Impacts of Energy Efficiency Provisions in Pending Senate Energy Efficiency Bills

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May 2012

ACEEE White Paper

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Contents

Acknowledgments

The authors express their appreciation to the Energy Foundation for its support that made this study possible. In addition, we acknowledge the important contributions by our ACEEE colleague Suzanne Watson. We also appreciate the patience and attention to detail of our editor Renee Nida.

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.

Abstract

On May 16, 2011, Senators Jeanne Shaheen (D-NH) and Rob Portman (R-OH) introduced the *Energy Savings and Industrial Competitiveness Act of 2011* (Shaheen-Portman; S. 1000). On July 14, 2011, this bill was ordered to be reported out by the Senate Energy and Natural Resources Committee with bipartisan support. This bill contains a variety of provisions designed to promote energy efficiency technologies and foster job creation. The Shaheen-Portman bill is expected to be combined with the *Implementation of National Consensus Appliance Agreement Act of 2011* (INCAAA; S. 398) on the Senate floor. INCAAA contains a variety of consensus agreements on new and updated minimum efficiency standards for a variety of products. These provisions passed in the House of Representatives in 2010 and nearly received unanimous consent in the Senate in late 2010. A revised version of the bill was ordered to be reported out of the Senate Energy Committee on April 12, 2011.

This analysis evaluates the energy efficiency provisions in both the Shaheen-Portman and INCAAA bills, and finds that these bills, individually and combined, can reduce energy use, save consumers money, and support a significantly larger number of jobs than would be sustained without the energy efficiency improvements. Our findings are summarized in the table below.

Summary of Key Findings for Shaheen-Portman and INCAAA bills

		Net Jobs Created	Net Annual Consumer Savings (billion 2009$)	Annual Primary Energy Savings (in Quadrillion Btu)	Annual CO_2 Emissions Avoided (in Million Metric Tons)
2020	Shaheen-Portman	80,000	4	0.5	29
	INCAAA	23,000	1	0.2	9
	Combined*	**102,000**	**5**	**0.7**	**38**
2030	Shaheen-Portman	159,000	20	1.9	108
	INCAAA	29,000	3	0.5	24
	Combined*	**185,000**	**23**	**2.3**	**132**

**"Combined" is a separate analysis and differs slightly from the sum of each bill individually*

This report discusses the national level impacts from these bills and describes the methodology used to estimate these impacts. The cumulative discounted net consumer savings (benefits minus costs) over the 2012–2030 period are estimated to be $59 billion for Shaheen-Portman, $11 billion for INCAAA, and $71 billion total. The benefit-cost ratio for the combined provisions is approximately 3:1.

These two bills represent important pieces of energy efficiency legislation. However, policymakers should recognize that these bills are only an initial down-payment on needed policy steps to maximize use of cost-effective energy efficiency resources to benefit the U.S. economy.

Introduction

Since the passage of the *Energy Independence and Security Act of 2007,* Congress has been considering significant energy efficiency legislation. A number of bills progressed in the 111th Congress, but ultimately were not enacted. In the first session of the 112th Congress (2011), a variety of bills were introduced, and two energy efficiency bills in particular were reported out of the Senate Energy and Natural Resources Committee. These bills are the *Energy Savings and Industrial Competitiveness Act of 2011* (Shaheen-Portman; S. 1000) and the *Implementation of National Consensus Appliance Agreements Act of 2011* (INCAAA; S. 398). Over the past several Congresses, the American Council for an Energy-Efficient Economy (ACEEE) has been examining the energy savings and macroeconomic impacts of major energy efficiency legislation (e.g., see Gold et al. 2009 and Laitner et al. 2010). This white paper provides a similar analysis of these two bills, both individually and combined.

Shaheen-Portman

On May 16, 2011, Senators Jeanne Shaheen (D-NH) and Rob Portman (R-OH) introduced the Shaheen-Portman bill. The bill contains a variety of provisions designed "to increase the use of energy efficiency technologies in the residential, commercial, and industrial sectors of our economy, while also fostering job creation." S. 1000 "uses a variety of low-cost tools to reduce barriers for private sector energy users and drive adoption of off-the-shelf efficiency technologies that will save businesses and consumers money, make America more energy independent, and reduce emissions" (Shaheen and Portman 2011).

We analyzed an amended version of the bill as reported out by the Senate Energy and Natural Resources Committee by an 18-3 vote on July 14, 2011. We analyzed five out of its 23 sections that would likely produce significant direct energy savings. Based on our initial assessment, these five provisions would likely achieve at least one-tenth of a "quad" of energy savings.[1] The five provisions are listed in Table 1.[2] A summary of each of these provisions is included in Appendix B. Other provisions in the bill would provide a variety of benefits, but not save energy directly, or would provide more modest energy savings.

Table 1: Significant Energy Efficiency Provisions in S. 1000

Title	Subtitle	Section
I. Buildings	A. Building Energy Codes	Sec. 101. Greater efficiency in building codes
	B. Worker Training and Capacity Building	Sec. 111. Building Training and Assessment Centers
II. Building Efficiency Finance		Sec. 201. Loan program for energy efficiency upgrades to existing buildings
III. Industrial Efficiency and Competitiveness	A. Manufacturing Energy Efficiency	Sec. 301. State partnership industrial energy efficiency revolving loan program
	D. Transformer Rebate Program	Sec. 331 Energy-efficient transformer rebate program

INCAAA

INCAAA contains a variety of consensus agreements on new and updated mandatory minimum efficiency performance standards for a number of products. These agreements have been negotiated between product manufacturers and energy efficiency advocates. These provisions passed the House of Representatives in 2010 and nearly received unanimous consent in the Senate at the end of the 111th

[1] One quad is a quadrillion (a 1000 trillion) British Thermal Units (Btu) of energy. One-tenth of a quad is the amount of energy used by 55,000 average American homes in a year.

[2] Several of these provisions did not reach one-tenth of a quad of savings in the final analysis. We still included them in our analysis.

Congress. A revised version of the bill was ordered to be reported out of the Senate Energy Committee on April 12, 2011 by an 18-4 bipartisan vote. Since then, some of the consensus standards have been adopted by the U.S. Department of Energy (DOE) by regulation, and therefore we have not included these provisions in our analysis. On the other hand, a new agreement to update existing standards on electric motors was included. Products included in our analysis are listed below:

- Commercial Furnaces
- Building Codes for Furnaces, Air Conditioner & Heat Pump
- Clothes Dryers
- Clothes Washers
- Dishwashers
- Electric Motors
- High-Output Outdoor Lamps
- Hot Food Holding Cabinets
- Portable Electric Spas
- Water Dispensers

Methodology

The overall approach was to estimate energy savings, provision by provision, using the best available data. Our analysis is based on the energy use forecast prepared in the *Annual Energy Outlook 2011* (EIA 2011b) by the Energy Information Administration (EIA is an independent agency within the U.S. Department of Energy). We developed bottom-up estimates of the energy savings, emissions reductions, federal and private investments, net consumer energy bill savings, and reductions in peak electric demand from each provision. Our methodology and key assumptions are discussed in Appendix C. Our cost and energy savings calculations were then run through our "DEEPER" input-output economic model to estimate economy-wide impacts including the net increase in jobs and impact on GDP. The DEEPER model is described in Appendix D.

Results

Implementation of the energy efficiency provisions in the Shaheen-Portman and INCAAA bills would produce significant energy and financial savings. The combination of more productive investments and the anticipated reduction in overall energy costs would catalyze an increase in the number of jobs within the U.S. The results are summarized below in Table 2, and detailed results from the analysis are presented in Appendix A. In the following sections we discuss impacts of the bill in greater detail.

Table 2: Summary of the Impacts of Shaheen-Portman and INCAAA

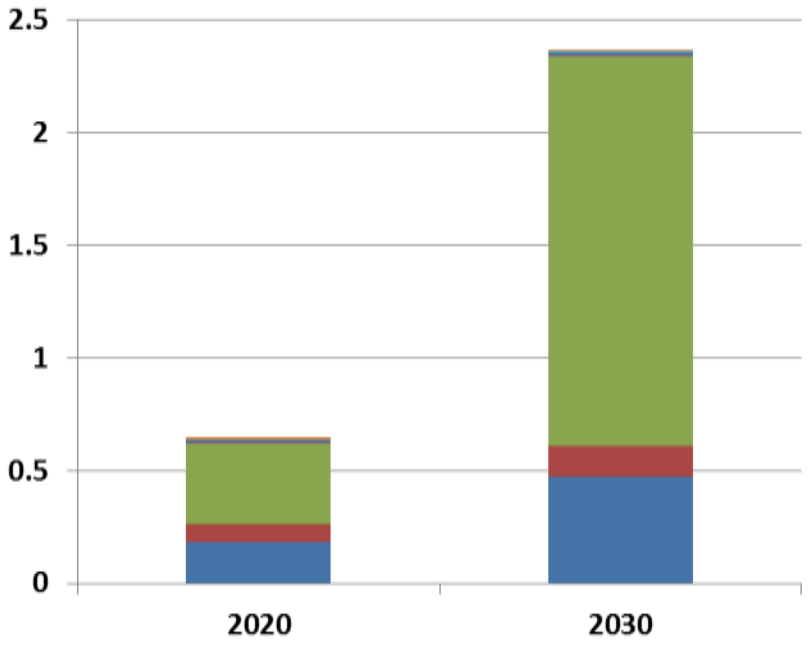
		Net Jobs Created	Annual CO_2 Emissions Avoided (in Million Metric Tons)	Net Annual Consumer Savings (billion 2009 $)	Annual Primary Energy Savings (in Quadrillion Btu)
2020	Shaheen-Portman	80,000	29	4	0.5
	INCAAA	23,000	9	1	0.2
	Combined*	**102,000**	**38**	**5**	**0.7**
2030	Shaheen-Portman	159,000	108	20	1.9
	INCAAA	29,000	24	3	0.5
	Combined*	**185,000**	**132**	**23**	**2.3**

**"Combined" is a separate analysis of the combined bills and differs slightly from the sum of each bill individually.*

Energy Savings

Overall, we estimate that the combined bills will reduce U.S. energy use in 2030 by 2.34 quads. This reduction is equivalent to Tennessee's current annual energy consumption (EIA 2011a). The largest contributor to savings in the Shaheen-Portman bill is the building codes provision (Sec. 101), which accounts for about 1.73 quads of energy savings in 2030, out of a total of 1.88 quads for all of Shaheen-Portman.[3] INCAAA contributes an additional 0.47 quads of savings in 2030. The energy savings from the Industrial Revolving Loans provision (Sec. 301) in the Shaheen-Portman bill is estimated to result in about 0.14 quads of savings. The majority of the savings from the combined provisions were from electricity (1.68 quads in 2030) but savings from natural gas are also substantial (0.66 quads in 2030). Oil savings are minimal. These energy savings will also reduce peak demand for electricity and the need for new power plants. We estimate peak demand savings in 2030 will be over 50,000 MW, equivalent to the output of about 100 coal-fired 500 MW power plants.[4] Additional details on energy savings by provision are included in Appendix A.

Figure 1: Primary Energy Savings in Quads by Provision



	BTAC	**<0.01**	**<0.01**
	Building Finance	**0.02**	**0.01**
	Transformers	**<0.01**	**<0.01**
	Building Codes	**0.36**	**1.73**
	Industrial Revolving Loans	**0.08**	**0.14**
	INCAAA	**0.18**	**0.47**
	Total	**0.65**	**2.34**

Some of these savings estimates are lower than estimates previously released by ACEEE (e.g., Nadel 2011). These changes can be attributed primarily to changes in these bills since they were first introduced, and secondarily to some new data. The version of Shaheen-Portman reported out by the

[3] Components do not sum to 2.34 because of rounding.
[4] Based on 2009 EIA capacity factor for coal-fired power plants: http://www.eia.gov/cneaf/electricity/epa/epat5p2.html

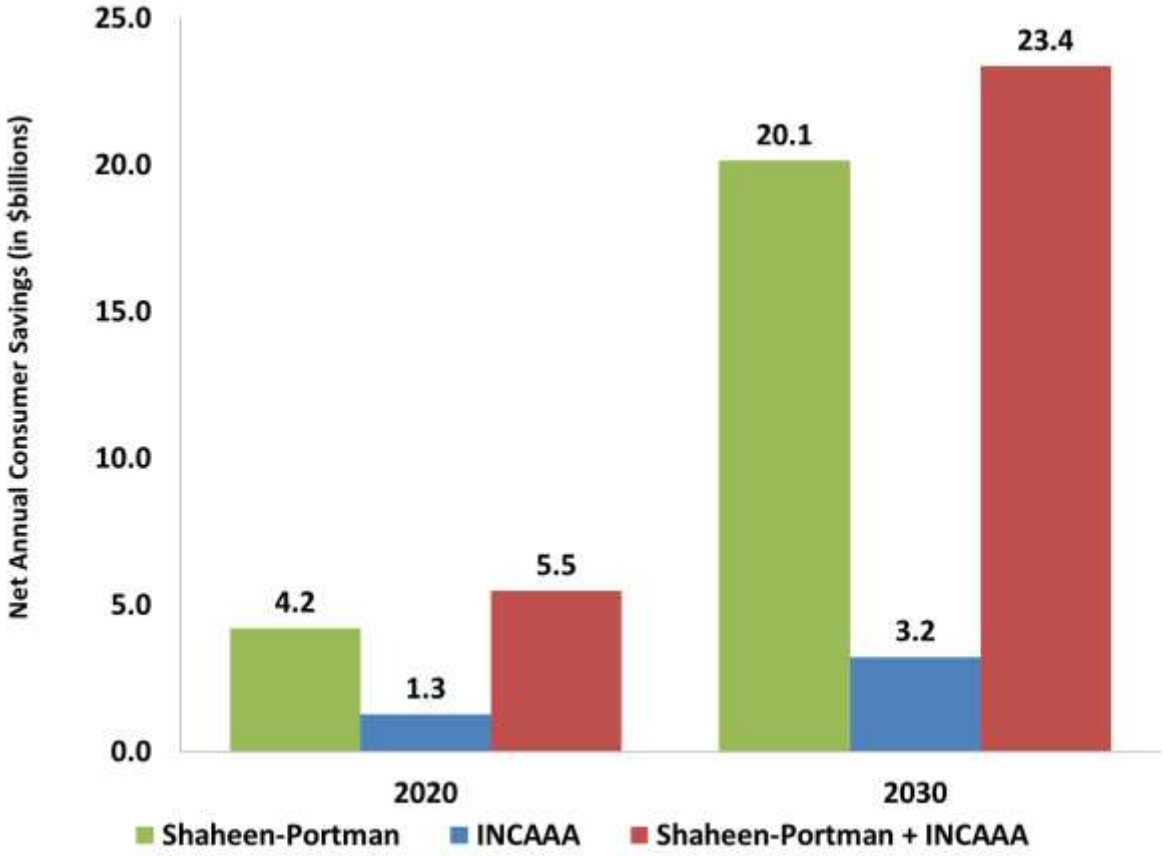
Senate Energy Committee had lower spending authorizations for several provisions, which lowers our savings estimates. In addition, the buildings code provision in the bill as introduced established a target for new buildings to use zero energy, meaning very high levels of energy efficiency, and then using renewable energy to meet remaining loads. This provision was deleted in Committee, causing us to lower our savings estimates. In the case of INCAAA, DOE has recently adopted final energy efficiency standards for central air conditioners, heat pumps, refrigerators, freezers, room air conditioners, and clothes dryers. As a result, Congressional adoption of these standards will not save any additional energy and our savings estimate for INCAAA is now less than half what we had estimated last year (Nadel 2011). Also, DOE has released some revised analyses on several products and we have incorporated these results.

Consumer Savings

Our analysis projects that consumers will save money due to the combined energy efficiency provisions in the Shaheen-Portman and INCAAA bills. We expect gross annual consumer savings to be $7 billion in 2020 and $28 billion in 2030, while annualized consumer costs are expected to be about $2 billion in 2020 and $5 billion in 2030. We project net annual consumer savings from the combined Shaheen-Portman and INCAAA bills to be over $5 billion in 2020 and over $23 billion in 2030.

Cumulative investment in INCAAA and the provisions in the Shaheen-Portman bill is expected to be about $20 billion in 2020 and $60 billion in 2030, nearly all of which comes from the private sector. The total cost to the federal government over the 2012–2030 period would be about $600 million under our assumption that appropriations will be 50% of authorized amounts.

Figure 2: Net Consumer Savings from Energy Efficiency Provisions*



* Components for 2030 do not sum to 23.4 because of rounding.

The discounted net consumer savings over the 2012–2030 period are estimated to be $59 billion for Shaheen-Portman, $11 billion for INCAAA, and $71 billion total. These numbers were derived at a 5% real discount rate and provide some perspective on the cumulative value of these measures to consumers. The benefit-cost ratio for all of the provisions is approximately 3:1. These figures are provided in Table 3.

Table 3: Net Present Value Costs and Benefits over the 2012–2030 Period*

	Cumulative Total Productive Investment (billion 2009$)	Cumulative Program Cost (billion 2009$)	Cumulative Consumer Savings (billion 2009$)	Net Consumer Savings (billion 2009$)	Benefit-Cost Ratio
Shaheen-Portman	24.66	0.24	84.29	59.38	3.38
INCAAA	9.53	0.01	20.82	11.27	2.18
Total	34.19	0.26	105.10	70.66	3.05

* All values calculated using a 5 percent real discount rate.

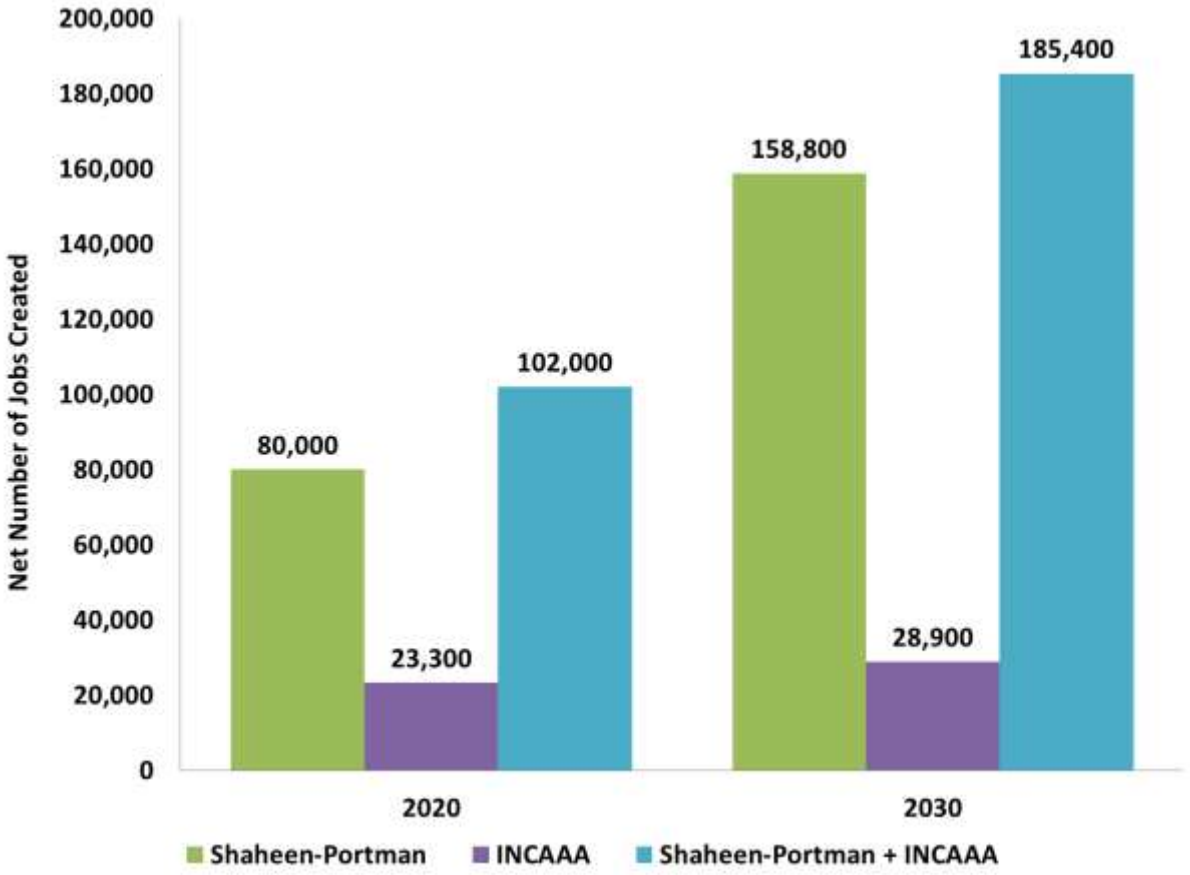
Job Creation

We estimate that projects initiated through the Shaheen-Portman bill and INCAAA coupled with energy bill savings resulting from the combined bills would support 102,000 net jobs in 2020, rising to 185,000 net jobs in 2030. We expect 159,000 jobs in 2030 would be supported as a result of the provisions in the Shaheen-Portman bill alone, and 29,000 jobs would be supported by INCAAA.

Some of these jobs will be direct jobs in construction and manufacturing, such as air conditioning manufacturers. Others will be indirect jobs, such as electrical equipment wholesalers. And a significant number will be induced jobs, created as workers whose jobs were created through the implementation of these provisions spend their earnings in other sectors of the economy. Jobs are created through shifts in spending patterns catalyzed by the implementation of the bills, and from consumer and business energy bill savings being spent in other sectors of the economy.[5] A comparison of jobs supported under Shaheen-Portman, INCAAA, and the "combined" scenario is provided in Figure 3.

[5] For more information on how ACEEE conducts jobs analysis, please see "How Does Energy Efficiency Create Jobs?" at http://aceee.org/fact-sheet/ee-job-creation.

Figure 3: Net Jobs Created from Energy Efficiency Provisions



Impact on GDP

Effective implementation of the different provisions in the Shaheen-Portman bill and INCAAA would contribute to a modest net increase in GDP. Our analysis indicates a small but net positive gain of nearly $5 billion in 2020 and over $8 billion in 2030 from Shaheen-Portman. INCAAA would contribute an additional $1.3 billion toward GDP in 2020 and another $1 billion in 2030.[6]

Emissions Reductions

By reducing the amount of fuel consumed, the energy efficiency provisions in the Shaheen-Portman and INCAAA bills should reduce the emissions of carbon dioxide (CO_2) and other air pollutants. The Shaheen-Portman bill alone is expected to reduce annual CO_2 emissions by about 29 million metric tons (MMT) in 2020, with the reduction in emissions increasing to 108 MMT in 2030. INCAAA would provide additional annual reductions of 9 MMT in 2020 and 24 MMT in 2030. Combined, these reductions in CO_2 emissions would be the equivalent of taking about 7.5 million cars off the road in 2020, and 26 million cars off the road in 2030.[7]

[6] All values reflect constant 2009 dollars.

[7] It is estimated that the average vehicle in the United States in 2009 traveled 11,720 miles per year and had 20.4 miles per gallon fuel economy. A vehicle emits approximately 20 pounds of carbon dioxide per gallon of fuel. There are 2,204.6 pounds of carbon dioxide per metric ton. Given these assumptions, each car in the U.S. emits about 5.1 metric tons of carbon dioxide equivalent per year. See http://www.epa.gov/cleanenergy/energy-resources/refs.html.

Conclusion

The energy efficiency provisions in the Shaheen-Portman and INCAAA bills will likely drive important but modest energy savings for consumers, even as they enhance greater opportunities for net increases in American jobs. Our assessment suggests that successful implementation of these bills will result in a net present value energy bill savings of $71 billion over the 2012–2030 period, and in turn, support a net increase of 185,000 jobs in 2030. In addition, the energy efficiency provisions in these two bills will reduce the amount of carbon dioxide emitted in the U.S. by over 130 million metric tons in 2030, which would be the equivalent of taking 28.1 million cars off the road.

These two bills represent important pieces of energy efficiency legislation. However, policymakers should recognize that these bills are only an initial down-payment on needed policy steps to maximize use of cost-effective energy efficiency resources to benefit the U.S. economy. More comprehensive bills didn't move forward in the 112th Congress due to the highly-polarized political environment. Exploring additional energy efficiency policies for the 113th Congress is thus even more important. Among the areas that ACEEE recommends Congress consider are:

- Setting energy savings targets for utilities, either via an energy efficiency resource standard or a clean energy standard that includes energy efficiency;[8]
- Tax reform that removes several barriers to energy efficiency investments in the current tax code;[9]
- Providing more information on the energy efficiency of a building to potential purchasers and renters and considering energy costs as part of mortgage decisions;[10] and
- Establishing a price on greenhouse gas emissions so that the private market has a clearer incentive to pursue investments that reduce emissions.

Energy efficiency represents an important opportunity to enhance the U.S. economy, while providing important energy and environmental benefits. In the current weak economy, helping consumers and businesses to reduce energy costs is more important than ever.

[8] See http://www.aceee.org/topics/eers.
[9] ACEEE is conducting research on these topics and will be publishing a series of white papers in early 2012.
[10] See http://www.aceee.org/topics/building-rating-and-disclosure.

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Appendix A: Detailed National Results of Energy Efficiency Provisions in Shaheen-Portman

			2020									
Title	Subtitle	Section	Electricity (TWh)	Avoided Peak Demand (MW)	Direct Natural Gas (TBtu)	Oil Savings (Million barrels per day)	Primary Energy Savings (Quads)	Carbon Dioxide (MMT)	Cumulative Federal Costs (billion 2009 $)	Cumulative Consumer Investments (billion 2009 $)	Annualized Consumer Costs (billion 2009 $)	Net Annual Consumer Savings (Billion 2009$)
I. Buildings	A. Building Energy Codes	101. Greater efficiency in building codes	30.71	8,292.21	142.93	0.00	0.36	23.59	0.09	12.73	1.02	3.68
	B. Worker Training and Capacity Building	111. Building Training and Assessment Centers	0.01	3.91	0.29	0.00	0.00	0.02	0.07	0.03	0.00	0.00
II. Building Efficiency Finance		201. Loan program for energy efficiency upgrades to existing buildings	1.20	323.99	3.44	0.00	0.02	0.81	0.02	1.17	0.11	0.03
III. Industrial Efficiency and Competitiveness	A. Manufacturing Energy Efficiency	301. State Partnership industrial energy efficiency revolving loan program	7.22	1,950.19	7.53	0.00	0.08	4.19	0.21	0.20	0.02	0.49
	D. Transformer Rebate Program	331. Energy efficient transformer rebate program	0.19	52.11	0.00	0.00	0.00	0.10	0.01	0.01	0.00	0.01
Shaheen-Portman Subtotal			**39.34**	**10,622.41**	**154.19**	**0.00**	**0.47**	**28.71**	**0.40**	**14.13**	**1.16**	**4.20**
INCAAA			14.83	4,005.42	28.15	0.00	0.18	9.26	0.01	5.86	0.62	1.27
Total			**54.18**	**14,627.83**	**182.34**	**0.00**	**0.65**	**37.97**	**0.41**	**20.00**	**1.78**	**5.47**

			2030									
Title	Subtitle	Section	Electricity (TWh)	Avoided Peak Demand (MW)	Direct Natural Gas (BCF)	Oil Savings (Million barrels per day)	Primary Energy Savings (Quads)	Carbon Dioxide (MMT)	Cumulative Federal Costs (billion 2009 $)	Cumulative Consumer Investments (billion 2009 $)	Annualized Consumer Costs (billion 2009 $)	Net Annual Consumer Savings (billion 2009$) (4)
I. Buildings	A. Building Energy Codes	101. Greater efficiency in building codes	135.60	36,611.37	574.30	0.00	1.73	100.91	0.10	41.09	3.30	19.30
	B. Worker Training and Capacity Building	111. Building Training and Assessment Centers	0.01	3.98	0.59	0.00	0.00	0.04	0.15	0.06	0.00	0.01
II. Building Efficiency Finance		201. Loan program for energy efficiency upgrades to existing buildings	0.49	132.78	1.41	0.00	0.01	0.33	0.03	1.29	0.01	0.05
III. Industrial Efficiency and Competitiveness	A. Manufacturing Energy Efficiency	301. State Partnership industrial energy efficiency revolving loan program	12.40	3,347.54	8.83	0.00	0.14	6.94	0.29	1.14	0.10	0.77
	D. Transformer Rebate Program	331. Energy efficient transformer rebate program	0.19	52.11	0.00	0.00	0.00	0.10	0.01	0.01	0.00	0.01
Shaheen-Portman Subtotal			**148.70**	**40,147.79**	**585.13**	**0.00**	**1.88**	**108.31**	**0.58**	**43.59**	**3.41**	**20.13**
INCAAA			38.23	10,322.95	72.20	0.00	0.47	23.75	0.02	16.44	1.75	3.23
Total			**186.93**	**50,470.74**	**657.33**	**0.00**	**2.34**	**132.06**	**0.60**	**60.03**	**5.16**	**23.36**

All savings are annual unless otherwise specified as cumulative.

Appendix B: Descriptions of Energy Efficiency Provisions in Shaheen-Portman and INCAAA

Shaheen-Portman

Section 101. Greater Energy Efficiency in Building Codes.

This section directs the Secretary of DOE to assist in the development of national model building codes developed by the International Code Council (ICC) and American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) and to assist states to adopt and implement these codes. The Secretary is directed to set energy-saving targets for future ICC and ASHRAE codes. States are directed to adopt the model code and ultimately achieve at least 90% compliance with these codes.

Section 111. Building Training and Assessment Centers.

This section establishes Building Training and Assessment Centers, based on DOE's Industrial Assessment Center program, which are 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.

Section 201. Loan Program for Energy Efficiency Upgrades to Existing Buildings.

Expands the current section 1703 and 1705 credit support program to explicitly include building energy efficiency retrofits. Currently energy efficiency retrofits are not included. Directs the Secretary of DOE to establish specific guidance to implement such a program. Authorizes $400 million for the program over 10 years.

Section 301. State Partnership Industrial Energy Efficiency Revolving Loan Program.

Establishes a revolving loan fund to support investments in industrial energy efficiency and CHP to be administered at the state level. The provision authorizes an annual appropriation of $400 million a year for FY2012 through FY2021. The provision requires that the Federal contribution to the loan fund be matched at state level.

Section 331. Energy Efficient Transformer Rebate Program.

Establishes a rebate programs for the purchase of high-efficiency distribution transformers, defined to be those that exceed Premium Efficiency levels developed by the National Electrical Manufacturers Association. Rebates average about $10/kVA of transformer capacity, which is about the same as the incremental cost of a Premium Efficiency transformer relative to a standard new transformer. $5 million per year is authorized for 2012 and 2013.

Title IV. Federal Energy Efficiency.

This section includes a variety of provisions that clarify and expand upon existing law. In general, these changes could make it easier to save energy, but do not require energy savings and therefore we did not attempt to estimate energy savings achieved. The one exception is section 401, Adoption of Personal Computer Power Saving Techniques by Federal Agencies. This section will save energy as improved power management techniques are adopted. However it is not included in our analysis as the savings are below the level needed for inclusion in our analysis (0.1 quad per year savings threshold after full implementation).

INCAAA

Establishes new energy efficiency standards for several types of home appliances, lighting fixtures, and other equipment. The Department of Energy has developed rules for some of the appliances included in INCAAA since its introduction, so we do not consider savings from these appliance standards in our analysis.

Appendix C: Methodology for the Assessment of Energy Efficiency Provisions in Shaheen-Portman and INCAAA

Introduction

The Energy Savings and Industrial Competitiveness Act of 2011, which passed the Senate Committee on Energy and Natural Resources on July 14, 2011, contains several important energy efficiency provisions. Several of these provisions were included in previous energy and climate legislation (ACES, ACELA, APA). ACEEE has produced preliminary national-level analyses of these provisions as part of previous bills.

The Implementation of National Consensus Appliance Agreements Act (INCAAA) was introduced in September 2010, and addresses energy efficiency in several categories of common household appliances. It is expected to be combined with the Shaheen-Portman bill when it is brought to the floor.

This appendix 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 the energy efficiency provisions in the Shaheen-Portman bill and INCAAA at the national level. This analysis projects the aggregate energy, carbon, and economic savings for Shaheen-Portman and INCAAA individually and as a whole.

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

Overall Scoring Methodology

For each of the policies mentioned below, this analysis estimates energy savings in 2020 and 2030. Estimates were calculated for electricity use, natural gas use, oil savings (including motor gasoline, diesel, and home fuel oil), and all energy sources together. This analysis also estimates federal and consumer costs, as well as gross consumer savings (based upon dollar savings from unused energy) and net consumer savings. In general, EIA's *Annual Energy Outlook 2011* (EIA 2011b) was used as the reference case. A number of key assumptions were taken from this document. These assumptions included projected energy prices and consumption by sector and by fuel type, power plant heat rates, and carbon dioxide emissions per unit of fuel saved.

A few sections of the bill 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. For our analysis we assumed that appropriations would be 50% of the levels authorized in the bills.

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 an interest rate of 5% real (e.g. not including inflation; if the nominal interest rate is 8% and inflation is 3%, then the real interest rate is approximately 5%). However, for the building financing provision, we used a 3% real interest rate, as with a federal guarantee, interest rates will be lower. These amortized net investment values were subtracted from the gross savings to calculate net savings. For most measures we used a 13-year measure life (based on studies

showing an average measure life of about 13 years for utility demand-side management programs (Friedrich et al. 2009). For building codes, we used an average measure life of 20 years.

Peak Savings and Emissions Savings

To calculate peak generation savings, we multiplied electric generation savings by a peak factor (kilowatt per kilowatt-hour) that quantifies the fraction of a product's annual hours of usage that occur during times of peak system demand. For this analysis we used a peak factor of 0.27 kW per MWh of energy savings. This figure was derived by ACEEE from data collected by EIA on energy and peak savings from utility energy efficiency programs.

CO_2 reductions were calculated separately for each fuel (electricity, natural gas and oil) using annual emissions factors we derived from energy use and emissions as estimated in EIA's *Annual Energy Outlook 2011* (EIA 2011b).

Key Assumptions Used in Analysis of Individual Sections

Section 101: Greater Energy Efficiency in Building Codes

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 an average of 30% electricity and natural gas savings in 2012 and 50% savings in 2019. The 30% savings are contained in national model reference codes adopted in 2010 but we assume a two-year delay before state adoption begins. The 50% savings levels are being targeted for 2015 and 2016 codes, but again, we build in a several year delay. Not all states are likely to implement these codes, so we assumed that state adoption increases from 10% to 80% between 2012 and 2017. We assume adoption drops to 35% in 2019 when the more stringent codes are introduced, before returning to 80% in 2023. We also assumed that 60% of buildings would correctly implement the codes initially in 2012, with compliance rising to 90% by 2017. Compliance drops to 70% when the new codes are implemented in 2019, but rises to 90% in 2021.

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 2009g). The amount of electricity and natural gas per home was calculated by dividing the delivered electricity and natural gas consumption by the number of homes. The same implementation assumptions for commercial buildings (e.g. percent savings, years, state adoption rates, etc.) were used for residential buildings.

An authorization of $200 million is included in the bill. We assume an appropriation of $10 million per year for ten years, beginning in 2012 (e.g., that total appropriations are half of the authorization).

Section 111: Building Training and Assessment Centers

Building Training and Assessment Center (BTAC) savings were based upon a ramp-up to 75 centers in 2016 assuming 26 assessments per center per 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. (EIA 2007) and energy savings of 10% to calculate savings from each assessment.

Section 201: Loan Program for Energy Efficient Upgrades to Existing Buildings

In analyzing the provision we assume it will apply to commercial buildings as we see energy service companies that serve the commercial sector as the prime beneficiaries of the program.

Costs and savings per dollar invested come from a database on energy service company projects compiled and maintained by Lawrence Berkeley National Laboratory (Goldman et al. 2002). The bill authorizes $400 million over ten years. We assume that actual appropriations will be half this, and spread evenly over the ten years. DOE has estimated that each dollar of loan guarantee leverages $5-10 of loans. The remaining 94% is used for loan guarantees. We chose the midpoint of this range for our analysis, meaning that if $18.8 million is available for loan guarantees each year, it will leverage $141 million in loans. We assume that program costs will be 3% of the appropriation and 3% is needed for a loan loss reserve.

Section 301: State Partnership Industrial Energy Efficiency Revolving Loan Program

For our analysis, we assume that half of the federal contribution is appropriated so a total contribution of $400 million is made annually to the loan pool over the ten year life of the provision. Our analysis assumes that federal and matching local loans are responsible for 85 percent of project investment with balance paid for in cash by the industrial firm. Loans are made at the ten-year Treasury bill rate as projected in Annual Energy Outlook (EIA 2011b), with a loan servicing cost of 3 percent of the principle amount and a 5 percent default rate both paid for out of the pool amount. Loan payments are assumed to be re-lent in the year they are repaid. We project the savings resulting from the investments to be equally distributed between electricity and fuels.

Section 331: Energy Efficient Transformer Rebate Program

We assume that $2.5 million is appropriated for 2012 and 2013, half of the amount authorized. We analyze this provision by estimating the number of kVA that could receive rebates within the funding available. Costs and savings per kVA come from a DOE analysis for pending new transformer efficiency standards (). We estimate that in 2012 the program is just getting going and our assumed funding is adequate, but in 2013 that the program will be oversubscribed. While funding is capped, we do assume that in 2013 an equal number of customers purchase such transformers on their own, after the rebate funds run out. And we assume similar self-funded implementation in 2014, after the program ends but attributable to the attention the program brings to efficient transformers.

INCAAA

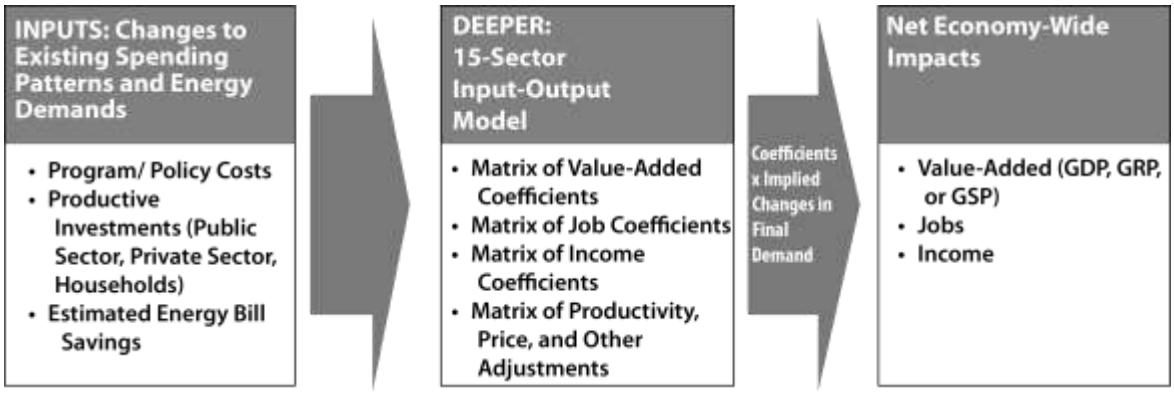
Savings from each individual appliance standard were estimated using a spreadsheet model that uses data on each product to calculate costs and savings. For each product estimates were developed for annual sales, baseline energy use, energy use with standards, percent of current product sales that already meet the standards, incremental product cost, and average equipment life. The methodology is described in more detail in the joint ACEEE/ASAP report *Ka-BOOM! The Power of Appliance Standards: Opportunities for New Federal Appliance and Equipment Standards* (Neubauer et al. 2009). Many of the product assumptions come from this report, but with a variety of revisions that will be published in a forthcoming ACEEE/ASAP report (Lowenberger et al. 2012) that updates the 2009 report.

Appendix D: Methodology of the Macroeconomic Model

To evaluate the macroeconomic impacts of a variety of energy efficiency, renewable energy, and climate policies at the local, state, and national level, ACEEE uses the proprietary **D**ynamic **E**nergy **E**fficiency **P**olicy **E**valuation **R**outine, or DEEPER model. The model has a 20-year history of use and development, though it was more recently renamed "DEEPER."

The DEEPER Modeling System is a 15-sector[11] quasi-dynamic input-output (I/O) model[12] of the U.S. economy that draws upon social accounting matrices[13] from the Minnesota IMPLAN Group,[14] energy use data from the U.S. Energy Information Administration's Annual Energy Outlook (AEO), and employment and labor data from the Bureau of Labor Statistics (BLS). The Excel-based tool is made up of three linked modules ((i) the Energy and Emissions Module; (ii) the Electricity Production Module; and (iii) the Macroeconomic Module)[15] and contains approximately two dozen interdependent worksheets. The model functions as laid out in the flow diagram below:

Diagram of the DEEPER Model



DEEPER results are driven by adjustments to energy service demands and alternative investment patterns resulting from projected changes in policies and prices between baseline and policy scenarios. The model is capable of evaluating policies at the national level through 2050. However, given uncertainty surrounding future economic conditions and the life of the impacts resulting from the policies analyzed, it is often used to evaluate out 10–15 years. Although the DEEPER Model, like most I/O models, is not a general equilibrium model,[16] it does provide accounting detail that balances changes in investments and expenditures within a sector of the economy. With consideration for goods or services that are imported, it balances the variety of changes across all sectors of the economy.[17]

[11] The current mix of 15 sectors reflects the analyst's efforts to exhibit key outcomes while maintaining a model of manageable size. It is possible to expand and reduce the number of sectors in the model with relatively easy programming adjustments. If the analyst chooses to reflect a different mix of sectors and stay within the 15 x 15 matrix, that can be easily accomplished through minor changes.

[12] Input-output models use economic data to study the relationships among producers, suppliers, and consumers. They are often used to show how interactions among all three impact the macroeconomy.

[13] A social accounting matrix is a data framework for an economy that represents how different institutions—households, industries, businesses, and governments—all trade goods and services with one another.

[14] See http://implan.com/V4/Index.php. The entire IMPLAN database for the U.S. economy can be expanded to more than 400 sectors as needed.

[15] See Laitner et al. (1998) for an example of an earlier set of modeling results. For a more recent review of modeling assessments, see also Laitner and McKinney (2008).

[16] General equilibrium models operate on the assumption that a set of prices exists for an economy to ensure that supply and demand are in an overall equilibrium.

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

The Macroeconomic Module contains the factors of production—including capital (or investment), labor, and energy resources—that drive the U.S. economy for a given "base year." DEEPER uses a set of economic accounts that specify how different sectors of the economy buy (purchase inputs) from and sell (deliver outputs) to each other.[18]

The DEEPER model is typically used to evaluate impacts of selected policies in 15 different economic sectors that are usually affected by changes in energy use and investment: 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.[19] The model looks at different labor intensities[20] in different sectors to provide insights about the net employment benefits to the economy.

The Macroeconomic Module translates the selected different policy scenarios, including necessary program spending and research and development (R&D) expenditures, into an annual array of physical energy impacts, investment flows, and energy expenditures over the desired period of analysis. DEEPER evaluates the policy-driven investment path for the various financing strategies, as well as the net energy bill savings anticipated over the study period. It also evaluates the impacts of avoided or reduced investments and expenditures otherwise required by the electric and natural gas sectors. These quantities and expenditures feed directly into the final demand worksheet of the module that generates the net changes in sector spending.

The resulting positive and negative changes in spending and investments in each year are converted into sector-specific changes in aggregate demand.[21] These results then drive the I/O matrices utilizing a predictive algebraic expression known as the Leontief Inverse Matrix,[22] which drives the input-output model according to the following predictive model:

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

where:

X = total industry output by sector
I = an identity matrix consisting of a series of 0's and 1's in a row and column format for each sector (with the 1's organized along the diagonal of the matrix)
A = the 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.[23]

[18] Further details on this set of linkages can be found in Hanson and Laitner (2009).
[19] Household spending is allocated to each of the sectors using the personal consumption expenditure data provided in the IMPLAN data set.
[20] This is the magnitude of jobs supported by a given level of investment.
[21] This is the total demand for final goods and services in the economy at a given time and price level.
[22] For a more complete discussion of these concepts, see Miller and Blair (1985).
[23] 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.

Employment quantities are adjusted annually according to assumptions about the anticipated labor productivity improvements based on forecasts from the Bureau of Labor Statistics. The DEEPER Macroeconomic Module traces how changes in spending will ripple through the U.S. economy in each year of the assessment period. **The end result is a net change between the reference and policy scenarios in jobs, income, and value-added,[24] which is typically measured as Gross Domestic Product (GDP), Gross Regional Product (GRP), or Gross State Product (GSP) for the study region (e.g., national, state, or local).**

Like all economic models, DEEPER has strengths and weaknesses. It is robust by comparison to some I/O models because it can account for price and quantity changes over time and is sensitive to shifts in investment flows. It also reflects sector-specific labor intensities across the U.S economy. However, it is important to remember when interpreting results for the DEEPER model that the results rely heavily on the quality of the information that is provided and the modeler's own assumptions and judgment. The results are unique to the specified policy design. The results reflect differences between scenarios in a future year, and like any prediction of the future, they are subject to uncertainty.

[24] This is the market value of all final goods and services produced within a country in a given period.