The American Power Act and Enhanced Energy Efficiency Provisions: Impacts on the U.S. Economy

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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 economic prosperity, energy security, and environmental protection. For more information, see 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.

Support for our work comes from a broad range of foundations, governmental organizations, research institutes, utilities, and corporations.

EXECUTIVE SUMMARY

Introduction

The current U.S. Congress has been working on energy and climate legislation steadily since being sworn into office in January, 2009. In June, 2009, the House of Representatives passed an energy and climate bill entitled the *American Clean Energy Security Act* (ACES). This bill included a cap-and-trade program on greenhouse gas emissions in most sectors of the U.S. economy and many significant energy efficiency provisions. ACEEE has previously analyzed the energy savings and economic impacts of this bill.

On May 12, 2010, after months of deliberation, Senators Kerry (D-MA) and Lieberman (I-CT), with input from Senator Graham (R-SC), introduced a discussion draft of comprehensive climate change legislation called the *American Power Act of 2010* (APA). This bill contains a cap-and-trade program on greenhouse gas emissions by utilities and large industrial emitters, a carbon fee on transportation fuels, and a modest allocation of funds to energy efficiency. It was designed to be combined with energy legislation developed by the Senate Energy and Natural Resources Committee called the *American Clean Energy Leadership Act* (ACELA). ACELA, which includes a number of key building and industrial energy efficiency provisions, was passed by the Senate Energy and Natural Resources Committee in June, 2009 and amended in May, 2010 to include additional energy efficiency provisions.

In contrast to the House-passed ACES bill, APA includes much less investment in energy efficiency. And relative to the energy efficiency provisions in ACES, the Senate Energy Committee ACELA bill includes somewhat more limited energy efficiency provisions. As a result, the combination of APA and ACELA achieves less energy savings than ACES and increases the cost of meeting the greenhouse gas emissions targets in both bills. APA does include more provisions for energy efficiency in transportation and industry than did ACES, representing opportunities for enhancements that, when combined with some of the provisions from the House-passed bill, could achieve even greater savings with significant benefits to average Americans.

This report analyzes the impacts of APA and ACELA on energy use, greenhouse gas emissions, and the U.S. economy. We examine the two together because APA is highly unlikely to be enacted on its own and is more likely to be enacted in combination with ACELA. Also, by examining the two together, we can better compare our results to our previous analysis of the House ACES bill. In addition to examining APA+ACELA, we also examined two scenarios with stronger energy efficiency provisions. We did this because our previous analyses show that energy efficiency helps moderate the cost of climate legislation, a key consideration in order for any legislation to be enacted into law.

Scope of Analysis

For this report we examine four cases:

Base case, business-as-usual, without APA or ACELA, based on the Reference Case in the *2010 Annual Energy Outlook* published by the Energy Information Administration.

APA+ACELA, including energy efficiency provisions in both APA and ACELA.

Enhanced case, in which the energy efficiency provisions in APA and ACELA are significantly expanded including:

- Establishing a 10% Energy Efficiency Resource Standard (EERS), either separate from or combined with a Renewable Energy Standard (RES). An EERS establishes energy savings targets for electric utilities, building on EERS requirements that have been adopted in 24 states.
- Devoting one-third of electric and natural gas utility allowances to energy efficiency. This is an increase relative to the 1/5 of allowances required of gas utilities in APA, and no efficiency requirements for electric utilities.
- Establishing industrial energy efficiency program funding at 0.25% of emissions allowances through 2030, and a Revolving Loan Fund with 20% of the energy-intensive, trade-exposed industries (EITE)

allocations. APA includes industrial energy efficiency program funding only for 2013-2015. The Revolving Loan Fund is in ACELA, but is unfunded.

- Continuing to provide emissions allowances for state energy efficiency and renewable energy programs through 2030, and increasing the percentage of emissions allowances to 6%. These allocations would approximately align with those in the House-passed ACES bill.
- Targeting Highway Trust Funds and Transportation Investment grants in APA so that they achieve greenhouse gas reductions.
- Strengthening conditions for the Clean Vehicle Technology Fund in APA; closing a loophole that lowers the bar for diesel vehicles to qualify; and including only vehicles that exceed federal fuel economy standards by at least 25 percent.

Expanded case, which represents the potential savings and impacts on the economy of a massive investment in energy productivity. This builds on the results of many recent studies on what is possible, as well as recent work suggesting that the larger economic productivity of the U.S. economy has been anchored to increased energy productivity throughout the past century; therefore, accelerated investment in more energy-productive behaviors, infrastructure, and technologies is needed to keep the U.S. economy strong.

Results

Overall, our analysis finds that benefits to society are maximized in the enhanced efficiency and expanded efficiency cases. Both of these cases provide substantial reductions in household energy costs relative to the base case and the APA+ACELA case. The benefits are achieved because of large reductions in energy use, which result in lower energy bills even though energy prices rise moderately. In addition, the enhanced and expanded cases also show significant increases in employment relative to the base and APA+ACELA cases. These employment benefits are achieved because energy efficiency is more labor-intensive per dollar spent than construction of power plants or extraction of energy resources. Also, when consumers and businesses save money on their energy bills, they spend much of their savings in ways that generate jobs.

Our analysis also finds that the APA+ACELA case does provide significant benefits relative to business-as-usual. In this case, consumers save money and jobs are generated, but these benefits are smaller than in the enhanced and expanded cases. Also, in the APA+ACELA cases, benefits are delayed relative to the enhanced and expanded cases because energy savings are smaller and take more years to offset the upfront costs of the initial investments required.

For all of our cases, we find that the size of the U.S. economy, as measured by GDP, is essentially the same. The savings from energy efficiency offset the impacts of climate legislation on energy prices; as a result, changes in GDP are minimal but generally positive. These impacts range from a decrease in GDP of -0.06% to an increase of 0.13%, varying by year and case. Although we did not analyze the impact of added productivity benefits from the energy efficiency investments, research suggests such improvements would reduce other costs in ways that might perhaps enhance the overall robustness of the economy.

In the following paragraphs, we summarize our results for each case. Then we discuss a few other notable findings involving carbon allowance prices and impact on oil consumption.

Base Case

Under the base case, U.S. energy use increases by 34% from 2010 to 2050. Greenhouse gas emissions increase by 11%. And the U.S. economy grows moderately, with GDP increasing an average of 2.6% per year.

APA+ACELA

Our analysis of APA+ACELA finds significant energy savings from the energy efficiency provisions in the bills. These energy efficiency provisions would reduce U.S. energy use by about 2.3% in 2020 relative to the base case, and save about 5.0% in 2030. Nearly 80% of the 2030 energy savings are attributable to provisions in ACELA that enact new appliance and equipment efficiency standards and direct that model building codes be revised to meet specific energy savings goals, and to provisions in APA that fund industrial energy efficiency programs and research and development (R&D) of new efficiency technologies.

There are no savings from the EERS in ACELA because its target for efficiency is below business-as-usual, and utility savings are modest because only gas utilities are required to invest in energy efficiency. Transportation savings are also modest, because increased vehicle efficiency is dealt with primarily outside the APA framework. Instead, new light- and heavy-duty vehicle efficiency standards are driven by requirements in the Energy Independence and Security Act of 2007 and subsequent rules adopted or under development by the Obama Administration.

Due to these energy savings, household savings are substantial, totaling about $256 per household in 2030 and $321 per household in 2050. There is a modest cost per household ($24) in 2020 since upfront costs for efficiency investments have not yet been repaid with energy savings.

Our economic analysis finds that APA+ACELA achieves its greenhouse gas emissions goals at modest cost to about 2035, but that as we approach 2050 and the emissions caps tighten, the price of emissions allowances rises to the price cap. Impacts on the U.S. economy are generally positive, with GDP rising slightly in most years (increase of 0% to 0.13%, depending on the year). Employment increases by 166,000 jobs in 2030 and about 500,000 jobs in 2050, although there are some small employment losses in 2020 (a decline of 60,000) due to the fact that investments made in early years are not yet achieving substantial benefits.

Enhanced Case

The enhanced case includes much more energy efficiency programs and savings. As a result, in 2020, the direct energy efficiency savings reduce U.S. energy use by 5.8% below projected levels. Energy use reductions hit 16% in 2030. The 2020 savings are a factor of 1.8 higher than under APA+ACELA while the 2030 savings are a factor of 2.4 higher. In the enhanced case, relative to the APA+ACELA case, savings particularly grow for the industrial programs (due to the revolving loan fund and continued R&D), the EERS (which now exceeds business-as-usual), utility and state programs, and transportation programs. Energy savings will continue to mount in the out-years.

In the enhanced case, household savings are about $200 higher per household per year in 2030 and 2050 relative to the APA+ACELA case. Impacts per household are also lower in 2020, with essentially no costs or savings relative to the base case.

Relative to the APA+ACELA case, the number of net jobs increases significantly, with 123,000 net jobs created in 2030 and 364,000 in 2030. In the APA+ACELA case, the number of net jobs was essentially modestly negative in 2020 and less than half the level of net jobs in the enhanced case in 2030. GDP in the enhanced case is essentially the same as the base case.

Expanded Case

The expanded case includes further improvements to energy efficiency in order to meet long-term energy-productivity targets. Relative to the base case, U.S. energy use is further reduced. Benefits per household also increase and range from $81 savings per household in 2020 to $849 per household in 2050. Net jobs increase further as well in the expanded case, with about 373,000 jobs created in 2020, 689,000 in 2030, and over 1.1 million in 2050. GDP tends to be slightly positive relative to the base case, with the increase in GDP ranging from 0.06% to 0.18%, depending on the year.

Carbon Prices

In the APA+ACELA and enhanced cases, by 2050 the carbon price reaches the price ceiling. This is not a major cost since energy use is down substantially and the higher costs apply to much fewer units of energy. This said, in order to meet the emissions targets in 2050, more offsets will need to be purchased in the final years of the analysis or the price cap relaxed somewhat. The exception to this pattern is the expanded case, where the increased levels of energy efficiency bring the price of allowances down to $113 per ton in 2050, allowing the emissions targets to be met without increased use of offsets. Thus, increased energy efficiency can reduce the use of offsets, particularly international offsets that receive preference in APA when the price cap is reached.

Conclusions

Overall, we find that APA+ACELA can provide significant energy savings (5.0% direct reduction in 2030), consumer financial savings ($256 per household in 2030), and emissions reductions, while generating jobs (166,000 in 2030). This case has a very small positive impact on the overall economy as measured by GDP (e.g., increases in GDP of 0% to 0.13%, varying by year).

The enhanced case roughly doubles the amount of energy savings achieved (16.9% direct savings in 2030), increasing consumer financial savings ($448 per household in 2030) and emissions reductions. The enhanced case also increases the number of jobs created (364,000 net jobs in 2030). Under the enhanced case, approximately 364,000 jobs are created in 2030. As with the APA+ACELA case, changes in GDP are very small.

The expanded case further increases energy savings and job creation. And in the expanded case, the need to purchase international offsets is also reduced.

This analysis shows that increasing the role of energy efficiency in the legislation will increase both household savings and job creation. Therefore, we recommend that the policies in the enhanced case be adopted including:

- Establishing a 10% Energy Efficiency Resource Standard (EERS), either separate from or combined with a Renewable Energy Standard (RES).
- Devoting one-third of electric and natural gas utility allowances to energy efficiency.
- Establishing industrial energy efficiency program funding at 0.25% of emissions allowances until 2030, and the establishment of a Revolving Loan Fund with 1/5 of the energy-intensive, trade-exposed industries (EITE) allocations.
- Continuing to provide emissions allowances for state energy efficiency and renewable energy programs through 2030, and increasing the percentage of emissions allowances to 6%.
- Targeting Highway Trust Funds and Transportation Investment grants so that they achieve greenhouse gas reductions.
- Strengthening conditions for the Clean Vehicle Technology Fund; closing the diesel loophole; and including only vehicles that exceed CAFÉ by at least 25 percent.

Much of the current debate about federal cap-and-trade legislation focuses on the costs of compliance. Most of the prior studies of APA and ACELA do not fully consider the energy efficiency provisions in these bills and none of the other studies examine the impacts if energy efficiency provisions are strengthened. A broader accounting of all of the efficiency provisions shows substantial savings for consumers and increased job creation. Based on these findings, we conclude that energy efficiency provisions are both key to achieving greenhouse gas emissions reduction and cost mitigation, and represent an important foundation for any Senate climate and/or energy legislation.

Although the energy efficiency provisions in APA as proposed by Senators Kerry and Lieberman and included in ACELA will result in important consumer cost savings and new job creation, they do not go far enough. With these recommended enhancements, a good bill can be made much better, decreasing U.S. energy use, increasing household savings, and improving the productivity of our economy.

INTRODUCTION

The current U.S. Congress has been working on energy and climate legislation steadily since being sworn into office in January, 2009. In June, 2009, the House of Representatives passed an energy and climate bill entitled the *American Clean Energy Security Act* (ACES). This bill included a cap and trade program on greenhouse gas emissions in most sectors of the U.S. economy and many significant energy efficiency provisions. ACEEE has previously analyzed the energy savings and economic impacts of this bill.

On May, 12, 2010, after months of deliberation, Senators John Kerry (D-MA) and Joseph Lieberman (I-CT), with input from Senator Lindsey Graham (R-SC), introduced a discussion draft of comprehensive climate change legislation, called the *American Power Act of 2010* (APA). This bill contains a cap-and-trade program on greenhouse gas emissions by utilities and large industrial emitters, a carbon fee on transportation fuels, and a modest allocation of funds to energy efficiency. This bill was designed to be combined with energy legislation developed by the Senate Energy and Natural Resources called the *American Clean Energy Leadership Act* (ACELA). ACELA, which includes a number of key building and industrial energy efficiency provisions, was passed by the Senate Energy and Natural Resources Committee in June, 2009 and amended in May, 2010 to include additional energy efficiency provisions.

In contrast to House-passed ACES bill, APA includes much less investment in energy efficiency. And relative to the energy efficiency provisions in ACES, the Senate Energy Committee ACELA bill includes somewhat more limited energy efficiency provisions. As a result, the combination of APA and ACELA achieves less energy savings than ACES and increases the cost of meeting the greenhouse gas emissions targets in both bills. APA does include more provisions for energy efficiency in transportation and industry than did ACES, representing opportunities for enhancements that, when combined with some of the provisions from the House-passed bill, could achieve even greater savings, with significant benefits to average Americans.

Experience within many of the states that are now successfully managing cost-effective energy programs demonstrates that energy efficiency is the quickest, least-cost, and most effective way to achieve both climate and other energy and economic development goals. See Friedrich et al. (2009) and also Cleetus et al. (2009) and Laitner (2009b) for national-level impacts. Indeed, numerous studies underscore the critical contribution of energy efficiency investments in saving households and businesses money while substantially reducing energy-related greenhouse gas emissions. See, for example, InterAcademy Council (2007); Ehrhardt-Martinez and Laitner (2008); Lovins (2008); American Physical Society (2008); Furrey et al. (2009); McKinsey & Company (2009); Laitner (2009a); AEF (2009); Gold et al. (2009); Houser (2009); and Cooper (2009). Moreover, recent research by Robert Ayres and Benjamin Warr (2009), summarized in Ayres and Ayres (2010) and Laitner (2010), indicates that without massive investments in energy productivity, the U.S. economy will be unable to maintain a fully prosperous level of economic activity.[1]

This report analyzes the impacts of APA and ACELA on energy use, greenhouse gas emissions, and the U.S. economy. We examine the two together because APA is highly unlikely to be enacted on its own and is more likely to be enacted in combination with ACELA. Also, by examining the two together, we can better compare our results to our previous analysis of the House ACES bill. In a few places we provide breakouts of the contribution of APA and ACELA to total savings and clearly label these as ACELA-only and APA-only. In addition to examining APA+ACELA, we also examined two scenarios with stronger energy efficiency provisions. We did this because our previous analyses show that energy efficiency helps moderate the cost of climate legislation, a key consideration in order for any legislation to be enacted into law.

ENERGY EFFICIENCY IN ACELA AND APA

ACELA contains a number of important energy efficiency provisions, some of which are similar to the House-passed ACES bill. It includes a Renewable Electricity Standard (RES) that includes energy efficiency, but the maximum level of efficiency in this provision (4% of electricity sales by 2020) is less than business-as-usual when it comes to electricity efficiency. In addition, ACELA includes a number of critical appliance standards, many of which were added in the May 2010 amendment. ACELA contains a number of key building and industrial energy

[1] For a further discussion of this point, see the box insert, “The Role of Efficiency in Creating a Robust Economy,” later in this report.

efficiency provisions as well. These authorize specific programs but are dependent upon appropriations for funding, unless there are APA emissions allowances to fund them. The energy efficiency provisions in ACELA are summarized in Table 1.

Table 1. Energy Efficiency Provisions in ACELA

Title	Subtitle	Section
Title I - Clean Energy Technology Deployment	Subtitle C - Federal Renewable Electricity Standard	Sec. 132 Federal renewable electricity standard
Title II - Enhanced Energy Efficiency	Subtitle A - Manufacturing Efficiency	Sec. 201 Industrial EE Revolving Loan Program
		Sec. 204 Future of Industry Program
		Sec. 204c Industrial Research and Assessment Centers
		Sec. 206 Innovation and Industry Grants
	Subtitle B - Improved Efficiency in Appliances and Equipment	Sec. 222 Reforms to Energy Star
		Sec. 224 Portable light fixtures
		Sec. 227 Commercial furnace standards
		Sec. 228 Motor efficiency rebate program
		Sec. 233 AHRI standards
		Sec. 235 Standards for Water Dispensers, Hot food holding cabinets, and Portable Electric Spas
		Sec. 239 Outdoor lighting fixtures
	Part I - Building Codes	Sec. 241 Building Codes
		Sec. 242 Multifamily and Manuf. Housing
		Sec. 243 Building Training and Assessment Centers
	Part II - Weatherization for low-income	Sec. 251 Weatherization assistance for low-income persons
	Part IV- State Energy Efficiency Grants Programs	Sec. 262 State Energy Efficiency Retrofit Programs
	Part VI - Energy Efficiency Information on Homes and Buildings	Sec. 281 Building energy performance labeling program

Table 2. Energy Efficiency Provisions in APA

Title	Subtitle	Section
American Power Act	Allowance Allocations	Sec. 782 Electricity customers
		Sec. 783 Natural Gas customers
		Sec. 784 Home Heating Oil and Propane Customers
		Sec. 1801 Clean Energy Tech R&D
		Sec. 4143 Low-Carbon Industrial Technology R&D
		Sec. 1602 Rural energy savings program
		Sec. 1603 State Allocations (other)
		Sec. 4001 Industrial Energy Efficiency (non-ACELA portion; EISA Sec. 451)
		Sec. 4111 Clean Vehicle Technology
		Sec. 1712 Transportation Planning
		Sec. 785 Highway Trust Fund Allowances
		Sec. 781 TIGER Grants

APA's efficiency provisions fall into a few distinct categories: consumer protection provisions that require local distribution companies (LDCs) or states to spend a portion of natural gas or fuel oil allowances on energy efficiency, state funding for energy efficiency, funding for R&D programs, industrial energy efficiency technical assistance and grants, and transportation planning and infrastructure funds. Most of these provisions will phase out by 2021, and a number end as early as 2015. These different provisions are summarized in Table 2.

The consumer protection section of the bill contains two energy efficiency provisions: 1) a requirement that natural gas utilities spend 1/5 of their allowance revenue (9% beginning in 2016) on energy efficiency programs; and 2) a requirement that state use ½ of their home heating oil revenue (1.9% beginning in 2013) for energy efficiency programs.

Energy efficiency programs are further supported by state allocations, which are specified for a variety of energy efficiency and renewable energy purposes, including energy efficiency programs, renewable technology deployment, smart grid technology, or surface transportation capital projects (up to 10%). The allocation for this purpose in APA is significantly lower than in ACES, beginning at 2% in 2013 and ramping down by 2021. A significant portion of these funds may likely be used to fund buildings energy efficiency provisions in ACELA. In addition, the bill establishes a rural energy savings program that creates a revolving loan fund for rural co-ops to use to administer energy efficiency programs in 2013-2015.

APA contains a transportation efficiency program, which receives $1.9 billion per year to support state and metropolitan areas in setting and meeting targets for reducing transportation-related greenhouse gas emissions. The bill contains funds for a Clean Vehicle Technology fund, which provides retooling incentives for the manufacture of advanced vehicles and components. However, the definition of advanced vehicle is currently too weak to support continuing progress in fuel efficiency.

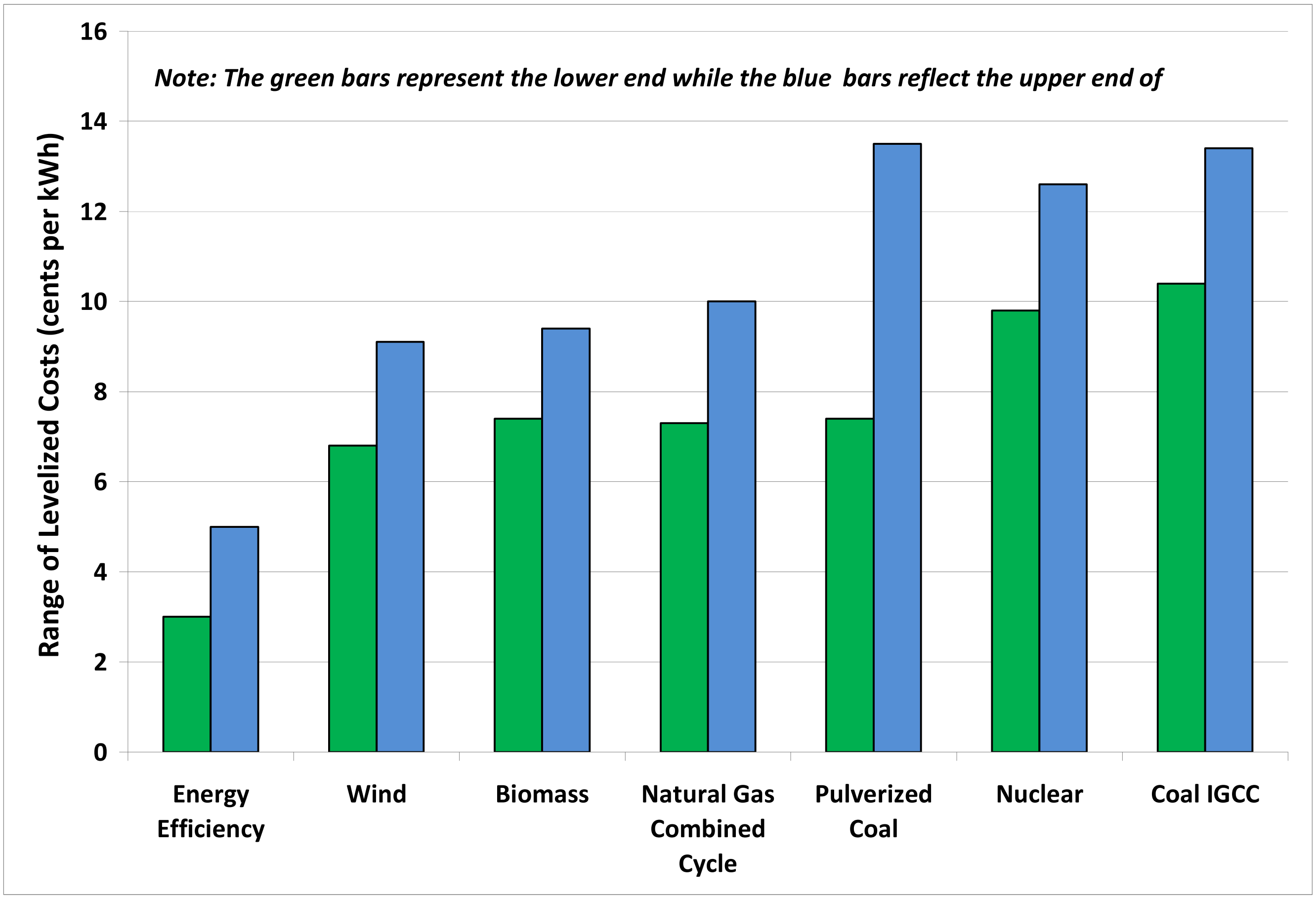
The industrial sector of the economy is different from other sectors in that it is both a major emitter of greenhouse gases (both from fuel combustion and direct process emission) and also a manufacturer of products that can reduce energy use and carbon emissions in other sectors. For these reasons, it is particularly important that climate legislation support a robust, efficient and competitive manufacturing sector. The bill provides a robust allocation to protect those Energy Intensive Trade Exposed Industries (EITE) beginning at 15% in 2016, and declining to zero by 2030. Two percent of the allocations are designated for use in "Industrial Energy Efficiency" provisions in 2013-2015, to be used to fund a waste energy and combined heat and power program, as well as ACELA provisions for "Future of Industry" industry co-funded R&D program, Industrial Assessment Centers (IAC), and innovation grants.

APA includes two major R&D provisions that together receive 3% of emissions allowances in 2013 but phase-out in 2021. One is focused on Clean Energy Technology, and has six allowable uses, including transportation efficiency, buildings/industrial efficiency, and advanced materials for energy/energy efficiency. The other is focused on Low-Carbon Industrial Technology R&D, designed to support competitiveness and job creation in the manufacturing industry.

A summary of the energy efficiency provisions in ACELA and in APA is included in Appendix A. These important provisions have been largely overlooked in discussions and analyses of the bill thus far. This report attempts to remedy this problem.

Energy efficiency policies offer a critical opportunity to offset increased energy costs that could result from the cap-and-trade provisions in the bill. When compared to traditional generation sources, energy efficiency is the least-cost energy resource available today. This is illustrated in Figure 1 below. Moreover, as discussed in subsequent sections of this report, energy efficiency offers the potential to create new jobs and reduce carbon dioxide emissions.

Figure 1. Levelized Electricity Resource Cost in 2008



Source: Lazard (2008)

ENHANCED AND EXPANDED EFFICIENCY ANALYSES

ACEEE's previous analyses of ACES (Gold et al. 2009; Laitner 2009b) clearly demonstrate the economic and environmental benefits from enhancing the energy efficiency in climate proposals.

As the Senate considers energy and climate legislation, it has the opportunity to significantly improve upon the work done in the House, in ACELA, and in APA, by expanding the economic benefits associated with energy efficiency and further offsetting the costs of cap-and-trade legislation.

In this analysis, we also consider the additional benefits that would result from the following six key enhancements to energy efficiency provisions:

1. Complement APA with energy legislation, including a robust energy efficiency resource standard.

Senator Kerry has proposed to complement APA with the ACELA bill reported out by the Senate Energy Committee. ACELA includes a variety of useful energy efficiency provisions including new appliance standards and building labeling, retrofit, and code provisions. But the combined renewable energy and energy efficiency standard—a key ACELA provision—is very weak. This provision calls for 15% of electric utility sales in 2020 to come from either renewable energy or energy efficiency, with energy efficiency capped at 4% of sales.

The overall efficiency cap needs to be increased as well as the energy-efficiency share. Twenty states are now on track to achieve 10% energy efficiency savings by 2020 (see Table 3). A similar stand-alone cumulative 10% by 2020 energy efficiency target should be included in ACELA. This increase in the level would save substantial energy in the 30 states that are not already on track to reach these savings levels. The level of electricity savings required under the EERS should begin at 0.75% of the 2 prior years' sales in 2012 and slowly ramp up to 10% cumulative savings in 2020. Implementing a national energy efficiency resource standard would commit every state to utilizing this least-cost resource, establish a baseline of cost-effective and achievable savings, and reduce carbon dioxide far more than states acting alone.

Table 3. 2020 Cumulative Electricity Saving Targets by State

Vermont	30%	Indiana	14%
New York	26%	Rhode Island	14%
Massachusetts	26%	Hawaii	14%
Maryland	25%	California	13%
Delaware	25%	Ohio	12%
Illinois	18%	Colorado	12%
Connecticut	18%	Utah	11%
Minnesota	17%	Michigan	11%
Iowa	16%	Pennsylvania	10%
Arizona	15%	Washington	~10%

Source: ACEEE analysis of state legislation and regulations.
Note: Where targets do not extend to 2020, we extrapolate based on annual savings rates that have been established.

2. Require electric and natural gas utilities to spend 33% of their free emissions allowances on energy efficiency.

Electric distribution companies are given up to 51% of emissions allowances for "consumer benefit". Most of these allowances are likely to be sold and used to reduce energy bills. But once the money is spent, there are no long-term benefits. A portion of these funds should be invested in energy efficiency programs that serve consumers, helping to reduce energy bills in the long-term. There is such a requirement in APA for natural gas utilities, which was reduced from 33% in the ACES House bill to 20% in this draft Senate bill. We recommend the House requirement for natural gas utilities be restored and a similar requirement be placed on electric utilities.

<u>Continue state energy efficiency programs in APA past 2015 or 2021.</u>

The limited number of energy-efficiency programs in APA phase out, some in 2015, others in 2021. These should be extended until 2030 *at a minimum*. Also, many of the programs in ACELA require funding if they are to save energy. Such funding should be included in APA by providing funds to states for ACELA programs. The building code, building retrofit, manufactured housing, and low-income housing programs in ACELA require up-front funding to provide consumer incentives and drive building energy efficiency. Without a dedicated stream of funding, such as the state energy efficiency emissions allowances, this source of savings for consumers will remain un-tapped.

For example, the ACES bill provides states 4.5% of allowances for state and local-administered energy efficiency and renewable energy all the way to 2050. This "SEED (State Energy and Environmental Development)" funding begins at 9.5% and drops to 4.5% by 2026, an average of about 6% per year. ACEEE recommends that 6.0% of the emissions allowances be used for the state and local energy efficiency and renewable energy programs, beginning in 2013 and extending until 2050. In our enhanced case, ACEEE modeled these additional funds as going to the states, but a portion of these funds could also be used to extend the Rural Energy Savings Program (Sec. 1602).

<u>Expand support for industrial energy efficiency provisions.</u>

While APA provides important transitional funding to manufacturing R&D and efficiency investment from 2013-15, this funding is not continued beyond this transitional period. Because of the long planning horizon that most industrial research and energy efficiency projects require (Elliott et al. 2008), funding needs to be sustained if these efforts are to have their desired impact on manufacturing carbon emissions. We recommend that an allocation of allowances to support these industrial efficiency programs be continued through 2030 out of the 15% allocation to Energy Intensive Trade Exposed (EITE) sectors of the economy. The certainty of funding for federal industrial efforts will allow for long-term planning and implementation that will provide the greatest impact for the program.

For industry to both reduce their own carbon emissions and produce the efficient products that will enable other sectors of the economy to reduce their emissions, the U.S. will need major new investments in manufacturing capacity. The funding for the industrial R&D provisions will provide the tools needed to achieve these goals, but industry will also need access to capital to rebuild its aging manufacturing infrastructure (Elliott et al. 2008). Both ACELA and the *Investments for Manufacturing Progress and Clean Technology (IMPACT) Act of 2009* (Sec. 1617 introduced by Senator Sherrod Brown, D-OH) establish modest revolving loan funds that fund investments in new manufacturing capacity that will enable the production of clean energy products and reductions in manufacturing sector emission. As an enhancement to APA, we suggest that 20% of the allocation to EITE be used to capitalize a revolving loan fund to support investments in energy efficiency, carbon reduction and clean technology manufacturing in EITE-eligible industries. The funds from the pool would be loaned up to 10 years at the current 1-year Treasury Bill rate, with loan repayments being re-lended to support additional investments. This revolving loan fund, combined with the funding resulting from the industrial share of the utility and state allocations discussed above would provide a pool of financing that would enable the modernization of U.S. industry. These investments would allow domestic manufacturing capacity to become more efficient and globally competitive, ensuring that the U.S. has a continued manufacturing base to support a sustainable future economy and retain or create important manufacturing jobs.

3. Enhance provisions to improve transportation efficiency.

Along with the very important transportation planning program, the bill allocates money to expand the Transportation Investment Generating Economic Recovery (TIGER) grant program now funded under the American Recovery and Reinvestment Act (ARRA) and to replenish the Highway Trust Find, for a total of about $6 billion per year. Funds for these programs need to be better targeted to ensure that they achieve greenhouse gas reductions while improving the efficiency of the transportation system. Projects considered for funding from allocations should be subject to selection criteria regarding greenhouse gas reductions and the cost-effectiveness of those reductions.

4. Strengthen conditions for the Clean Vehicle Technology Fund.

The bill establishes a Clean Vehicle Technology Fund with auction revenues to provide retooling incentives for the manufacture of advanced vehicles and components. The Clean Vehicle Technology Fund as currently formulated would likely deliver only modest savings. The definition of advanced vehicle is currently too weak to support continuing progress in fuel efficiency. An enhanced provision should raise the efficiency threshold for eligible vehicle models to ensure they exceed CAFE requirements and eliminate the loophole that allows diesel vehicles to qualify at a lower efficiency level than gasoline and alternative fuel vehicles.

The results of including the improvements in the legislation, as outlined in the six items above, are hereinafter referred to collectively as “Enhanced APA” and these energy savings are added to the provisions of the Senate bills as detailed in Tables 1 and 2. Our enhanced efficiency case also includes a few other provisions, such as Sec. 1696—study and standards for video game consoles, Sec. 1637, and Sec. 1639—tax bills for building and industrial incentives introduced by Senators Jeff Bingaman (D-NM), Olympia Snowe (R-ME), and Diane Feinstein (D-CA).

The various provisions in the “enhanced case” are described in Appendix B.

In addition to the “enhanced energy efficiency case,” we created an “expanded efficiency” case, which represents the potential savings and impacts on the economy of a massive investment in energy productivity. This generally builds on the discussion found in Laitner (2009a, 2009b) and the High-GDP Fast-Shift Efficiency Scenario found in Harvey (2010). It also relies on the assumptions in the National Academy of Sciences report, *Real Prospects for Energy Efficiency in the United States* (AEF 2009). Further discussion on some of the aggressive energy-savings measures that would be involved is provided in Appendix C. In general the expanded efficiency case suggests roughly a 30 percent additional energy productivity improvement by 2030. This is extended through 2050 with an assumption of further R&D and program expenditures to drive these results. Part of the motivation for an “expanded energy efficiency” case emerges from work recently published by Ayres and Warr (2009) which suggests that the larger economic productivity of the U.S. economy has been anchored to the increased energy productivity throughout the past century. The implication drives what we now call the “economic imperative” of an accelerated investment in more energy productive behaviors, infrastructure and technologies in order to keep the U.S. economy strong.

ESTIMATED ECONOMIC, ENERGY, AND CARBON SAVINGS FROM ENERGY EFFICIENCY PROVISIONS

Methodology

ACEEE has estimated the impacts of these energy efficiency provisions using analysis tools developed over the years for different sectors and types of provisions. During the past two decades, ACEEE has become recognized for providing estimates of the impacts of energy efficiency provisions in federal energy legislation (Geller et al. 1992; Nadel et al. 2005; Gold et al. 2009; and Laitner 2009b). We mapped these analytical techniques into a pair of Excel-based models that allow for:

- individual assessments of each provision and various changes to the provisions;
- projection of national and state level energy and carbon dioxide emissions reductions; and
- an estimation of macroeconomic and employment impacts.

The foundation of this modeling effort is an assessment of the energy savings, net consumer costs, and emissions savings for each individual provision within APA and ACELA. The approach used for each energy efficiency provision varies in its approach and impact. Further details and key assumptions are discussed in Appendix D. Because of the complexity of these provisions and the potential for interaction, some of the less critical elements of the provisions have been simplified. Still, the cost and performance characterization of the energy efficiency measures are more detailed than those in recent analyses by the U.S. Environmental Protection Agency (EPA 2010), for example.

Because the energy-savings model allows key overall parameters, as well as measure-specific parameters, to be varied, the model can easily explore alternate scenarios such as the enhanced case presented above. The model is designed such that additional provisions can be added with relative ease so that it can be used to explore an evolving suite of legislative provisions.

This report provides a detailed analysis of cost-effective efficiency options within an economic modeling framework. But to evaluate these energy efficiency provisions within the context of a national climate policy, the overall APA bill and the two high-efficiency scenarios were analyzed with ACEEE’s DEEPER model (the **D**ynamic **E**nergy **E**fficiency **P**olicy **E**valuation **R**outine; see Laitner 2009b for a more complete description and prior use of the model to evaluate other climate policies). This macroeconomic evaluation consists of three steps.

First, we calibrate the DEEPER model to establish a current set of economic accounts for the United States (IMPLAN 2009) and then use the Energy Information Administration’s *Annual Energy Outlook 2010* (EIA 2010) to establish reference case out to the year 2050 (the last year for which the APA establishes specific emissions targets). In this respect, we incorporate the anticipated investment and spending patterns that are suggested by the standard forecast assumptions.[2] These range from typical spending patterns by businesses and households within the period of analysis to the anticipated construction of new electric power plants and other energy-related spending that might also be highlighted in the forecast.

Second, we transform the set of APA+ACELA policy assumptions into the direct inputs that are needed for the economic model. The resulting inputs include such parameters as:

The combination of carbon and energy price increases as well as the annual policy and/or program spending that drives the key policy investments and behaviors;

[2] In fact, the *Annual Energy Outlook 2010* extends only to the year 2035, but we rely on a number of other forecasts to provide a reasonable extrapolation of energy prices and energy consumption patterns out to the year 2050. Since we are effectively modeling changes from a given reference case forecast, the precise reference case projection doesn’t matter as much as the appropriate characterization of alternative patterns of investments and changes in energy prices that are likely to result from the implementation of any given climate or energy policy.

The capital and operating costs associated with more energy-efficient technologies; and
The energy bill savings that result from the various energy efficiency policies described in the main body of the report.

Once the model is calibrated and tested, we are then able to evaluate the larger economic impacts over the 2013 to 2050 time horizon. More details on the DEEPER model are provided in Appendix E.

National-Level Results

The energy efficiency provisions in enhanced legislation would produce impressive benefits relative to the base APA+ACELA bills. These benefits include net consumer savings, jobs created, and carbon dioxide reductions, which will each be discussed in greater detail in the next sections. Net consumer savings and jobs created are summarized in Table 4. Detailed results from the analysis are presented at the national level in Appendix F by provision and by fuel.

Table 4. ACEEE Estimates of Benefits from Energy Efficiency in APA

		Net jobs created (in thousands)	Net annual consumer savings per household (in 2007$)
2020	APA/ACELA	-60	-$24
	Enhanced Efficiency	123	-$3
	Expanded Efficiency	373	$81
2030	APA/ACELA	166	$256
	Enhanced Efficiency	364	$448
	Expanded Efficiency	689	$673
2050	APA/ACELA	504	$321
	Enhanced Efficiency	663	$521
	Expanded Efficiency	1,154	$849

The Role of Efficiency in Creating a Robust Economy

Most observers of U.S. energy policy might think of energy efficiency as a useful tool to smartly manage the growth of energy consumption. They might also see it as a cost-effective means to ease our transition into a post-carbon world. The good news is that the evidence supports both of these notions (Laitner 2009a, 2009b). But there is also emerging evidence that demonstrates that energy efficiency plays a more critical role within the economic process than is generally understood.

Building on the work of Georgescu-Roegen (1971), and very much in the tradition of Kneese et al. (1971), Hall et al. (1992), and others, professors Robert U. Ayres and Benjamin Warr (2009) convincingly document the critical link between our nation's overall economic productivity and the declining cost of energy-related services.

The analysis published by Ayres and Warr departs from the standard review of declining energy intensity—generally measured as the number of units of energy that are needed to support a given level of economic activity or Gross Domestic Product (GDP). They have developed, instead, a new and more complete data set that includes: (i) commercially-sold energy as reported by the U.S. Energy Information Administration (EIA 2009d), including the more familiar items such as gallons of gasoline or kilowatt-hours of electricity; and (ii) estimates for contributions from labor, draft animals, and the biomass resources that directly contribute to economic activity.

As of 2005, Ayres and Warr suggest that, when evaluated in terms of total useful energy needed to support the U.S. economy compared to the total amount of energy that is available for use, America has a rather anemic 13 percent level of overall energy efficiency. Perhaps of greater concern is that this level of (in)efficiency has not improved significantly in recent years and it may now be constraining our nation's economic recovery.

Historical evidence indicates that energy efficiency has already contributed greatly to the growth of our economy. Since 1970, the U.S. economy has more than tripled in size. Notably, however, three-quarters of the new demand for energy services necessary to support this expansion was met through significant improvements in energy efficiency, while only one-quarter of the new demand required the development of new energy supplies (Ehrhardt-Martinez and Laitner 2008). As such, energy efficiency has been characterized as the farthest reaching, least-polluting, and fastest growing energy success story of the last 40 years. In essence, energy efficiency is the cost-effective investment "in the energy we *don't* use to produce our nation's goods and services." Despite these critical contributions, however, the importance of energy efficiency has remained largely invisible and measures of efficiency are typically absent from today's policy models and analyses.

The good news is that the historical contributions of energy efficiency represent only a small fraction of a much larger resource. While efficiency has provided the equivalent of ~300 billion barrels of oil equivalent for use in our economy since 1970 (with new supply kicking in perhaps less than120 billion barrels in that same period of time), studies of the potential contributions of efficiency suggests that current efficiency gains reflect only the tip of the full economic potential to meet future energy-related demands (Laitner 2009a, 2009c). Indeed, Ayres and Warr (2009), Laitner et al. (2009), and Ayres and Ayres (2010) suggest that unless we redirect our annual investment streams toward more efficient infrastructures, facilities, and equipment, the economy may support significantly fewer jobs in a substantially less robust economy in the next decade or two.

Energy Efficiency in Recent Climate and Energy Proposals

As suggested in Appendix C, "How Big Energy Efficiency?", there are a growing number of studies all of which suggest a very large efficiency potential—should we choose to make the appropriate investments in more productive technologies and their complementary infrastructures. The American Power Act builds upon years of work by both the U.S. House of Representatives and U.S. Senate on energy and climate proposals. Both the House-passed *American Clean Energy and Security Act* (ACES) and the Senate energy-only bill, the *American Clean Energy Leadership Act of 2009* (ACELA), will interact with this bill, either in conference (ACES) or on the Senate floor (ACELA). Figure 2 below compares estimated savings from energy efficiency from these bills and other recent legislation.

In 2020, the energy savings from APA including ACELA would be slightly more than the savings from the *Energy Policy Act of 2005* (EPAct), and would be about half of the savings of the House-passed ACES and the *Energy Independence and Security Act of 2007* (EISA). These savings more than double in 2030, due to investments made early in the bill whose savings climb for a number of years.

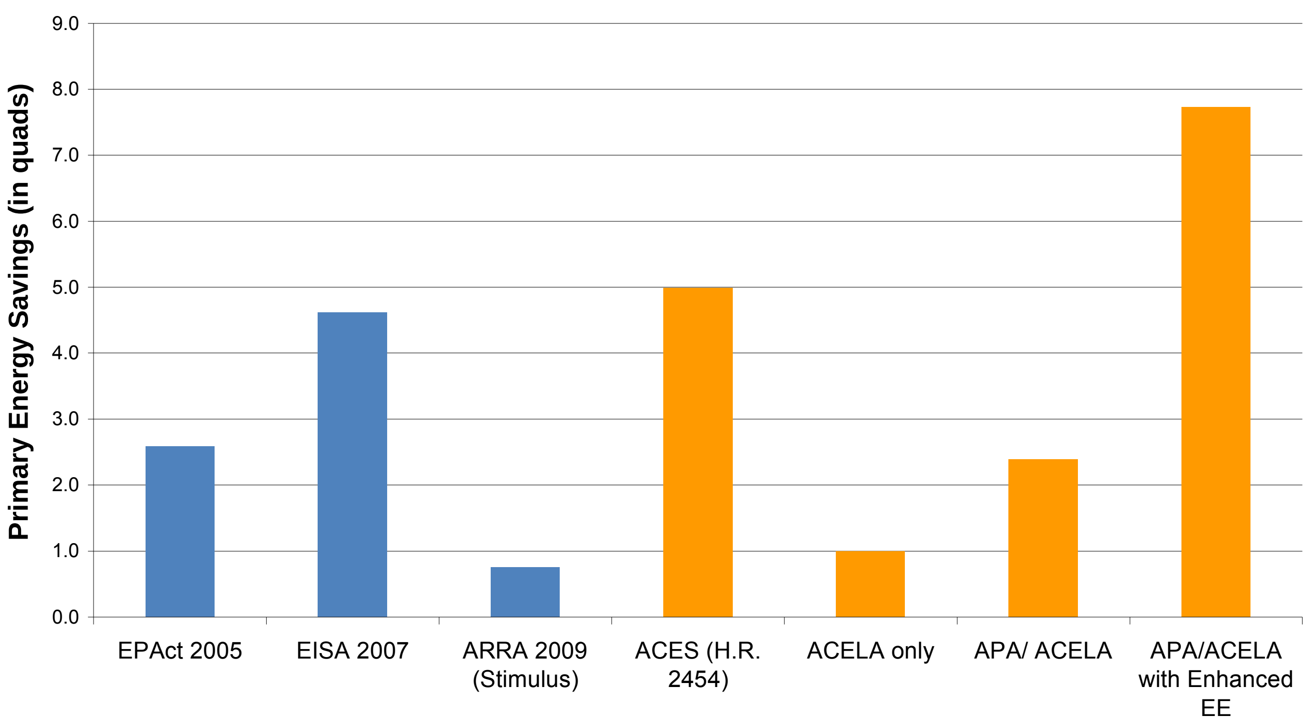
In the enhanced case, the energy savings in 2020 are double the savings from the APA+ACELA bills. This comparison is shown in Figure 2.

ACEEE's September 2009 analysis of the ACES demonstrated that the energy efficiency provisions in the bill would save 4.9 quads in 2020 and 8.8 quads in 2030. In comparison, the energy efficiency provisions in APA+ACELA will save 2.4 quads in 2020 and 5.6 quads in 2030. In general, ACES provided higher levels of investment in energy efficiency, although APA provides better provisions for industrial and transportation energy efficiency.

In September 2009, ACEEE analyzed the impacts of recommended enhancements to ACES, including a 10% EERS, additional state funding and transportation planning funds, and a requirement that electric utilities use 33% of their allocation for energy efficiency. All of the above enhancements were included in the APA+ACELA Enhanced Case, but a number of recommended enhancements were added for this analysis. In particular, a number of significant industrial energy efficiency provisions were added to the enhanced case. This change came in response to increased Senate and White House interest in mitigating the impacts of climate change on energy-intensive, trade-exposed industries (see U.S. Congress 2010 and Interagency Working Group 2009). In addition, the underlying APA bill contained a small, short-term industrial program on which to build our enhancements. As a result, estimated energy savings of 18.8 quads for the enhanced case of APA is 17% greater in 2030 than ACEEE's enhanced case for ACES (16.1 quads).

The energy-only bill, ACELA, would provide significantly less savings than APA+ACELA. ACEEE's "Enhanced Efficiency Case" modeled only a few changes that could be made to ACELA alone, like the EERS, video game console standards, and tax incentive additions. The other provisions in our enhanced case are either authorized in ACELA (without funding, and therefore without energy savings), or are based increased allocations funds to energy efficiency in APA. As a result, if the APA does not move forward, alternative sources of funding would need to be found for these enhancements to result in energy savings.

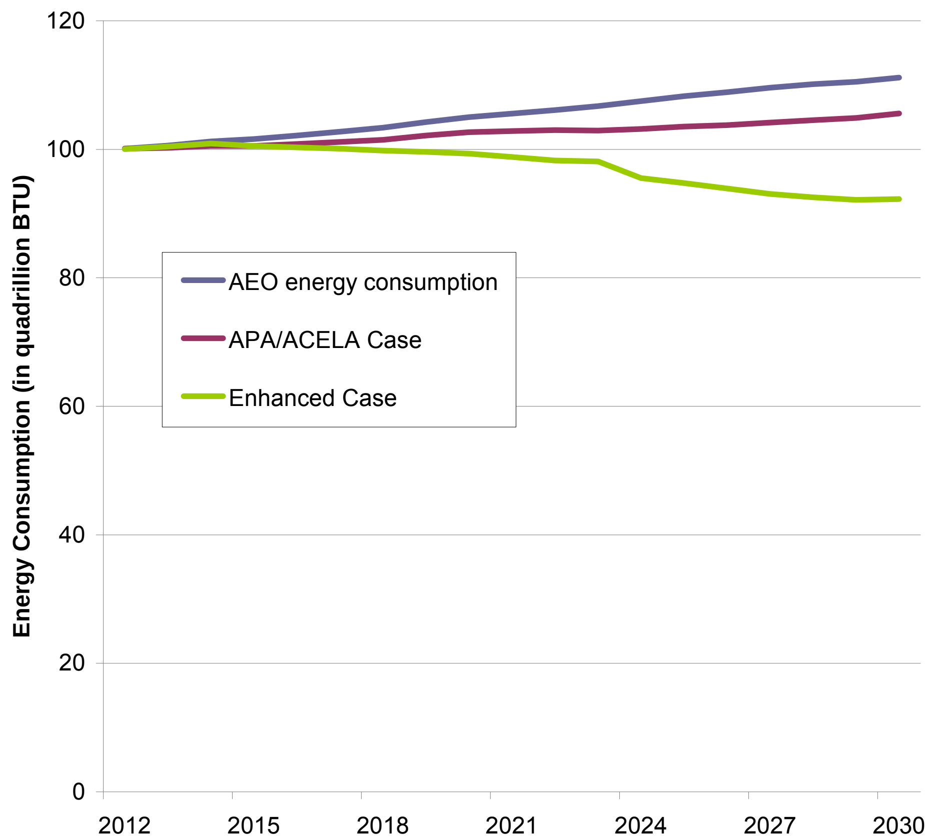
Figure 2. Potential Energy Savings in 2020 from Federal Energy Legislation 2005–2010



Energy Savings

The energy savings from APA+ACELA's energy efficiency provisions would reduce national energy consumption by 2.3% and 5.0% in 2020 and 2030, respectively, relative to the Annual Energy Outlook (AEO) 2010 forecast (EIA 2010) (see Figure 3). In total, the existing energy efficiency provisions in APA+ACELA could reduce U.S. energy use by 2.4 quadrillion Btu, which accounts for about 2.3% of projected U.S. energy use in 2020. This amount of energy saved is more than the annual energy use of 35 of the 50 states (EIA 2007b). By 2030, this level of energy savings increases to 5.6 quads. The 2030 electricity savings in APA+ACELA is the equivalent of displacing the peak demand from 235 medium-sized power plants (with a capacity of 300 MW). Of the 2020 savings, about 42% is from ACELA and 58% from APA. By 2030, these percentages change to 57% and 43%.

Figure 3. Primary Energy Use in the EIA Reference Case and Direct Savings from the APA+ACELA and Enhanced Cases



The direct energy efficiency provisions in the Enhanced APA+ACELA scenario could reduce national consumption by 7.4% and 16.9% in 2020 and 2030, respectively, relative to the AEO 2010 forecast (EIA 2010) (see Figure 3). With this enhanced level of investment in energy efficiency, the savings equate to a reduction in energy use on the order of over 7.7 quadrillion Btu in 2020 and almost 18.8 quadrillion Btu in 2030. To illustrate how much energy is saved in 2030 under this enhanced case, this is more than the amount of energy used in one year by all of the households in the United States combined.[3]

The expanded case has even larger savings, based on long-term efficiency opportunities. Total energy savings reductions are larger in the macroeconomic results, because in addition to savings from the energy efficiency provisions, there is the price effect which drives both energy efficiency and more efficient electricity generation (improving the heat rates further lowering primary energy). Some of these are described in Appendix C—"How Big

[3] 15.69 quads could fuel 165,163,617 households based on *2005 Residential Energy Consumption Survey's* (EIA 2009d) national annual average energy consumption per household of 95 million Btu. Total households in 2005 are 124,522,000.

Efficiency." Overall, the expanded case has about 30% higher savings than the enhanced case, reducing U.S. energy use by 19% in 2030, and nearly 23% in 2050.

In total, the existing energy efficiency provisions in APA and ACELA could reduce U.S. oil use by 0.2 million barrels per day in 2020 and 0.9 million barrels per day in 2030 (see Table 5). These savings approximately double in the enhanced case—0.4 million barrels per day in 2020 and 1.3 million barrels per day in 2030. By way of comparison, in 2009, U.S. offshore oil production totaled 1.7 million barrels per day. Transportation sector energy efficiency can contribute several million barrels per day more by 2030 outside the climate bill, through vehicle efficiency standards now underway and a transportation bill reauthorization that prioritizes oil security. This is not only an economic benefit but also has strong and positive implications for the nation's energy security and overall environmental quality.

Table 5. Oil Savings from Energy Efficiency Provisions in ACELA and APA

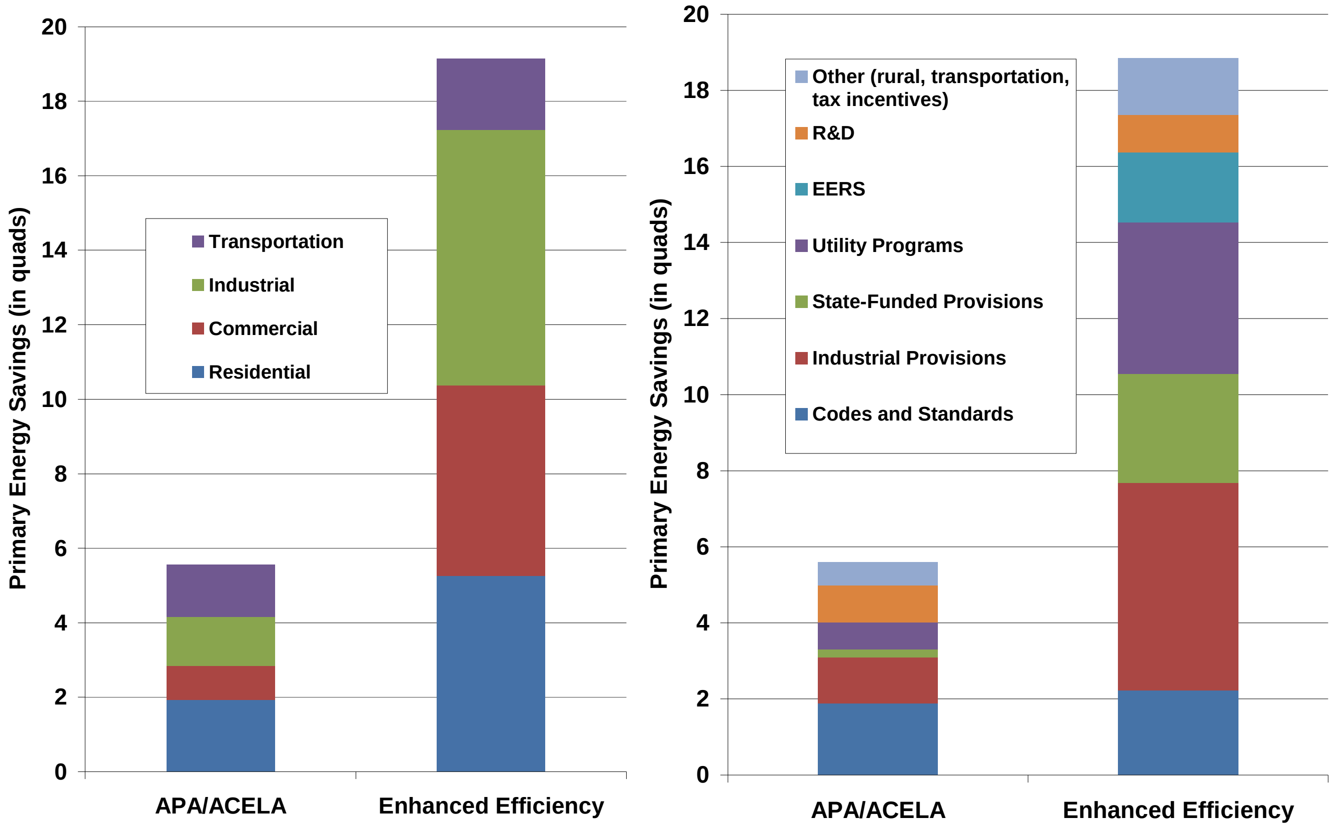
	2020	**2030**
Distillate Fuel Oil	0.076	0.147
Gasoline	0.123	0.656
Diesel	0.044	0.077
APA/ACELA Total	**0.242**	**0.880**
Distillate Fuel Oil	0.111	0.265
Gasoline	0.225	0.836
Diesel	0.096	0.163
Enhanced Efficiency Total	**0.432**	**1.263**

Energy Savings Distribution

The enhancement of the energy efficiency provisions in APA changes the relative importance of different parts of the bill and the end-use sectors that are impacted by the bill. Figure 4 presents the distribution of energy savings by end-using sectors and major groupings of provisions under both the APA+ACELA and the Enhanced Efficiency scenarios. Our APA+ACELA scenario shows that in the base bill, the residential sector is the primary beneficiary. With the inclusion of the enhancements, the benefits expand for all sectors. The industrial sector becomes the largest contributor, in large part due to the allocation of funding from allowances to multiple funding programs that enable modernization of domestic manufacturing. We also find a dramatic expansion of savings in commercial sector due to more robust provisions and funding.

Transportation sector savings are modest in both the base and enhanced case, though the bill takes very important steps toward establishing transportation planning and investment priorities for an efficient and sustainable transportation system. The large opportunities for increased vehicle efficiency are being dealt with primarily outside the APA framework. New light- and heavy-duty vehicle efficiency standards are driven by requirements in the Energy Independence and Security Act of 2007 (EISA) and the subsequent rules adopted or under development by the Obama Administration. A separate ACEEE analysis has estimated that the new light-duty standards for model years 2012 to 2016 will save more than 3 quads by 2030 (Langer 2009). If these vehicle efficiency improvements were included in APA, then the transportation energy savings would be the largest. Heavy-duty standards for model years 2014-2017 and the next round of light-duty standards (2017-2025) have yet to be set, but they are expected to add several additional quads by 2030.

Figure 4. Proportion of Energy Savings from Major Energy Efficiency Provision Categories and End-Use Sector in APA+ACELA and with Enhanced Provisions in 2030



Of the major groupings of provisions, nearly 80% of the 2030 energy savings in the base bill are attributable to the codes and standards, industrial, and R&D provisions. As noted previously, there are no EERS savings (since the ACELA target for efficiency is below business as usual) and utility savings are modest because only gas utilities are required to invest in energy efficiency.

In the enhanced case, the EERS is increased above business-as-usual, generating electricity savings in the 30 states that are not already on track to achieve the 10% savings by 2020 target. Utility and state program savings increase as all utilities are required to invest in energy efficiency and also states have funds to implement the ACELA programs, as well as continue some of the programs begun under ARRA. The allocation amounts to transportation planning and infrastructure remain unchanged, but are more narrowly targeted to projects and programs that reduce emissions at relatively low cost.

The growth in industrial savings are particularly notable. In APA, funding for industrial energy efficiency programs at DOE is provided only during the transitional period from 2013 to 2015, and there is very limited funding available from other provisions such as the EERS, allocation of utility allowance to energy efficiency and allocations to state programs. The provision provides funding for program authorized under Secs. 451-453 of EISA, of which Sec. 451 and 452 are the most significant.

Sec. 451 provides grants and loans for the installation of waste energy recovery (also referred to as recycled energy) and combined heat and power (CHP) projects. DOE has identified expanded CHP and recycled energy as a significant energy efficiency opportunity, but the first cost of projects has been identified as a significant barrier to expanded implementation (Shipley et al. 2008). Sustained funding for these projects would provide important resources needed to realize the opportunities from CHP. We project that the funding available in an expanded provision would increase installations by over 175 GW by 2030, while also recovering significant thermal energy as well that would displace industrial natural gas consumptions.

Sec. 452 provides funding for the research, technical assistance, and workforce development activities of the DOE's Industrial Technology Program (ITP). Industrial energy efficiency savings requires persistence and patience, since energy savings projects, particularly those that require process modification, require at minimum 4 years (Elliott, Shipley & McKinney 2008). The development of new technologies through research require at minimum 7 years. In the enhanced case, we extend these programs through 2029 allowing for significant impact to occur from the provision of a funding stream that is not dependent upon the whims of appropriations. ITP's Industries of the Future (IOF) research activities (in particular the energy industry-specific research, co-directed and co-funded by industry) has been documented to be among the most impactful federally-funded R&D programs by both an independent review panel (ITP 2009) and the National Academies (NRC 2001, 2007). The Industrial Assessment Center program is the most important source of new energy engineers and has proven successful for over three decades, though now being [grossly] under-funded (Trombley 2009).

In addition to the development of new technologies, workforce, and access to technical assistance, manufacturing needs access to capital to realizing the large energy efficiency opportunities that exist in the manufacturing sector. The majority of U.S. manufacturing capacity is over 30 years old, and in need of modernization to remain globally competitive and to deploy technologies necessary to reduce the energy intensity of the plants (Elliott 2009). To accomplish this revitalization of domestic manufacturing will require tens of billion dollars over the next two decades. These four elements coupled together can achieve energy intensity reductions of as much as 50% across manufacturing, similar to those that have been realized over the past two decades using technologies developed together by the government and industry through the IOF program. The allocation of allowances to the revolving loan fund (complemented by the funding from the allocation of a portion of the utility and state allowances to promote the investment in new, efficient, and competitive manufacturing capacity) will provide the capital necessary to modernize U.S. manufacturing. Investing these allowance proceeds instead of using them just to moderate costs insures that manufacturing firms will continue to benefit into the future from these free allocations. In addition, these funds would be used to retool manufacturing plants to produce the products and materials needed to make other sectors of the economy more efficient, enabling the revitalization of the domestic manufacturing base.

Carbon Dioxide Emissions Reductions

By avoiding the consumption of fuels, the energy efficiency provisions in APA+ACELA reduce the emissions of carbon dioxide. The energy savings in APA+ACELA would reduce carbon dioxide emissions in 2020 by 139 MMT and in 2030 by 342 MMT. The direct savings from energy efficiency measures alone would provide a reduction of 2.4% and 5.5% of EIA's projected national CO_2 emissions in 2020 and 2030, respectively. This level of CO_2 emissions avoided would be like removing about 25 million automobiles from the road in 2020 (for one year) and removing 63 million automobiles from the road in 2030 (for one year).

Under the Enhanced APA+ACELA scenario, energy efficiency measures could reduce CO_2 emissions by 470 MMT in 2020 and by 1121 MMT in 2030 (see Figure 6). With these enhancements, this level of CO_2 emissions avoided would be the equivalent of removing 86 million automobiles from the road in 2020 and 207 million automobiles from the road in 2030.

The direct energy efficiency savings contribute about 7.2% of the 2020 GHG reductions and about 9.7% of the 2030 reductions. Reductions due to direct energy efficiency provisions in the enhanced case are much greater, totaling about 24% of the 2020 reductions and 32% of the 2030 reductions.

Carbon Price Signal and Energy Efficiency Investment

Experts agree (plus three decades of experience show) that only limited new energy efficiency will occur simply through the creation of a carbon price signal alone. Homeowners and businesses have many things on their minds, and a 0-25% increase in energy prices will result in only a small change in energy consumption, thus failing to capture much of the most cost-effective emissions reduction potential (EPA 2009b). For example, research on gasoline consumption has found that a 10% increase in fuel costs might result in only a 0.5-2% decrease in vehicle energy use in the short run (and 2-6% in the long run), some due to more efficient vehicles and some due to less driving (Small and Van Dender 2007; Komanoff undated; Greene 2005).

An energy price signal is far more effective when complemented by technical assistance and complementary policies to encourage and help consumers and businesses adopt energy efficiency measures in their homes and businesses, because many market barriers exist that hinder the ability of the market to respond to energy price increases alone. The major barriers include:

1. In many cases those who pay the energy bill (e.g., tenants) are not the owner (e.g., the landlord), resulting in little incentive for either to invest in efficiency. Also, many purchases are made on a "panic" basis (e.g.. when the water heater leaks) and there is no time for comparison shopping.

2. Power generators in the U.S. are regulated monopolies with only limited competition. The greater the consumer demand for energy, the greater their profits. Historically the primary way to drive energy efficiency improvements is through targeted legislative and regulatory reform that is both cost-effective and productive.

3. Oil, gas, coal and other forms of energy generation are subsidized and incentivized with tax breaks so there is greater financial incentive to produce more of these forms of energy rather than to become more efficient in how much energy we use. Energy efficiency must be on a level playing field with traditional fossil fuels in terms of tax treatment and subsidies in order to have a fair and open market in which to play.

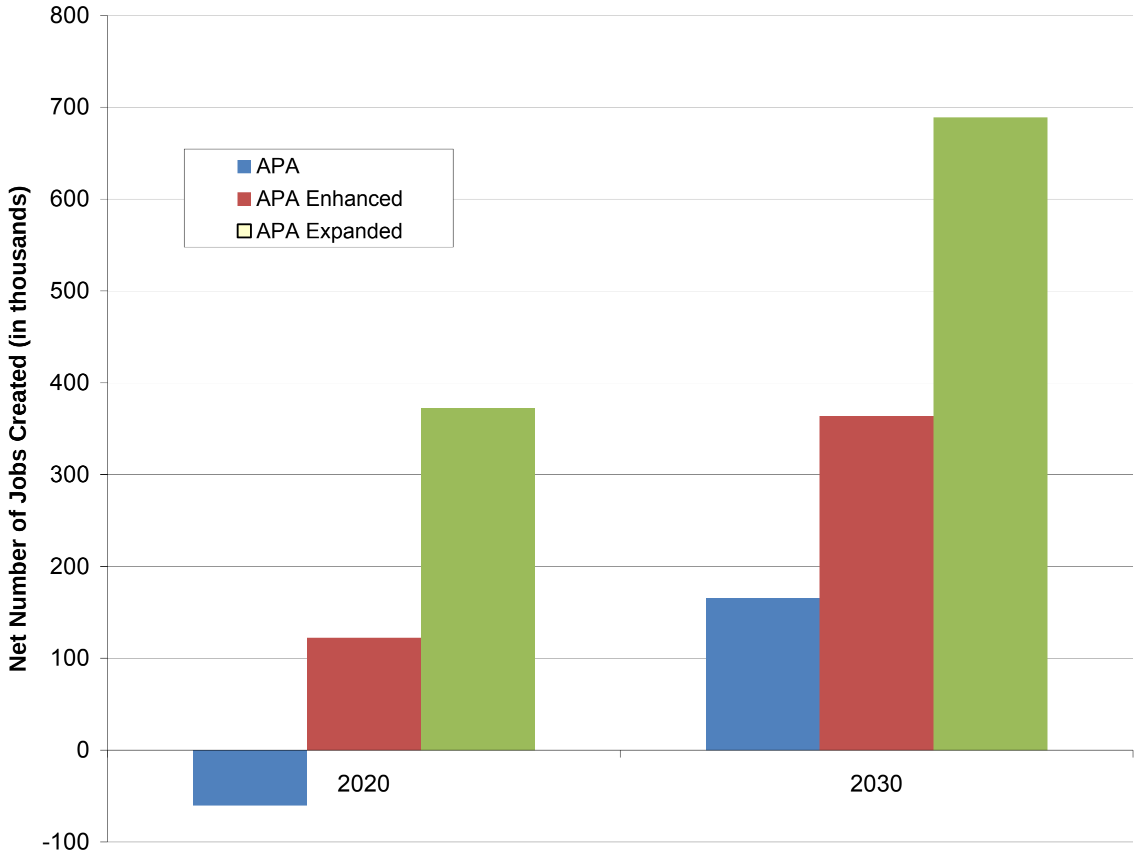
4. Current proposals give carbon credits to electric utilities for free to pass on as bill reductions to consumers. This blunts the price signal of carbon regulation; instead, a portion of these funds should go to help consumers reduce their energy use, saving energy and money for many years.

Job Creation

APA plus ACELA will create about 166,000 net new jobs in 2030 and 367,000 net new jobs in 2050.[4] Under the Enhanced APA+ACELA scenario, net new jobs in 2020 would be approximately 123,000. By 2030, the positive effects of the enhanced energy efficiency investments are made clear with about 364,000 net new jobs being created. The net new jobs further increase to 552,000 net new jobs in 2050. There is a significant increase between jobs created in 2020 and in 2030 under the Enhanced APA+ACELA scenario. The 2030 values are greater due to increased utility and state spending on energy efficiency programs, the industrial loan program, and the fact that R&D in earlier years begins to produce energy savings. In the expanded case, net new jobs increases further, to 373,000 in 2020, 689,000 in 2030, and 1,020,000 in 2050. A comparison of jobs created under APA+ACELA and the Enhanced APA+ACELA is provided in Figure 6 below.

[4] The figures reported here should be considered approximate. Given the many ambiguities in APA, the many unknowns, and the imprecise nature of economic policy modeling, the figures reported here should be considered the midpoint of a range, with endpoints about 30% higher and lower than the figures reported here.

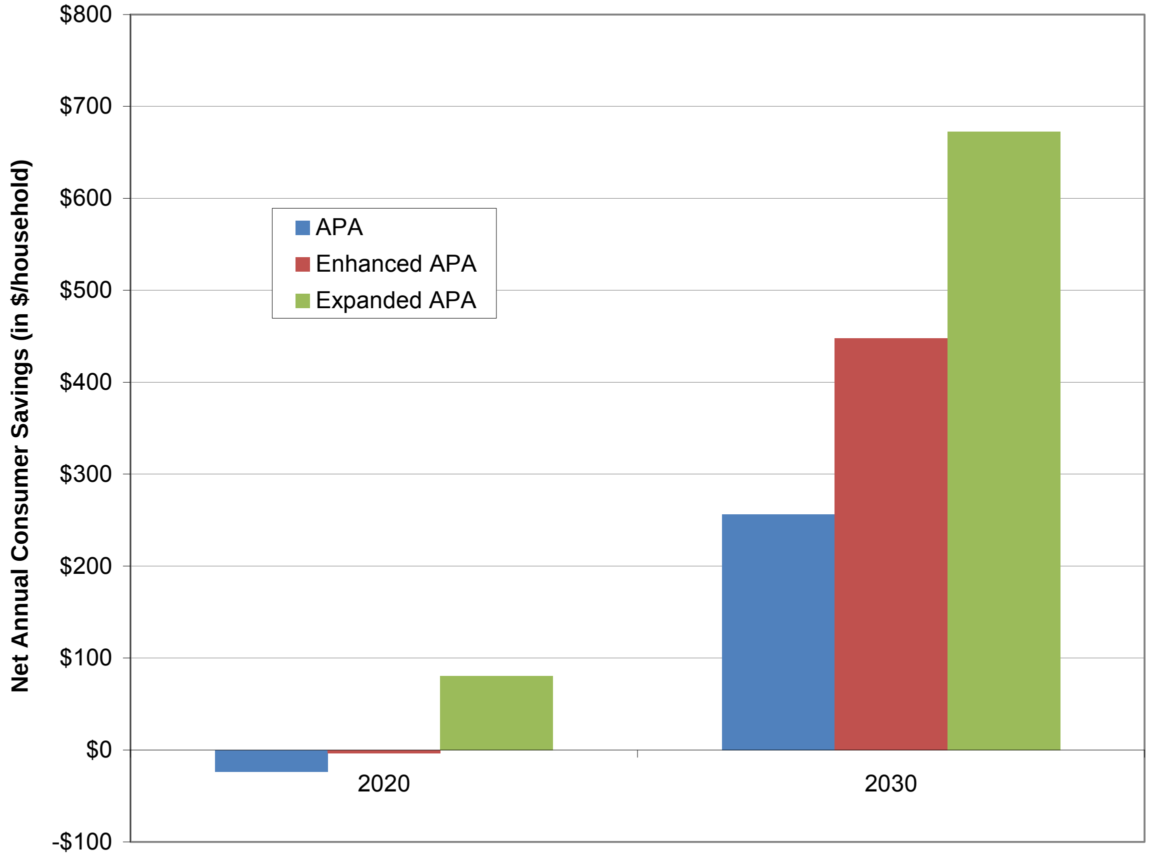
Figure 6: Net New Jobs Created from Energy Efficiency Provisions in APA+ACELA



Net Consumer Savings

APA and ACELA, including the energy efficiency provisions as displayed in Tables 1 and 2 above, produce significant energy savings and economic benefits relative to the base case by 2030 (we used the Energy Information Administrations *2010 Annual Energy Outlook* as our base case). The legislation as a whole would cost, on average, about $24 per household in net consumer savings in 2020. By 2030, the legislation would provide a net benefit of about $256 per household, on average. The enhanced provisions we analyzed further increase the positive impacts of energy efficiency. In 2020, under the Enhanced APA, the cost to consumers are somewhat lower than the APA+ACELA case, about $3 per household. However, by 2030 under the enhanced scenario, consumer savings reach over $448 per household. A comparison of net consumer savings under APA and under the enhanced scenario is provided in Figure 7.

Figure 7. Net Consumer Household Savings from Energy Efficiency Provisions in APA



Note: this part of the model is being refined, and some changes are expected. The per household savings numbers are preliminary, as the model appears to be particularly sensitive to certain factors.

Impacts on the U.S. Economy

In all three APA+ACELA cases, the impact to the economy is small and generally net positive (see the highlighted results from the various cases as shown in Appendix G) The reason for this outcome is that there is sufficient substitution of productive capital to maintain economic output while allowing a significant reduction in greenhouse gas emissions in response to the rising costs of carbon and somewhat higher energy prices. The weakest response occurs in the adjustment period of 2013 to 2020 in the basic APA+ACELA case that generates a very small loss of jobs in 2020 (-0.03%). But this rises to small net positive numbers with more than 100,000 net jobs in 2030 and continuing to increase to just over 500,000 jobs by 2050 even as GDP is essentially unchanged (fluctuating from a high of +0.08% in 2040 to a low of -0.16% in 2050). In the APA enhanced and expanded energy efficiency case, productive investments allow a significant consumer and business savings that drives employment gains from about 260,000 net jobs in 2020 to a high of more than 1 million net jobs by 2050. Because the composition of the economy is shifting away from capital-intensive energy industries to a more labor-intensive economic activity, overall GDP is essentially unchanged even as we see a small but net positive increase in jobs. At the same time, the 2050 net consumer savings (tracking net energy bill savings after the program and investment costs are repaid) exceed $300 billion in the APA+ACELA case to more than $600 billion in both the Enhanced and Expanded cases. For more results, see Appendix G.

The Effect of Carbon Prices on the U.S. Economy

In the basic and the enhanced APA+ACELA cases, by 2050 the carbon price reaches the price ceiling. This is not a major cost, since energy use is down substantially and the higher costs apply to much fewer units of energy. This said, in order to meet the emissions targets in 2050, more offsets will need to be purchased in the final years of the analysis or the price cap relaxed somewhat. The exception to this pattern is the expanded case, where the increased levels of energy efficiency bring the price of allowances down to $113 per ton in 2050, allowing the emissions targets to be met without increased use of offsets. Thus, increased energy efficiency can reduce the use of offsets, particularly international offsets which receive preference in APA when the price cap is reached. For more information on both the price cap and the use of offsets to support lower prices, please see Appendix G.

CONCLUSIONS

Overall, we find that APA+ACELA can provide significant energy savings (5.0% direct reduction in 2030), consumer financial savings ($256 per household in 2030), and emissions reductions, while generating jobs (166,000 in 2030). This case has a very small positive impact on the overall economy as measured by GDP (e.g., increases in GDP of 0% to 0.13%, varying by year).

The enhanced case roughly doubles the amount of energy savings achieved (16.9% direct savings in 2030), increasing consumer financial savings ($448 per household in 2030) and emissions reductions. The enhanced case also increases the number of jobs created (364,000 net jobs in 2030). Under the enhanced case, approximately 364,000 jobs are created in 2030. As with the APA+ACELA case, changes in GDP are very small.

The expanded case further increases energy savings and job creation. And in the expanded case, the need to purchase international offsets is also reduced.

This analysis shows that increasing the role of energy efficiency in the legislation will increase both household savings and job creation. We therefore recommend that the policies in the enhanced case be adopted including:

- 10% Energy Efficiency Resource Standard (EERS), either separate from or combined with a Renewable Energy Standard (RES);
- One-third of electric and natural gas utility allowances devoted to energy efficiency;
- Industrial energy efficiency funding at 0.25% of emissions allowances until 2030, and the establishment of a Revolving Loan Fund with 1/5 of the Energy Intensive, Trade Exposed Industries (EITE) allocations;
- Continue providing emissions allowances for state energy efficiency and renewable energy programs out to 2030, and increase the percentage of emissions allowances to 6%;
- Target Highway Trust Funds and TIGER grants so that they achieve greenhouse gas reductions; and
- Strengthen conditions for the Clean Vehicle Technology Fund, closing the diesel loophole and including only vehicles that exceed CAFÉ by at least 25 percent.

Much of the current debate about federal cap-and-trade legislation focuses on the costs of compliance. Most of the prior studies of APA and ACELA do not fully consider the energy efficiency provisions in these bills and none of the other studies examine the impacts if energy efficiency provisions are strengthened. A broader accounting of all of the efficiency provisions shows substantial savings for consumers and increased job creation. Based on these findings, we conclude that energy efficiency provisions are both key to achieving greenhouse gas emissions reduction and cost mitigation, and represent an important foundation for any Senate climate and/or energy legislation.

Although the energy efficiency provisions in APA as proposed by Senators Kerry and Lieberman and included in ACELA will result in important consumer cost savings and new job creation, they do not go far enough. With our proposed changes, a good bill can be made much better, decreasing U.S. energy use, increasing household savings, and improving the productivity of our economy.

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Appendix A. Descriptions of Energy Efficiency Provisions in APA

Description of Provisions in ACELA

Sec. 132 Federal Renewable Electricity Standard

The Senate bill includes a Renewable Electricity Standard (RES) that includes energy efficiency, but ACEEE credits no savings to this part of the bill as the maximum level of efficiency in this provision (4% of electricity sales by 2020) is less than business-as-usual when it comes to electricity efficiency. States are currently on track to reduce nationwide electricity use by about 6% by 2020.

Sec. 201 State Partnership Industrial Energy Efficiency Revolving Loan Program

This provision would authorize DOE to fund "eligible lenders" to establish a revolving loan fund. The funds could be used by commercial or industrial manufacturers to either reduce energy intensity (including feedstocks) or increase the industrial competitiveness of the United States. The lenders would be community or economic development lenders who partner with state government agencies and a private financial institution to provide additional funding. All federal funds must be matched at least dollar-for-dollar. Each program should last for 10 years. No lender would receive more than $100 million in federal funds in a single year. The total authorization is for $500 million per year for 3 years (2010–2012).

Sec. 204 Future of Industry Program and Sec. 204(c): Industrial Research and Assessment Centers

This provision re-authorizes DOE's Industrial Technologies Program. Subsection (b), which directs DOE to create industry-specific roadmaps to direct R&D funding through the program, is not scored as it does not offer any new appropriations. Subsection (c) Industrial Research and Assessment Centers expands authorizations for the highly successful yet underfunded *Industrial Assessment Center* (IAC) program. These centers are located at universities throughout the country and train engineering students to, along with expert faculty, provide no cost energy audits to small to mid-sized manufacturing firms. This provision would lift the cap on the number of IACs and establish up to 10 "Centers of Excellence" at current IACs around the country, which would house regional expertise and coordinate among the local IACs. Each Center of Excellence would be funded at $500,000. IACs would be directed to better communicate with other federal, state, and regional programs and organizations, such as Manufacturing Extension Partnerships and national labs. Up to $5 million would go toward placing students at manufacturing sites after an audit to help identify more savings and implement recommendations. Internship costs would be shared with the employer. IAC authorizations would ramp up to $40 million by 2012 and beyond.

Sec. 206 Innovation and Industry Grants

This provision would establish grants awarded to state-industry partnerships to develop, demonstrate, and commercialize new energy- waste-, or pollution-reducing industrial technologies. Each grant would be no more than $500,000 and the state-industry partnership would have to match federal funds dollar-for-dollar.

Secs. 222–227 Reforms to ENERGY STAR, Portable Light Fixtures, Commercial Furnace Standards

Sec. 222 details reforms to ENERGY STAR, including: division of responsibilities between DOE and EPA, demonstration that ENERGY STAR-qualified products meet the criteria, regular review of product standards, and publishing of standardized building energy audit methods. Sec. 227 includes stronger standards for gas- and oil-fired warm air furnaces to take effect in 2011. Lighting standards in Sec. 224 will improve the efficiency of most portable lighting fixtures manufactured on or after January 1, 2012.

Sec. 228 Motor Efficiency Rebate Program

Sec. 228 details a motor efficiency rebate program for the purchase and installation of some new electric motors. This program is authorized to be funded through appropriations beginning at $80 million in 2011, and declining by $5 million each year until 2015.

Sec. 241 Building Codes

Sec. 241 of the bill establishes new building code standards for new building efficiency, providing for 30% improvements in 2010 and 50% improvements in 2016 for residential and commercial buildings. States will be responsible for adoption and enforcement of the codes,[5] which will be funded at a rate of $100 million for FY 2009–2013, and such sums as are necessary in subsequent years.

Sec. 242 Multifamily and Manufactured Homes

ACELA establishes a program to promote energy efficiency in manufactured homes and multifamily (more than five units) buildings in Sec. 242. This program provides financial assistance in the form of grants to states and local governments to carry out programs to increase energy efficiency in these buildings.

Sec. 243 Building Training and Assessment Centers

Sec. 243 of ACELA establishes Building Training and Assessment Centers, based on DOE's Industrial Assessment Center program, designed to train new building engineers and technicians. This program also provides commercial and institutional building owners with technical assistance, and promotes R&D in clean energy technologies.

Sec. 251 Low Income Weatherization

This provision provides authorization for $1.7 billion for FY 2011–2015 for the Weatherization Assistance Program (WAP) at DOE.

Sec. 262 Building Retrofit Program

Sec. 262 of the bill establishes the Retrofit for Energy and Environmental Performance (REEP) program to promote comprehensive energy efficiency retrofits for residential and commercial buildings, in which per building energy savings of 20% or more are targeted.

Sec. 281 Building Labeling/Disclosure

Sec. 281 establishes a voluntary building energy performance labeling program. This program will serve as a rating system designed primarily to help homebuyers and renters compare the energy efficiency of homes, and also help buyers and tenants compare the energy efficiency of commercial buildings of the same type. EPA is authorized to use the energy performance information developed to establish a voluntary ENERGY STAR program recognizing high efficiency retrofits of existing commercial and residential buildings.

Amendments to ACELA (Sections 233–239)

In May, 2010, the Senate Energy Committee adopted a number of amendments to ACELA. The key energy efficiency amendments adopted consensus efficiency standards on pole-mounted outdoor lighting fixtures and on residential furnaces, air conditioners, and heat pumps. The latter revise existing standards and establish different standards for the North and South. Also included were new standards on hot food holding cabinets, drinking water dispensers, and portable electric spas, as well as several reforms to the process for setting standards in the future.

[5] The U.S. Department of Energy will be responsible for implementation in states that do not incorporate the new standards into their state building codes.

Additional Transportation Provisions

ACELA includes provisions to speed deployment and integration of plug-in electric drive vehicles. One provision would offer DOE financial support for state and local government programs that install recharging infrastructure or assist individuals and fleets in the purchase of plug-in vehicles and batteries. A second provision aims to bring about standardization of infrastructure, components, and protocols for plug-in electric vehicles, such as vehicle-to-grid connectors and communications, and battery safety. These are not covered in this analysis.

Description of Provisions in APA

Sec. 783 Natural Gas Customers

Beginning in 2016, Sec. 783 dedicates 9% of allowances to natural gas LDCs on behalf of natural gas consumers. This allocation declines to zero from 2026 to 2030. The provisions specifies that at least 20% of allowances must be used to support cost-effective energy efficiency programs for natural gas consumers, which will be overseen by state PUCs.

Sec. 784 Home Heating Oil and Propane Customers

Sec. 784 states that from 2013–2015, 1.9% of allowances from 2013–2015 and 1.5% of allowances from 2016–2025 are allocated to states on behalf of heating oil and propane consumers. This allocation declines to zero from 2026–2030. One-half of these funds must be used to support cost-effective energy efficiency programs. Priority for the programs will be given to existing programs and to fuel-blind, coordinated programs.

Sec. 1602 Rural Energy Savings Program

The rural energy savings program provision amends Subtitle D of the Consolidated Farm and Rural Development Act to create loans and limited grants for cost-effective energy efficiency programs run by public power and rural electric coops.

Sec. 1603 Support for State Renewable Energy and Energy Efficiency Programs

This provision distributes 2% of allowances to states until 2018, 1% of allowances in 2018–2019, and 0.5% of allowances until 2021 to states to conduct a variety of programs. Allowable uses include energy efficiency programs, renewable technology deployment, smart grid technology, or surface transportation capital projects (up to 10%). The provision prioritizes expanding existing programs rather than creating new ones, and supplementing rather than supplanting existing programs. The allowable energy efficiency programs include building codes, energy-efficient manufactured homes, building labeling, low-income energy efficiency improvements, and energy efficiency building retrofits. These uses line up with the “Buildings Efficiency” subtitle in ACELA, the energy-only committee bill passed by the Senate Energy and Natural Resources Committee.

Sec. 1801 Clean Energy Tech R&D

This provision provides 2% of emissions allowances from 2013–2021 for “clean energy technology R&D” programs designed to develop energy technologies and promote U.S. leadership in advanced technologies. One of the six purposes for which this can be used is “improves energy efficiency for transportation, including electric vehicles.” The other five are: renewables, energy transmission/storage, building/industrial efficiency, smart grid, and produces an “advanced material” for energy/energy efficiency application.

Sec. 4143 Low-Carbon Industrial Technology R&D

Sec. 4143 establishes a federally funded research and development center to support development and demonstration of technology that provides immediate and long-term direct improvement in the competitiveness of and job creation in the domestic manufacturing sector, likely similar to ARPA-E, the Advanced Research Projects Agency-Energy.

Sec. 2101's Industrial Energy Efficiency Provision

Section 2101 dictates allowance distributions by adding ''Sec. 781. Allocation of Emission Allowances" to the Clean Air Act. "Sec. 781(b)2" directs 0.5% of annual emission allowances for 2013-2015 (not to exceed $1.5 billion total) to industrial energy efficiency. 3.23% of these funds go toward the National Institute of Standards and Technology's (NIST) Manufacturing Extension Partnership (MEP) program, which provides technical and business support to manufacturing facilities. The remaining 97.7% is directed toward funding sections 451, 452, and 453 of the Energy Independence and Security Act of 2007 (EISA). Sec. 451 provides grants for combined heat and power (CHP) and waste heat recovery. Sec. 452 funds collaborative R&D with energy-intensive industries as funding the Industrial Assessment Center program which provides free energy audits to small to mid-sized manufacturers. (Sec. 452 is amended by ACELA; see description of ACELA Sec. 204 above for details.) Sec. 453 seeks to improve energy efficiency in data centers. Within the 97.7%, 26.67% of allowance value is directed to go toward projects involving sensors, information networks, and controls, and 13.33% is directed to be used for small to mid-sized manufacturers.

Section 4111 Investing in Clean Vehicles (savings not quantified)

Section 4111 establishes the Clean Vehicle Technology Fund, providing auction revenues from 1% of allowances 2013-2020 and 0.5% in 2021 to promote advanced vehicles. At least 25% of these auction revenues must be made available to EPA and DOE for deployment activities. The remaining funds will be available for grants to vehicle and component manufacturers to convert facilities to the production of low-emitting, efficient vehicles or parts for such vehicles. A minimum of 25% of these grant funds must go to plug-in electric drive vehicles and components. Heavy-duty vehicle manufacturers are eligible for these grants for certain advanced vehicle types.

Sections 1711 Transportation Efficiency, 1712 Investing in Transportation GHG Reduction, and 1721 *Highway Trust Fund; TIGER Grants*

Section 1711 directs EPA in consultation with DOT to set, by regulation, national goals for emissions of greenhouse gases from the transportation sector that are commensurate with the economy-wide reduction targets established in the bill. States and metropolitan areas must develop targets and strategies that contribute to the achievement of the national goals and state targets, respectively. The section sets out technical requirements and appropriate strategies for these state and metropolitan area activities.

Section 1712 directs DOT to distribute allowances valued at up to $1.875 billion per year to States and metropolitan areas to plan for and carry out strategies needed to meet the greenhouse gas reduction targets established pursuant to 1711.

Section 1721 augments the Highway Trust Fund with allowances valued at up to $2.5 billion per year, for projects "to promote the safety, effectiveness, and efficiency of transportation in the United States" and that are "consistent with" the provisions of Section 1711.

An additional allocation of up to $1.875 billion per year is made (Section 781(f)) to expand the Transportation Investment Generating Economic Recovery (TIGER) grant program established under the American Recovery and Reinvestment Act of 2009. This program provides grants to states and municipalities on a competitive basis for transportation infrastructure improvements that create jobs, provide long-term economic benefits, and have a significant impact on the Nation, a metropolitan area or a region

APPENDIX B. DESCRIPTIONS OF ENHANCED PROVISIONS

For ACELA:

10% Energy Efficiency Resource Standard

As an enhancement to APA, we propose a stand-alone energy efficiency resource standard (EERS). The EERS in ACELA is a part of a combined renewable energy and energy efficiency standard. It calls for 15% of electric utility sales in 2020 to come from either renewable energy or energy efficiency, with energy efficiency capped at 4% of sales.

The overall cap needs to be increased as well as the energy efficiency share. Twenty states are now on track to achieve 10% energy efficiency savings by 2020. A similar cumulative 10% by 2020 energy efficiency target should be included in ACELA. The level of electricity savings required under the EERS would begin at 0.75% of the 2 prior years' sales in 2012 and slowly ramp up to 1.5% incremental annual savings in 2020. The standard is expressed in cumulative terms (10%) because energy efficiency measures installed in early years will continue to save energy throughout the compliance period such that total energy savings in 2020 will be 10% of 2018 and 2019 sales. This proposed compliance increase in energy efficiency targets is exclusive of building codes and appliance standards, and does not allow for interstate trading of energy efficiency savings.

Sec. 1637 Expanding Building Efficiency Incentives Act of 2009

This bill, proposed by Senators Bingaman, Snowe and Feinstein, contains three tax incentive provisions relating to building energy efficiency. It increases the commercial building deduction to $3/square foot. The provision also extends the current $2,000 new homes tax credit. In addition, the provision authorizes a 50% whole home savings credit of $5,000.

Sec. 1639 Expanding Industrial Energy Efficiency Incentives Act of 2009

This bill, also proposed by Senators Bingaman, Snowe and Feinstein, would expand or establish tax incentives in four areas for industrial or large commercial facilities. The bill modifies a recently enacted tax incentive for the installation of combined heat and power. The new incentive would apply to any size system and apply to the first 25 MW, instead of the first 15 MW for systems up to 50 MW. Furthermore, it expands the definition of "combined heat and power" to include back pressure steam turbines or waste heat from certain industrial processes. Sec. 1639 would also establish a tax credit for advanced, variable speed motors. The $120/kW credit would be available to manufacturers of motors and appliances. In addition, the bill would create a $150/ton tax credit for replacing old chillers with newer, more efficient chillers that do not use CFCs. Finally, Sec. 1639 aims to improve water efficiency. A 10–30% tax credit would be available to projects that increase the reuse of water and implement water efficiency measures such that the net direct and indirect[6] energy use related to water is reduced

Sec. 1696 Green Gaming Act

Sec. 1696 requires the DOE to conduct a study on video game console energy, and to determine whether minimum energy efficiency standards should be established.

For APA:

Secs. 3001 and 3101 Electricity and Natural Gas Consumers

Secs. 3001 and 3101 provide emission allowances that go directly to electricity and natural gas local distribution companies for the "benefit of consumers." For the consumer benefits provisions to produce long-term benefits for the electricity and natural gas customers they are designed to help, APA should increase the percentages of the benefits required to be invested in energy efficiency. Most of these allowances are likely to be sold and used to reduce energy bills. But once the money is spent, there are no long-term benefits.

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[6] Direct energy use is energy consumed at the plant, while indirect water use is energy related to the sourcing, treatment, transport, collection, and disposal of water by entities other than the plant.

A portion of these funds should be invested in energy efficiency programs that serve consumers, helping to reduce energy bills in the long term. There is such a requirement in APA for natural gas utilities, which was reduced from 33% in the ACES House bill to 20% in this draft Senate bill. A similar requirement should apply to free allowances given to electric utilities. ACEEE recommends that the bill require electric utilities to spend 33% of their free emissions allowances on energy efficiency, and natural gas utilities to spend 33% on energy efficiency.

Sec. 1603 Support for State Renewable Energy and Energy Efficiency

Continue state energy efficiency programs in APA; don't end them in 2015 or 2021.

The limited number of energy efficiency programs in APA phase out—some in 2015, others in 2021. These should be extended until 2030 at a minimum. Also, many of the programs in ACELA require funding if they are to save energy. Such funding should be included in APA by providing funds to states for ACELA programs. The building codes, retrofits, manufactured housing, and low-income housing programs in ACELA require funding to provide consumer incentives and drive building energy efficiency. Without a dedicated stream of funding, like the state energy efficiency emissions allowances, this source of savings for consumers will remain untapped.

For example, the ACES bill provides states 4.5% of allowances for state and local-administered energy efficiency and renewable energy all the way to 2050. This "SEED (State Energy and Environmental Development)" funding begins at 9.5% and drops to 4.5% by 2026, an average of about 6% per year. ACEEE recommends that 6% of the emissions allowances be used for the state and local energy efficiency and renewable energy, beginning in 2013 and extending until 2050.

Transportation Enhancements in APA

Sec. 4111 Investing in Clean Vehicles (savings not quantified)

The Clean Vehicle Technology Fund as currently formulated would likely deliver only minimal savings. An enhanced provision would raise the efficiency threshold for eligible vehicle models to ensure they exceed CAFE requirements and eliminate the loophole that allows diesel vehicles to qualify at a lower efficiency level than gasoline and alternative fuel vehicles.

Sec. 4111 provides funding for retooling facilities to manufacture Advanced Technology Vehicles, defined as vehicles that exceed the fuel economy target of four years prior by at least 15%. Given that the recently adopted CAFE standards for 2012 to 2016 increase by over 4% per year and that a similar rate of progress will likely be required for the 2017 to 2025 period, Clean Vehicle Technology Funds could be awarded for the manufacturer of vehicles of average, or even below-average, efficiency. In addition, there is currently an exception to the efficiency threshold for diesel vehicles, which would in effect allow diesels to qualify if they were as little as 5% more efficient than required under CAFE four years prior.

In the Enhanced Case, eligible vehicles would be required to exceed the CAFE target four years prior by at least 25%. In addition, diesel vehicles would be required to meet this condition on an energy-equivalent basis, i.e., without the mile-per-gallon inflation that is an artifact of the higher energy density of diesel fuel.

Secs. 1711 Transportation Efficiency, 1712 Investing in Transportation GHG Reduction, and 1721 Highway Trust Fund; TIGER Grants

In the Enhanced Case, projects considered for funding from allocations to the Highway Trust Fund and the TIGER grant program would be subject to selection criteria regarding greenhouse gas reductions and the cost-effectiveness of those reductions.

The Enhanced Case leaves Sec. 1712 unchanged while requiring that projects funded with allowances to the Highway Trust Fund and the TIGER grants program are subject to the same selection criteria that projects funded under Sec. 1712 are. In particular, candidate Trust Fund and TIGER grant projects would be judged in part on their greenhouse gas reductions and on the cost-effectiveness of those reductions.

While it seems clear that projects funded under these programs should demonstrate greenhouse gas reductions, the cost-effectiveness criterion deserves further inspection. Projects and policies improving the energy efficiency of the transportation system typically provide a host of benefits beyond greenhouse gas reductions, the most obvious being fuel savings. The savings methodology we applied to this provision considers cost per ton only, but given that greenhouse gas reductions are in this context proportional to fuel savings, this is a reasonable way to compare the efficacy of measures. At the same time, a host of interdependent measures will be required to achieve the transformation to a low-carbon transportation system, and not all will do well on a narrow cost-effectiveness test.

Moreover, a climate and energy bill cannot be expected to achieve that transformation on its own, but only to help set the course. The impending reauthorization of the transportation bill will need to establish policy and allocate funds consistent with the principles and requirements set out in the climate bill if the potential to reduce transportation greenhouse gas emissions is to be realized. From that larger perspective, the requirements of APA Sec. 1711 that goals be set for transportation sector greenhouse gas emissions, commensurate with the overall emissions targets of the bill, are crucial.

Industrial Enhancements in APA

Extension of Funding for EISA Secs. 451–453

EISA Secs. 451 and 452 represent the key authorizing language for the industrial program activities at DOE. APA funds these provisions with an allocation of 0.5% of allowances from 2013 to 2015. This funding is not continued beyond this transitional period. Because of the long planning horizon that most industrial research and energy efficiency projects require (Elliott et al. 2008), funding needs to be sustained if these efforts are to have their desired impact on manufacturing carbon emissions. In our enhanced case we recommend that an allocation of allowances to support these industrial efficiency programs be continued through 2030 at 0.25% of total allowances out of the 15% allocation to EITE. The certainty of funding for federal industrial efforts will allow for long-term planning, particularly of research activities that will provide the greatest impact for the program.

Establishment of a Revolving Loan Fund for Energy Efficiency and Clean Energy Product Production

For industry to both reduce their own carbon emissions and produce the efficiency products that will enable other sectors of the economy to reduce theirs, the U.S. will need major new investments in manufacturing capacity. The funding for the provision above will provide the resources and tools needed to achieve these goals, but industry will also need access to capital to rebuild its aging manufacturing infrastructure (Elliott et al. 2008). Both ACELA and the IMPACT bill (S. 1617) establish modest revolving loan funds that fund investments in new manufacturing capacity, enabling the production of clean energy products and reductions in manufacturing sector emissions. As an enhancement to APA, we suggest that a fifth of the allocation to EITE be directed to establish a revolving loan fund to support these capital investments in EITE industries. These investments will contribute to the goal of mitigating the impacts of increased energy prices resulting from carbon regulation on energy-intensive trade exposed-industries by structurally changing and reducing the carbon footprint of manufacturing facilities. In addition, these investments will effectively finance the modernization of the U.S.' manufacturing base, helping to keep U.S. manufacturing globally competitive.

The funds from the pool would be loaned to manufacturing companies for capital investments up to 10 years at the 1-year Treasury Bill rate effective at the date of the loan. A 3% administrative charge would be allowed to cover costs of loan origination, with these charges being deducted from the loan pool. Loan repayments would be re-lended to support additional investments until fully expended. Loans could be made by a variety of eligible entities, including state governments, economic development agencies, and community development banks. or commercial financial institutions, or partnerships of the above that meet the goals of this provision. ACEEE suggests that the definition of "eligible lender" in Sec. 201 of ACELA be used for this provision.

APPENDIX C. HOW BIG ENERGY EFFICIENCY?

Economist William Baumol and his colleagues (2009) once wrote, "for real economic miracles one must look to productivity growth." As it turns out, energy efficiency investments have been a critical resource in promoting ongoing economic productivity throughout all levels of the economy (see the prior box insert, "The Role of Efficiency in Creating a Robust Economy").

But some might ask the question, "Just how big is energy efficiency?" Perhaps the surprising news is that the opportunity for gains in energy efficiency (energy productivity) is bigger than we imagine, although perhaps harder to achieve than we might think. Among the more credible estimates, is a study published by the National Renewable Energy Laboratory (Griffith et al. 2007) which suggested that if all commercial buildings were rebuilt by applying a comprehensive package of energy efficiency technologies and practices, they could reduce their typical energy use by 60 percent. Adding the widespread installation of rooftop photovoltaic power systems could lead to an average 88 percent reduction in the use of conventional energy resources. Even more intriguing, many buildings could actually be producing more energy than they consume—in effect, transforming our nation's building stock into power plants.

The current electricity generation and transmission system in the U.S. now operates at an efficiency of about 32 percent. That is a level of performance that is essentially unchanged since 1960. What the U.S. wastes in the production of electricity today is more than Japan uses to power its entire economy (author calculations using various data from the Energy Information Administration). At the same time, a study published by the Lawrence Berkeley National Laboratory (Bailey and Worrell 2005) suggested that a variety of waste to energy and recycled energy systems could pull enough waste heat from our nation's industrial facilities and buildings to meet 20 percent of current U.S. electricity consumption. And that is only the beginning of potentially large efficiency gains in power generation. So combining even a 50 percent efficiency gain in our nation's buildings with a minimum 25 percent productivity improvement in power production provides a total 60 percent efficiency gain (author calculations).

MIT research scientist Daniel Cohn (2008) suggests that new plasma gasification technologies could provide up to 40 billion gallons of liquid fuels from municipal and industrial wastes. That is about one-quarter of current gasoline consumption. In September 2009, Volkswagen introduced a sleek new two-passenger prototype car that achieved a phenomenal 240 miles per gallon (mpg). But even if the typical cars in 2050 achieve only a 50 mpg rating, but we also have new incentives to reduce driving by 20 percent, and that also increases the typical passenger load from 1.6 to two persons per car, fuel consumption would decrease 72 percent (author calculations).

Moving beyond component or device efficiency improvements, there are significant system efficiencies that contribute to future solutions as well. One new study completed for the Urban Land Institute identified a package of some 50 programs and policies that could reduce transportation-related greenhouse gas emissions by 24 percent by 2050 by acting to change travel behavior and land-use patterns. The emissions reduction hit 47 percent by adding road pricing techniques, ranging from pay-as-you-go insurance to charging Americans for every mile driven (Cambridge Systematics 2009). Adding improved fuel performance standards beyond what might occur through these behavioral and system efficiencies would further enhance these savings.

Management consultant Jeffrey Luke (1998) suggested that individuals have "a natural tendency to choose from an *impoverished option bag* (emphasis in the original). Cognitive research in problem solving shows that individuals usually generate only about 30 percent of the total number of potential options on simple problems, and that, on average, individuals miss about 70 to 80 percent of the potential high-quality alternatives." The question here might be whether prior assessments of climate policies have also been limited by a similarly impoverished option bag?

Jacobson and Delucchi (2009) observe the possibility of efficiency, wind, water, and solar technologies providing 100 percent of the world's energy, eliminating all fossil fuels by 2030. They acknowledge the numbers are large but note that "society has achieved massive transformations before." They the World War II transition when "the U.S. retooled automobile factors to produce 300,000 aircraft, and other countries produced 486,000 more." In other words, we have the technical capacity to move in this direction. Harvey (2009) notes that the opportunity may not be limitations of technology; rather, he suggests, it may be more about the lack of a trained, motivated, and properly equipped professional and construction workforce. Laitner (2004) observes that rather than practical limits on further efficiency gains, it might be more the limits of public policy to encourage further innovations.

Appendix D. Methodology for the Assessment of Energy Efficiency Provisions in APA

Introduction

The American Clean Energy Leadership Act of 2009 (ACELA), which passed through the Energy and Natural Resource Committee on June 18, 2009, includes important energy efficiency provisions. ACEEE produced several preliminary, national-level analyses of the various iterations of ACELA as the bill worked toward passage.

The discussion draft of the American Power Act (APA) was released by Senators Kerry and Lieberman on May 12, 2010. This climate change bill includes a number of energy efficiency provisions, and statements by Senator Kerry indicate that the ACELA bill from June 2009 will be combined with this bill when it is brought to the floor.

This document explains the construction of the Excel model used in this analysis and presents the key assumptions that were made in this analysis.

Methodology

The foundation of this model is an assessment of each of the energy efficiency provisions in ACELA and APA at the national level. This analysis projects the aggregate energy, carbon, and economic savings for the bill as a whole.

ACEEE's analysis focuses on provisions from the Clean Energy Technology Deployment (Title I) and Enhanced Energy Efficiency (Title II) titles in ACELA, and on emissions allowances related to energy efficiency in APA. The approach used to model each provision was developed by research leads at ACEEE.

The next sections provide details on key aspects of the analysis, identifying key assumptions and data sources used.

Federal Legislative Scoring Methodology

Energy Savings and Avoided Emissions Analysis

For each of the policies mentioned below, this analysis estimates energy savings in 2020 and 2030. Estimates were calculated for electricity use, peak energy demand, natural gas use, oil savings (including motor gasoline, diesel, and home fuel oil), and all energy sources together. This analysis also estimates federal, state/utility, and consumer costs, as well as gross consumer savings (based upon dollar savings from unused energy) and net consumer savings (gross savings minus consumer costs for efficiency measures). In general, EIA's *Annual Energy Outlook 2010* (EIA 2010) was used as the reference case. A number of key assumptions was taken from this document. These assumptions included projected energy prices and consumption by sector and fuel type, power plant heat rates, and carbon dioxide emissions per unit of fuel saved. To estimate peak demand savings, we used the ratio of peak demand savings per unit reduction in electricity sales from an EIA study of demand-side management (EIA 2000).

A few sections of ACELA authorize the establishment of a specific program, sometimes with an accompanying funding level. However, these authorizations must be followed by an explicit appropriation of funds, handled by the House and Senate Appropriations Committees. Because we are unsure what amount will be appropriated, where programs require substantial spending, we generally assume zero funding, although there are a few exceptions as described with each provision. In particular, where APA provisions provide funding for similar programs to those detailed in ACELA, we ascribed funding levels commensurate with the bill's instructions for those programs.

The American Power Act provides funding for many energy efficiency programs and policies through emissions allowances from cap-and-trade revenue. These provisions were scored using the percentages of allowances specified in Sec. 781 of the bill, multiplied by the total estimated value of the allowances. The total value of allowances in each year was calculated using prices from an earlier EPA analysis of the House ACES bill (EPA 2009b) and the number of allowances available as enumerated in Sec. 721 of the bill (see below).

"Calendar Year	Emission Allowances (MtCO2e)
2013	4,722
2014	4,635
2015	4,548
2016	5,524
2017	5,417
2018	5,310
2019	5,202
2020	5,095
2021	4,941
2022	4,788
2023	4,634
2024	4,481
2025	4,327
2026	4,174
2027	4,021
2028	3,867
2029	3,714
2030	3,560

Interest Rates Used

To calculate annualized net consumer investment values, we amortized consumer investments for each provision in a given year (and in years with savings from prior investments) using a real interest rate of 4.5% and measure lives in Table D-1. 4.5% reflects the average utility cost of capital used in DSM filings and plans excluding the effects of inflation (Nadel 2004). We exclude inflation because all of our financial figures are in constant 2007 dollars. These amortized net investment values were subtracted from the gross savings to calculate net savings.

Table 1. Measure Life Values Used in Calculating Annualized Consumer Cost

Provision in ACELA	Measure Life
Sec. 201 Industrial EE Revolving Loan Program	13
Sec. 204c Industrial Research and Assessment Centers	10
Sec. 206 Innovation and Industry Grants	13
Sec. 222 Reforms to ENERGY STAR	10
Sec. 228 Motor Efficiency Rebate program	18
Sec. 241 Building Codes	20
Sec. 242 Multifamily and Manufactured Homes	20
Sec. 243 Building Assessment Centers	10
Sec. 251 Low Income Weatherization	20
Sec. 262 Building Retrofit Program	15
Sec. 281 Building Labeling/Disclosure	5

Provision in APA	Measure Life
Sec. 782 Electricity Consumers	12
Sec. 783 Natural Gas Consumers	18
Sec. 784 Allocation for Home Heating Oil and Propane	18
Sec. 4001 Industrial Energy Efficiency—Sec. 451 in EISA	15
Transportation Planning, Highway Trust Fund, and TIGER Grants	20

Recommended Enhanced Energy Efficiency Provisions in ACELA/APA	Measure Life
Sec. 1637 Building Energy Efficiency Incentives Act of 2009	40
Sec. 1639 Expanding Industrial Energy Efficiency Incentives Act of 2009	10
Sec. 1696 Green Gaming Act	5

Key Assumptions Used in Analysis

Free Allowances Calculations

Calculations of free allowances were based on an ACEEE analysis of electric allowances, which averages results from ADAGE and IGEM (EPA 2009). The cost of saved energy figures come from a 2009 ACEEE study that cites an average levelized electric utility program cost of $0.025/kWh and a 12-year measure life. This study incorporates a 5% real discount rate in the calculations (Friedrich et al. 2009). The electric Total Resource Cost (TRC) used was $0.046 per kWh. For natural gas programs, a gas utility program cost of $0.37/therm and an 18-year measure life were used. The gas TRC cost was measured at $0.68 per therm.

Industrial Provisions

Industrial Energy Efficiency (Sec. 2101—APA)
APA provides 0.5% of emissions allowances from 2013-2015 to be used to fund Secs. 451, 452, and 453 of the *Energy Independence and Security Act of 2007* (EISA), not to exceed $1.5 billion total. We assumed that ½ of the funding would go to fund Sec. 451, the waste heat recovery provision in EISA, and ½ would go to fund Sec. 452, the industrial energy efficiency provision. ACELA modifies Sec. 452 for a number of relevant provisions, so ACEEE assumed that the funds for Sec. 452 would fund those programs (the Future of Industry Program, Industrial Research and Assessment Centers, and Innovation and Industry Grants) based upon their ACELA requirements.

In the enhanced efficiency case analysis, after the 0.5% of emissions allowances from 2013-2015, we allocated 0.25% of emissions allowances, extending out to 2030. Again, ½ were used for Sec. 451 of EISA, and ½ were used for the three provisions in Sec. 452 of EISA.

Industrial Energy Efficiency—Waste Heat Recovery (Sec. 451 of EISA; funding in APA)
In the base APA analysis, the funding for the Waste Heat Recovery Grant program was calculated using ½ of the 0.5% allocated to "Industrial Energy Efficiency." This translated to $180-190 million dollars per year of spending in 2013-2015. In the enhanced efficiency case, 0.25% of allowance value was extended out to 2030, and the funding for the Waste Heat Recovery Grant program was again assumed to be ½ of the 0.25%, translating to $120-150 million dollars per year from 2016-2030.

The EISA specified a grant rate of $10/MWh or $2.93 $/MMBtu, so these rates were used to generate estimates of electricity and natural gas savings from this provision. We grouped all potential projects into two categories based on the savings rates given in the bill. The first type, combined heat and power (CHP) and waste energy recovery to electricity (WRE) projects, generates electricity onsite at the expense of additional fuel (assumed to be natural gas). We assume that generating electricity onsite does not reduce the amount of end-use electricity consumed and that most of the electricity generated is sold to the wholesale market, so electricity and dollar savings, program spending, and additional fuel costs are not counted in the industrial sector. 67% of the funding for this provision was assumed to be used for CHP/WRE. The remaining 33% are assumed to be used for waste heat recovery for thermal energy, which directly offsets fuel use in the industrial sector by capturing wasted heat and reuses it onsite.

To assess the consumer costs, total annual electricity and natural gas savings were multiplied by the cost of saved energy and the federal share of investments was subtracted out.

Industrial EE Revolving Loan Program (Sec. 201 - ACELA)
This provision was only analyzed in the enhanced efficiency case, because ACELA provides authorizations, but no appropriations. In addition, APA did not provide emissions allowances to fund this program. In the enhanced case, we allocated one-fifth of EITE allowances (which are 15% of total allowances in 2016-2025, then ramping

down to zero by 2030) to the revolving loan fund. We assumed a loan default rate of 5% and a 3% loan servicing fee for administrative costs. The loans, as dictated by the legislation, follow the 10-year Treasury Bill interest rate. Consumer costs were calculated assuming a 15% down payment on the loan. Half the investment was assumed to apply to electricity saving measures, and half to fuel saving measures. Natural gas and fuel oil savings were broken out according to the projected consumption ratios for all industry excluding refining[7] from AEO 2010.

Future of Industry Program (Sec. 204 - ACELA)
In the base APA analysis, the funding for the Future of Industry Program (FOI)[8] was calculated using ½ of the 0.5% allocated to "Industrial Energy Efficiency," minus the amounts for Sec. 204c ($20 million/year) and Sec. 206 ($5 million/year). This translated to $150-164 million dollars of spending in 2013-2015. In the enhanced efficiency case, the 0.25% allowance was continued from 2016 to 2030, and the funding for the Future of Industry program was again assumed to be ½ of the 0.25%, minus the $20 million/year and $5 million/year for Secs. 204c and 206.

To calculate energy savings from FOI, we assumed that half of the savings would be natural gas savings and half the savings would be electricity savings. The funding stream was translated into energy savings using a rate of 2.5 Tbtu saved/million$, based on the historic savings rate as result of DOE's IOF program (NRC 2007). Since this is an R&D program, savings were assumed to begin 7 years after funding begins to account for the time it has taken IOF research to reach commercialization in the past. Savings were assumed to ramp-in over 5 years to account for market uptake of the technology.

In the base case, we assumed that only half the savings would be implemented due to the capital constraints in industry. In the enhanced case, we assume these capital constraints no longer exist because of the presence of funding from the revolving loan fund (Sec. 201), and allocations of allowances to LDC and states. To avoid doubling counting of savings in the enhanced case, the IOF savings estimates were reduced to account for interactions between this R&D program that creates energy efficiency savings opportunities and the incentive programs that help fund their implementation. Half of the enhanced case energy savings from the revolving loan program (Sec. 201) were subtracted from IOF savings. In addition, because the enhanced case assumes significant funding is available from allocations to electric utilities and states, as well as funding to achieve savings via an energy efficiency resource standard (EERS), we therefore attribute any remaining electricity savings form the IOF program to these incentive provisions.

To assess the consumer costs, total annual electricity and natural gas savings were multiplied by the cost of saved energy and the federal share of investments was subtracted out.

Industrial Research and Assessment Centers (Sec. 204c - ACELA)
In the base APA analysis, funding of $20 million/year was assumed in 2013-2015, coming out of the 0.5% of allocation funds dedicated to EISA provisions 451 and 452. In the enhanced case, funding of $20 million/year is extended out to 2030, as a part of ACEEE's recommendation that 0.25% of emissions allowances be dedicated to industrial energy efficiency out to 2030.

There are currently 26 Industrial Assessment Centers (IAC) performing about 13 audits per year each. Base case savings were based on performing 30 audits per year each. Enhanced case savings were based upon ramping up to 34 centers by 2014 and performing 30 audits per year each.

Based on Industrial Assessment Center data, this analysis assumed an average implemented savings of 400,000 kWh and 2,500 MMBtu per audit (IAC 2009). To calculate the cost to industrial plant owners, the national weighted average for installed cost of industrial measures ($0.17 /kWh and ~ $17 /MMBtu) was used (ACEEE et al. 2009).

Innovation and Industry Grants (Sec. 206 - ACELA)
In the base APA analysis, funding of $5 million/year is assumed in 2013-2015, coming out of the 0.5% of allocation funds dedicated to EISA provisions 451 and 452. In the enhanced case, funding of $5 million/year is assumed out to 2030.

[7] The oil refining sector is not covered by the industrial provisions in the American Power Act.
[8] ACELA re-authorized the longstanding Industries of the Future (IOF) program as the Future of Industry (FOI) program. We use the terms interchangeably.

The funding stream was translated into energy savings using a rate of 2.5 Tbtu saved/million$, based on the historic savings rate as result of DOE's NICE3 program (NRC 2007). This was divided by 2 to reflect the fact that the IOF program was extraordinarily successful, and that any new program may not have the same level of success. In addition, savings were delayed by 5 years to reflect the delay between the grants' distribution and realized energy savings. To calculate energy savings from these grants, it was assumed that half of the savings would be natural gas savings and half the savings would be electricity savings.

Appliance and Equipment Standards

Energy Conservation Standards—AC, Furnaces, Heat Pumps (Sec. 233)
Savings from the AC, Furnace, and Heat Pump standard were determine by extending a spreadsheet created for the ACEEE/ASAP join report, *Ka-BOOM! The Power of Appliance Standards: Opportunities for New Federal Appliance and Equipment Standards* (Neubauer et al. 2009). Shipment and market share data was provided by AHRI.

Savings from the enhanced Building Codes portion of the standard were made assuming that states representing 80% of nationwide sales adopt the specific air-conditioner and heat pump standards for new construction specified in the legislation, and states representing 50-65% of nationwide sales adopt the furnace standards for new construction specified in the legislation (higher in the North than in the South).

Determinations and Procedures (Sec. 233)
ACEEE calculated the subtotal of estimated savings from all applicable federal rulemakings as estimated in Ka-BOOM! The Power of Appliance Standards: Opportunities for New Federal Appliance and Equipment Standards (Neubauer et al. 2009) and assumed 2% additional savings from the improvements to the rulemaking process specified in this section.

Portable Light Fixtures (Sec. 224 - ACELA), Commercial Furnace Standards (Sec. 227- ACELA), Bottle-Type Water Dispensers, Commercial Hot Food Holding Cabinets, and Portable Electric Spas (Sec. 235- ACELA), Outdoor Lighting (Sec. 239- ACELA)
Energy savings from appliance standards were estimated using a complex spreadsheet created by ACEEE for the Appliance Standards Awareness Project (ASAP). The methodology and assumptions are detailed in an ACEEE/ASAP joint report, *Ka-BOOM! The Power of Appliance Standards: Opportunities for New Federal Appliance and Equipment Standards* (Neubauer et al. 2009).

Motor Efficiency Rebate program (Sec. 228 - ACELA)
Estimates from the Motor Efficiency Rebate program in the bill were made using a spreadsheet developed by Rob Boteler of Emerson Motor Company (Boteler 2009).

Buildings Provisions

Rural Energy Savings Program (Sec 1602)
This program is funded using 0.5% of the emissions allowances for years 2013-2016. To determine the funding stream for the program, we assumed a loan default rate of 5% and a 3% loan servicing fee for administrative costs. Consumer costs were calculated assuming a 13% down payment on the loan. The language is unclear about the type of program that would be funded by this provision, so estimates of residential retrofit savings were used to calculate the energy savings from the program.

The number of participating homes for residential retrofits was calculated by assuming that administrative costs account for 15% of the funds allocated to the program and that retrofits cost $3,000 per home. Energy savings were determined using estimates of 1,709 kWh[9] of electricity saved per home and 30.6 MMBtu[10] of natural gas saved per home, derived from NYSERDA home performance program results, but adjusted to reflect national average weather conditions (Jones 2009). We allocated the Btu savings using national figures for consumption of distillate fuel oil and natural gas.

[9] N.Y. is 934 kWh/home—we increase by an 1.83 multiplier based on US/NY avg. cooling.
[10] N.Y. is 40.2 mBtu—we discount by 24% based on NY/US avg. heating degree.

State Renewable Energy and Energy Efficiency Programs (Sec. 1603—APA)
Sec. 1603 of APA designates five different program types that can use the state allocation funds, including energy efficiency purposes, renewable energy purposes, cost-effective energy efficiency programs, smart grid, and surface transportation capital projects (not to exceed 10% of the state funds). The allowable energy efficiency programs include building codes, energy-efficient manufactured homes, building labeling, low-income energy efficiency improvements, and energy efficiency building retrofits. These uses line up with the "Buildings Efficiency" subtitle in ACELA, the energy-only committee bill passed by the Senate Energy and Natural Resources Committee.

Although ACELA provisions are not explicitly mentioned here, each of these "energy efficiency purposes" is a part of the ACELA bill, and to calculate the level of savings for the ACELA provisions, we assumed their funding came from Sec. 1603 of APA, even though the bill does not explicitly state this. We assumed that 60% of the state funds would go to energy efficiency projects—half of which (30% of the allocation) would go towards general state programs and half of which (30% of the allocation) would go to fund the five programs detailed in ACELA and mentioned in Sec. 1603 of APA.

General State Programs:
30% of the funds dedicated to Sec. 1602 were assumed to be used for general state programs. To calculate energy savings from these programs, we assumed half the savings came from electricity and half of the savings came from natural gas.

To translate carbon allowances funding into electricity savings, we used the cost of saved energy figures from an ACEEE study that cites an average levelized electric utility program cost of $0.025/kWh and a 12-year measure life (Friedrich et al. 2009). The electric Total Resource Cost (TRC) used was $0.046 per kWh. For natural gas programs, a gas utility program cost of $0.37/therm and an 18-year measure life were used. The gas TRC cost was measured at $0.68 per therm.

For the enhanced energy efficiency case, funding of 6% of emissions allowances/year were designated to state programs. We assumed that 60% of the state funds would go to energy efficiency projects—this would be used to fund the five energy efficiency programs mentioned in the bill language, and the remainder to fund general state energy efficiency programs. This would provide $2.5 to $4.4 billion in funding for state energy efficiency from 2013-2030. Savings were calculated using the same method as the bill analysis, assuming that all five ACELA-authorized programs would be funded first, and the remainder of the funds would be used for general state energy efficiency programs.

Specific Energy Efficiency Programs:
For these programs (building codes, energy-efficient manufactured homes, building energy performance labeling, low-income energy efficiency, and energy efficiency retrofits), full funding was assumed based on the language in ACELA or ACEEE's assumptions as detailed above. After the cost of fully funding these programs is subtracted out, $140 million to $2.8 billion would be available from 2016-2030 for general state energy efficiency programs.

Building Codes (Sec. 241 - ACELA)
For commercial codes, we calculated the amount of electricity and natural gas consumed on average per square foot of commercial space. Those buildings affected by the code are new stock, so we used new additions as the amount of square footage participating, and then applied 35% electricity savings and 25% gas savings for an average of 30% in 2010 and 55% electricity savings and 45% gas savings for average of 50% in 2016. Each improvement in codes was delayed by an implementation period of two years (so the 30% savings begin in 2012), accounting for time for states to adopt and begin enforcing the codes.

In the APA and enhanced case, we assumed that 60% of buildings would correctly implement the codes, increasing the implementation percentage by 5% every year. Each time a new level of savings is required by the bill, the percent of implementation moves back down to 60% and increases by 5% until the next standard is required. Building codes savings are not directly tied to funding. Rather, the implementation percentages references above were determined based on assumptions made in ACEEE's ACES analysis (Gold et al. 2009), and multiplied by a factor to account for lower funding from Sec. 1603 of APA. As a result of this last factor, the percentage of buildings that correctly implement the codes is higher in the enhanced case, due to higher funding for code implementation activities.

For residential codes, we calculated new additions to the residential stock of Single-Family Homes by subtracting the difference in the new stock from the previous year, and included an assumption that 1/100 of the stock would be lost to demolition each year (EIA 2010). The amount of electricity and natural gas/home was calculated by dividing the delivered electricity and natural gas consumption by the number of homes. The same implementation assumptions for commercial buildings were used for residential buildings.

To assess the consumer costs, federal investment was subtracted from the savings from reduced energy bills, assuming an average simple payback period of 7 years.

Multifamily and Manufactured Homes (Sec. 242 - ACELA)
For the enhanced case, the calculations were based upon a spending estimate of $50 million in the first year of the program, ramping up to $500 million by the 5th year, and continuing at $500 million to 2030 (Sec. 242 specifies "such sums as are necessary; these spending amounts are based upon an ACEEE proposal). For the APA+ACELA case, these amounts were multiplied by the percentage expected to be funded by Sec. 1603 from APA. We assumed that each federal dollar would be matched by a participant dollar.

To calculate the energy savings, we assumed savings of 1,202 kWh of electricity per apt and 32 MMBtu of fuel per apartment. Total annual savings were calculating with a 20-year measure life.

Building Assessment Centers (Sec. 243 - ACELA)
Building Assessment Center (BAC) savings were based upon a ramp-up to 75 centers in 2016 assuming 26 assessments/center/year, based on Industrial Assessment Center data. This is a new program, so the number of centers will initially be zero. This analysis calculated electricity, natural gas, and fuel oil use per square foot and assumed a mean commercial building size of 13,900 sq. ft. and energy savings of 10% (ACEEE estimate) to calculate savings from each assessment (EIA 2010).

Low Income Weatherization (Sec. 251 - ACELA)
Sec. 251 of ACELA specifies that $1.7 billion be spent in years 2011-2015. Our analysis assumes that funding would not begin until 2013, when APA's emissions allowances begin. For the APA+ACELA case, these amounts were multiplied by the percentage expected to be funded by Sec. 1603 from APA.

We assumed that 40% of the energy savings would come from saved electricity and 60% would come from saved natural gas, and that there would be a 10-year payback for electricity and natural gas measures (ORNL 2005).

Building Retrofit Program (Sec. 262 - ACELA)
Estimates of savings from Home Retrofits in the enhanced efficiency case were based upon an assumption of $300 million in 2012, $600 million in 2013, and $1 billion/year in federal spending from 2014-2030. For the APA+ACELA case, these amounts were multiplied by the percentage expected to be funded by Sec. 1603 from APA.

The number of participating homes was calculated by assuming that administrative costs account for 15% of the SEED funds and that retrofits cost $3,000 per home. Energy savings were determined using estimates of 1,709 kWh[11] of electricity saved per home and 30.6 MMBtu[12] of natural gas saved per home, derived from NYSERDA home performance program results, but adjusted to reflect national average weather conditions (Jones 2009). We allocated the Btu savings using national figures for consumption of distillate fuel oil and natural gas.

For Commercial Retrofits, we assumed the building retrofit funds would be equally allocated between residential and commercial retrofits. To calculate participation levels, we calculated the cost of the retrofits for 1 billion square feet, assuming a federal retrofit cost of $0.75/sq. ft., and used this amount per square footage to the amount of funding for commercial retrofits. Electricity, natural gas, and distillate fuel oil consumption and savings were calculated per square foot using EIA (2007a) total commercial consumption and total commercial square feet data, and 30% savings were assumed for electricity and 20% for natural gas and distillate fuel oil. The federal

[11] N.Y. is 934 kWh/home—we increase by an 1.83 multiplier based on US/NY avg. cooling.
[12] N.Y. is 40.2 mBtu—we discount by 24% based on NY/US avg. heating degree.

cost was calculated based upon the amount of funding assumed for REEP. Consumer costs were calculated by assuming a 1:1 ratio of federal to consumer costs, given a total cost of $1.50/square foot (Osborn et al. 2002).

Building Labeling/Disclosure (Sec. 281 - ACELA)
To calculate the number of homes participating in building labeling in the enhanced efficiency case, we assumed a ramp-up to 1 million homes per year in 2013, and multiplied by the ratio of new households to total households (EIA 2010) to reflect that the provision only applies to new construction. In the APA bill analysis, the ramp-up of homes was multiplied by a factor to reflect the amount of home labeling expected to be funded by the state emissions allowance allocation in Sec. 1603.

A measure life of 5 years was used in residential buildings. The amount of electricity and natural gas consumption per home was calculated by dividing the delivered electricity and natural gas consumption by the number of homes.

Similar approaches were used to calculate commercial building labeling savings, using the consumption per square foot of commercial space, and participation levels ramped up to the product of 1 billion square feet in 2013, and the percent of new square footage to reflect that the provision only applies to new construction. We used a measure life of 5 years for the electricity, natural gas, and fuel oil measures that result from labeling programs. Five percent savings were assumed from the program for both commercial and residential buildings.

To calculate the federal costs, ACEEE estimated a cost of $50 million per year for the program, with $25 million/year for residential labeling and $25 million/year for commercial labeling. We used a 3-year payback period for all measures in calculating the consumer investments.

Consumer Protection Provisions

Electricity Consumers (Sec. 3001 - APA)
APA does not designate a certain portion of the allowances to electricity LDCs to be used for energy efficiency, so no energy savings were assumed from this provision. We do expect utilities that are presently operating energy efficiency programs to use some APA funds to help fund their planned programs, but we assume that these savings are included in the base case.

Sec. 3001 provides between 45.4% and 7.5% of allowances for electric LDCs from 2013 to 2029. The enhanced energy efficiency case assumes that beginning in 2013, 5% of allowances will be used for energy efficiency, ramping up in increments of 3% every year to 20% in 2018, and staying at 20% out to 2029.

To translate carbon allowances funding into energy savings, we used a price of 2.5 cents/kWh based on the ACEEE program cost review study (Friedrich et al. 2009). We multiplied the amount of savings by a factor of 0.82 to account for a customer investment: utility cost ratio (Friedrich et al. 2009). To account for the interaction between electric utilities and EERS, we assumed that savings from the one-third dedicated to energy efficiency for electric utilities would count towards a 10% EERS, and removed the amount of overlap savings from the electric utilities savings. Since existing state EERS's will save about 6%, and the federal EERS about 4%, by subtracting the full 10% EERS from the electric utility savings, we are not counting any savings from current and planned utility programs.

Natural Gas Customers (Sec. 3101 - APA)
To calculate energy savings from natural gas utility allowances, we used the carbon allowance values from EPA's IGEM and ADAGE reports, and used the percentages from Sec. 3101 to determine the total value of allowances. This section designates 1/5 of all natural gas LDC allowances to be used for energy efficiency.

To account for business-as-usual natural gas program spending, we used the amount of natural gas spending ($292.8 million/year) in 2006 (Eldridge et al. 2008). To translate spending into energy savings, we used the cost and measure life data for natural gas programs (see "Free Allowances Calculations" above). We multiplied the amount of natural gas savings by a factor of 0.82 to account for a 0.82 consumer to federal investment match (Friedrich et al. 2009).

In the enhanced case, the same cost of saved energy assumptions were used, but instead of designating 1/5 of allowances to energy efficiency, the enhanced case includes 1/3 of allowances to energy efficiency.

Home Heating Oil and Propane (Sec. 784)
To calculate energy savings from the heating oil and propane utility allowances, we used the carbon allowances values from EPA's IGEM and ADAGE reports, and used the percentages from Sec. 781 to calculate the value of these allowances. These values were divided in half because half of these funds are specifically allocated to energy efficiency programs in the bill. To translate spending into energy savings, we used the cost and measure life data for natural gas programs (see "Natural Gas" above). We multiplied the amount of savings by a factor of 0.82 to account for a customer investment to program cost ratio (Friedrich et al. 2009).

Research and Development Provisions

Low Carbon Industrial Technology R&D (Sec 4161)
The Low Carbon Industrial Technology R&D provision receives 1% of the carbon allowances from 2013-2020, and .5% of the allowances in 2021. This provision is designed to support research and development in the manufacturing sector but also to benefit other sectors, so ACEEE assumed that 50% of the savings would accrue to the manufacturing sector, and 25% of the savings would accrue to both the buildings and transportation sectors (to account for buildings and transportation materials and products created by this R&D funding).

ACEEE compiled estimates of quad savings from DOE's EERE program projections, specifically from transportation, buildings, and industry (NREL 2007). A ratio of APA: DOE present investment was created and applied to the EERE savings in quads to estimate the total number of quads savings from APA investments in efficiency R&D for each sector. The implementation of this ratio was delayed by 15 years for all sectors (buildings, transportation, and industry) to reflect delays between investment and realized savings.

In addition, a probability of success rate of 12.5% for buildings, 12.5% for industry, and 10% for transportation was applied, based on ACEEE judgment. These are ½ the assumptions made in the Clean Energy Technology R&D section, because this provision authorizes a higher risk category of R&D. These ratios are essentially a discount relative to DOE projections so as to be conservative. A multiplier of one-third in 2020 and one-half in 2030 was also included for transportation R&D to reflect overlap with vehicle fuel economy standards, and a multiplier of two-thirds was applied for buildings to reflect those codes and standards already accounted for in estimates of savings from the bill.

To figure out the distribution of fuel savings, we assumed that savings would follow total national fuel consumption patterns (EIA 2010).

Clean Energy Technology R &D (Sec 1801—APA)
APA provides 2% of emissions allowances from 2013-2021 for "clean energy technology R&D. One of the six purposes for which this can be used is "improves energy efficiency for transportation, including electric vehicles." The other five are: renewables, energy transmission/storage, building/industrial efficiency, smart grid, and produces an "advanced material" for energy/energy efficiency application.

To calculate savings from this provision, we assumed that 41% of the funds would be used for energy efficiency—that 1/6 (16%) of the funds would be used for transportation energy efficiency, 1/6 (16%) would be used for building/industry efficiency, and that of the "advanced material for energy efficiency application,", ½ (or 1/12 of the total R&D funds, 8%) would create energy efficiency savings.

ACEEE compiled estimates of quad savings from DOE's EERE program projections, specifically from transportation, buildings, and industry (NREL 2007). A ratio of ACES: DOE present investment was created and applied to the EERE savings in quads to estimate the total number of quads savings from ACES investments in efficiency R&D for each sector. The implementation of this ratio was delayed by 10 years for buildings and transportation and by 7 years for industry to reflect delays between investment and realized savings.

In addition, a probability of success rate of 25% for buildings, 25% for industry, and 20% for transportation was applied, based on ACEEE judgment. These ratios are essentially a discount relative to DOE projections so as to be conservative. A multiplier of one-third in 2020 and one-half in 2030 was also included for transportation R&D to reflect overlap with vehicle fuel economy standards, and a multiplier of two-thirds was applied for buildings to reflect those codes and standards already accounted for in estimates of savings from the bill.

To figure out the distribution of fuel savings, we assumed that savings would follow total national fuel consumption patterns (EIA 2010).

Transportation Provisions

Investing in Clean Vehicles (Sec. 4111)

We did not attempt to assign savings to this section. The weak efficiency threshold for eligible vehicle models means that grants could go to facility conversions to manufacture vehicles of average efficiency, providing no savings. Even in our Enhanced Case, where Advanced Technology Vehicles would be required to have superior efficiency, savings from the Clean Vehicle Technology Fund are not ensured, due to the structure of CAFE standards. Because CAFE standards apply not to individual vehicles but to manufacturer fleet averages, any highly efficient vehicles a manufacturer produces can be used to offset its production of low efficiency vehicles, allowing the manufacturer to remain in compliance with the standards. At the same time, it is important to recognize that well-designed retooling incentives can spur the development of truly advanced technologies and, by helping manufacturers absorb the costs of technology improvements, make ambitious increases in average fuel economy more feasible.

The 19% of grant money that must go to plug-in electric drive vehicle and component manufacturing facilities could accelerate their arrival, but the amount of money available (an estimated $1.4 billion over 9 years) will not automatically play a major role in this transition. Both DOE's Advanced Technology Vehicles Manufacturing Loan Program and the Advanced Battery Program under ARRA have provided more money than this, over a much shorter time period.

Secs. 1711 Transportation Efficiency, 1712 Investing in Transportation GHG Reduction, and 1721 Highway Trust Fund; TIGER Grants

We based the estimates of savings from the allocations to transportation planning and infrastructure on results of the *Moving Cooler* study (http://www.movingcooler.info/) completed by Cambridge Systematics in 2009 on behalf of a diverse group of transportation stakeholders. The study analyzed six coherent bundles of national transportation greenhouse gas policies and measures that could be implemented between now and 2050, and estimated greenhouse gas reductions and implementation costs for each of them. This allows the assignment of an average cost-per-ton-saved for each bundle. It is important to note that this cost-per-ton reflects only implementation costs and does not account for the fuel savings or other benefits of the measures in the bundles.

The measures comprising the bundles coincide to a great extent with the transportation efficiency strategies listed in Sec. 1711 and eligible for funding under Sec. 1712. We chose two *Moving Cooler* bundles as representative of investments that might be made under the funding provisions discussed here (i.e., Sec. 1712, Highway Trust Fund, and TIGER grants). The two bundles, Low Cost and Long Term/Maximum Results, have quite different costs-per-ton. We used these values, together with the specified carbon allocation amounts, to estimate the oil savings and greenhouse gas reductions from the three provisions.

Further assumptions in estimating the savings and economic impacts of these provisions were as follows. For Sec. 1712, Inventing in Transportation Greenhouse Gas Emissions Reduction Programs, we assumed that funded activities would be typified by the Low Cost Bundle, given that quantity of greenhouse gas emissions and cost-effectiveness of reducing those emissions are two of the considerations in awarding funding under this section. Because planning, modeling, and other non-construction activities are such an important element of this program, we assumed that only half of the funds would be spent on infrastructure projects. Freight investments, and hence diesel fuel savings, were assumed to be 25% of the total, given the share of all transportation greenhouse gas emissions associated with goods movement.

For Highway Trust Fund and TIGER Grants, the priority of greenhouse gas reductions and of cost-effectiveness in reducing emissions are not explicit; Trust Fund allowances are to be used in a manner only "consistent with" the greenhouse gas planning and efficiency provisions of Sec. 1711, while the TIGER program is oriented largely toward job creation. Hence we assumed that only 50% of projects funded with these allocations reduce greenhouse gases. Furthermore, for those projects that did reduce emissions, we assumed a cost-per-ton equal to the average of the costs-per-ton of the Low Cost and Long Term/Maximum Results bundles. One-quarter of Trust Fund dollars were again assumed to go to freight projects, while freight projects were half of TIGER grants, based on the orientation of the TIGER grant program to date.

These assumptions are summarized in the table below.

Assumptions Used to Evaluate Savings from APA Transportation Planning and Infrastructure Allocations

	Sec. 1712	Highway Trust Fund	TIGER Grants
Percent of Total Funds for GHG-Reduction Projects/Measures	100%	50%	50%
Low Cost/Max Results Bundle Split	100%/0%	50%/50%	50%/50%
Infrastructure Investment as a Percent of Total Federal Expenditure	50%	95%	95%
Freight Investment Share	25%	25%	50%

To estimate savings for the Enhanced Case, we assigned all allocations for the Highway Trust Fund and TIGER grants to projects that reduce greenhouse gases (100% in the first line of the table), and we assumed that average cost-per-ton across all three programs is the cost-per-ton of the Low Cost Bundle (100%/0% in the second line of the table).

Enhanced Case Assumptions

In addition to the enhanced assumptions mentioned for specific provisions above, ACEEE recommends adding the following energy-saving provisions. These were analyzed as a part of the Enhanced Case.

ACELA:

<u>Federal Renewable Electricity Standard (Sec. 132 - APA)</u>
The enhanced energy efficiency case of this analysis includes a 10% Energy Efficiency Resource Standard by 2020, either a stand-alone EERS, or a Combined Efficiency and Renewable Energy Standard (CERES) that includes 10% for energy efficiency. The impacts for the EERS were calculated by adapting the model developed for the ACEEE report, *Laying the Foundation for Implementing a Federal Energy Efficiency Resource Standard* (Furrey et al. 2009).

<u>Sec. 1637 Expanding Building Efficiency Incentives Act of 2009</u>
This bill included three major energy efficiency tax incentives—to increase the commercial building deduction, to extend the current new homes credits, and a new credit for 50% whole home savings. We analyzed each separately, generally using the same assumptions as described above for estimating savings from building codes, but adjusting savings upwards to the levels specified for the tax credits, but then subtracting the building code savings so we do not double-count savings. Participation rates for the tax incentives are ACEEE estimates and range from 1-5% of new construction each year, with participation rates lower in early years and also lower for the commercial sector than for the residential sector. Cost to the Treasury is based on the per home and per square foot incentives in the bill. In addition, ACEEE estimated that consumers will have to pay $1000 per new home and $1.95/commercial building sq. ft., above and beyond the federal tax incentive.

<u>Sec. 1639 Expanding Industrial Energy Efficiency Incentives Act of 2009</u>
This bill included four major energy efficiency tax incentives—on advanced motors, chillers, CHP, and water savings. ACEEE did not include an analysis of the water savings in this analysis. For chillers, ACEEE worked with AHRI to develop a detailed spreadsheet on the existing stock of CFC chillers and how much it would cost and how much can be saved by installing more efficient chillers. We estimate that 15% of this stock would be replaced during the three years of the tax incentive and assumed the energy savings extend for 10 years, after which the chiller would have been replaced anyway.

Sec. 1696 Green Gaming Act

ACEEE averaged estimates of the energy savings from a 1-hour automatic shutdown and a 3-hour automatic shutdown from measurements taken as a part of the “Lowering the Cost of Play” study (Horowitz 2008). To calculate a weighted average of the energy savings from turning off consoles, those measurements were applied in a weighted average using 2007 sales numbers to determine the market share of different game consoles. These savings were divided in half, because the analysis assumed that 50% of users leave their game consoles on after use, and 50% of users turn them off after use (Horowitz 2008). The energy savings would only apply to those users who normally leave their game consoles on.

APPENDIX E. METHODOLOGY OF THE MACROECONOMIC MODEL

As implied in the main part of this report, the impact assessment described here is really an examination of how changed behaviors and investment flows might reasonably characterize an alternative and perhaps a more productive energy and economic future. As business leaders and policymakers first think about the policy implications of suggested climate change legislation, they may conclude that the implied transition to a less carbon-intensive economy will end up costing more. On the other hand, when all system costs are properly included and balanced, it can be shown—on a net basis—that the alternative future or the enacted policy scenarios may actually cost less.

In a format consistent with a number of other past studies that inform this debate (see, for example, McKinsey & Company 2009; CCS 2008; Laitner and McKinney 2008; Barrett et al. 2005; Laitner et al. 2006; Lovins et al. 2004; Interlaboratory Working Group 2000), this appendix highlights the major analytical assumptions that underpin the assessment described in the main part of the report.

The assumptions generally fall into four major categories: prices, quantities, investment flows, and input-output modeling. Each of these categories is subscripted by sector and by end-use energy or fuels. The analytical tool used to evaluate the energy and climate policy impacts is the DEEPER Model, which is described next. This is then followed by the major price, cost, income, and demand assumptions that underpin the results summarized in the main body of the report.

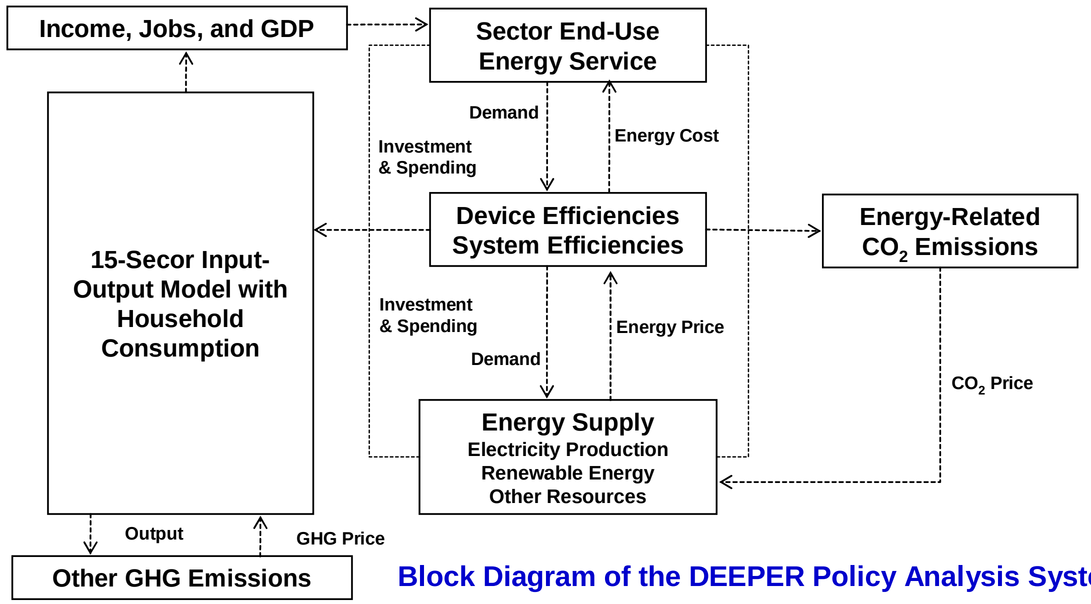
The DEEPER Modeling System

The **D**ynamic **E**nergy **E**fficiency **P**olicy **E**valuation **R**outine—the DEEPER Modeling System—is a 15-sector quasi-dynamic input-output model of the U.S. economy.[13] Although an updated model with a new name, the DEEPER model has an 18-year history of use and development. See Laitner, Bernow, and DeCicco (1998) for an example of an earlier set of modeling results.[14] Laitner and McKinney (2008) also review past modeling efforts using this modeling framework. The model is used to evaluate the macroeconomic impacts of a variety of energy efficiency, renewable energy, and climate policies at both the state and national level. The timeframe of the model for evaluating policies at the national level is 2010 through 2050, or in the case of evaluating the American Power Act, the period 2013 through 2050. In its current implementation, the model solves for the set of energy prices that achieves a desired, exogenously determined level of greenhouse gas emissions (i.e., below some previously defined reference case).

The model includes a representation of both energy-related CO_2 emissions and all other greenhouse gas emissions as well as emissions reduction opportunities. The DEEPER Model focuses, in particular, on the use of energy in all sectors of the economy, electricity production, and energy-related CO_2 emissions as well as on the prices, policies, and programs necessary to achieve the desired emissions reductions. The DEEPER Model is an Excel-based analytical tool with three linked modules combining approximately two dozen interdependent worksheets. The primary analytic modules are: (i) the Energy and Emissions Module, (ii) the Electricity Production Module, and (iii) the Macroeconomic Module. The block diagram of the DEEPER Modeling System on the following page lays out the analytical framework of the model.

[13] There are two points that might be worth noting here. First, the model solves recursively. That is, the current year set of prices and quantities is dependent on the previous years' results. As the model moves through time, there are both secular and price-quantity adjustments to key elasticities and coefficients within the model. Second, there is nothing particularly special about this number of sectors. The problem is to provide sufficient detail to show key negative and positive impacts while maintaining a model of manageable size. If the analyst chooses to reflect a different mix of sectors and stay within the 15 x 15 matrix, that can be easily accomplished. Expanding the number of sectors will require some minor programming changes and adjustments to handle the larger matrix.

[14] When both equilibrium and dynamic input-output models use the same technology assumptions, both models should generate reasonably comparable set of outcomes. See Hanson and Laitner (2005) for a diagnostic assessment that reached that conclusion.



Block Diagram of the DEEPER Policy Analysis System

The model outcomes are driven primarily by the demands for energy services and alternative investment patterns as they are shaped by changes in policies and prices. A key feature of the model is one that also allows consumer behaviors to also adjust to changing preferences. This follows the logic outlined in Laitner, DeCanio, and Peters (2000), and fits within the framework outlined by Ehrhardt-Martinez (2008). The changes are implemented in what we call a price-preference ratio following Laitner (2009b) and Laitner and Hanson (2006). The functional form of the price-preference ratio is computed as an index of price divided by the consumer's implicit discount rate. This is a rate that reflects a desired return on investment. For example, if a consumer chooses not to adopt a technology, for whatever reason, unless it pays for itself over a 2-year period, that suggests a 50 percent discount rate; or said differently, a desire to earn at least a 50 percent return on his or her investment in an energy-efficient technology. All else being equal, either a doubling of prices or a 50 percent reduction in the implicit discount rate (or some equivalent combination of the two) will have the same impact on the various elasticities within the model.[15]

Although the DEEPER Model is not a general equilibrium model, it does provide sufficient accounting detail to match import-adjusted changes in investments and expenditures within one sector of the economy and balance them against changes in other sectors. As shown in the block diagram above, the demand for energy-related services is the starting point for policy-induced changes. Both price and non-price policies—including standards, technical assistance, financial incentives, research and development (R&D), or general information and labeling programs (e.g., the EPA and DOE ENERGY STAR programs)—can shift consumer preferences and the availability of technologies. Implementation of these policies stimulates an array of changes in prices, investments, and expenditures. These changes include program costs and incentives that might be needed to shift behaviors and investments so that the energy and emissions targets are satisfied. As changing demands confront a changing mix of energy resources, GHG prices (in constant dollars per metric ton of avoided CO_2-equivalent emissions) and energy prices (in constant dollars per million Btus of energy) are likely to change in response. The combination of new policies and induced changes in prices stimulates changes in investments and other consumer behaviors. These changes in investments and consumer behaviors drive the final results that emerge from application of the DEEPER Model.[16] With this preliminary characterization of the model, the sections that follow describe the three major modules within DEEPER.

[15] One nice feature of this functional form is that it is less important to determine the "right" starting implicit discount rate as it is to show what a shift in the size of that rate might matter.
[16] As noted in Hanson and Laitner (2004), a combination of price and non-price policies can generally produce a much more cost-effective policy resolution than either type of policies would induce by itself. The resulting deployment of new technologies depends on the assumed effectiveness of programs that might be implemented and the incentives being offered. Implementation of these policies—along with the resulting deployment of new technologies—strengthens the ability of the

Energy and Emissions Module: The DEEPER Model is benchmarked to the most current version of the *Annual Energy Outlook* (EIA 2010), which now extends out through 2035. Based on data available from other sources like Economy.com (2010), which now goes out to 2040, we must make a reasoned estimate of how the economy might grow through the year 2050 in a "Business-as-Usual" or Reference Case scenario, and how that will, in turn, affect energy use, fuel and electricity prices, and greenhouse gas emissions.

Key Reference Case Scenario Data for DEEPER Policy Runs in Key Benchmark Years						
	2010	**2013**	**2020**	**2030**	**2050**	**Annual Growth Rate 2010-2050**
Gross Domestic Product (Billions of 2007 Dollars)	13,711	15,122	18,472	23,824	38,217	2.6%
Energy-Use or Delivered Energy (quads)	69.46	72.4	75.5	79.9	91.4	0.7%
Electricity Consumption (Billion kWh)	3,617	3,809	4,083	4,472	5,307	1.0%
Energy-Related CO_2 Emissions ($MMTCO_2e$)	5,527	5,718	5,807	5,919	6,085	0.2%
Non-Energy GHG Emissions ($MMTCO_2e$)	1,034	1,100	1,218	1,173	1,206	0.4%
Total GHG Emissions ($MMTCO_2e$)	6,562	6,818	7,026	7,092	7,290	0.3%
Household Electricity Price (2007 $/kWh)	0.103	0.105	0.106	0.112	0.128	0.5%
Household Natural Gas Price (2007 $/MBtu)	10.65	11.22	11.69	13.15	16.92	1.2%
Total Household Energy Bill (Billion 2007 $)	220.84	225.68	241.36	275.61	361.30	1.2%
Total Economy-Wide Energy Bill (Billion 2007 $)	1,093.1	1,259.1	1,449.5	1,686.4	2,407.3	2.0%
Ecomomy-Wide Average Energy Price (2007 $/MBtu)	15.74	17.39	19.21	21.11	26.34	1.3%

The main reference case assumptions are shown in the table above for key benchmark years 2010 through 2050. In general the economy is expected to grow at a rate of about 2.6 percent annually; total end-use energy consumption will grow 0.7 percent per year while electricity use is expected to grow at about 1.0 percent per year. Rising energy prices (with all values in 2007 dollars) will increase total household energy expenditures at a rate of about 1.2 percent annually. Because of the expected growth in petroleum fuel (not shown here) and natural gas prices, the nation's total energy bill (across all sectors and all fuels) will grow about 2.0 percent per year—escalating from an estimated $1.1 trillion dollars in 2010 to about $2.4 trillion by 2050.

Some of the important inputs derived from this module that feed into the macroeconomic model described below include:

- The policies and measures that are phased in over time;
- The stringency of the emissions reduction target;
- The rates of growth in energy-related prices;
- The pattern of consumer and investor decisions concerning the adoption of new technologies; and
- The resulting innovations that lead to new technologies and/or changes in demands for services.

market to respond to the price signal. In this context, prices act as a signal for necessary changes, rather than as punishment for consumers and producers.

Output, Employment, Wages, and Value Added Data, 2007				
	Output*	**Jobs**	**Wages***	**Value Added***
Agriculture	371,484	3,771,606	41,790	159,152
Oil and Gas Extraction	410,704	662,110	47,008	226,025
Coal Mining	28,358	81,277	6,745	15,719
Other Mining	52,745	164,553	11,165	30,838
Electric Utilities	359,446	537,905	60,619	258,661
Natural Gas Utilities	126,746	108,900	12,427	43,816
Transportation, Water, Sewer	695,045	4,182,656	194,295	311,975
Construction	1,617,010	11,320,144	440,861	688,847
Manufacturing	5,187,399	13,799,875	936,431	1,482,617
Petroleum Refineries	557,555	70,410	13,059	85,483
Wholesale Retail Trade	2,444,344	25,248,416	906,865	1,646,136
Services	9,822,773	83,879,288	3,006,503	6,012,169
Financial Services	2,030,984	8,203,043	617,879	1,087,844
Government	1,898,597	24,878,120	1,517,927	1,758,319
Totals	25,603,191	176,908,303	7,813,573	13,807,600
*Millions of 2007 Dollars				

Macroeconomic Module: This set of spreadsheets contains the "production recipe" for the U.S. economy for a given "base year." For this study, the base year used was 2007. The input-output (or I-O) data, currently purchased from the Minnesota IMPLAN Group (IMPLAN 2009), is essentially a set of economic accounts that specifies how different sectors of the economy buy (purchase inputs) from and sell (deliver outputs) to each other. Further details on this set of linkages can be found in Hanson and Laitner (2009). Although IMPLAN now has a 2008 set of accounts, there has been insufficient time to update DEEPER to a 2008 base year. However, a preliminary review suggests there is little additional benefit in updating to the later data set. For this study, the model was run to evaluate impacts of the selected policies upon 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.[17] To provide the reader with a sense of scale for these major sectors, the table above provides sector output, jobs, compensation, and the value-added contributions to the nation's gross domestic product (in millions of 2007 dollars). As described below, examining the job and value-added intensities of the different sectors in this table provides early insights of likely scenario outcomes.

The principal energy-related sectors of the U.S. economy are not especially job-intensive. For example, taking total employment for the natural gas and electric utilities and dividing it by the total number of revenues received by those two sectors, it turns out that the nation's utilities support only 1.3 direct jobs for every one million dollars of revenue received in the form of annual utility bill payments. The rest of the economy, on the other hand, supports about 7 direct jobs per million dollars of receipts. *Thus, any productive investment in energy efficiency that pays for itself over a short period of time will generate a net energy bill savings that can be spent for the purchase of goods and services other than energy.* The impact of a one million dollar energy bill savings suggests there may be a net gain of about 5.7 jobs (that is, 7 jobs supported by a more typical set of consumer purchases compared to the 1.3 jobs supported by the electric and natural gas utilities). Depending on the sectoral interactions, however, this difference may widen or close as the changed pattern of spending works its way through the model, and as changes in labor productivity changes the number of jobs needed in each sector over a period of time.[18]

Based on the scenarios mapped into the Energy and Emissions module, the set of worksheets in the Macroeconomic Module translates the selected energy policies into an annual array of physical energy impacts,

[17] While there are only 14 sectors shown in the table above, household spending is allocated to each of the sectors using the personal consumption expenditure data provided with the IMPLAN data set.
[18] As we will see later in this appendix, DEEPER does capture sector trends in labor productivity. That means the number of jobs needed per million dollars of revenue will decline over time.

investment flows, and energy expenditures over the desired period of analysis. Using appropriate technology cost and performance characterization as it fits into the investment stream algorithm discussed below, DEEPER estimates the needed investment path for an alternative mix of energy efficiency and other technologies (including efficiency gains on both the end-use and the supply side). It also evaluates the impacts of avoided or reduced investments and expenditures otherwise required by the electric generation sector. These quantities and expenditures feed directly into the final demand worksheet of the module. The final demand worksheet provides the detailed accounting that is needed to generate the implied net changes in sector spending. Once the mix of positive and negative changes in spending and investments have been established and adjusted to reflect changes in prices within the other modules of DEEPER, the net spending changes in each year of the model are converted into sector-specific changes in final demand. This then 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 matrix of production coefficients for each row and column within the matrix (in effect, how each column buys products from other sectors and how each row sells products to all other sectors)
Y = final demand, which is a column of net changes in spending by each sector as that spending pattern is affected by the policy case assumptions (changes in energy prices, energy consumption, investments, etc.)

This set of relationships can also be interpreted as

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

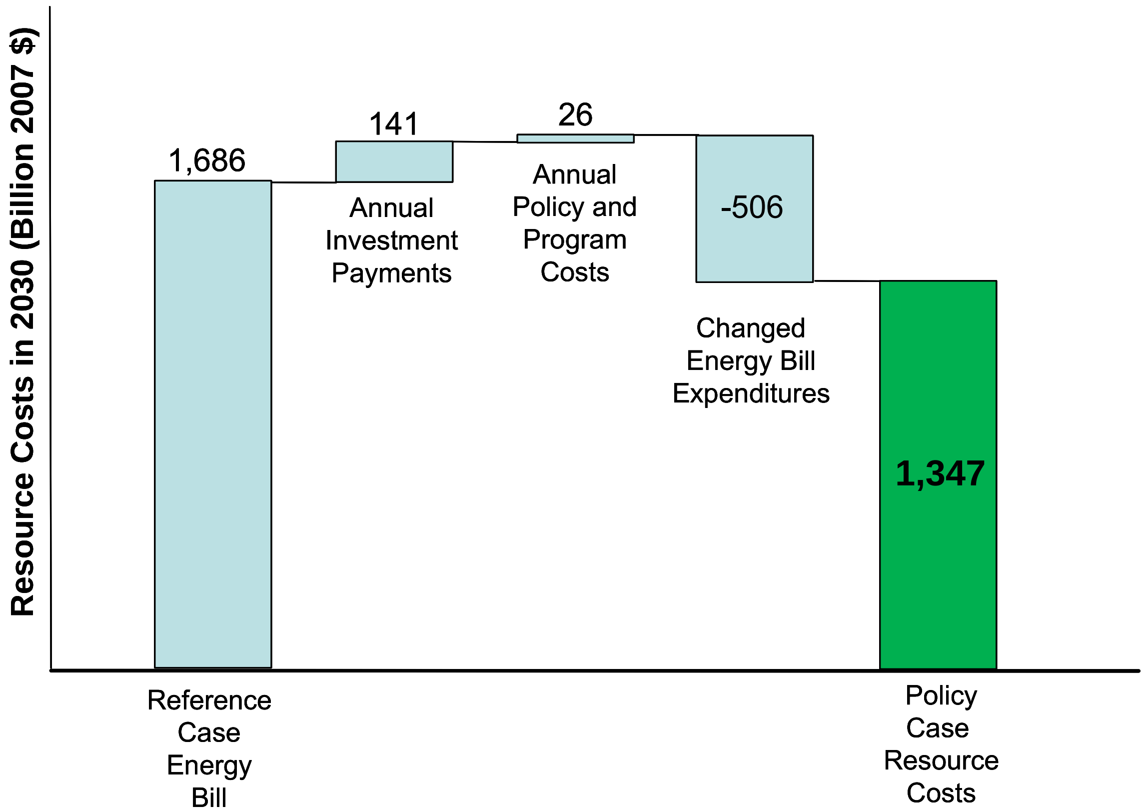
which reads, a change in total sector output equals the expression $(I-A)^{-1}$ times a change in final demand for each sector.[19] Employment quantities are adjusted annually according to exogenous assumptions about labor productivity in each of the sectors within the DEEPER Modeling System (based on Bureau of Labor Statistics forecasts; see BLS 2008). From a more operational standpoint, the macroeconomic module of the DEEPER Model traces how each set of changes in spending will work or ripple its way through the U.S. economy in each year of the assessment period. The end result is a net change in jobs, income, and GDP (or value-added).

For each year of the analytical time horizon (i.e., 2013 to 2050 for the climate policy assessment in this report), the model copies each set of results into this module in a way that can also be exported to a separate report. For purposes of this separate report, and absent any anomalous outcomes in the intervening years, we highlight the decadal results in order to focus attention on the differences in results emerging from various alternative policy scenarios. For a review of how an I-O framework might be integrated into other kinds of modeling activities, see Hanson and Laitner (2009). While the DEEPER Model is not an equilibrium model, we borrow some key concepts of mapping technology representation for DEEPER, and use the general scheme outlined in Laitner and Hanson (2009). Among other things, this includes an economic accounting to ensure resources are sufficiently available to meet the expected consumer and other final demands reflected in different policy scenarios.

The diagram on the following page illustrates the way DEEPER tracks changes in expenditures to evaluate the macroeconomic impacts of policy scenarios. In this case the example is drawn from the energy efficiency provisions in APA and ACELA for the year 2030. The base case energy expenditures are estimated to be $1,686 billion (in 2007 dollars) for 2030. The enhanced energy efficiency provisions require an outlay of $141 billion in combined energy efficiency investments together with payments to the market for borrowing the necessary funds. The entire case is drive by both the price signal and an estimated $26 billion in various program spending to catalyze the investments and more energy-efficient behaviors. Even with an increase in energy prices brought about by higher prices for carbon dioxide emissions, the economy-wide energy bill savings are estimated to be

[19] Perhaps one way to understand the notation $(I-A)^{-1}$ is to think of this as the positive or negative impact multiplier depending on whether the change in spending is positive or negative for a given sector within a given year.

$506 billion in 2030. The bottom line is a net reduction from the reference case energy bill so that businesses and consumers are paying only $1,387 billion for energy as a result of the climate legislations.



Source: DEEPER Analysis of APA+ACELA

Energy Prices

The sector prices for electricity and fuels are shaped by the change in the cost of CO_2 emissions as a function of their carbon intensities. For example, if the permit price goes up to 50$ per metric ton, all energy prices would adjust according to the carbon content of each fuel as referenced in the EPA Greenhouse Gas Emissions Inventory (EPA 2009a). In the case of natural gas, for example, the CO_2 content is listed at 0.05306 tonnes per million Btu. If the reference case price of natural gas for industrial customers is $8.69/MBtu in 2030, the new price would be 0.05306 * $50 + 8.69, or $11.34/MBtu, a roughly 30 percent increase in the price to industry.

Technology Investment Streams

As previously noted, the investment costs are estimated for three different categories of emissions reductions: energy efficiency investments, low-carbon energy supply technologies, and non-CO_2 emissions reductions. The key set of assumptions for each of the major sources of investment flows is summarized below.

Energy Efficiency

One critical piece of information needed to evaluate the impact of these scenarios is the cost of investment in energy efficiency technologies. To derive this information, we adapt the structure of the Long-Term Industrial Energy Forecast or LIEF model (Cleetus et al. 2003). The key relationship in this model is the current gap between average and best energy efficiency technology or the best efficiency practice.

The assumption in the LIEF model is that as a sector moves closer and closer to best practice or best technology (sometimes referred to as the production frontier), the cost of efficiency investment per unit of energy saved will increase. The rate of that potential cost increase depends on the energy prices, the elasticity of the efficiency supply curve, and the discount rate. It also depends on how innovations and R&D policies might shift the best technology or best practice frontier. As used in this exercise, the investment cost is shown as:

Investment per Unit Energy Savings = $\left[\frac{1-G_0}{1-S}\right]^{(1/A)} * \left[\frac{P}{C}\right]$

where:

> P = price of energy in the base year
> C = capital recovery factor (CRF) or sector implicit discount rate for the given year
> A = an elasticity that reflects the magnitude of the investment response to changes in price levels or the capital recovery factor
> S = percent of sector energy savings in current year compared to base year consumption
> G_0 = the energy intensity gap, or the difference between best and average practice

In many ways this can be thought of as the energy savings that should be economically viable in the base year, but have not been realized.

By way of example, the data might suggest that today there is a current energy intensity gap of 25 percent based on the potential for long-term efficiency gains through the year 2050, a long run efficiency substitution elasticity of 0.6, and an implicit discount rate of 20 percent.[20] With energy prices of about $12.19 per million Btu in 2010, these assumptions suggest an average payback of about 3.7 years for a 10 percent efficiency gain based on prices in 2010. This rises to a 10-year payback for a 50 percent efficiency gain by 2050. Based on the much higher reference case prices in 2050, these paybacks would decline over time to 1.4 and 3.7 years. These results are broadly consistent with results summarized in Laitner et al. (2006) and Hanson and Laitner (2004).[21]

At the same time, the DEEPER Model uses a modified accounting function for each of the end-use sectors and fuels as they are impacted by the American Power Act provisions, out to 2030. Using estimates from McKinsey & Company (2009), AEF (2009), Gold et al. (2009), and Eldridge et al. (2009), among others, each of the cost curve functions was adjusted by sector to reflect both the current and anticipated technology costs and performance reflected in those various studies. In the modeling characterized in this report, the payback periods typically begin at about 2.5 to 3 years in 2013, and depending on policy assumptions, R&D, changes in implicit discount rates, and how quickly efficiency is "used up," the payback periods in 2050 might range from 5 to 9 years.

Emissions Reductions

Drawing from the IGEM model data used in the EPA (2009b) assessment, this analysis complements the detailed efficiency improvement costs with a simplified set of marginal abatement cost curves for standard for domestic non-CO_2. This curve is represented by the following formula:

> Domestic Offsets = 16.1 * Price $^{0.854}$

[20] This adaptation of the LIEF equation ignores the autonomous time trend component. In other words, as used here, the assumption of an efficiency gap remains static and there is only movement toward best practice or best technology rather than improvement in the base year representation of best practice or best technology. As the historical record suggests, the gap may actually grow to 50 percent—if the U.S. chooses to invest in greater innovation and energy productivity improvements. Hence, the use of a fixed 25 percent gap for purposes of estimating investment costs will tend to overstate the cost of the new efficiency gains.

[21] Although this is not emphasized in either the report or appendix, DEEPER also can explore changes in costs needed to drive a final result. For example, as it is now configured, if investments cost 20 percent less than now projected for the year 2050, the net gain in jobs shown in the main report increase by about 3.5 percent. On the other hand, if the investments run about 50 percent more than now suggested, the net increase in jobs might decline by about 9 percent. But this would continue to be a highly positive net gain in 2050. The significance of this finding is that the framework of the American Power Act framework—especially if it includes a greater emphasis on energy productivity benefits—is likely to generate a robust outcome for the American economy for all the reasons described earlier in the report.

Where:

> Price = the CO_2e price needed in a given year to reach the necessary reduction target (beyond any energy efficiency and renewable energy reductions made possible through complementary policies and programs).

There is a huge uncertainty with the eventual cost of international offsets. As an important conservatism in this analysis, the assumption now embedded in DEEPER is that all international emissions reductions will be made at the average weighted CO_2e price. The result of this set of assumptions, especially with limits imposed on international offsets, undoubtedly overstates the required permit price. Still it is an insufficient effect to reduce the domestic benefits driven by the significantly larger energy productivity gains. As Hanson (2007) suggests, however, even if the current generation of models captured the full potential of today's technology and market flexibilities, the long-term carbon price could be considerably lower than we estimate based on today's knowledge. We know that there will be some breakthroughs on the technological, political, and international scenes, and a shift in consumer preferences and behaviors. All of these imply the strong likelihood that we will find solutions that are not too much more expensive than today. In fact, there is also evidence that some could be even cheaper (see also Knight and Laitner 2010). In the analysis of the APA+ACELA provisions, we constrained both domestic and international offsets to provide no more than 1,000 million metric tons each within any given year. Following the outlines of the APA provisions, total emissions in this report were designed to be reduced from a reference case projection of 7,290 $MMTCO_2e$ in 2050, down to 1,747 $MMTCO_2e$ also by 2050. As this suggested cap is loosen or tightened, the CO_2e price would of course be changed. Again following the APA provisions, the 2050 ceiling price for CO_2e set at $147/t$CO_2e$. If that price is exceeded, the amount of emissions reduction is relaxed to the point where the price falls back under the cap.

Policy and Program Costs

One of the working assumptions in this review is that that policies and programs are needed to drive the requisite investments. In generating an estimate of what these incremental costs might look like, we borrow from a study by Amy Wolfe and Marilyn Brown, *Estimates of Administrative Costs for Energy Efficiency Policies and Programs* (Interlaboratory Working Group 2000, Appendix E-1). In that study the average administrative cost is assumed to be $0.60 per million Btu of efficiency gains. In Eldridge et al. (2009) and McKinsey & Company (2009), these program costs were generally assumed to run about 15-20 percent of the annual investments in efficiency gains. In Table 4 of this main report, comparing the program cost totals with the annual payments for investments, the range is shown to be approximately 24 percent in the early years as program activity and R&D investments scale up early in the scenario. Under the current assumptions this declines to about 18 percent by 2050.

APPENDIX F. DETAILED NATIONAL RESULTS OF ENERGY EFFICIENCY PROVISIONS IN APA AND WITH PROPOSED ENHANCEMENTS

Estimates from APA+ACELA in 2020:

Annual Energy Savings Estimates			2020									
Title	Subtitle	Section	Electricity (TWh)	Avoided Peak Demand (MW)	Direct Natural Gas (TBTu) (1)	Oil Savings (Million barrels per day)	Primary Energy Savings (Quads)	Carbon Dioxide (MMT)	Cumulative Federal Investments (billion 2007 $)	Annualized Consumer Costs (billion 2007 $)	Gross Annual Consumer Savings (billion 2007$) (2)	Net Annual Consumer Savings (Billion 2007$)
Title I - Clean Energy Technology Deployment	Subtitle C - Federal Renewable Electricity Standard	Sec. 132 Federal renewable electricity standard	negligible savings beyond baseline									
Title II - Enhanced Energy Efficiency	Subtitle A - Manufacturing Efficiency	Sec. 201 Industrial EE Revolving Loan Program	0.00	-	0.0	0.000	0.0	0.0	$0.0	$0.0	$0.0	$0.0
		Sec. 204 Future of Industry Program	5.55	1,498	18.9	0.000	0.1	4.3	$0.5	$0.2	$0.5	$0.3
		Sec. 204c Industrial Research and Assessment Centers	0.5	143	3.3	0.000	0.0	0.5	$0.1	$0.0	$0.1	$0.0
		Sec. 206 Innovation and Industry Grants	3.3	890	10.2	0.000	0.0	2.6	$0.0	$0.0	$0.5	$0.5
		Sec. 224 Portable light fixtures	3.0	822	0.0	0.000	0.0	1.8	$0.0	$0.0	$0.3	$0.3
		Sec. 227 Commercial furnace standards	0.0	-	0.9	0.000	0.0	0.1	$0.0	$0.0	$0.0	$0.0
		Sec. 228 Motor efficiency rebate program	no savings				no savings					
		Sec. 233 AC, Furnace, and Heat Pump standards	10.0	2,697	52.2	0.000	0.2	8.7	$0.0	$0.8	$1.6	$0.8
		Sec. 233 - Reform to Appliance Standards	1.5	407	19.0	0.0	0.0	1.9	$0.0	$0.1	$0.4	$0.3
		Sec. 235 Standards for Water Dispensers, Hot food holding cabinets, and Portable Electric Spas	0.5	125	0.0	0.000	0.0	0.3	$0.0	$0.0	$0.0	$0.0
		Sec. 239 Outdoor lighting fixtures	24.9	6,713	0.0	0.000	0.3	14.9	$0.0	$0.2	$2.8	$2.6
	Part I - Building Codes	Sec. 241 Building Codes	22.8	6,163	64.5	0.000	0.3	17.1	$0.9	$1.7	$3.0	$1.4
		Sec. 242 Multifamily and Manuf. Housing	0.1	14	1.4	0.000	0.0	0.1	$79.4	$0.0	$0.0	$0.0
		Sec. 243 Building Training and Assessment Centers	0.1	20	0.2	0.000	0.0	0.1	$0.1	$0.0	$0.0	$0.0
	Part II - Weatherization for low-income	Sec. 251 Weatherization assistance for low-income persons	1.0	261	2.5	0.000	0.0	0.7	$0.8	$0.0	$0.1	$0.1
	Part IV- State Energy Efficiency Grants Programs	Sec. 262 State Energy Efficiency Retrofit Programs	1.5	418	2.3	0.000	0.0	1.1	$0.5	$0.1	$0.2	$0.1
	Part VI - Energy Efficiency Information on Homes and Buildings	Sec. 281 Building energy performance labeling program	2.7	718	7.2	0.000	0.0	2.0	$0.1	$0.1	$0.4	$0.2
ACELA Subtotal			**77.4**	**20,891**	**182.7**	**0.001**	**1.0**	**56.1**	**$82.3**	**$3.2**	**$9.9**	**$6.7**
American Power Act	Allowance Allocations	Sec. 782 Electricity customers	0.0	-	0.0	0.000	0.0	0.0	$0.0	$0.0	$0.0	$0.0
		Sec. 783 Natural Gas customers	0.0	-	207.3	0.000	0.2	10.8	$7.7	$0.5	$2.4	$1.9
		Sec. 784 Home Heating Oil and Propane Customers	0.0	-	0.0	0.073	0.2	11.5	$5.9	$0.5	$0.5	$0.0
		Sec. 1801 Clean Energy Tech R&D	1.2	331	14.1	0.001	0.0	1.6	$6.0	$0.3	$0.3	$0.0
		Sec. 4143 Low-Carbon Industrial Technology R&D	0.0	-	0.0	0.000	0.0	0.0	$3.0	$0.0	$0.0	$0.0
		Sec. 1602 Rural energy savings program	0.9	240	14.5	0.001	0.0	1.4	$1.1	$0.0	$0.3	$0.3
		Sec. 1603 State Allocations (other)	6.8	1,831	45.8	0.000	0.1	6.5	$3.4	$0.4	$1.1	$0.7
		Sec. 4001 Industrial Energy Efficiency (non-ACELA portion; EISA Sec. 451)	0.0	-	533.4	0.000	0.5	27.9	$0.1	$0.0	$3.6	$3.6
		Sec. 4111 Clean Vehicle Technology	savings not quantified									
		Sec. 1712 Transportation Planning	0.0	-	0.0	0.1	0.2	14.9	$7.5	$0.3	$4.9	$4.6
		Sec. 785 Highway Trust Fund Allowances	0.0	-	0.0	0.0	0.1	4.6	$19.4	$0.4	$1.5	$1.1
		Sec. 781 TIGER Grants	0.0	-	0.0	0.0	0.1	4.2	$14.9	$0.3	$1.4	$1.1
Total (APA and ACELA)			**86.3**	**23,294**	**997.8**	**0.242**	**2.4**	**139.6**	**$151.4**	**$5.8**	**$26.0**	**$20.1**

Additions from Enhanced Energy Efficiency Case in 2020:

Annual Energy Savings Estimates			2020									
Title	Subtitle	Section	Electricity (TWh)	Avoided Peak Demand (MW)	Direct Natural Gas (TBTu) (1)	Oil Savings (Million barrels per day)	Primary Energy Savings (Quads)	Carbon Dioxide (MMT)	Cumulative Federal Investments (billion 2007 $)	Annualized Consumer Costs (billion 2007 $)	Gross Annual Consumer Savings (billion 2007$) (2)	Net Annual Consumer Savings (Billion 2007$)
Additional Measures	S. 1637	*Expanding Building Efficiency Incentives Act of 2009*	6.7	1,803	27.2	0.001	0.1	5.6	$0.9	$0.1	$1.0	$1.0
	S. 1639	*Expanding Industrial Energy Efficiency Incentives Act of 2009*	7.3	1,973	0.0	0.000	0.1	4.4	$1.1	$0.3	$0.7	$0.4
		CHP in S. 1639	22.9	6,185	-120.4	0.000	0.1	7.4	$0.1	$0.3	$0.9	$0.6
	S. 1696	*Green Gaming Act*	16.1	4,358	0.0	0.000	0.2	9.7	$0.0	$0.0	$1.6	$1.6
Enhanced Efficiency Case	EERS	*EERS - 10%*	176.4	56,739	0.0	0.000	1.8	129.0		$13.0	$17.4	$4.3
	Fully Funded ACELA (in addition to base case)	Sec. 201 Industrial EE Revolving Loan Program	31.90	8,613	259.6	0.028	0.7	37.1	$18.0	$0.0	$4.6	$4.6
		Sec. 204 Future of Industry Program	0.00	-	0.00	0.00	0.00	0.00	$0.0	$0.0	$0.0	$0.0
		Sec. 204c Industrial Research and Assessment Centers	1.5	396	9.2	0.000	0.0	1.4	$0.1	$0.0	$0.2	$0.2
		Sec. 206 Innovation and Industry Grants	1.1	297	3.4	0.000	0.0	0.9	$0.0	$0.0	$0.2	$0.2
		Sec. 228 Motor efficiency rebate program	8.78	2,370	0.0	0.000	0.1	5.3	$0.4	$0.1	$0.5	$0.5
		Sec. 241 Building Codes	6.6	1,784	18.7	0.000	0.1	4.9	$0.0	$0.5	$0.9	$0.4
		Sec. 242 Multifamily and Manuf. Housing	2.7	732	72.2	0.001	0.1	5.6	-$75.2	$0.3	$1.2	$0.8
		Sec. 243 Building Training and Assessment Centers	0.3	81	0.7	0.000	0.0	0.2	$0.3	$0.0	$0.0	$0.0
		Sec. 251 Weatherization assistance for low-income persons	7.1	1,910	21.5	0.001	0.1	5.5	$6.0	$0.0	$1.0	$1.0
		Sec. 262 State Energy Efficiency Retrofit Programs	47.1	12,714	69.6	0.003	0.6	32.3	$7.4	$0.9	$5.7	$4.7
		Sec. 281 Building energy performance labeling program	10.6	2,873	28.9	0.001	0.1	8.1	$0.6	$0.5	$1.4	$0.9
	Allowance Allocations (in addition to base case)	Sec. 782 Electricity customers	0.00	-	0.0	0.000	0.0	0.0	$84.0	$7.5	$0.0	-$7.5
		Sec. 783 Natural Gas customers	0.00	-	164.6	0.000	0.2	8.6	$6.1	$0.4	$1.9	$1.5
		Sec.1603 State allocations	9.8	2,634	65.9	0.000	0.2	9.3	$4.9	$0.6	$1.7	$1.0
		Sec. 785 Highway Trust Fund Allowances	0.0	-	0.0	0.082	0.2	11.6	$0.0	$0.0	$3.8	$3.8
		Sec. 781 TIGER Grants	0.0	-	0.0	0.073	0.1	10.6	$0.0	$0.0	$3.7	$3.7
		Sec. 4001 Industrial Energy Efficiency (non-ACELA portion; EISA Sec. 451)	0.0	-	619.7	0.0	0.6	32.4	$0.2	$0.0	$4.2	$4.1
Total (with additional recommended measures)			**443.2**	**128,755**	**2238.4**	**0.432**	**7.7**	**469.5**	**$206.2**	**$30.4**	**$78.5**	**$48.0**

Notes:

1. Direct gas represents the natural gas saved directly by the measures
2. Gross consumer savings are preliminary estimates assuming AEO 2010 projected energy prices.
3. Industries of the Future Savings have no additional electricity savings in the enhanced case because these R&D measures are funded by the EERS, State allocations and Electric LDC allocations in the enhanced case.

Estimates from APA+ACELA in 2030:

Annual Energy Savings Estimates			2030									
Title	Subtitle	Section	Electricity (TWh)	Avoided Peak Demand (MW)	Direct Natural Gas (TBTu) (1)	Oil Savings (Million barrels per day)	Primary Energy Savings (Quads)	Carbon Dioxide (MMT)	Cumulative Federal Investments (billion 2007 $)	Annualized Consumer Costs (billion 2007 $)	Gross Annual Consumer Savings (Billion 2007$) (3)	Net Annual Consumer Savings (Billion 2007$) (4)
Title I - Clean Energy Technology Deployment	Subtitle C - Federal Renewable Electricity Standard	Sec. 132 Federal renewable electricity standard	negligible savings beyond baseline									
Title II - Enhanced Energy Efficiency	Subtitle A - Manufacturing Efficiency	Sec. 201 Industrial EE Revolving Loan Program	0.00	-	0.00	0.000	0.0	-	$0.0	$0.0	$0.0	$0.0
		Sec. 204 Future of Industry Program	86.24	23,286	275.41	0.000	1.2	66	$0.5	$2.0	$8.0	$6.0
		Sec. 204c Industrial Research and Assessment Centers	0.0	-	0.0	0.000	0.0	-	$0.1	$0.0	$0.0	$0.0
		Sec. 206 Innovation and Industry Grants	3.3	890	10.2	0.000	0.0	3	$0.0	$0.0	$0.5	$0.5
		Sec. 224 Portable light fixtures	3.9	1,041	0	0.000	0.0	2	$0.0	$0.0	$0.4	$0.4
		Sec. 227 Commercial furnace standards	0.0	-	2	0.000	0.0	0	$0.0	$0.0	$0.0	$0.0
		Sec. 228 Motor efficiency rebate program	no savings				no savings					$0.0
		Sec. 233 AC, Furnace, and Heat Pump standards	28.2	7,602	122	0.000	0.4	23	$0.0	$1.7	$4.4	$2.7
		Sec. 233 - Reform to Appliance Standards	2.8	-	36.6	0.0	0.1	3.6	$0.0	$0.1	$0.8	$0.6
		Sec. 235 Standards for Water Dispensers, Hot food holding cabinets, and Portable Electric Spas	0.6	163	0	0.000	0.0	0	$0.0	$0.0	$0.1	$0.0
		Sec. 239 Outdoor lighting fixtures	58.0	15,664	0	0.000	0.6	35	$0.0	$0.5	$6.6	$6.1
	Part I - Building Codes	Sec. 241 Building Codes	59.1	15,958	124	0.000	0.7	42	$1.9	$4.0	$8.0	$3.9
		Sec. 242 Multifamily and Manuf. Housing	0.1	15	1	0.000	0.0	0	$84.3	$0.0	$0.0	$0.0
		Sec. 243 Building Training and Assessment Centers	0.1	25	0	0.000	0.0	0	$0.2	$0.0	$0.0	$0.0
	Part II - Weatherization for low-income	Sec. 251 Weatherization assistance for low-income persons	1.0	261	2	0.000	0.0	1	$0.8	$0.0	$0.1	$0.1
	Part IV- State Energy Efficiency Grants Programs	Sec. 262 State Energy Efficiency Retrofit Programs	1.7	447	2	0.000	0.0	1	$0.5	$0.1	$0.2	$0.1
	Part VI - Energy Efficiency Information on Homes and Buildings	Sec. 281 Building energy performance labeling program	5.1	1,374	15	0.001	0.1	4	$0.1	$0.1	$0.7	$0.6
ACELA Subtotal			**250.0**	**66,726**	**590.9**	**0.001**	**3.2**	**181**	**$88.4**	**$8.6**	**$29.9**	**$21.3**
American Power Act	Allowance Allocations	Sec. 782 Electricity customers	0.0	-	0.0	0.000	0.0	-	$0.0	$0.0	$0.0	$0.0
		Sec. 783 Natural Gas customers	0.0	-	408.1	0.000	0.4	21	$19.5	$1.3	$5.6	$4.3
		Sec. 784 Home Heating Oil and Propane Customers	0.0	-	0.0	0.140	0.3	22	$11.9	$1.0	$0.1	-$0.9
		Sec. 1801 Clean Energy Tech R&D	2.0	527	20.6	0.353	0.7	50	$6.0	$2.0	$18.3	$16.3
		Sec. 4143 Low-Carbon Industrial Technology R&D	3.8	1,021	39.9	0.094	0.3	17	$3.0	$0.6	$5.6	$5.0
		Sec. 1602 Rural energy savings program	1.3	355	21.8	0.001	0.0	2	$1.1	$0.0	$0.5	$0.5
		Sec. 1603 State Allocations (other)	7.1	1,920	34.8	0.000	0.1	6	$3.6	$0.2	$1.2	$0.9
		Sec. 4001 Industrial Energy Efficiency (non-ACELA portion; EISA Sec. 451)	0.0	-	0.0	0.000	0.0	-	$0.1	$0.0	$0.0	$0.0
		Sec. 4111 Clean Vehicle Technology	savings not quantified									
		Sec. 1712 Transportation Planning	0.0	-	0.0	0.2	0.3	23.8	$16.9	$0.6	$8.8	$8.2
		Sec. 785 Highway Trust Fund Allowances	0.0	-	0.0	0.1	0.1	10.0	$41.1	$0.8	$3.7	$2.9
		Sec. 781 TIGER Grants	0.0	-	0.0	0.1	0.1	7.5	$33.7	$0.6	$2.8	$2.1
Total (APA and ACELA)			**264.1**	**70,550**	**1116.1**	**0.880**	**5.6**	**342**	**$225.4**	**$15.9**	**$76.4**	**$60.4**

Additions from Enhanced Energy Efficiency Case in 2030:

Annual Energy Savings Estimates			2030									
Title	Subtitle	Section	Electricity (TWh)	Avoided Peak Demand (MW)	Direct Natural Gas (TBTu) (1)	Oil Savings (Million barrels per day)	Primary Energy Savings (Quads)	Carbon Dioxide (MMT)	Cumulative Federal Investments (billion 2007 $)	Annualized Consumer Costs (billion 2007 $)	Gross Annual Consumer Savings (Billion 2007$) (3)	Net Annual Consumer Savings (Billion 2007$) (4)
Additional Measures	S. 1637	*Expanding Building Efficiency Incentives Act of 2009*	6.7	1,803	28	0.001	0.1	6	$0.9	$0.1	$1.1	$1.1
	S. 1639	*Expanding Industrial Energy Efficiency Incentives Act of 2009*	0.0	-	0	0.000	0.0	-	$1.1	$0.0	$0.0	$0.0
		CHP in S. 1639	15.3	4,123	-80	0.000	0.1	5	$0.1	$0.3	$0.5	$0.2
	S. 1696	*Green Gaming Act*	16.1	4,358	0	0.000	0.2	10	$0.0	$0.0	$0.0	$1.6
Enhanced Efficiency Case	EERS	*EERS - 10%*	183	58,957	0	0.000	1.8	134	$0.0	$8.6	$19.7	$11.1
	Fully Funded ACELA (in addition to base case)	Sec. 201 Industrial EE Revolving Loan Program	143.87	38,844	993	0.108	2.7	155	$87.0	$1.5	$21.5	$20.0
		Sec. 204 Future of Industry Program (3)	-86.24	(23,286)	205.11	0.00	-0.69	-40.99	$1.7	$1.6	-$4.1	-$5.7
		Sec. 204c Industrial Research and Assessment Centers	3.4	921	16	0.000	0.1	3	$0.3	$0.0	$0.4	$0.4
		Sec. 206 Innovation and Industry Grants	2.2	593	3	0.000	0.03	2	$0.1	$0.0	$0.3	$0.3
		Sec. 228 Motor efficiency rebate program	8.78	2,370	0.00	0.000	0.1	5	$0.4	$0.0	$0.6	$0.5
		Sec. 241 Building Codes	27.7	7,486	58	0.000	0.3	20	$0.0	$1.9	$3.7	$1.8
		Sec. 242 Multifamily and Manuf. Housing	6.0	1,620	160	0.002	0.2	12	-$75.1	$0.4	$2.9	$2.5
		Sec. 243 Building Training and Assessment Centers	0.4	102	1	0.000	0.0	0	$0.6	$0.0	$0.1	$0.0
		Sec. 251 Weatherization assistance for low-income persons	7.1	1,910	21	0.001	0.1	5	$6.0	$0.0	$1.1	$1.1
		Sec. 262 State Energy Efficiency Retrofit Programs	91.3	24,651	122	0.004	1.1	62	$17.4	$2.2	$11.6	$9.4
		Sec. 281 Building energy performance labeling program	20.4	5,495	59	0.002	0.3	16	$1.1	$0.4	$3.0	$2.6
	Allowance Allocations (in addition to base case)	Sec. 782 Electricity customers	283.38	76,512	0.00	0.000	3.0	170	$169.2	$10.5	$27.5	$17.1
		Sec. 783 Natural Gas customers	0.00	-	330.10	0.000	0.3	17	$15.8	$1.1	$4.5	$3.5
		Sec.1603 State allocations	55.1	14,881	385.7	0.000	1.0	53	$27.6	$3.4	$10.6	$7.2
		Sec. 785 Highway Trust Fund Allowances	0.0	-	0.0	0.154	0.3	22	$0.0	$0.0	$8.1	$8.1
		Sec. 781 TIGER Grants	0.0	-	0.0	0.111	0.2	16	$0.0	$0.0	$6.1	$6.1
		Sec. 4001 Industrial Energy Efficiency (non-ACELA portion; EISA Sec. 451)	0.0	-	2047.9	0.0	2.0	107.2	$0.6	$0.0	$16.3	$16.3
Total (with additional recommended measures)			**1048.9**	**291,890**	**5465.0**	**1.263**	**18.8**	**1121.0**	**$479.9**	**$47.9**	**$211.9**	**$165.6**

APPENDIX G. MACROECONOMIC RESULTS

DEEPER Policy Results from K-L Basic Efficiency Scenario

	2010	2020	2030	2040	2050
Ref Case Primary Energy Use (Quads)	97.29	106.39	113.43	122.19	130.78
Ref Case Emissions (MMTCO2e)	6,562	7,026	7,092	7,163	7,290
Carbon Price ($/tCO2e)	$0	$28	$47	$94	$147
Policy Case Primary Energy Use (Quads)	97.29	83.91	71.29	73.62	76.49
		21%	37%	40%	42%
Policy Case Reductions (MMTCO2e)					
Energy-Related	0	1,166	2,168	2,460	2,919
Other Domestic	0	281	434	782	1,000
International Offsets	0	285	451	839	1,000
U.S. Policy Case Emissions (MMTCO2e)	6,562	5,293	4,038	3,081	2,372
Percent Reduction from RefCase	0%	25%	43%	57%	67%
Financial Impacts (Billion 2007 Dollars)					
Program Cost	$0	$26	$20	$4	$4
Annual Payments	$0	$114	$106	$22	$26
Energy Bill Savings	$0	$137	$381	$350	$375
Net Savings	$0	-$3	$254	$324	$345
Net Savings per Household (actual)	$0	-$24	$256	$280	$321
Net Savings as Pcnt HH Income		0.0%	0.2%	0.2%	0.2%
Macroeconomic Impacts					
Employment (thousands of jobs)	0	-60	166	367	504
Percent from RefCase	0.00%	-0.03%	0.07%	0.14%	0.17%
Net GDP Impacts	$0	$9	$30	$32	$1
Percent from RefCase		0.05%	0.13%	0.13%	0.00%

DEEPER Policy Results from K-L Enhanced Efficiency Scenario

	2010	2020	2030	2040	2050
Ref Case Primary Energy Use (Quads)	97.29	106.39	113.43	122.19	130.78
Ref Case Emissions (MMTCO2e)	6,562	7,026	7,092	7,163	7,290
Carbon Price ($/tCO2e)	$0	$33	$52	$109	$147
Policy Case Primary Energy Use (Quads)	97.23	78.58	61.95	65.04	68.83
Policy Case Reductions (MMTCO2e)					
Energy-Related	3	1,451	2,636	2,858	3,229
Other Domestic	0	316	471	882	1,000
International Offsets	0	323	491	951	1,000
U.S. Policy Case Emissions (MMTCO2e)	6,559	4,937	3,493	2,471	2,062
Percent Reduction from RefCase	0%	30%	51%	65%	72%
Financial Impacts (Billion 2007 Dollars)					
Program Cost		$33	$26	$4	$4
Annual Payments		$148	$141	$24	$25
Energy Bill Savings		$187	$506	$476	$557
Net Savings		$5	$339	$448	$529
Net Savings per Household (actual)		-$3	$448	$471	$521
Net Savings as Pcnt HH Income		0.0%	0.3%	0.3%	0.3%
Macroeconomic Impacts					
Employment (thousands of jobs)		123	364	552	663
Percent from RefCase		0.06%	0.15%	0.21%	0.22%
Net GDP Impacts		$5	$5	$2	-$16
Percent from RefCase		0.03%	0.02%	0.01%	-0.04%

DEEPER Policy Results from K-L Expanded Efficiency Scenario and Shifting Consumer Preference from 20% Hurdle Rate in 2050 to 15% Hurdle Rate in 2050

	2010	2020	2030	2040	2050
Ref Case Primary Energy Use (Quads)	97.29	106.39	113.43	122.19	130.78
Ref Case Emissions (MMTCO2e)	6,562	7,026	7,092	7,163	7,290
Carbon Price ($/tCO2e)	$0	$20	$23	$78	$113
Policy Case Primary Energy Use (Quads)	97.20	74.30	52.44	55.31	58.75
Policy Case Reductions (MMTCO2e)					
Energy-Related	5	1,682	3,131	3,318	3,644
Other Domestic	0	205	234	666	913
International Offsets	0	205	235	708	986
U.S. Policy Case Emissions (MMTCO2e)	6,557	4,934	3,491	2,471	1,747
Percent Reduction from RefCase	0%	30%	51%	66%	76%
Financial Impacts (Billion 2007 Dollars)					
Program Cost		$44	$39	$7	$6
Annual Payments		$189	$208	$36	$36
Energy Bill Savings		$300	$752	$773	$899
Net Savings		$66	$504	$731	$857
Net Savings per Household (actual)		$81	$673	$803	$849
Net Savings as Pcnt HH Income		0.1%	0.5%	0.5%	0.5%
Macroeconomic Impacts					
Employment (thousands of jobs)		373	689	1,020	1,154
Percent from RefCase		0.18%	0.29%	0.38%	0.38%
Net GDP Impacts		$11	$19	$43	$32
Percent from RefCase		0.06%	0.08%	0.18%	0.08%