Assessment of the House Renewable Electricity Standard and Expanded Clean Energy Scenarios

Bill Prindle, Maggie Eldridge, John A. "Skip" Laitner, R. Neal Elliott, and Steven Nadel

December 2007

Report Number E079

1001 Connecticut Avenue, N.W., Suite 801, Washington, D.C. 20036
(202) 429-8873 phone, (202) 429-2248 fax, http://aceee.org

CONTENTS

ACKNOWLEDGMENTS

The authors express their appreciation to the Energy Foundation, whose support made this report possible. We also express our appreciation to Christopher MacCracken and his colleagues at ICF International for undertaking the modeling with their IPM® model, and Steve Clemmer and his colleagues at Union of Concerned Scientists (UCS) for their assistance in developing cost estimates on conventional and renewable generation resources. Thanks also to Jeff Deyette of UCS and Christopher MacCracken for reviewing an earlier draft of the report. Finally, thanks to Vanessa McKinney of ACEEE for her help with the modeling and to Renee Nida for her editorial assistance.

ABOUT THE AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY (ACEEE)

ACEEE is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. For more information, see http://www.aceee.org. ACEEE fulfills its mission by:

- Conducting in-depth technical and policy assessments
- Advising policymakers and program managers
- Working collaboratively with businesses, public interest groups, and other organizations
- Organizing conferences and workshops
- Publishing books, conference proceedings, and reports
- Educating consumers and businesses

Projects are carried out by staff and selected energy efficiency experts from universities, national laboratories, and the private sector. Collaboration is key to ACEEE's success. We collaborate on projects and initiatives with dozens of organizations including federal and state agencies, utilities, research institutions, businesses, and public interest groups.

ACEEE is not a membership organization. Support for our work comes from a broad range of foundations, governmental organizations, research institutes, utilities, and corporations.

EXECUTIVE SUMMARY

The American Council for an Energy-Efficient Economy's analysis of the Renewable Electricity Standard (RES) included in the August House energy bill (H.R. 3221) shows that this provision would provide positive energy, economic, and environmental benefits. It would reduce wholesale electricity prices and customer bills, decrease the need for new fossil fuel powerplants, and create new jobs, while also lowering carbon emissions. The analysis dispels arguments that the RES would raise electricity rates and harm the reliability of the power grid.

Our analysis uses the Integrated Planning Model (IPM®) model developed by ICF International specifically to model the electric power sector in the U.S. IPM® is widely used by federal and state agencies, utilities, and others in energy and environmental policy analysis. For macroeconomic analysis, we use the DEEPER model (a dynamic input-output model) to estimate the net employment and income effects as well as the impact on the national and regional Gross Domestic Product (GDP).

The House RES would require utilities to provide 15% of total sales from renewable energy generation by 2020. Energy efficiency resources could provide up to 27% of this requirement. As a national policy, it is expected that states would use varying mixes of renewable electricity generation, energy efficiency resources, and purchased credits. This provision would in 2030 reduce carbon dioxide (CO_2) emissions by 100 million metric tons (MMT), save 22 billion kilowatt-hours (kWh) of electricity usage, create 32,000 net new jobs annually, and displace the need for 29 500-MW coal-fired powerplants compared to a business-as-usual (BAU) scenario.[1] These savings would be worth over $60 billion cumulatively through 2030.

Our analysis also looks beyond the current RES provision, which results in relatively modest additional renewable energy and energy efficiency resources since many states are already pursuing these policies. Twenty-five states plus Washington, D.C. have renewable resource standards for utilities, and 10 or more states have utility resource requirements for efficiency. The federal RES would moderately expand the impact of these policies while spreading the benefits to more regions of the country that do not currently have renewable energy or energy efficiency policies in place at the state level.

Because the House RES provision is relatively modest, we also modeled more aggressive renewable and efficiency standards, including a 10% electricity efficiency target coupled with 5% natural gas efficiency, and a 15% RES coupled with a separate 15% Energy Efficiency Resource Standard (EERS). The latter "15-15" policy package would by 2030 avoid 121,000 MW of conventional powerplant construction, reduce wholesale electricity prices by about 0.5 cents per kWh, save 507 billion kWh of electricity usage per year, and reduce annual CO_2 emissions by about 590 MMT per year. The policy would also create nearly $591 billion in net consumer savings and 259,000 net new jobs in 2030 compared to business-as-usual.

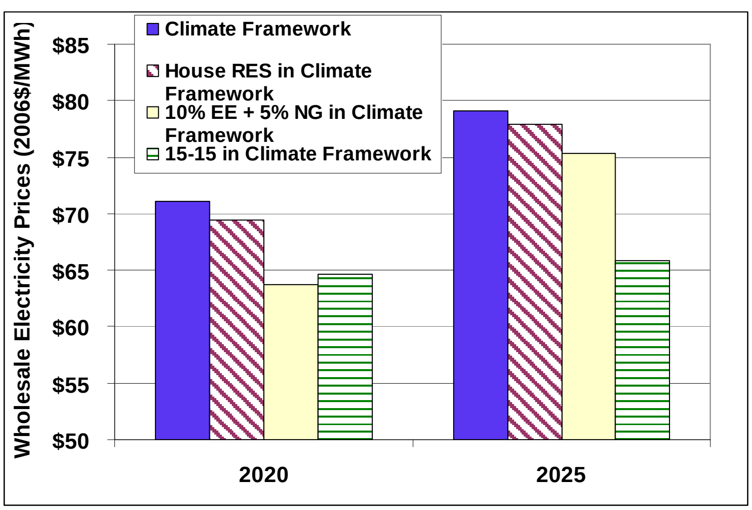
[1] Displaced conventional capacity is from avoided coal, natural gas, and nuclear powerplant construction.

Because concerns have been raised about the regional impacts of RES policies, our analysis examined the effects on energy prices and other variables in the Midwest and Southeast regions. Our regional findings were comparable with the national-level results: electricity prices fall, capacity needs are reduce, consumers realize net savings, and jobs grow. In the House RES, consumers save a net $14 billion and $13 billion in the Midwest and Southeast regions, respectively. These savings grow to $102 billion and $118 billion in the more aggressive 15-15 scenario. We find that the concerns about negative impacts in these regions are not borne out by quantitative analysis.

The analysis also shows that RES and EERS policies can be key foundation stones for a U.S. power sector climate policy. We modeled the effect of these provisions within a climate policy scenario, using the Bingaman-Specter bill as a moderate climate policy framework. We ran the same RES-EERS scenarios, adding a set of assumptions based on the Bingaman-Specter bill, using IPM® in similar fashion. The results show that in a climate policy context, RES-EERS policies would provide even greater benefits. The House RES provision would save 55,000 MW of conventional capacity, 246 billion kWh, and about 750 MMT of carbon emissions compared to business-as-usual. The more aggressive 15-15 policy package would contribute 153,000 MW of conventional powerplant capacity avoidance, nearly 700 billion kWh in energy savings, and about 960 MMT of CO_2 emissions.

The IPM® modeling performed in this analysis clearly shows that the House RES and the more aggressive clean energy scenarios all serve to reduce wholesale electricity prices. In the Southeast and Midwest regions, IPM® results show prices falling modestly for the House RES, and more substantially for the more aggressive scenarios. These same effects occur when the clean energy scenarios are modeled in a carbon policy framework (see Figure ES-1).

Figure ES-1. Wholesale Electricity Prices in Climate Framework and Clean Energy Scenarios

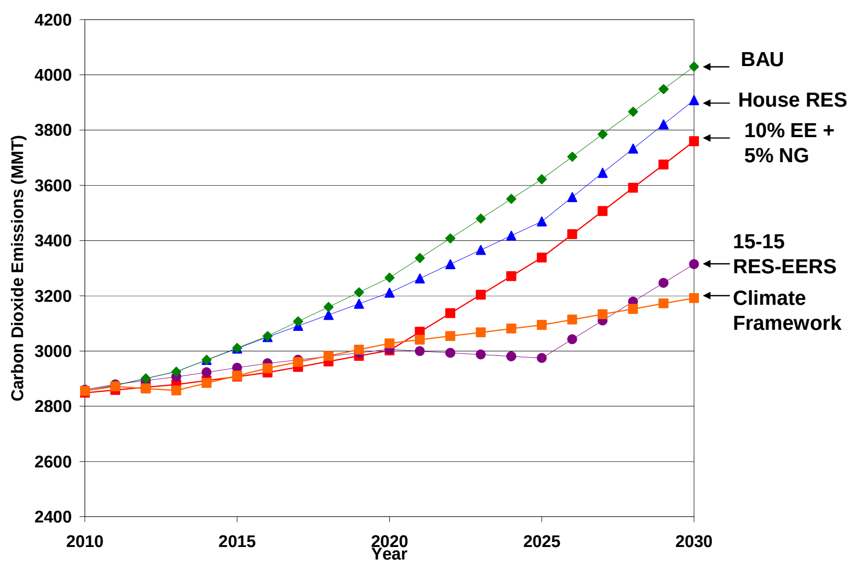


The House RES and other RES-EERS policies would help not only electricity prices, bills, capacity, and emissions, but would also help reduce prices for natural gas. Because so much electricity generation on the margin is natural-gas fired, bringing more renewables onto the grid and backing off demand through efficiency provide major savings for natural gas. Our analysis shows moderate natural gas price savings, ranging as high as $0.53 per MMBtu at the wholesale level. These gas price reductions provide a range of other benefits, including consumer heating bills savings, and an economic boost for industries heavily dependent on natural gas for feedstocks as well as fuel.

Perhaps most strikingly, the cumulative carbon emission reductions through 2030 from the 15-15 RES-EERS policy package would be roughly the same as the total power sector carbon emission reductions from the Bingaman-Specter bill. But the RES-EERS package would achieve these carbon savings while reducing wholesale electricity prices and providing other energy and economic benefits.[2] While some increase in retail rates would occur to support programs for realizing these savings, net consumer electric bills would decrease. These findings add urgency to the case for enacting strong RES-EERS standards, either now in an energy policy or later in a climate policy bill.

We conclude that this analysis of the House RES provision and more aggressive RES-EERS targets shows strongly that setting strong renewable and efficiency standards for utilities reduces electricity and natural gas wholesale prices, cuts consumer electricity bills, avoids needs for new powerplants, and cuts carbon emissions. Moreover, an aggressive RES-EERS policy achieves similar carbon savings in the power sector than would the Bingaman-Specter bill (see Figure ES-2) at substantially lower energy and carbon prices. RES-EERS policies are thus Congress' best policy path for the power sector, and should be a specific and integral part of any U.S. energy and climate policy.

Figure ES-2. Annual CO_2 Emissions in BAU and Clean Energy Scenarios



[2] Wholesale electricity price reductions reported from IPM® do not take into account costs of energy efficiency programs. These costs for efficiency are included in the macro-economic analysis, which estimates impacts on total consumer energy bills, employment, wages and GDP. While we do not explicitly model how efficiency program costs impact retail electricity prices, the net effect on consumer energy bills takes into account these program costs.

INTRODUCTION

The House of Representatives passed H.R. 3221 in August 2007, containing a Renewable Electricity Standard provision that would require covered utilities to obtain 15% of their electricity resources from renewable sources by 2020. An amendment that was added late in the process would allow up to 27% of resource requirements to be met through energy efficiency.[3] In 2020, the efficiency amendment would mean that up to 4 of the 15 percentage points of the requirement could be met through efficiency. These provisions would reduce energy prices and consumer expenditures—in contrast to critics' assertions to the contrary—while reducing carbon emissions. As we show later in this report, the expansion of the energy bill to include even greater efficiency investments would enhance both financial and economic returns.

The energy bill's RES provision and its efficiency component resulted from several underlying factors:

- The leadership of the 25 states (plus D.C.) that have a RES (also variously referred to renewable energy portfolio or renewable portfolio standards) and the 13 states that have EERS in place.[4] Their experience is showing that these clean energy policies work, are affordable, and provide a spectrum of economic and environmental benefits.
- The need to pursue both energy efficiency and renewable energy in a coordinated way. Without moderating demand growth through efficiency, renewable energy will have difficulty overtaking the growth in conventional generation. To begin cutting power sector carbon emissions in the near future, we need to pursue both. The many synergies between energy efficiency and renewable energy were documented in an earlier ACEEE report (Prindle and Eldridge 2007). Indeed, energy efficiency has been shown to be a surprisingly cost-effective and very large energy resource in a growing number of studies (Ehrhardt-Martinez and Laitner 2007).
- The perception that some states have less generous renewable resource endowments than others. Efficiency resources, by comparison, are available in fairly consistent amounts in each state. Efficiency was added to the RES to increase flexibility, so that if renewables are less available in a given area or timeframe, efficiency can provide a limited part of the resource requirement.
- Earlier discussions in the Senate. Much of the House language was developed in the Senate in previous Congresses that passed RES provisions and also in the current Congress' efforts to find a 60-vote level of support for a 15% RES. Because this language had been discussed among several member offices, it was easier to include in the House bill.

The House RES provision affords the first opportunity to enact a national policy that would tap the synergies of renewable energy and energy efficiency for the power sector. It is thus important to gain a clearer and more detailed understanding of the benefits and costs that

[3] Under the House RES, the governor of a state has to petition to opt into the energy efficiency provision.
[4] For a listing of the state EERS provisions, see http://aceee.org/energy/state/6pgEERS.pdf.

would occur from combining these two resource types in a single policy framework. To address this need, ACEEE undertook an analysis to evaluate the potential energy, economic, and environmental impacts of the House RES, and also to extend the discussion to more aggressive RES-EERS standards, in both an energy policy and a climate policy context. Because the current RES resource levels are relatively modest, we wanted to examine more aggressive scenarios that reflect what leading states are implementing today.

We also wanted to examine the impacts of RES-EERS policies in a climate policy context, because climate is the next big clean energy issue facing Congress. Accordingly, we modeled RES-EER policies in scenarios that included overall climate policies.

METHODOLOGY

Clean Energy Scenarios

ACEEE developed three clean energy scenarios, each with varying targets for renewable energy and energy efficiency. The first scenario models the House Renewable Electricity Standard, which has a 2020 nominal target of 11% renewable energy and 4% energy efficiency. The second scenario is an efficiency-only target of 10% electricity efficiency and 5% natural gas efficiency by 2020. The third scenario is a more aggressive 15% efficiency plus 15% renewables target by 2025. See Table 1 for the varying targets by year.

Table 1. Nominal Renewable Energy and Energy Efficiency Targets

	House RES (Scenario 1)		10% EE + 5% NG (Scenario 2)	"15-15" (Scenario 3)	
	Renewables	Efficiency	Efficiency	Renewables	Efficiency
2015	4.7%	1.8%	6%	4.8%	4.8%
2020	11%	4%	10%	10%	10%
2025	11%	4%	10%	15%	15%

We present the results of the three scenarios in two frameworks: relative to a business-as-usual framework; and relative to a climate policy framework based on the Bingaman-Specter [S.1766] bill. The BAU framework assumes a 3-pollutant case without federal climate change policy. In other words, this case assumes current air regulatory assumptions for nitrogen oxides (NO_x), sulfur dioxide (SO_2), and mercury. The climate policy framework, a 4-pollutant case, adds a carbon dioxide (CO_2) component. This case assumes a climate policy representative of the Bingaman-Specter proposal, which calls for reducing covered emissions to 60% below 2006 levels by 2050 and caps emissions upstream on fuels subject to a "safety valve" that puts an upper bound on CO_2 allowance prices.

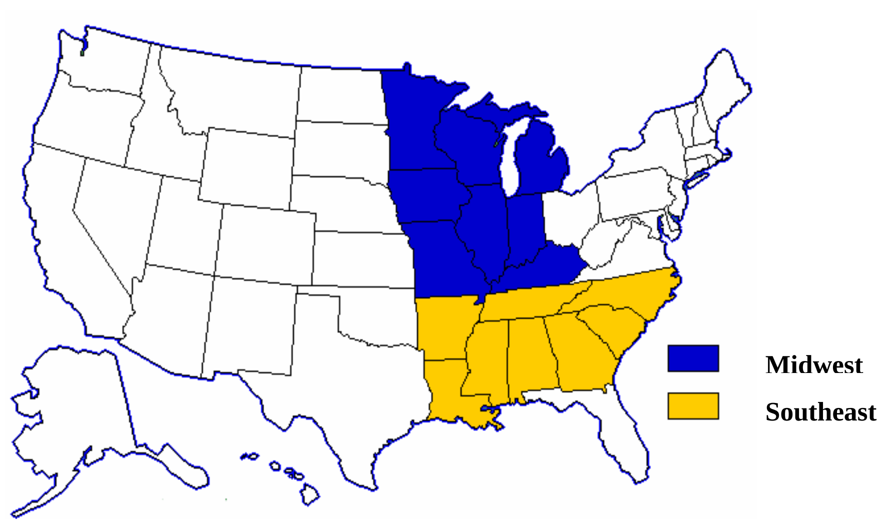
Because existing state-level energy efficiency and renewable energy policies will result in increased renewable energy and energy efficiency in the reference case that would go to satisfy the RES and EERS requirements, ACEEE adjusted the nominal targets for each scenario to reflect the percent of total additional demand to which the policy requirements are applicable. See Appendix A for a detailed discussion of efficiency targets, allocations by sector, and costs.

Integrated Planning Model (IPM®)

ICF International was then engaged to run its *Integrated Planning Model* (IPM®) based on electric load growth adjusted by the Clean Energy Scenarios targets. This model provides electric sector financial impacts of the multiple scenarios and reference cases. These include the electricity price impacts and policy compliance costs.[5] Regional impacts were also modeled in the IPM® results, including the Midwest and Southeast regions of the U.S (see Figure 1). These regions are based on power pool boundaries and hence differ from regional definitions developed by the Census Bureau and others.

IPM® requires several assumptions to generate a projection. Three critical assumptions are electric load growth, the cost and performance of new generating capacity, and fuel prices. ACEEE selected the sources for these assumptions and the assumptions were entered into IPM® to be analyzed by ICF. The reference case electricity load forecast for the IPM® analysis is based on the *Annual Energy Outlook 2006* "Reference Case" (EIA 2006). For this analysis, the cost of new renewable and conventional generation capacity options were developed by the Union of Concerned Scientists (Clemmer 2007), derived from market data and information collected by Black and Veatch. Natural gas and coal prices came from *Annual Energy Outlook 2007* (EIA 2007). Based on these assumptions, the IPM® model then forecasted electricity prices for each regional electric market.

Figure 1. Map of Regions Studied for IPM® and DEEPER Analyses



5 Wholesale electricity price reductions reported from IPM® do not take into account costs of energy efficiency programs. These costs for efficiency are included in the macro-economic analysis, which estimates impacts on total consumer energy bills, employment, wages, and GDP. While we do not explicitly model how efficiency program costs impact retail electricity prices, the net effect on consumer energy bills takes into account these program costs.

The DEEPER Model

To assess the macroeconomic impacts of the different scenarios, ACEEE then used its *Dynamic Energy Efficiency Policy Evaluation Routine* (DEEPER) model to estimate the net employment and income effects as well as the impact on the national and regional GDP. DEEPER is a dynamic input-output model that adapts the IPM® financial flows and assumptions into a form that enables us to provide a richer assessment of economic impacts that would result from the House Energy Bill. In the BAU framework, we report DEEPER results for each of the national scenarios and scenarios one and three for the Midwest and Southeast regions (see Figure 1). We also present results for the national scenarios one and three in the climate policy framework.

Using the DEEPER model, we also conducted an exploratory analysis to assess the economic impacts of a 30% electricity efficiency standard by 2030. The exercise was completed outside of the IPM® analysis and was to provide a meaningful context that might help policymakers understand the potential benefit of this larger efficiency resource, ACEEE expanded the analysis beyond the review of the House RES and more aggressive 10-5 EERS and 15-15 EERS-RES policies. Further description of this exploratory analysis is included in the results section below.

RESULTS

Overview

We present the results of our analysis in three frameworks and an exploratory analysis of a 30% national EERS:

1. **A Business-as-Usual Framework**. This framework assumes the "Reference Case" electric load growth forecast from the *Annual Energy Outlook 2006* (EIA 2006) and more recent energy price and power generation cost projections from EIA and the Union of Concerned Scientists, respectively. Explanation of key assumptions used in this framework is provided below; further details are included in Appendix A.

2. **A Climate Policy Framework.** We used the Bingaman-Specter bill as representative of the most moderate of the climate policy bills in active consideration in Congress. This assessment involved additional assumptions to modify the business-as-usual case; these are explained below, with further details in Appendix A.

3. **Regional Frameworks.** Because concerns have been raised about the effects of the House RES provision on regions of the country currently experiencing lower-than-average electricity prices, we included analyses at the regional level for the Southeast and Midwest. Key assumptions are explained below, with further details in Appendix A.

4. **Exploratory Analysis—30% National EERS.** To create a meaningful context that might help policymakers understand the potential benefit of this larger efficiency

resource, ACEEE expanded the analysis beyond the review of the House RES and more aggressive 10-5 EERS and 15-15 EERS-RES policies. Specifically, we conducted an exploratory analysis to assess the economic impacts of a 30% electricity efficiency standard by 2030. The exercise was completed outside of the IPM® analysis.

Business-as-Usual Framework

The business-as-usual framework is keyed to a reference case based on the modified *Annual Energy Outlook 2006*. Within this framework we examined three policy scenarios:

1. *House RES*—the provision as passed in H.R. 3221, providing 15% of anticipated electricity needs from renewable energy resources by 2020, with up to 27% of resource requirements allowed to be met through energy efficiency investments and technologies.
2. *10-5 EERS*—An energy efficiency resource standards policy that sets an energy savings target of 10% of total electricity utility power sales and 5% of total natural gas utility sales by 2020.
3. *15-15 RES-EERS*—A more aggressive set of renewable and efficiency targets, requiring 15% renewables and 15% energy efficiency targets to be met by 2020, with no fungibility between renewables and efficiency resource requirements.

Scenario One: House RES

ACEEE's analysis shows that the House RES generates positive energy and environmental benefits. In 2020, the House RES scenario reduces projected electricity consumption by 49 terawatt-hours (TWh), a 0.9% reduction compared to the BAU forecast.[6] Wholesale electricity prices drop slightly by about $1 per MWh in 2025, which represents a 1.6% reduction compared to BAU. The policy also reduces the need for new fossil fuel generation capacity, and reduces carbon emissions. Net new renewable capacity by 2030 comes largely from wind (nearly 18,000 MW), solar (5,000 MW), and biomass (4,000 MW). These IPM® results are summarized in Table 2.

These results indicate generally positive impacts from the House RES policy: it reduces electricity and natural gas prices, reduces electricity consumption and consumer bills, avoids the need for substantial amounts of fossil fuel generation, and reduces carbon dioxide emissions. While the magnitude of these impacts is modest, they are directionally positive. In this sense they contradict claims that the RES will increase energy prices.

Table 3 summarizes the results of the DEEPER model macroeconomic analysis. The table shows that the House RES would create an average of nearly 28,000 net new jobs each year, provide total cumulative consumer savings of nearly $61 billion through 2030, inject $1.8

[6] A terawatt-hour is the same as one billion kilowatt-hours (kWh). Currently the U.S. uses 3,996 TWh annually. Under a typical forecast that is expected to increase 41% to 5,635 TWh by 2030.

billion in added wages into the economy each year, and increase gross domestic product by about $1.4 billion annually.[7]

Table 2. Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in House RES Scenario Relative to Business-as-Usual

House RES	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)*	-$0.68	-$1.05	-$0.60
Henry Hub NG Prices (2006$/MMBtu)	-$0.05	-$0.11	-$0.10
Change in Cumulative Capacity Additions (MW)			
Coal	-6,715	-17,178	-14,468
Natural Gas	-1,410	-4,093	-1,005
Nuclear	0	0	-332
Renewables**	988	31,389	26,867
Total (Net) Capacity Additions	-7,763	8,952	9,896
Change in Electricity Consumption (TWh)	-49	-39	-22
Change in Emissions			
CO_2 (Million Metric Tons)	-45	-126	-100
Hg (Tons)	0	0	0
NOx (Thousand Tons)	-3	-13	-10
SO_2 (Thousand Tons)	-19	-50	18

* All prices in the IPM® model are presented in 2003$. We convert all prices to 2006$ using a Consumer Price Index (CPI) conversion factor.
** Here and in subsequent tables, renewable capacity additions include a varying mix of wind, biomass, solar, geothermal, and landfill gas.

Table 3. National DEEPER Results for House RES Scenario Relative to Business-as-Usual

Net Consumer Savings, Cumulative through 2030 (Million$)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
60,541	27,891	1,757	1,445

Scenario Two: "10-5"—EERS Targets at 10% Electricity + 5% Natural Gas

This scenario is based on a legislative proposal discussed in the Senate in 2007 setting energy savings goals for utilities covered by the provision (e.g., investor-owned utilities). This proposal extends the energy savings goals for covered utilities to 10% of electricity sales and 5% of natural gas sales by 2020.

The IPM® results for this scenario show a substantial expansion of benefits, including greater energy savings, significantly lower energy prices, reduced generation capacity needs, and

[7] Cumulative consumer savings, annual wages and annual GDP are presented here and throughout the report in constant, undiscounted dollars. Jobs are presented in actual jobs.

reduced carbon dioxide emissions. Energy savings grow six-fold compared to the House RES provision. This increase may seem out of proportion to the increase in the target, in that the House RES allows up to 4% of resource requirements to be met through efficiency, while this scenario increased electricity savings to 10%. The magnitude of the increase in energy savings is partly due to the fact that some efficiency gains from current state policies and programs are factored into the analysis. These savings reduce the net gains from the House RES, because its 4% cap on efficiency doesn't "push the envelope" far beyond the savings from current state initiatives. A 10% electricity target, however, pushes far beyond what can be expected from current policies.

This "10-5" scenario also avoided the need to increase powerplant capacity by more than doubling the megawatts that are "not needed" to be built as a result of greater energy efficiencies that reduce energy demand growth. Carbon dioxide emission reductions also expand by at least a factor of two.

Table 4. Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario Two Relative to Business-as-Usual

10% EE + 5% NG	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)	-$4.68	-$2.49	-$1.54
Henry Hub NG Prices (2006$/MMBtu)	-$0.39	-$0.21	-$0.20
Change in Cumulative Capacity Additions (MW)			
Coal	-25,118	-31,811	-33,165
Natural Gas	-22,097	-19,118	-17,665
Nuclear	0	0	-1,286
Renewables	-1,255	-1,908	-780
Total (Net) Capacity Additions	-51,064	-55,431	-55,490
Change in Electricity Consumption (TWh)	-298	-306	-310
Change in Emissions			
CO_2 (Million Metric Tons)	-217	-234	-222
Hg (Tons)	0	0	0
NOx (Thousand Tons)	-23	-19	-13
SO_2 (Thousand Tons)	-106	0	-5

The DEEPER results for this scenario, like the IPM® results, show large increases in benefits for the macro economy, as shown in Table 5. Net new jobs increase five times compared to the House RES scenario, consumer net savings increase by nearly nine times, and wages more than triple. The economy continues to expand although GDP, one popular measure of economic activity, falls slightly in this scenario. Compared to the BAU projection, GDP falls by 0.03%, or about $4 billion annually. However, the change in this specific measure of activity is more than offset by the more critical economic benefits of net gains in jobs and wages. Moreover, 0.03% change in projected GDP by 2030 is much smaller than the variability of business economist forecasts of GDP growth from year to year, which in

Annual Energy Outlook 2007 ranges from 2.1% in the low growth scenario for 2020-2030 to 3.4% (EIA 2007).[8]

Table 5. National DEEPER Results for "10-5" EERS Scenario Relative to Business-as-Usual

Net Consumer Savings, cumulative through 2030 (Million$)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
525,531	145,020	5,813	-4,292

Scenario Three: "15-15"—RE Target at 15%, EE Target at 15%

This scenario assumes that Congress passes a more aggressive set of standards for the power sector, with separate 15% targets for renewable generation and electricity savings. Each resource target would be met separately, with no fungibility between resource types.

Table 6 shows that the "15-15" scenario generates the greatest benefits of all. Electricity usage savings grow substantially, on the order of 60% compared to the 10-5 scenario in 2025 and 2030. Electricity prices fall further, by up to $7 per mWh (0.70 cents per kWh). This policy would avoid up to 82,000 MW of coal powerplant capacity, more than 160 plants of 500 MW each. Net new renewable capacity by 2030 compared to BAU would come from biomass (24,000 MW), wind (20,500 MW), and solar (10,000 MW). Carbon dioxide emission reductions become quite substantial, exceeding 500 million metric tons per year after 2020, which represents about 18% of power sector carbon dioxide emissions forecast in the *Annual Energy Outlook*.

Macroeconomic results from the DEEPER model, displayed in Table 7, show that the 15-15 scenario provides economic benefits on the same order as those provided by the 10-5 scenario. Net new jobs increase by 142,000 annually compared to the BAU reference case, slightly less than the 10-5 scenario. Net cumulative consumer savings and wages are slightly higher than in 10-5, at $591 billion and $6.1 billion, respectively. GDP also falls slightly in this scenario, by an average of $5 billion annually, which is about $1 billion more than in the 10-5 scenario. Again, these GDP effects, while negative, are very small, and are quite small in proportion to the benefits created by an average 142,000 new jobs each year and nearly $591 billion in net cumulative savings to consumers. GDP losses can be attributed in part to reduced capital investment in the energy sector, and the loss of investor returns on that capital.

[8] It's worth noting that the difference in GDP between this and other scenarios (compared to the more moderate first RES scenario) results from the cost-effective substitution of technologies that save money for businesses and consumers. The added spending power tends to support more jobs and wages even as investment in the utility sector declines and its contribution to GDP diminishes slightly.

Table 6. Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario Three Relative to Business-as-Usual

15% RES + 15% EERS	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)	-$3.50	-$6.98	-$5.01
Henry Hub NG Prices (2006$/MMBtu)	-$0.30	-$0.43	-$0.53
Change in Cumulative Capacity Additions (MW)			
Coal	-26,568	-70,011	-82,761
Natural Gas	-18,209	-35,418	-36,670
Nuclear	0	0	-1,500
Renewables	-1,228	44,054	54,625
Total (Net) Capacity Additions	-49,540	-66,365	-71,401
Change in Electricity Consumption (TWh)	-278	-490	-507
Change in Emissions			
CO_2 (Million Metric Tons)	-214	-533	-588
Hg (Tons)	1	-1	-1
NOx (Thousand Tons)	-19	-67	-27
SO_2 (Thousand Tons)	-84	-203	25

Table 7. National DEEPER Results for "15-15" RES-EERS Scenario Relative to Business as Usual

Net Consumer Savings (Cumulative Million$ through 2030)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
590,723	142,068	6,102	-5,010

Climate Framework

We included a climate framework in our analysis to assess the impact of RES-EERS policies on energy prices, carbon emissions, and other key variables in the presence of an economy-wide carbon cap-and-trade system. It is argued by some that a cap-and-trade policy obviates the need for more targeted policies like RES and EERS. This analysis was designed to assess whether RES or EERS policies would magnify the benefits or reduce the costs of cap-and-trade polices.

The climate framework used for this analysis was based on the Bingaman-Specter bill in its most recent discussion draft, which calls for reducing covered emissions to 60% below 2006 levels by 2050 and caps emissions upstream on fuels. We added the cap-and-trade and safety valve provisions in this legislation to the three RES-EERS scenarios, and compared them to the business-as-usual reference case.

Scenario One: House RES in Climate Framework

The benefits of the House RES policy would increase substantially should it be enacted in parallel with a Bingaman-Specter type climate policy. Energy savings would be three to ten times greater in this climate framework. Coal powerplant needs would likewise fall by almost ten times the megawatts avoided in the BAU framework; more than 240 500-MW plants would be avoided by 2030. Carbon dioxide emissions would be reduced five to seven times as much as in the BAU framework.

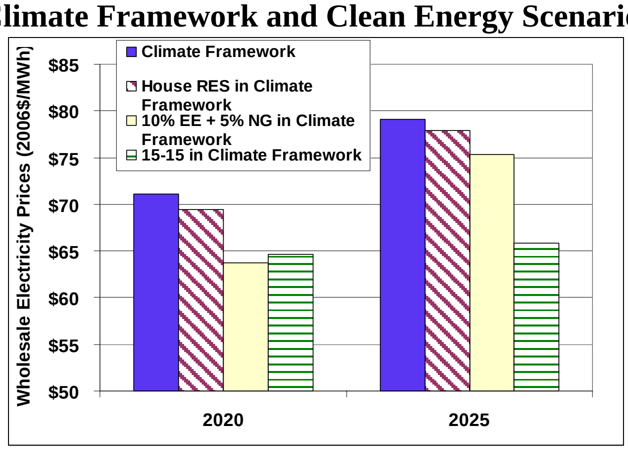
Table 8. Change in Annual Capacity, Electricity Sales, and Emissions in House RES Scenario plus Climate Bill Relative to Business-as-Usual

House RES + Climate Bill	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	-28,752	-77,898	-123,065
Natural Gas	309	15,145	31,079
Nuclear	0	11,712	37,095
Renewables	6,134	30,756	26,144
Total (Net) Capacity Additions	-24,920	-23,539	-32,001
Change in Electricity Consumption (TWh)	-163	-217	-246
Change in Emissions			
CO_2 (Million Metric Tons)	-224	-499	-745
Hg (Tons)	0	0	-2
NOx (Thousand Tons)	-36	-57	-69
SO_2 (Thousand Tons)	-149	-105	-65

Electricity and Natural Gas Price Impacts in the Climate Framework

The RES-EERS policies have the effect of reducing the price increases that would occur in a climate policy framework (see Figure 2). To illustrate the relative effect of the RES-EERS policies on electricity prices, we created the graphic in Figure 2 below, which shows the prices relative to the climate policy alone.

Figure 2. Wholesale Electricity Prices in Climate Framework and Clean Energy Scenarios



Note that in Figure 2, electricity prices are lower when the climate policy is combined with any of the three RES-EERS scenarios than would be the case with the climate policy alone. These reductions run as high as $14/MWh, or about 1.4 cents per kWh, in the 15-15 scenario.

DEEPER results (see Table 9 below) for the House RES scenario show, when compared to a climate policy reference case,[9] a net $132 billion in cumulative consumer savings, an average of 41,000 net new jobs each year, and an average annual increase of about $2 billion and $1 billion in wages and GDP, respectively.

Table 9. National DEEPER Results for House RES Scenario in Climate Framework Relative to Climate Policy Reference Case

Net Consumer Savings (Cumulative Million$ through 2030)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
131,710	41,120	2,226	922

Scenario Two: 10% Electricity + 5% Natural Gas in Climate Framework

This scenario shows IPM® modeling results in a range comparable to those from the House RES provision. Benefits are slightly higher in later years, as reflected by greater coal capacity savings, electricity usage reductions, and carbon emission reductions in 2030. These results are summarized in Table 10. As noted above, Figure 2 shows that the 10-5 scenario reduces prices relative to the climate policy effect. It would reduce wholesale power prices as much as $7/mWh compared to the effects of the Bingaman-Specter climate bill.

Table 10. Change in Annual Capacity, Electricity Sales, and Emissions in Scenario Two plus Climate Bill Relative to Business-as-Usual

10% EE + 5% NG Scenario + Climate Bill	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	-28,752	-77,956	-133,096
Natural Gas	-33,071	-7,335	11,054
Nuclear	0	5,107	30,814
Renewables	1,567	12,539	18,722
Total (Net) Capacity Additions	-67,812	-75,212	-80,124
Change in Electricity Consumption (TWh)	-396	-467	-509
Change in Emissions			
CO_2 (Million Metric Tons)	-340	-557	-854
Hg (Tons)	0	0	-2
NOx (Thousand Tons)	-48	-66	-82
SO_2 (Thousand Tons)	-233	7	-105

[9] DEEPER results for the clean energy scenarios in a climate framework are compared to an estimated climate policy reference case rather than business-as-usual. Assessing detailed macro-economic impacts of the climate policy compared to BAU was beyond the scope of this project. We therefore use a rough estimation of the effects of the climate policy as a reference case and model the scenario impacts within this framework.

Scenario Three: 15-15 Scenario in Climate Framework

Based on IPM® results, the 15-15 scenario combined with climate policy produces the greatest total benefits of the three scenarios. This scenario produces the greatest energy savings, the greatest powerplant capacity avoidance, and the deepest carbon dioxide emission reductions of the three scenarios. This is consistent with the 15-15 scenario's impacts measured against the BAU reference case alone; with the addition of climate policy provisions, the benefits increase.

The 15-15 scenario has such a powerful effect on energy markets that it actually reduces electricity and gas prices in certain years, compared to the BAU reference case, even with a climate policy placing strong upward pressure on prices.

Table 11. Change in Annual Capacity, Electricity Sales, and Emissions in Scenario Two plus Climate Bill Relative to Business –as-Usual

15-15 Scenario + Climate bill	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	-28,752	-77,956	-138,026
Natural Gas	-31,423	-41,537	-22,645
Nuclear	0	0	7,985
Renewables	3,340	43,602	53,189
Total (Net) Capacity Additions	-63,916	-84,142	-107,752
Change in Electricity Consumption (TWh)	-376	-600	-699
Change in Emissions			
CO_2 (Million Metric Tons)	-333	-668	-958
Hg (Tons)	0	0	-2
NOx (Thousand Tons)	-47	-80	-91
SO_2 (Thousand Tons)	-211	-111	-47

The macroeconomic impacts of the 15-15 scenario, when modeled by DEEPER in a climate policy framework, show about six times the net cumulative consumer savings, average net jobs, and average wages compared to the House RES. GDP increases by about $600 million, slightly less than the House RES. These results are shown in Table 12.

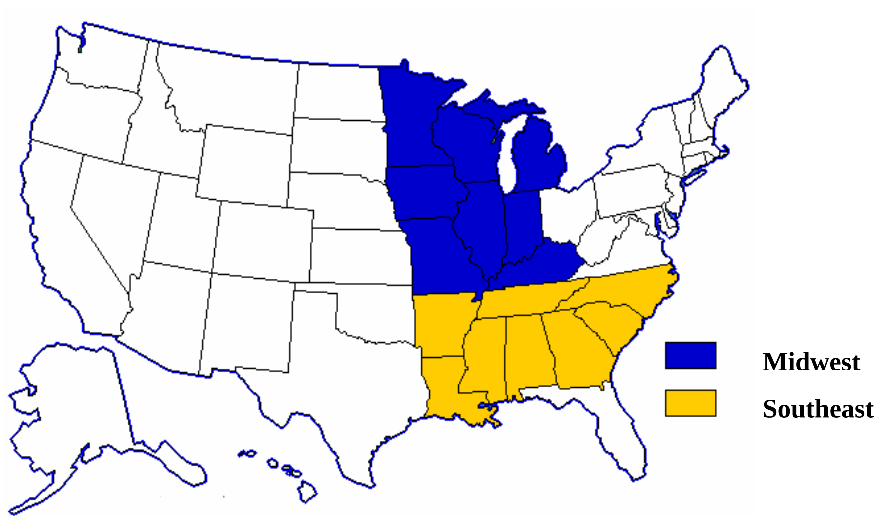
Table 12. National DEEPER Results for 15-15 Scenario in Climate Framework Relative to Climate Policy Reference Case

Net Consumer Savings (Cumulative Million$ through 2030)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
810,545	240,285	12,262	586

Regional Impacts

Much of the controversy around the House RES provisions stems from regional concerns that the unequal geographic distribution of renewable electricity generation options could impose unequal costs in different parts of the country. To address these concerns, we examined the impacts of two of the three scenarios in the Midwest and Southeast regions (see Figure 3), which are two of the regions where these concerns are most often expressed. We focused on the House RES and the 15-15 scenarios, which span the range of impacts in this analysis.

Figure 3. Map of Regions Studied for IPM® and DEEPER Analyses



Midwest

The House RES would reduce electricity and natural gas wholesale prices in the Midwest states, while also reducing electricity consumption, capacity additions, and carbon dioxide emissions (see Table 13 below). Net new renewable capacity by 2030 compared to BAU would come primarily from wind and additional capacity from biomass. While the absolute magnitude of these numbers is modest, they represent net savings to all energy consumers.

The more aggressive 15-15 scenario, however, would produce dramatically greater benefits. Whole electricity prices would fall by up to one cent per kWh, and natural gas prices would fall four to five times as much as in the House RES scenario (see Table 14 below). The 15-15 policy would avoid 5-10 times the capacity needs as the House RES, and save 10-20 times as much energy. Carbon emission reductions would fall in similar ranges.

Table 13. Midwest Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario One Relative to Business as Usual

House RES	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)	-$0.86	-$1.48	-$0.44
Henry Hub NG Prices (2006$/MMBtu)	-$0.05	-$0.11	-$0.10
Change in Cumulative Capacity Additions (MW)			
Coal	0	-150	-506
Natural Gas	-1,278	-1,853	-796
Nuclear	0	0	0
Renewables	37	474	118
Total (Net) Capacity Additions	-1,241	-1,529	-1,184
Change in Electricity Consumption (TWh)	-8	-6	-4
Change in Emissions			
CO_2 (Million Metric Tons)	-5	-6	-3
Hg (Tons)	0	0	0
NOx (Thousand Tons)	0	2	6
SO_2 (Thousand Tons)	-3	11	-4

Table 14. Midwest Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario Three Relative to Business-as-Usual

15-15 Scenario	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)	-$5.13	-$9.87	-$8.31
Henry Hub NG Prices (2006$/MMBtu)	-$0.30	-$0.43	-$0.53
Change in Cumulative Capacity Additions (MW)			
Coal	0	-1,663	-2,685
Natural Gas	-9,258	-17,165	-19,200
Nuclear	0	0	0
Renewables	222	1,578	1,231
Total (Net) Capacity Additions	-9,036	-17,314	-20,718
Change in Electricity Consumption (TWh)	-46	-80	-82
Change in Emissions			
CO_2 (Million Metric Tons)	-29	-52	-49
Hg (Tons)	0	0	0
NOx (Thousand Tons)	7	5	10
SO_2 (Thousand Tons)	6	42	98

Economic impacts from the House RES, estimated in the DEEPER model, show net consumer savings of more than $14 billion cumulatively, and a net annual gain of more than 700 jobs (see Table 15). Wages fall slightly by $38 million per year on average, as does gross state product by an average of $336 million per year in the House RES. We note that the $14 billion in consumer savings outweighs the smaller losses in wages and GSP, and that the consumer energy savings represent a much larger fraction of total energy expenditures than do the changes in wages and GSP, because the base dollar amounts in wages and GSP are much larger.

Table 15. Midwest DEEPER Results for House RES and 15-15 Scenarios Relative to Business-as-Usual

	Net Consumer Savings (Cumulative Million$ through 2030)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
House RES	14,177	735	-38	-336
15-15	102,547	12,931	137	-2,293

Compared to the House RES, the 15-15 scenario shows much greater economic benefits: 7 times the net consumer savings and 18 times the net annual gain in jobs. The 15-15 scenario shows an increase of $137 million in average annual wages, but a decline of $2 billion in GSP. Similarly to the House RES scenario, the $103 billion in cumulative consumer savings outweighs the smaller loss in GSP.

Southeast

IPM® results show a similar set of positive benefits from the House RES in the Southeast as in the Midwest, with energy prices, capacity needs, energy use, and carbon emissions all falling modestly (see Table 16 below). Net new renewable capacity by 2030 compared to BAU would come primarily from biomass and additional capacity from wind. These effects are relatively small in absolute terms, but they nonetheless represent benefits, and thus run counter to claims that the RES would raise prices and threaten reliability in this region.

For the 15-15 scenario, IPM® shows much greater benefits in the Southeast, just as it does in the Midwest (see Table 17 below). Electricity prices fall six to ten times as far, with capacity avoidance increasing by similar ratios. Net new renewable capacity by 2030 compared to BAU would come primarily from biomass (6,400 MW) and additional capacity from wind (680 MW). Energy use falls 8-15 times as far as in the House RES scenario, and carbon emissions fall by up to eightfold.

Table 16. Southeast Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario One Relative to Business-as-Usual

House RES	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)	-$0.32	-$0.62	-$0.28
Henry Hub NG Prices (2006$/MMBtu)	-$0.05	-$0.11	-$0.10
Change in Cumulative Capacity Additions (MW)			
Coal	-2,457	-3,081	-3,215
Natural Gas	682	666	1,213
Nuclear	0	0	0
Renewables	0	1,874	1,491
Total (Net) Capacity Additions	-1,933	-699	-669
Change in Electricity Consumption (TWh)	-10	-8	-5
Change in Emissions			
CO_2 (Million Metric Tons)	-12	-18	-18
Hg (Tons)	0	0	0
NOx (Thousand Tons)	-1	3	-1
SO_2 (Thousand Tons)	-19	-7	-14

Table 17. Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario Three Relative to Business as Usual

15-15 Scenario	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)	-$3.03	-$3.70	-$2.74
Henry Hub NG Prices (2006$/MMBtu)	-$0.30	-$0.43	-$0.53
Change in Cumulative Capacity Additions (MW)			
Coal	-7,216	-21,718	-27,448
Natural Gas	-3,803	-1,774	-659
Nuclear	0	0	0
Renewables	-67	5,472	7,104
Total (Net) Capacity Additions	-12,868	-19,802	-22,785
Change in Electricity Consumption (TWh)	-58	-67	-76
Change in Emissions			
CO_2 (Million Metric Tons)	-49	-135	-142
Hg (Tons)	0	0	0
NOx (Thousand Tons)	-1	-6	-5
SO_2 (Thousand Tons)	-17	-70	-55

Macroeconomic effects of the House RES policy in the Southeast show a pattern similar to the Midwest results. Net consumer savings are $13 billion cumulatively and average jobs increase slightly, while average wages and GSP fall slightly. On balance, the House RES provides substantial consumer benefits with a very small economic impact. In the 15-15 scenario, consumer savings rise to an $118 billion, and almost 6,000 new jobs are created.

Average annual wages fall by about $530 million and GSP about $4 billion. On balance, the value of consumer savings and new jobs exceeds small wage and GSP impacts.

Table 18. Southeast DEEPER Results for House RES and 15-15 Scenarios Relative to Business-as-Usual

	Net Consumer Savings (Cumulative Million$ through 2030)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
House RES	13,412	106	-82	-435
15-15	118,214	5,964	-533	-3,966

Exploratory Analysis—30% National EERS

Energy efficiency is increasingly recognized as the energy resource of first choice. Both ACEEE's own wide range of studies (e.g., Nadel and Geller 2001; Laitner 2004, Nadel 2006, and Elliott, Langer, and Nadel 2006) and those of other respected research groups such as the McKinsey Global Institute (Bressand et al. 2007) and the United Nations Foundation (Expert Group on Energy Efficiency 2007) provide a substantial documentation for cost-effective opportunities to extend the energy efficiency resource in ways that increase both economic prosperity and environmental quality.

Yet, the current Congressional debate tends to constrain the integration of what might be termed the full economic potential of the energy efficiency resource. To create a meaningful context that might help policymakers understand the potential benefit of this larger efficiency resource, ACEEE expanded the analysis beyond the review of the House RES and more aggressive 10-5 EERS and 15-15 EERS-RES policies. Specifically, we conducted an exploratory analysis to assess the economic impacts of a 30% electricity efficiency standard by 2030. The exercise was completed outside of the IPM® analysis. However, the key results from that external analysis were mapped into the DEEPER model, which then allowed us to evaluate the economy-wide impacts of the larger 30% efficiency potential.

For this extended exercise we used the conservative assumption that both energy efficiency program and technology investment costs would increase as more and more of the efficiency gains were allowed to enter the scenario. In the case of policy costs, we assumed an eventual doubling by 2030. Also consistent with the literature, we assumed that investment costs for efficiency upgrades would increase slowly so that by 2030 they are 50% greater than in 2008. We further specified that combined heat and power (CHP) and other recycled energy technology investments would slowly increase so that they are double the 2008 values by 2030. Finally, and generally following the IPM® wholesale price response, we determined that a 30% electricity savings would drop natural gas prices to about 84% of the standard reference case assumptions (i.e., a price reduction of 13%).

Given this working set of assumptions, we determined that the impacts can be substantial. We found that a 30% Energy Efficiency Resource Standard—even with the substantially higher costs—could generate a cumulative energy bill savings of $229 billion over the period

2008 through 2030, and produce an average annual gain of 300,000 jobs over that same period. These results are summarized in Table 19. Given the magnitude of these prospective returns, Congressional leaders may want to expand their review of the energy efficiency resource and do more to incorporate it into their policy framework.

Table 19. National DEEPER Results for Exploratory 30% EERS Scenario Relative to Business-as-Usual

Net Consumer Savings, Cumulative through 2030 (Million$)	Average Net Annual Jobs (Actual)	Average Annual Wages (Million$)	Average Annual GDP (Million$)
229,107	305,000	17,098	4,665

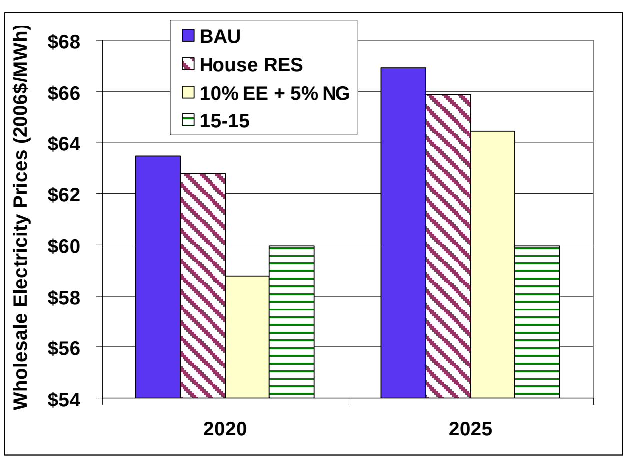
DISCUSSION

Price Impacts

The IPM® modeling performed in this analysis clearly shows that the House RES and the more aggressive clean energy scenarios all serve to reduce both electricity and natural gas wholesale prices. This result refutes the primary criticism of the RES—that it will raise energy prices. Even in the Southeast and Midwest, where these concerns have been most strongly expressed, IPM® results show prices falling modestly for the House RES and more substantially for the more aggressive scenarios. Figure 4 below illustrates these effects.

The finding that prices fall further in the more aggressive scenarios suggests that the House RES is a moderate step that should be viewed as a downpayment on a more aggressive U.S. energy policy.

Figure 4. Wholesale Electricity Prices in Business as Usual and Clean Energy Scenarios



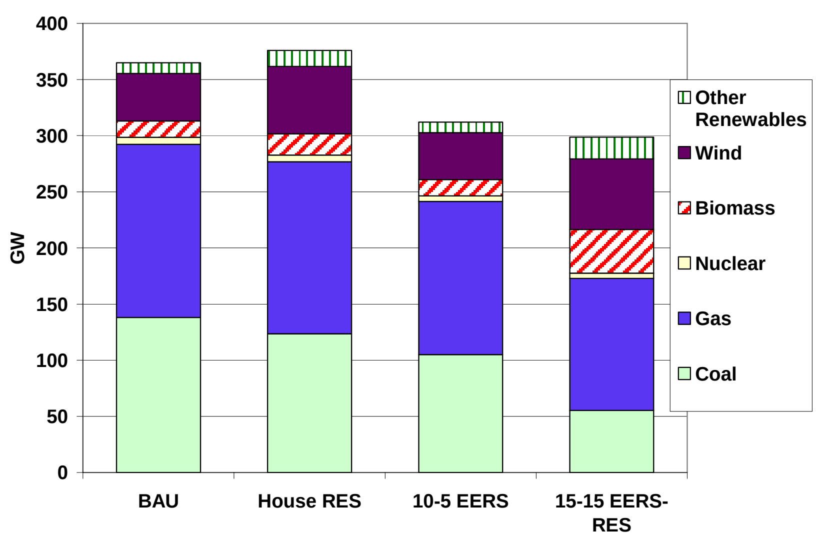
Powerplant Capacity Impacts

Many in the electric power industry are calling for the construction of new powerplants to meet the growing needs for new power generation capacity, with shortages looming in several regions (NERC 2007). These plans for construction of new powerplants are beginning to raise concerns (Cusick 2007; Gardner 2007; Loder 2007; Smith 2007). These concerns are twofold: that new plants are proving to be much more expensive than anticipated, raising the specter of increasing electricity rates, and that construction of new fossil-fired capacity would have serious implications for carbon dioxide emissions and global warming.

The House RES and the more aggressive policies all serve to avoid the need for a significant part of expected needs for new fossil-fuel generation capacity (see Figure 5 below). The House RES reduces non-renewable capacity additions by almost 10%; the 15-15 scenario cuts the growth in non-renewables by almost half, or the equivalent of 250 500-MW coal-fired plants.

Avoiding capacity construction through RES-EERS policies thus moderates electricity and natural gas prices, reduces the risk of blackouts and related reliability concerns, and prevents "locking in" of fossil-combustion facilities that will complicate the attainment of carbon dioxide emission reduction goals.

Figure 5. 2030 Cumulative Capacity Addition Mix in Business-as-Usual and Clean Energy Scenarios



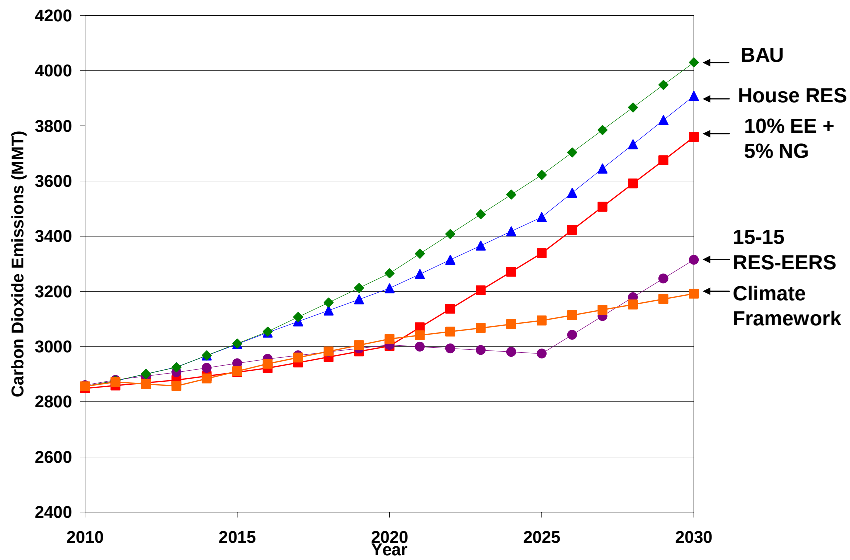
Carbon Dioxide Emissions Impacts

Our analysis of the House RES and the more aggressive RES-EERS policy options shows that this policy approach can be one of the best downpayment policies the U.S. can enact now to get a head start on reducing carbon dioxide emissions. The energy efficiency component reduces the growth in energy demand, which increases the effect of the increase in renewable energy supply. For example, a 15% RES by itself would allow carbon dioxide emissions to continue to increase through 2020 and beyond, because electricity demand will grow by more than 15% by 2020. But a 15-15 policy would reduce the growth in U.S. power sector carbon dioxide emissions by about 60% in 2020, 75% in 2025, and 67% in 2030.

In fact the 15-15 RES-EERS policy would, by itself, reduce carbon emissions in the power sector by roughly the same amount as the entire Bingaman-Specter bill would achieve in this sector. This makes an aggressive RES-EERS policy not a substitute for, but rather a very effective complement to, any federal climate policy.

Figure 6 below illustrates the carbon dioxide emissions impacts.

Figure 6. Annual CO_2 Emissions in BAU and Clean Energy Scenarios



Economic Impacts

Our macroeconomic analysis, using the DEEPER model, shows that a House RES policy, as well as more aggressive RES and EERS policies, would generate substantial consumer savings, substantial job and wage growth, and very small GDP costs.

In the BAU framework, consumer savings range from about $60 billion to nearly $600 billion on a cumulative basis as the aggressiveness of the scenarios progresses. These consumer savings stem primarily from the drop in energy bills, as efficiency technologies pay for themselves and reduce the net cost of providing energy services. Net jobs range from about 28,000 average net new jobs per year to 145,000, and net new wages rise from $1.8 billion to $6.1 billion. The net effect on jobs and wages comes from the increase in jobs supported by efficiency and renewable investments, minus any losses in jobs in conventional energy supply sectors.

The overall effects on the macro-economy are small, and vary in directionality. The House RES increases GDP by an average of $2 billion annually on average, while the more aggressive scenarios show negative GDP impacts in the $5–6 billion/year range. We note that these GDP impacts are vanishing small. Average annual GDP is about $16 trillion in the *Annual Energy Outloook* reference case forecast; in that context, $6 billion represents about 0.04% (four one-hundredths of one percent) of GDP. Moreover, consumer net savings overwhelm these small GDP impacts.

Regional Impacts

Our analysis shows that a national RES-EERS policy reduces energy costs and produces positive economic benefits both nationwide and in regions like the Southeast and Midwest, which are sometimes characterized as having fewer renewable resources and lower electricity prices than other regions. The IPM® and DEEPER modeling results show that electricity and natural gas wholesale prices fall under a House RES scenario, and fall even further under more aggressive RES-EERS scenarios. These effects are roughly comparable in the Southeast and Midwest. Moreover, the RES-EERS scenarios reduce capacity needs, energy consumption, and carbon emissions. The macroeconomic analysis shows that large consumer savings and growth in jobs outweigh small GSP impacts. The House RES and the more aggressive RES-EERS policies are thus good energy and economic policies for both of these regions as well as for the nation as a whole.

CONCLUSIONS

ACEEE conducted a robust assessment of the likely impacts of the House RES and more aggressive RES and EERS policies on energy prices, consumer bills, carbon emissions, and the wider economy. Using state-of-the-art modeling techniques widely employed in energy and environmental policy analysis, we examined these policies in both a business-as-usual framework and a climate policy framework.

Reviewing the range of analytical results from the IPM® and DEEPER modeling, in the context of U.S. energy and climate policy, leads to the following conclusions:

- The House RES reduces electricity prices. Power prices at the wholesale level fall in virtually every scenario we examined. Prices fall much more significantly in the more aggressive scenarios, suggesting that the House RES should be seen as a modest first step toward more substantial RES and EERS policy goals.

- The House RES reduces the need for new fossil fuel powerplants, cutting capacity additions for conventional generation almost 20%. The more aggressive RES-EERS scenarios do even better; the 15-15 scenario cuts conventional capacity additions by almost half. This suggests the House RES can help avoid the reliability risks as well as the electricity rate increases associated with expensive new powerplants.

- The House RES is a good first step toward comprehensive climate policy. It cuts the growth in power sector carbon dioxide emissions, making a downpayment on what is likely the greatest environmental challenge the U.S. has ever faced. The more aggressive RES-EERS policies have much larger carbon dioxide emission reduction impacts; the 15-

15 policy would avoid the great majority of the forecast growth in emissions from the U.S. power sector, achieving roughly the same impacts as the more elaborate Bingaman-Specter climate bill.

- The House RES and more aggressive policies are good economic policies. They create enormous consumer net benefits, ranging up to $600 billion, while increasing jobs and wages.

- The House RES does not penalize certain regions. Benefits that flow to the Southeast and Midwest are directionally similar to those for the nation as a whole. Prices moderate, capacity needs are reduced, and consumer benefits and job creation are positive.

For all these reasons, we conclude that the House RES is a moderate policy step with positive energy, economic, and environmental benefits. It should be enacted now, to create the framework for setting more substantial goals down the road that will do more for U.S. electricity and climate policy than any single measure this Congress could enact.

REFERENCES

Bressand, Florian, Diana Farrell, Pedro Haas, Fabrice Morin, Scott Nyquist, Jaana Remes, Sebastian Roemer, Matt Rogers, Jaeson Rosenfeld, and Jonathan Woeztel. 2007. *Curbing Global Energy Demand Growth: The Energy Productivity Opportunity*. San Francisco, Calif.: McKinsey Global Institute.

Clemmer, S. 2007. Personal communication with Maggie Eldridge. Washington, D.C.: Union of Concerned Scientists.

Cusick, D. 2007. "IGCC Plan Scrapped by Orlando Utility, Southern Co." *Greenwire*, Nov. 15.

Ehrhardt-Martinez, Karen; and John A. "Skip" Laitner. 2007. *The U.S. Energy Efficiency Market: Assembling a Better Picture*. Forthcoming. Washington, D.C.: American Council for an Energy-Efficiency Economy.

[EIA] Energy Information Administration. 2005. *Electric Power Annual,* Table 9.4: Demand-Side Management Program Annual Effects by Sector, 1994 through 2005. http://tonto.eia.doe.gov/FTPROOT/electricity/034805.pdf. Washington, D.C.: U.S. Department of Energy.

———. 2006. *Annual Energy Outlook 2006.* http://www.eia.doe.gov/oiaf/aeo/index.html. Washington, D.C.: U.S. Department of Energy.

———. 2007. *Annual Energy Outlook 2007.* http://www.eia.doe.gov/oiaf/aeo/index.html. Washington, D.C.: U.S. Department of Energy.

Elliott, R. Neal, Therese Langer, and Steven Nadel. 2006. *Reducing Oil Use through Energy Efficiency: Opportunities Beyond Light Cars and Trucks.* http://www.aceee.org/pubs/e061.htm. Washington, D.C.: American Council for an Energy-Efficient Economy.

Expert Group on Energy Efficiency. 2007. *Realizing the Potential of Energy Efficiency Targets, Policies, and Measures for G8 Countries.* Washington, D.C.: United Nations Foundation.

Gardner, T. 2007. "Greens Rejoice as Analyst Sours on U.S. Coal." *Reuters*, July 20.

Hamrin, J., E. Vine, and A. Sharick. 2007. *The Potential for Energy Savings Certificates (ESC) as a Major Tool in Greenhouse Gas Reduction Programs.* San Francisco, Calif.: Center for Resource Solutions.

Hanson, Donald A. and John A. "Skip" Laitner. 2007. "Input-Output Equations Embedded within Climate and Energy Policy Analysis Models." Forthcoming in Faye Duchin and

Sangwon Suh, Editors, *Input-Output Analysis Handbook.* New York, N.Y.: Kluwer Academic Press.

[IMPLAN] Minnesota IMPLAN Group, Inc. 2007. A 2006 dataset for Michigan. Accessed January. Stillwater, Minn.: Minnesota IMPLAN Group, Inc.

Laitner, John A. "Skip." 2004. "How Far Energy Efficiency?" In *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Laitner, John A. "Skip." 2007. *An Annotated Review of 30 Studies Describing the Macroeconomic Impacts of State-Level Scenarios That Promote Energy Efficiency and Renewable Energy Technology Investments*. Forthcoming. Washington, D.C.: American Council for an Energy-Efficient Economy.

———. Draft DEEPER Documentation. Forthcoming. Washington, D.C.: American Council for an Energy-Efficient Economy.

Laitner, John A. "Skip," Stephen Bernow, and John DeCicco. 1998. "Employment and Other Macroeconomic Benefits of an Innovation-Led Climate Strategy for the United States." *Energy Policy*, 26(5), 425–433.

Loder, A. 2007. "Plan for $2B Coal Plant Is Quashed." *Tampa Bay Times* via *tampabay.com*, Oct. 5.

Nadel, Steven. 2006. *Energy Efficiency Resource Standards: Experience and Recommendations.* http://www.aceee.org/pubs/e063.htm. Washington, D.C.: American Council for an Energy-Efficient Economy.

Nadel, Steven and Howard Geller. 2001. *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions through Greater Energy Efficiency.* http://www.aceee.org/pubs/e012.htm. Washington, D.C.: American Council for an Energy-Efficient Economy.

[NERC] North American Electric Reliability Corporation. 2007. *2007 Long-Term Reliability Assessment: 2007-2016.* ftp://www.nerc.com/pub/sys/all_updl/docs/pubs/LTRA2007.pdf. Princeton, N.J.: North American Electric Reliability Corporation.

Prindle, B. and M. Eldridge. 2007. *The Twin Pillars of Sustainable Energy: Synergies between Energy Efficiency and Renewable Energy Technology and Policy.* http://www.aceee.org/pubs/e074.htm. Washington, D.C.: American Council for an Energy-Efficient Economy.

Smith, R. 2007. "Power Companies Consider Options for Energy Sources." *Wall Street Journal*¸ Oct. 29, A10.

APPENDIX A: DETAILED METHODOLOGY

Reference Case

The reference case electricity forecast is based on a modification of the *Annual Energy Outlook 2006* "Reference Case" (EIA 2006). For this analysis, the cost of new renewable and conventional generation capacity options were developed by the Union of Concerned Scientists (Clemmer 2007), derived from market data and information collected by Black and Veatch. Natural gas and coal prices come from EIA's *Annual Energy Outlook 2007* (EIA 2007).

Clean Energy Scenarios

ACEEE developed three clean energy scenarios, each with varying targets for renewable energy and energy efficiency. The first scenario models the House Renewable Electricity Standard, which sets a 2020 nominal target of 11% renewable energy and 4% energy efficiency.[10] The second scenario is an efficiency-only target of 10% electricity efficiency and 5% natural gas efficiency by 2020. The third scenario is a more aggressive 15% efficiency plus 15% renewables target by 2025. See Table A-1 for the varying targets by year.

Table A-1. Nominal Renewable Energy and Energy Efficiency Targets

	House RES (Scenario 1)		10% EE + 5% NG (Scenario 2)	"15-15" (Scenario 3)	
	Renewables	Efficiency	Efficiency	Renewables	Efficiency
2015	4.7%	1.8%	6%	4.8%	4.8%
2020	11%	4%	10%	10%	10%
2025	11%	4%	10%	15%	15%

The nominal targets for each scenario were then adjusted to account for two factors:

- The percent of total electricity demand to which the policy targets are applicable: requirements apply only to investor-owned utilities (IOUs) (municipal and cooperative utilities are exempt) that sell at least one million MWh per year. This represents about 80% of total U.S. electricity demand.
- Existing baseline energy efficiency, including efficiency represented in EIA's *Annual Energy Outlook* forecast and additional efficiency from state-level EERS and RES policies.

The remainder of the efficiency targets that will not be met through current and expected baseline efficiency is the adjusted target. The calculation to derive this target is shown in Equation 1 and the targets are shown in the Table A-2. It is important to note that because these targets represent requirements spread out over the *entire* U.S. electric load, about 20%

[10] Hydro-electric power is not applicable toward meeting the renewable energy targets in any of the scenarios. In the House RES bill, Hawaii is exempt from meeting the targets.

of which is not subject to requirements (munis and co-ops), they are not equal to the requirements for individual utilities. Requirements for IOUs covered under the policies would be somewhat higher.

Equation 1. Adjusted target = (Nominal target - % of baseline efficiency - % additional savings from state-level programs) * (% applicable of electricity demand)

Table A-2. Adjusted Renewable Energy and Energy Efficiency Targets

	House RES (Scenario 1)		10% EE + 5% NG (Scenario 2)	"15-15" (Scenario 3)	
	Renewables	Efficiency	Efficiency	Renewables	Efficiency
2015	3.8%	0%	3%	3.8%	2.2%
2020	8.8%	1%	6%	8%	5.7%
2025	8.8%	0.8%	6%	12%	9.4%

We present the results of the three scenarios in two frameworks: a business-as-usual framework and a climate policy framework, which is based on the Bingaman-Specter bill. The BAU framework assumes a 3-pollutant case without federal climate change policy. In other words, this case assumes current air regulatory assumptions for NO_x, SO_2, and mercury. The climate policy framework, a 4-pollutant case, adds a CO_2 component. This case assumes a climate policy representative of the Bingaman-Specter proposal, which calls for reducing covered emissions to 60% below 2006 levels by 2050 and caps emissions upstream on fuels subject to a safety valve that caps the allowance price.

Integrated Planning Model

Our analysis uses the IPM® model developed by ICF International specifically to model the electric power sector in the U.S. IPM® is widely used by federal and state agencies, utilities, and others in energy and environmental policy analysis. ICF was engaged to run IPM® for each of the clean energy scenarios, in both the business-as-usual and climate frameworks, for national and regional analyses. ICF used the adjusted national scenario targets developed by ACEEE as inputs for the IPM® model. The model projects CO_2 emissions from the electric sector, cumulative capacity additions by type, national generation mix by type, and national average wholesale energy prices.

IPM® requires several assumptions to generate a projection. Three critical assumptions are electric load growth, the cost and performance of new generating capacity, and fuel prices. ACEEE selected the sources for these assumptions and the assumptions were entered into IPM® to be analyzed by ICF. We assume reference load growth from the *Annual Energy Outlook 2006* (EIA 2006), cost of capacity options from the Union of Concerned Scientists, and natural gas and coal prices from the *Annual Energy Outlook* 2007 (EIA 2007). ACEEE converted all price and cost results from the IPM® model, data from *Annual Energy Outlook 2006*, and efficiency costs to constant 2006 dollars using the Consumer Price Index (CPI). We used 2006$ to be consistent with the DEEPER model (described next), which uses a base year of 2006 based on available data from IMPLAN (2007).

Efficiency Allocations

The IPM® analysis reports changes in utility electricity load and generation resulting from efficiency, but does not disaggregate these efficiency savings by specific sectors or measures. The changes in electricity sales result from end-use electricity efficiency measures as well as onsite distributed generation that displaces grid-supplied electricity. We allocated the annual efficiency results from the IPM® scenario analyses into five categories:

1. residential end-use energy efficiency
2. commercial end-use energy efficiency
3. industrial end-use energy efficiency
4. industrial combined heat and power (CHP) onsite distributed generation[11]
5. commercial/institution CHP onsite distributed generation

Based on experience in Italy, we would anticipate that CHP would account for a substantial portion of this reduction (Hamrin, Vine, and Sharick 2007). We thus assume that CHP accounts for one-third of the electricity savings and that these savings are equally distributed between industrial and commercial/institutional sectors based on ACEEE's analysis of the potential for CHP in the U.S. The balance is allocated to end-use efficiency based on EIA data on demand-side management program annual effects by sector from its annual electricity power industry report (EIA 2005). Natural gas savings that occur in scenario two are based on an ACEEE analysis of a 5% national target for natural gas efficiency.

Costs

We estimated capital costs for each of the categories on a per kWh basis using ACEEE estimates from various sources. All capital costs are a one-time cost, incurred during the initial period of the efficiency investment. We calculate annual capital costs by multiplying incremental efficiency in a given year by the per kWh capital cost.

For the three end-use efficiency sectors, we assume an average measure life of 13 years. For these sectors, we assume that half of each year's investment occurs in the year prior to the savings and the remaining half occurs in the same year as the savings. This approach accounts for the fact that on average only half a year of savings are realized in the year the investment is made. Any changes in operating cost—positive or negative—are ignored in these assumptions. The literature suggests that this is a conservative assumption because on average efficiency measures tend to reduce non-energy cost of ownership (e.g., with high-efficiency lighting the relamping interval is reduced, thus reducing labor associated with lighting maintenance).

A program and administrative charge, also estimated on a per kWh basis, is added to the direct investment costs reflecting the administrative, technical assistance, and evaluation costs associated with delivering energy efficiency programs.

---

[11] CHP systems, also known as cogeneration, generate electricity and thermal energy in a single, integrated system.

For the two CHP investment categories, we assume an average 15-year measure life, and that the full incremental investment cost is incurred in the year prior to the savings being realized. For simplifying purposes, all the systems are assumed to be natural gas-fueled. In the case of CHP, we do account for incremental non-fuel operation and maintenance (O&M) costs, and incremental fuel costs. Because we assume that the CHP systems displace a new or existing boiler, we only attributed the incremental fuel over and above that which would be required for boiler operation to the power generation (this is the approach spelled out the in House EERS legislation). We use the ratio of industrial and non-industrial generation from CHP to installed capacity from the *Annual Energy Outlook 2007* (EIA 2007) to attribute installed cost to additional onsite CHP generation. A fixed O&M cost of 1¢/kWh was assumed based on ACEEE review of typical system operating data. Fuel cost is based on an average net incremental heat rate for CHP of 4,100 Btu/kWh and the average forecasted retail cost of natural gas for the sector. No program costs are assumed for the CHP investment.

Table A-3. Cost Assumptions for Energy Efficiency Investments and Programs

	Electricity ($/kWh)		**Natural Gas ($/mBtu)**			
	Capital	Program/Admin Costs	Capital	Program/Admin Costs	O&M	Fuel
Residential	$0.308	$0.077	$18.04	$4.51	NA	NA
Commercial	$0.188	$0.038	$12.52	$2.50	NA	NA
Industrial	$0.131	$0.020	$9.80	$1.47	NA	NA
CHP—Industrial	NA	NA	$0.208	NA	$0.01	$0.027
CHP—Commercial/ Institutional	NA	NA	$0.430	NA	$0.01	$0.039

For all efficiency categories, including electricity and natural gas, after the end of the measure lifetimes, we assume full reinvestments occur to renew the level of savings. This is a conservative approach, because a portion of the savings from initial investments becomes accounted for in the baseline efficiency, and therefore the renewed investment would most likely be somewhat less than the initial investment. A full reinvestment is thus a conservative assumption. Reinvestments occur after 13 years for non-CHP efficiency measures and 15 years for CHP. Because initial savings begin in different years for each scenario analysis, reinvestments also begin in different years for each scenario. In scenario one, however, savings first occur in 2017, and therefore reinvestments do not occur before 2030, the last year included in the analysis.

To estimate total costs in a given year, we multiply the incremental electricity savings from each sector by the per-kWh cost for that sector. These disaggregated costs by sector are then totaled into three categories: investment costs, CHP operating and fuel costs, and program costs. These annual values are used as an input to the DEEPER analysis, which models economic impacts (see Table A-3 for a summary of these costs).

The DEEPER Model

To assess the macroeconomic impacts of the different scenarios, ACEEE then used its *Dynamic Energy Efficiency Policy Evaluation Routine* (DEEPER) model to estimate the net employment and income effects as well as the impact on the national and regional GDP. DEEPER is a dynamic input-output model that adapts the IPM® financial flows and assumptions into a form that enables us to provide a richer assessment of economic impact that results from the House Energy Bill. In the BAU framework, we report DEEPER results for each of the national scenarios and scenarios one and three for the Midwest and Southeast regions. We also present results for the national scenarios one and three in the climate policy framework.

The DEEPER Model is a 15-sector economic impact model of the U.S. economy. Although an updated model with a new name, the model has a 15-year history of development and use for state energy policy assessments. See, for example, Laitner, Bernow, and DeCicco (1998) and Laitner (2007) for a review of past modeling efforts. The model is generally used to evaluate the macroeconomic impacts of a variety of energy efficiency and renewable energy technologies at both the state and national level. The model now evaluates policies for the period 2008 through 2030. DEEPER is an Excel-based analytical tool that consists generally of six key modules or worksheets. These modules include:

Global data: The information in this module consists of the critical time series data and key model coefficients and parameters necessary to generate the final model results. The time series data includes the projected reference case energy quantities such as trillion Btus and kilowatt-hours, as well as the key energy prices associated with their use. It also includes the projected gross state product, wages, and salary earnings, as well as information on key technology assumptions. The sources of information include data from the Energy Information Administration, the Bureau of Economic Analysis, the Bureau of Labor Statistics, and Economy.com. One of the more critical assumptions in this study is that alternative patterns of electricity consumption will change and/or defer the mix of investments in conventional powerplants. Although we can independently generate these impacts within DEEPER, for this set of analyses we substituted the IPM® estimates of avoided or altered patterns of powerplant investment and spending.

Macroeconomic model: This module contains the “production recipe” for the region’s economy for a given “base year”—in this case, 2006, which is the latest year for which a complete set of economic accounts are available for the regional economy. The I-O data, currently purchased from the Minnesota IMPLAN Group (IMPLAN 2007), is essentially a set of input-output accounts that specify how different sectors of the economy buy (purchase inputs) from and sell (deliver outputs) to each other. In this case, the model is now designed to evaluate impacts for 15 different sectors, including: Agriculture, Oil and Gas Extraction, Coal Mining, Other Mining, Electric Utilities, Natural Gas Distribution, Construction, Manufacturing, Wholesale Trade, Transportation and Other Public Utilities (including water and sewage), Retail Trade, Services, Finance, Government, and Households.

Investment and savings: Based on the scenarios mapped into the model, this worksheet translates the energy policies into a dynamic array of physical energy impacts, investment flows, and energy expenditures over the desired period of analysis.

Price dynamics: Normally DEEPER employs an independent algorithm to generate energy price impacts given changes in consumption. For these runs, however, we simply substituted the IPM® driven price changes into DEEPER. Especially at the national level these impacts can have a large economic impact as reduced consumption places a downward pressure on natural gas and coal prices such that all energy consumers benefit from reductions generated within the electricity sector.

Final demand: Once the changes in spending and investments have been established and adjusted to reflect changes in prices and labor productivity within the previous modules of the DEEPER model, the net spending changes in each year of the model are converted into sector-specific changes in final demand, which drives the input-output model according to the following predictive model:

$$X = (I-A)^{-1} * Y$$

where:

X = total industry output by sector
I = an identity matrix consisting of a series of 0's and 1's in a row and column format for each sector (with the 1's organized along the diagonal of the matrix)
A = the production or accounting matrix also consisting of a set of production coefficients for each row and column within the matrix
Y = final demand, which is a column of net changes in final demand by sector

This set of relationships can also be interpreted as

$$\Delta X = (I-A)^{-1} * \Delta Y$$

which reads, a change in total sector output equals $(I-A)^{-1}$ times a change in final demand for each sector. Table 3 in the main report provides an illustration of the general approach used in this kind of model.

Results: For each year of the analytical time horizon, the model copies each set of results in this module in a way that can also be exported to a separate report.

There are other support spreadsheets as well as routines in visual basic programming that support the automated generation of model results and reporting. For more detail on the model assumptions and economic relationships, please refer to the model documentation (Laitner forthcoming). For a review of how an I-O framework might be integrated into other kinds of modeling activities, see Hanson and Laitner (2007).

APPENDIX B: REFERENCE CASE AND REGIONAL DATA

National Reference Case

Table B-1. National Reference Case Data

	2020	2025	2030
Prices			
Wholesale Electricity Prices (2006$/MWh)	$63.46	$66.93	$69.29
Henry Hub NG Prices (2006$/MMBtu)	$6.46	$7.03	$7.63
Cumulative Capacity Additions (MW)			
Coal	28,752	77,956	138,026
Natural Gas	89,515	117,507	154,181
Nuclear	0	0	1,500
Renewables (Biomass, Solar & Wind)	45,860	55,108	66,503
Total (Net) Capacity Additions	153,299	239,743	349,382
Electricity Consumption (TWh)	4,884	5,229	5,635
Emissions			
CO_2 (Million Metric Tons)	2,687	2,981	3,317
Hg (Tons)	21	18	17
NOx (Thousand Tons)	2,164	2,205	2,246
SO_2 (Thousand Tons)	5,010	4,366	4,112

Midwest Reference Case and Scenario Data

Table B-2. Midwest Reference Case Data

	2020	2025	2030
Prices			
Wholesale Electricity Prices (2006$/MWh)	$59.32	$64.50	$67.73
Henry Hub NG Prices (2006$/MMBtu)	$6.46	$7.03	$7.63
Cumulative Capacity Additions (MW)			
Coal	0	1,663	3,691
Natural Gas	12,872	20,779	30,323
Nuclear	0	0	0
Renewables (Biomass, Solar & Wind)	7,989	9,810	11,739
Total (Net) Capacity Additions	20,547	31,938	45,439
Electricity Consumption (TWh)	807	852	901
Emissions			
CO_2 (Million Metric Tons)	587	608	618
Hg (Tons)	5	4	4
NOx (Thousand Tons)	469	465	455
SO_2 (Thousand Tons)	1,463	1,151	972

Table B-3. Midwest Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario Two Relative to Business as Usual

10% EE + 5% NG	2020	2025	2030
Prices			
Wholesale Electricity Prices (2006$/MWh)	-$5.98	-$4.32	-$2.62
Henry Hub NG Prices (2006$/MMBtu)	-$0.39	-$0.21	-$0.20
Cumulative Capacity Additions (MW)			
Coal	0	-1,112	-1,634
Natural Gas	-9,718	-10,453	-9,542
Nuclear	0	0	0
Renewables (Biomass, Solar & Wind)	72	-27	-34
Total (Net) Capacity Additions	-9,646	-11,592	-11,210
Electricity Consumption (TWh)	-49	-50	-50
Emissions			
CO_2 (Million Metric Tons)	-29	-27	-19
Hg (Tons)	0	0	0
NOx (Thousand Tons)	6	10	12
SO_2 (Thousand Tons)	-6	65	7

Table B-4. Midwest Change in Annual Capacity, Electricity Sales, and Emissions in Scenario One in Climate Framework Relative to Business as Usual

House RES in Climate Framework	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	0	-1,663	-3,691
Natural Gas	-6,299	-7,930	-9,959
Nuclear	0	0	4,500
Renewables	238	440	26
Total (Net) Capacity Additions	-6,270	-9,362	-9,333
Change in Electricity Consumption (TWh)	-32	-37	-34
Change in Emissions			
CO_2 (Million Metric Tons)	-36	-46	-62
Hg (Tons)	0	0	0
NOx (Thousand Tons)	11	24	32
SO_2 (Thousand Tons)	-18	70	145

Table B-5. Midwest Change in Annual Capacity, Electricity Sales, and Emissions in Scenario Two in Climate Framework Relative to Business as Usual

10% EE + 5% NG Scenario in Climate Framework	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	0	-1,663	-3,691
Natural Gas	-12,872	-16,091	-18,017
Nuclear	0	0	1,500
Renewables	-155	336	14
Total (Net) Capacity Additions	-13,873	-18,264	-21,040
Change in Electricity Consumption (TWh)	-74	-80	-82
Change in Emissions			
CO_2 (Million Metric Tons)	-71	-71	-76
Hg (Tons)	0	0	0
NOx (Thousand Tons)	-13	5	26
SO_2 (Thousand Tons)	-74	107	164

Table B-6. Midwest Change in Annual Capacity, Electricity Sales, and Emissions in Scenario Three in Climate Framework Relative to Business as Usual

15-15 Scenario in Climate Framework	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	0	-1,663	-3,691
Natural Gas	-12,872	-20,332	-25,899
Nuclear	0	0	0
Renewables	83	1,484	1,158
Total (Net) Capacity Additions	-13,361	-21,104	-29,025
Change in Electricity Consumption (TWh)	-70	-106	-116
Change in Emissions			
CO_2 (Million Metric Tons)	-70	-95	-97
Hg (Tons)	0	0	0
NOx (Thousand Tons)	-20	-15	2
SO_2 (Thousand Tons)	-55	39	168

Southeast Reference Case and Scenario Data

Table B-7. Southeast Reference Case Data

	2020	2025	2030
Prices			
Wholesale Electricity Prices (2006$/MWh)	$63.88	$66.84	$68.44
Henry Hub NG Prices (2006$/MMBtu)	$5.95	$6.39	$6.79
Cumulative Capacity Additions (MW)			
Coal	7,216	22,534	41,751
Natural Gas	18,244	20,629	26,104
Nuclear	0	0	0
Renewables	312	515	1,009
Total (Net) Capacity Additions	16,104	34,010	59,196
Electricity Consumption (TWh)	1,013	1,097	1,198
Emissions			
CO_2 (Million Metric Tons)	559	648	756
Hg (Tons)	4	4	3
NOx (Thousand Tons)	337	343	363
SO_2 (Thousand Tons)	895	771	771

Table B-8. Change in Annual Energy Prices, Capacity, Electricity Sales, and Emissions in Scenario Two Relative to Business as Usual

10% EE + 5% NG	2020	2025	2030
Change in Prices			
Wholesale Electricity Prices (2006$/MWh)	-$3.45	-$1.39	-$0.70
Henry Hub NG Prices (2006$/MMBtu)	-$0.39	-$0.21	-$0.20
Change in Cumulative Capacity Additions (MW)			
Coal	-7,216	-10,636	-11,953
Natural Gas	-4,428	-1,165	-1,422
Nuclear	0	0	0
Renewables (Biomass, Solar & Wind)	-100	-146	-84
Total (Net) Capacity Additions	-12,783	-12,986	-14,498
Change in Electricity Consumption (TWh)	-62	-62	-63
Change in Emissions			
CO_2 (Million Metric Tons)	-51	-65	-70
Hg (Tons)	0	0	0
NOx (Thousand Tons)	7	-2	-8
SO_2 (Thousand Tons)	-37	-6	-41

Table B-9. Southeast Change in Annual Capacity, Electricity Sales, and Emissions in Scenario One in Climate Framework Relative to Business as Usual

House RES in Climate Framework	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	-7,216	-22,534	-40,525
Natural Gas	698	4,141	13,219
Nuclear	0	9,060	14,345
Renewables (Biomass, Solar & Wind)	72	1,963	1,469
Total (Net) Capacity Additions	-7,516	-8,440	-12,562
Change in Electricity Consumption (TWh)	-33	-35	-38
Change in Emissions			
CO_2 (Million Metric Tons)	-43	-133	-225
Hg (Tons)	0	0	-1
NOx (Thousand Tons)	-10	-20	-37
SO_2 (Thousand Tons)	72	-6	-61

Table B-10. Southeast Change in Annual Capacity, Electricity Sales, and Emissions in Scenario Two in Climate Framework Relative to Business as Usual

10% EE + 5% NG Scenario in Climate Framework	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	-7,216	-22,534	-41,751
Natural Gas	-9,346	1,362	5,768
Nuclear	0	3,607	13,821
Renewables (Biomass, Solar & Wind)	0	294	413
Total (Net) Capacity Additions	-19,145	-19,854	-24,332
Change in Electricity Consumption (TWh)	-81	-84	-87
Change in Emissions			
CO_2 (Million Metric Tons)	-65	-136	-246
Hg (Tons)	1	0	-1
NOx (Thousand Tons)	14	0	-25
SO_2 (Thousand Tons)	54	19	-59

Table B-11. Southeast Change in Annual Capacity, Electricity Sales, and Emissions in Scenario Three in Climate Framework Relative to Business as Usual

15-15 Scenario in Climate Framework	2020	2025	2030
Change in Cumulative Capacity Additions (MW)			
Coal	-7,216	-22,534	-41,751
Natural Gas	-8,137	-6,503	-700
Nuclear	0	0	7,398
Renewables (Biomass, Solar & Wind)	0	6,646	7,095
Total (Net) Capacity Additions	-18,029	-25,067	-30,634
Change in Electricity Consumption (TWh)	-77	-87	-96
Change in Emissions			
CO_2 (Million Metric Tons)	-63	-156	-258
Hg (Tons)	0	0	-1
NOx (Thousand Tons)	13	8	-17
SO_2 (Thousand Tons)	53	13	-56