts. The public and private investments stimulated by the energy-efficiency policies outlined in this study will have a positive impact on employment in the South. The electric utility and the natural gas sectors directly and indirectly employ about 5.6 and 8.4 jobs, respectively, for every $1 million of spending in the South. But, sectors vital to energy-efficiency improvements, like construction and manufacturing, generate 16.5 jobs per $1 million of spending.[1] (All of the remaining sectors in the South have an average employment coefficient of 13.9 jobs per million dollars of spending.) By diverting expenditures away from non-labor intensive sectors, energy-efficiency policies can positively impact employment growth.

The results shown in Table ES.1 are based on (1) this study's estimated energy savings and investment costs from implementing nine energy-efficiency policies, (2) national, regional, and state input-output coefficients provided by the Minnesota IMPLAN Group for 2008, and (3) calculators developed by the American Council for an Energy Efficient Economy, the Center for American Progress, and the President's Council of Economic Advisors.

Policies that drive a higher level of efficiency investments can create new jobs quickly, and can sustain a favorable employment balance because of the utility bill savings that foster long-term growth in other productive sectors of the economy. The combination of direct and indirect job growth attributed to the energy-efficiency policy scenario is estimated to be 380,000 in 2020 and 520,000 in 2030. In comparison, there were 5.4 million unemployed residents in the South at the end of 2009.[2]

[1] These estimates are based on 2008 IMPLAN data.

[2] Bureau of Labor Statistics. (2010) Civilian labor force and unemployment by state and selected area, seasonally adjusted (Last modified: January 22, 2010, Accessed: March 9, 2010). http://www.bls.gov/news.release/laus.t03.htm

Impact on Gross Regional Product (GRP). A vigorous commitment to energy efficiency would have a small, positive impact on the level of economic activity of the South. Specifically, the GRP of the South would increase by $1.23 billion in 2020 and by $2.12 billion in 2030. These changes are small relative to the South's $4.7 trillion economy in 2007.[3]

Cost-Effectiveness of the Portfolio of Energy-Efficiency Policies

As Table ES.3 shows, the portfolio of nine energy-efficiency policies is cost-effective. The two policies addressing commercial buildings have the highest combined ratio of benefits to costs using the "total resource cost test." Over the 20-year period, an investment of $31.5 billion[4] would generate energy bill savings of $126 billion. Energy bill savings would begin immediately in 2010, would grow through 2030, and would then taper off until 2050 when the useful life of the improved technologies is expected to end. The result is a benefit/cost (B/C) ratio of 4.0 for the commercial sector. That is, for every dollar invested by the government and the private sector, four dollars of benefit is received. The industrial and residential sector policies are similarly cost effective with B/C ratios of 3.4 and 1.3.

The savings from the greater efficiency stimulated by these nine policies would total approximately $448 billion in present value to the U.S. economy. It would require an investment over the 20-year planning horizon of approximately $200 billion in present value terms. These costs include both public program implementation costs as well as private-sector investments in improved technologies and practices.

Among the nine individual policies, only two have benefit/cost ratios of less than one – indicating that they are not cost-effective. These include appliance incentives and standards (with a B/C ratio of 0.3) and combined heat and power incentives (with a B/C ratio of 0.7). When clothes washers and refrigerators are removed from the suite of appliance standards with incentives, the B/C ratio rises to 0.7. When carbon dioxide emission reductions are valued at a range of $15 per metric ton in 2010 rising to $51 in 2030), both of these policies approach or exceed the breakeven B/C ratio of 1.

According to the total resource cost test, the most cost-effective policy is tighter commercial appliance standards (with a B/C ratio of 4.6) followed by B/C ratios of 4.5 for industrial plant utility upgrades and 4.1 for residential building codes with third-party verification. These high B/C ratios combined with the fact that we examined an incomplete set of policies and technologies suggests that greater levels of investment could generate additional, cost-effective energy savings.

[3] Bureau of Economic Analysis. (2008). GDP by State.
http://www.bea.gov/newsreleases/regional/gdp_state/gsp_newsrelease.htm.
[4] In 2007 dollars, using a 7% discount rate.

Table ES.3 Total Resource Cost Tests by Sector (Million $2007)			
Residential Sector Policies			
	NPV Cost	NPV Benefit	B/C Ratio
Building Codes with Third-Party Verification	$10,000	$41,400	4.1
Appliance Incentives and Standards	$25,500	$7,060	0.3
Expanded Weatherization Assistance Program	$5,840	$6,420	1.1
Residential Retrofit and Equipment Standards	$86,600	$119,000	1.4
Combined Policies	**$115,000**	**$143,000**	**1.3**
Commercial Sector Policies			
	NPV Cost	NPV Benefit	B/C Ratio
Tighter Commercial Appliance Standards	$26,300	$109,000	4.6
Commercial Retrofit Incentives	$8,540	$20,900	2.4
Combined Policies	**$31,500**	**$126,000**	**4.0**
Industrial Sector Policies			
	NPV Cost	NPV Benefit	B/C Ratio
Industrial Plant Utility Upgrades	$10,800	$48,400	4.5
Industrial Process Improvement Policy	$36,000	$128,811	3.6
Combined Heat and Power Incentives	$16,900	$11,400 $17,600*	0.67 1.04*
Combined Policies	**$53,200**	**$179,000**	**3.4**

* Includes the environmental benefits from CO_2 emissions avoided by CHP systems.

Water Conservation from Energy Efficiency

Water conservation is an important co-benefit of policies that promote the efficient use of electricity. Based on a water calculator developed for this project, the freshwater consumed in the process of cooling conventional and nuclear thermoelectric power plants in the Southern NERC regions is forecast to grow to 334 billion gallons in 2020 and 381 billion gallons in 2030.

Implementation of the nine Energy-efficiency policies examined here could avoid generation that in turn would save southern NERC regions 8.6 billion gallons of

freshwater in 2020 and 20.1 billion gallons in 2030. On a percentage basis, this represents 56% of the projected growth in water consumption over the next decade, and 43% of the projected growth for the following decade. These savings in 2030 represent about one-quarter of the current total water needs of the City of Atlanta.

Policy Supply Curves for Energy Efficiency in the South

Energy-efficiency supply curves have typically focused on individual technologies. Since the emphasis of this report is on energy-efficiency potential that is achievable with policy initiatives, we have developed policy supply curves. The magnitude of energy demand resources that can be achieved by launching aggressive energy-efficiency policies is shown along the horizontal axis, and the vertical axis presents the levelized cost of delivering these energy demand resources. The policies are ordered from the lowest to the highest levelized cost. Only the electricity supply curve is presented here, in Figure ES.5. Chapter 6 also presents energy-efficiency supply curves for total energy savings and natural gas. In all cases, we focus on the year 2020.

The electricity efficiency supply curve for the South (Figure ES.5) illustrates how more than 2,000 TBtu of electricity savings could be realized from implementing eight energy-efficiency policies. (The combined heat and power policy could not be assigned a levelized cost value.)

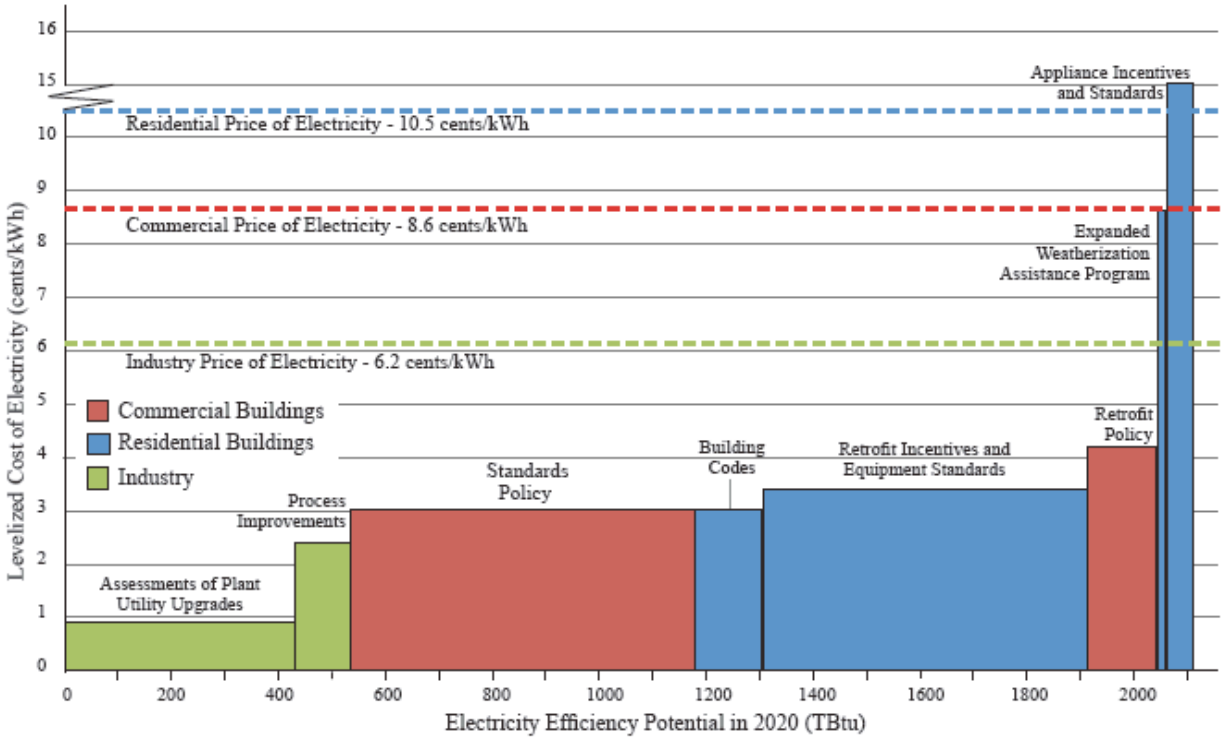

Figure ES.5 Supply Curve for Electricity Efficiency Resources in the South in 2020 (RCI Sectors)

The supply curve also highlights the large, low-cost potential of industrial efficiency opportunities, which together could save more than 500 TBtu of electricity for a levelized cost that is significantly lower than the price of electricity for industrial consumers (6.2 cents/kWh). The next most cost-effective efficiency option is the commercial standards policy, followed by building codes, bringing the cumulative savings for these four policies to nearly 900 TBtu. When the retrofit incentives and equipment standards are added, a large additional savings can be achieved. The three remaining policies do not save as much electricity and are more costly.

The natural gas supply curve distributes approximately 1,450 TBtu of savings across the eight efficiency policies. Commercial standards and residential building codes offer particularly low-cost, but somewhat limited natural gas savings. Industrial plant utility upgrades and process improvements, on the other hand, offer low-cost and large-scale opportunities for natural gas savings in the South.

Carbon Constrained Sensitivity Analysis

An analysis of the sensitivity of our study's findings to a particular key parameter was undertaken to ensure the analysis helps capture some of the uncertainties associated with SNUG-NEMS forecasting. This sensitivity is called the Carbon-Constrained Future (CCF). It was chosen because the national regulation of greenhouse gases appears possible and will affect how energy-efficiency policies are perceived and implemented. The scenario is modeled by assuming a $\$15/tCO_2$ price on carbon in 2010, increasing linearly to $\$51/tCO_2$ in 2030.

Given our interest in how energy-efficiency policies interact with other supply- and demand-side initiatives, we evaluated the CCF constraint both on its own and in the presence of energy-efficiency polices. In this combined set up of CCF + energy-efficiency policies, the effect of efficiency policies on consumption under the assumption of a Carbon Constrained Future appears to be additive. That is, the efficiency policies reduce consumption by approximately the same increment when added to either the Reference scenario or the CCF.

However, this is not to say that there is no interactive effect at all. Rather, the interaction is apparent when examining the reduction in CO_2 emissions. Emission reductions from energy-efficiency policies result from the consumption of less energy, while the reductions from the Carbon-Constrained Future result primarily from switching to cleaner fuels. When these two policy scenarios are imposed simultaneously, the interactions between them grow over time, as the cleaner fuels predicted in a CCF scenario become the fuels not consumed as the result of energy-efficiency investments. This effect is noticeable in Figure ES.6 starting around 2025.

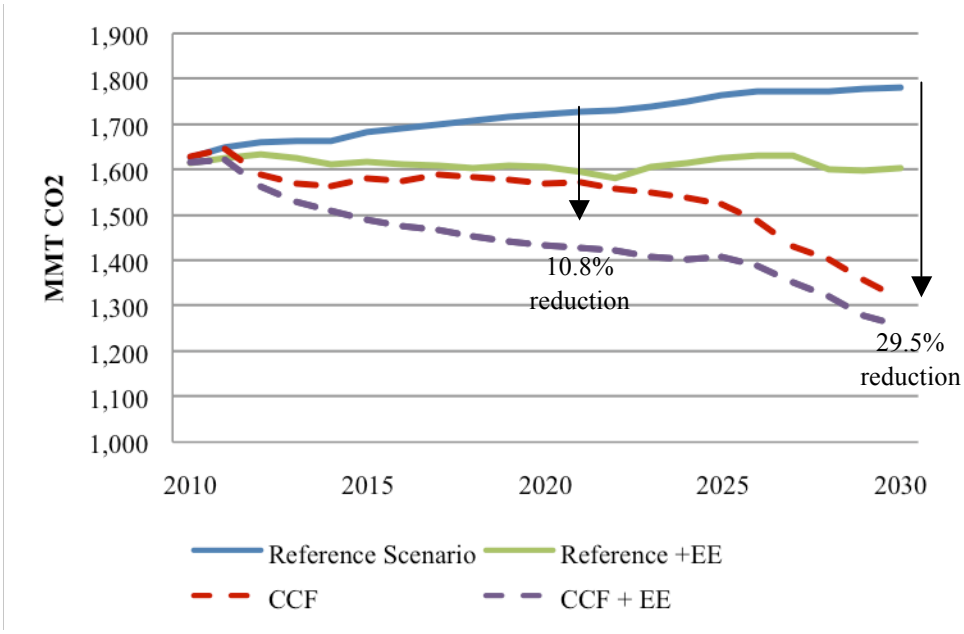

Figure ES.6 Carbon Dioxide Emissions with Energy-Efficiency Policies

Conclusions

If the South could achieve the substantial energy-efficiency improvements that have already been shown effective in other regions and nations, carbon emissions across the South would decline, air quality would improve, and plans for building new power plants could be downsized or postponed, all while saving ratepayers money.

While we examined nine policies, others exist that would lead to additional efficiency. However, these nine were chosen because they were all deemed likely to be cost-effective, significant, large, realistic, and quantifiable. We do not examine the impact of energy-efficiency investments on peak demand reductions. While clipping system peaks is critical to electric power planners, we treat this as an ancillary benefit of improved energy efficiency. Nor do we examine the role of demand-response or load-management programs aimed strictly at shifting on-peak consumption to off-peak hours. These are also valuable "demand-side" resources that merit further assessment.

The energy-efficiency policies described in this report could set the South on a course toward a more sustainable and prosperous energy future. If utilized effectively, the region's substantial energy-efficiency resources could reverse the long-term trend of expanding energy consumption. With a concerted effort to use energy more wisely, the South could grow its economy, create new jobs, and improve the health of its citizens and ecosystems.

Without new supporting policies, this potential for energy-efficiency improvement will not be realized. Energy-efficiency upgrades require consumer and business investment and they compete with other priorities. With so many demands on financial and human capital, cost-effective energy-efficiency improvements are easily ignored. Through a

combination of information dissemination and education, financial assistance, regulations, and capacity building, consumers can be encouraged to invest in energy efficiency. In addition, expanded research and development and public-private partnerships are needed to innovate and deploy transformational technologies that enlarge the efficiency potential over the long run.

The ability to convert this vision into reality will depend on the willingness of consumer, business and government leaders to champion the kinds of policies modeled here.