2015 Federal Energy Efficiency Legislation: Projected Impacts

Lowell Ungar, Chetana Kallakuri, and James Barrett

September 2015

An ACEEE White Paper

529 14th Street NW, Suite 600, Washington, DC 20045

Phone: (202) 507-4000 • Twitter: @ACEEEDC

Facebook.com/myACEEE • aceee.org

Contents

About the Authors

Lowell Ungar supports effective federal energy efficiency policies. He promotes agency actions under existing authorities, develops legislative proposals, and analyzes existing and proposed policies and programs. He joined ACEEE in 2013.

Prior to joining ACEEE, Lowell was director of policy at the Alliance to Save Energy, working primarily to develop federal energy efficiency legislation and build stakeholder and policymaker support. He played a key role in enacting legislation on building energy codes, appliance efficiency standards, tax incentives, Department of Energy programs and funding, federal energy management, and other areas. He also co-wrote reports on buildings and utility policy issues. Before working at the Alliance he was a legislative aide in both the US Senate and the House of Representatives.

Lowell earned a PhD in physical chemistry from the University of Chicago and a BS in chemistry with distinction and with honors in humanities from Stanford University.

Chetana Kallakuri works in the ACEEE Policy Program on the impacts of federal energy efficiency policies. She also works on the International Energy Efficiency Scorecard, a periodic ACEEE publication. She joined ACEEE in 2015.

Chetana graduated from the Yale School of Forestry and Environmental Studies in 2014 with a master of environmental management degree and a concentration in energy and the environment. Prior to joining ACEEE, she worked with a Virginia-based tribal nonprofit in 2014. As an Environmental Defense Fund Climate Corps fellow in the summer of 2013, she analyzed building energy use for Southwestern Energy. She also worked as a student consultant with Natural Resources Defense Council's India Initiative in 2013, evaluating energy efficiency measures for commercial buildings in India.

James Barrett concentrates on the nexus of climate change, energy efficiency, and economics and has written extensively on the role of efficiency in achieving environmental and economic goals.

Prior to joining ACEEE, Jim was executive director of Redefining Progress, a public policy think tank dedicated to promoting a healthy environment, a strong economy, and social justice. Before that he was an economist at the Economic Policy Institute, a senior economist on the Democratic staff of the Joint Economic Committee, and a staff economist at the Institute for Biological Energy Alternatives.

Jim earned his bachelor of arts in economics from Bucknell University and his master of arts and PhD in economics from the University of Connecticut.

Acknowledgments

This report was made possible in part through the generous support of the Energy Foundation. In addition to the authors, Steve Nadel, Neal Elliott, Meegan Kelly, Rachel Cluett, and Jennifer Amann contributed to the analysis in the report, and Suzanne Watson contributed to its conception. External expert reviewers of individual provision analyses or the full paper included the following. (External review does not imply affiliation or endorsement.)

Elizabeth Beardsley, USGBC
Andrew Burr, IMT
Cara Carmichael, RMI
Jim Davis, UCLA
Jim Edelson, NBI
Don Gilligan, NAESCO
Chuck Goldman, LBNL
Charlie Haack, ICF International
Jeff Harris
Bruce Hedman, IIP
Adam Hinge, SEP
Bryan Howard, USGBC
Bing Liu, PNNL
Cliff Majersik, IMT
Jeff Mang, Hogan Lovells
Michael Muller, Rutgers
Kinga Porst, GSA
Robert Sahadi, IMT
Jennifer Schafer, Cascade Associates
Bob Slattery, ORNL
Rodney Sobin, NASEO
Denise Swink, SMLC

We also would like to thank Brett Dillon from IBS Advisors and Clayton Traylor and Ken Gear from Leading Builders of America for their assistance. Thanks to Fred Grossberg for managing the editorial process, Sean O'Brien and Roxanna Usher for copy editing, and Patrick Kiker and Eric Schwass for their help in launching this report.

Executive Summary

Both the House and the Senate have been drafting broad energy bills in which energy efficiency is a key pillar. Energy efficiency helps achieve many of the bills' goals: it creates jobs and fosters economic development, reduces strain on supply infrastructure, and cuts pollution—all while saving consumers money.

ACEEE analyzed 15 energy efficiency policies to estimate their impacts on consumers, the economy, the environment, and the energy system. To simplify macroeconomic analysis and the presentation of results, we assigned the policies to three packages: a **first down** package that includes several provisions in the Senate bill and a few that could be added, a **touchdown** package that shows the impact of a broader policy to encourage efficiency throughout the economy, and a **fumble** package with provisions that would roll back current policies. Figure ES-1 shows the results.

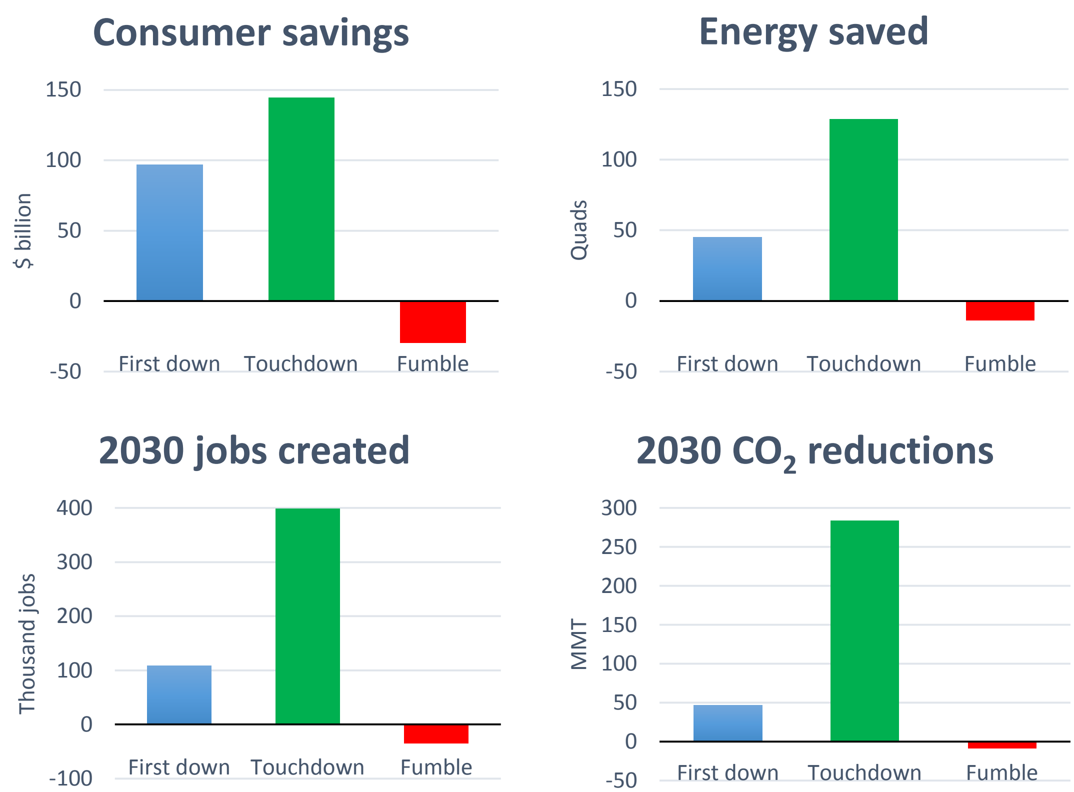

Figure ES-1. Results of three policy packages

We estimate the first down package would

- create 110,000 jobs in 2030
- reduce carbon dioxide emissions by almost 50 million tons in 2030, the equivalent of taking about 10 million cars and light trucks off the road
- save consumers almost $100 billion over the lifetime of measures through 2040

The potential benefits of the touchdown package are several times larger. On the other hand, the fumble package could cost consumers tens of billions of dollars and result in the loss of thousands of jobs.

Table ES-1 shows the cumulative impacts of individual provisions. By far the largest impact would be from a federal Energy Efficiency Resource Standard, requiring electric and natural gas utilities to help their customers save energy. The next largest impacts come from building energy codes. By modifying assistance to state and local governments on codes, the Portman-Shaheen bill could save consumers—and the Blackburn-Schrader bill could cost them—billions of dollars.

Other measures would help families and businesses save energy through recognition of savings in mortgages, better access to information, and programs to accelerate innovation in industry and in commercial buildings. Threats to energy savings include provisions that would hinder the effective appliance efficiency standards program, specifically with regard to furnaces and ceiling fans.

Table ES-1. Cumulative impacts of individual provisions (PS is Portman-Shaheen; BS is Blackburn-Schrader)

Provision	Bill	Consumer net savings ($ billion)	Benefit-cost ratio	Cumulative energy savings (quads)
First down total		**96.8**	**2.4**	**45.00**
Building codes – PS	S.720, Sec. 101	61.4	2.7	30.97
SAVE underwriting	S.720, Sec. 433	12.1	3.0	4.42
E-Access	S.1044	12.6	3.3	3.32
Commercial benchmarking	S.1052	1.2	2.6	0.34
Smart buildings	S.1046	3.8	2.0	1.32
Nonprofit retrofits	S.600/H.R. 2132	0.0	2.1	0.01
Federal building standards	S.869	0.5	1.2	0.70
Fossil fuel standard repeal	S.869	-0.7	0.7	-0.81
Federal deep retrofits	S.1055	0.3	1.0	1.73
Industrial Assessment Centers	S.720, Sec.202	0.7	4.1	0.27
Smart manufacturing	S.1054	5.0	2.0	2.73
Touchdown total		**144.6**	**1.4**	**128.37**
Energy efficiency standard	S.1063	144.6	1.4	128.37
Fumble total		**-35.2**	**0.4**	**-15.83**
Building codes – BS	H.R. 1273	-23.3	0.4	-12.53
Furnace standard conditions	S.1029	-5.9	0.5	-1.28
Ceiling fan standard bar	S.1048/H.R. 3072	-5.3	0.2	-1.21
Fossil fuel standard repeal		-0.7	0.7	-0.81

The impacts are estimated for the lifetime of new measures through 2040. Consumer savings are the net present value of energy savings minus the needed additional investment. The benefit-cost ratio is generally the ratio of the present values of savings to investments. Note that fossil fuel standard repeal is paired with strengthened federal building efficiency standards in S.869 but is by itself in the fumble package. These "repeal and replace" provisions have also been linked to the SAVE Act mortgage underwriting provision.

Introduction

Both the House Energy and Commerce Committee and the Senate Energy and Natural Resources Committee began to consider broad energy legislation early this year with a determined bipartisan tone. That meant they turned immediately to energy efficiency as a key pillar. Energy efficiency can create jobs, foster economic development, reduce strain on supply infrastructure, and reduce pollution—all while saving consumers money.

Both the House Energy and Commerce Committee's "Architecture of Abundance" and the Senate Energy Committee's *Energy Policy Modernization Act of 2015* currently await full committee markup prior to consideration by the full House and Senate, and, assuming they make it that far, an attempt to reconcile the two. Both bills use popular energy efficiency measures to build bipartisan support.

That being said, the attempt to build support for the legislation in today's Congress has meant the exclusion of some important but more controversial energy efficiency measures, as well as the inclusion of certain counterproductive measures that would *reduce* energy efficiency. Thus this analysis is the tale of three packages of energy efficiency policies: one that would move us downfield toward a healthier economy and cleaner skies, one that would go farther to change the game, and one that would lose ground we have already gained.

Provisions and Packages

After considering over 50 energy efficiency provisions that have been introduced into legislation this year, we selected 15 of them to analyze for this paper. We chose these 15 based on our assessment of their likely impact (positive or negative) on energy efficiency if they were enacted and on how seriously they were being considered. The provisions we analyzed include the following, with more detailed descriptions in Appendix B.

- *Building energy codes*. The **Portman-Shaheen codes** provision would expand federal assistance, but the **Blackburn-Schrader codes** provision would severely constrict it.
- *Mortgages*. The **SAVE Act** would consider energy bill savings for efficient homes in determining eligibility for mortgages.
- *Information*. Provisions on **access to utility bill information** and on **commercial building benchmarking** would give building owners better energy use information.
- *Buildings programs*. Two provisions would support **smart buildings** with real-time controls and energy retrofits of buildings owned by **nonprofit organizations**.
- *Equipment*. Two provisions would prevent pending administrative updates of appliance efficiency standards, one on **furnaces** and one on **ceiling fans**.
- *Federal buildings*. The Hoeven-Manchin bill would repeal a standard on **fossil-fuel energy use** by federal buildings and replace it with extended **efficiency standards** and targets. Another bill would require **deep energy retrofits** in federal buildings.
- *Industry programs*. A **smart manufacturing** provision would authorize a program on advanced controls in factories, and another provision would update DOE's industrial efficiency programs, particularly the **Industrial Assessment Centers**.
- *Utilities*. An **Energy Efficiency Resource Standard (EERS)** would require electric and natural gas utilities to use energy efficiency to help meet customer needs.

To simplify macroeconomic analysis and the presentation of results, we assigned the policies to three packages (see table 1 below). The **first down** package is based on provisions that were also considered in the last Congress as part of the Shaheen-Portman bill, now the Portman-Shaheen bill (S.720). We added new provisions that also have attracted broad support. We believe this strong package would pass if it were put to a vote today. The **touchdown** package shows what a more aggressive policy (the broad EERS proposal) could achieve. We also analyzed a **fumble** package that includes some of the proposed rollbacks of current law; these risk losing savings we are already achieving.

As of this writing, the Senate bill is most similar to the first down package. It includes most of the first down provisions, although it also includes the negative furnace standard provision (which is in the fumble package). The first down package shows that the Senate bill would be enhanced by inclusion of SAVE Act underwriting reforms, consumer access to energy bill information, commercial building benchmarking support, and additional smart manufacturing measures.

The House bill includes only one provision we analyzed, on Industrial Assessment Centers. It is not similar to any of the packages. It may be more similar to no package, as its impacts, though positive, would be smaller than those of any of the three packages we analyzed.

Table 1. Provisions analyzed in this paper and the packages in which they are included

Provision	Sector	Bill	Key sponsors
First down			
Building codes – PS	Res. + Com.	S.720, Sec. 101	Portman + Shaheen
SAVE underwriting	Residential	S.720, Sec. 433	Bennet + Isakson
E-Access	Res. + Com.	S.1044	Markey
Commercial benchmarking	Commercial	S.1052	Franken
Smart buildings	Commercial	S.1046/H.R. 2564	Cantwell + Murkowski
Nonprofit retrofits	Commercial	S.600/H.R. 2132	Klobuchar/Cartwright
Federal building standards Fossil fuel standard repeal	Federal Federal	S.869 S.869	Hoeven + Manchin Hoeven + Manchin
Federal deep retrofits	Federal	S.1055	Franken
Industrial assessment centers	Industry	S.720, Sec. 202	Portman + Shaheen
Smart manufacturing	Industry	S.1054	Shaheen + Alexander
Touchdown			
Energy efficiency standard	Utilities	S.1063	Franken
Fumble			
Building codes – BS	Res. + Com.	H.R. 1273	Blackburn + Schrader
Furnace standard conditions	Res. Equipment	S.1029	Hoeven + Alexander
Ceiling fan standard bar	Res. Equipment	S.1048/H.R. 3072	Alexander/Dent
Fossil fuel standard repeal (also in first down package)			

Note that fossil fuel standard repeal is paired with strengthened federal building efficiency standards in S.869 but is by itself in the fumble package. These "repeal and replace" provisions have also been linked to the SAVE Act mortgage underwriting provision.

Methodology

First we estimated likely national energy savings, monetary and emissions savings, and costs for each provision. These are projections for what we believe is a likely scenario for implementation, not for maximum potential impacts. Details on the methodology and assumptions we used are in Appendix C.

We then assembled the policies into the three packages and used a simplified version of our DEEPER input-output model (described in Appendix D) to estimate their net macroeconomic impacts. We estimated how many jobs would be created and lost due to the investment of government and consumer funds into efficiency measures (and the loss of other uses of those funds) and due to the consequent reduction in payments from consumers to utilities.

While we have given best estimates, there is a high level of uncertainty in all these numbers. In some cases there are few data to show a provision's impact, and we had to base assumptions on the judgment of the authors with review by outside experts.

Results

Figure 1 shows key estimated impacts for the three packages.

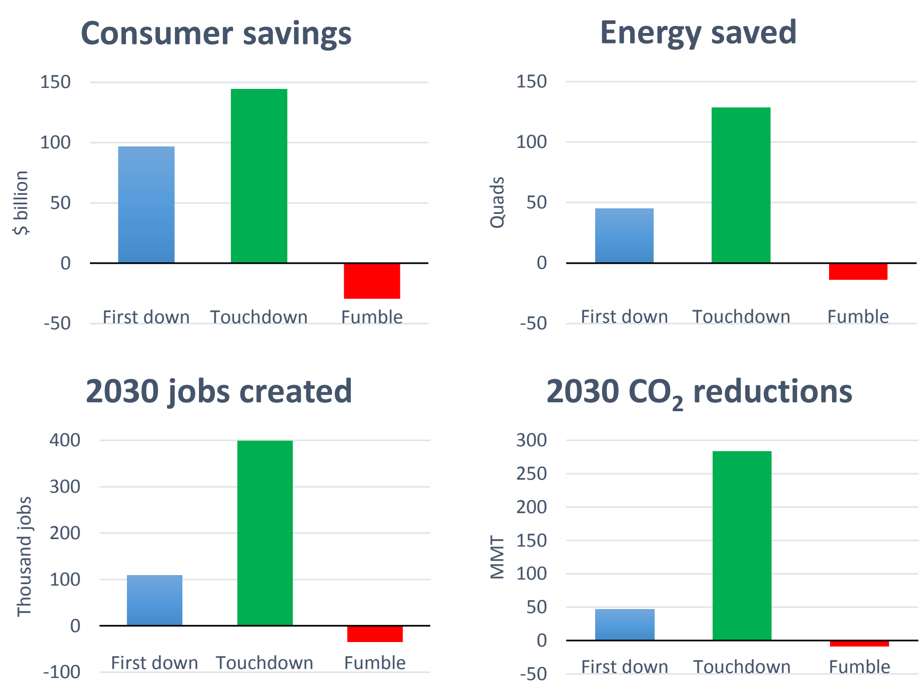

Figure 1. Estimated key impacts from different packages of policies. Consumer savings are net present value of energy savings minus investment; energy saved is cumulative for the lifetime of measures taken through 2040.

The results illustrate the multiple benefits of energy efficiency: smart efficiency policies can grow the economy, improve the environment, and save consumers money. We estimate the first down package would create 110,000 jobs in 2030, reduce carbon dioxide emissions by almost 50 million metric tons (MMT) in that year (the annual emissions of about 10 million cars and light trucks), and save consumers almost $100 billion over the lifetime of measures through 2040 (net after added investments). That is still only a fraction of the potential benefits of energy efficiency. The impacts of the touchdown package are several times larger. On the other hand, the fumble package shows that the wrong provisions could cost consumers billions of dollars.

ENERGY AND FINANCIAL SAVINGS

Figure 2 further illustrates the impacts of the three packages. These grow steadily as more efficient homes and commercial buildings are built, more buildings are upgraded, and energy management improves. By 2032 the first down package yields one quadrillion Btu (quad) in savings, about 1% of total US projected energy use in that year.

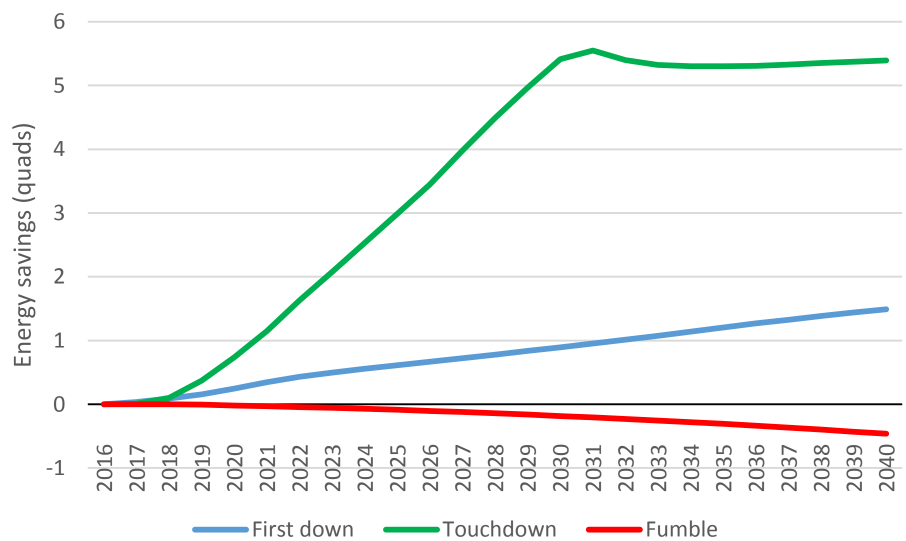

Figure 2. Annual energy savings by year for each of the packages

Table 2 shows estimated key impacts from individual policies. More detailed results are in Appendix A. The results show a range of impacts. By far the largest would be from a federal EERS. Although significant investments would be required, the savings would be remarkable—well over 100 quads of cumulative energy and $100 billion net savings in addition to what we expect existing state-level EERS policies to achieve. The next largest impact would come from policies on building energy codes. Through additional assistance and encouragement for development and implementation of state codes, we estimate the codes provision in the Portman-Shaheen bill and the Senate Energy Committee bill could save consumers over $50 billion. On the other hand, we believe the related Blackburn-Schrader bill would hinder current Department of Energy work on the development and adoption of effective codes, and thus would cost consumers billions of dollars.

Table 2. Estimated key impacts of individual provisions

Provision	Consumer net savings ($ billion)	Benefit-cost ratio	Cumulative energy savings (quads)
First down total	**96.8**	**2.4**	**45.00**
Building codes – PS	61.4	2.7	30.97
SAVE underwriting	12.1	3.0	4.42
E-Access	12.6	3.3	3.32
Commercial benchmarking	1.2	2.6	0.34
Smart buildings	3.8	2.0	1.32
Nonprofit retrofits	0.0	2.1	0.01
Federal building standards	0.5	1.2	0.70
Fossil fuel standard repeal	-0.7	0.7	-0.81
Federal deep retrofits	0.3	1.0	1.73
Industrial assessment centers	0.7	4.1	0.27
Smart manufacturing	5.0	2.0	2.73
Touchdown total	**144.6**	**1.4**	**128.37**
Energy efficiency standard	144.6	1.4	128.37
Fumble total	**-35.2**	**0.4**	**-15.83**
Building codes – BS	-23.3	0.4	-12.53
Furnace standard conditions	-5.9	0.5	-1.28
Ceiling fan standard bar	-5.3	0.2	-1.21
Fossil fuel standard repeal	-0.7	0.7	-0.81

Impacts are estimated for the lifetime of new measures through 2040. Consumer savings are the net present value of energy savings minus the needed additional investment. The benefit-cost ratio is generally the ratio of the present values of savings to investments.

Other measures with large impacts would help families and businesses adopt better technologies and practices through recognition of savings in mortgages (SAVE); improve access to information; and accelerate innovation in industry and commercial buildings. Threats include provisions that would hinder the effective appliance efficiency standards program, specifically furnace and ceiling fan standards.

JOB CREATION AND ECONOMIC GROWTH

These packages of energy efficiency policies also would make a significant difference in the economy, as illustrated by the net creation of jobs. Figure 3 expands the snapshot in figure 1 to show the growth in job creation over time from the three packages. By 2030 the first down package would result in a net increase of 110,000 jobs in the United States. By way of comparison, total employment in all utilities is 561,000 (BLS 2015). The projected increase includes jobs in the construction, manufacturing, software, and other industries that would implement the efficiency measures, as well as jobs created throughout the economy by families and businesses spending the money they have saved in lower utility bills.

The economic model also shows economic growth directly. For example, the first down package would increase gross domestic product (GDP) by $7 billion in 2030 as a result of the efficiency investments and the added money in consumers' pockets. It does not include possible additional impacts from making companies more competitive.

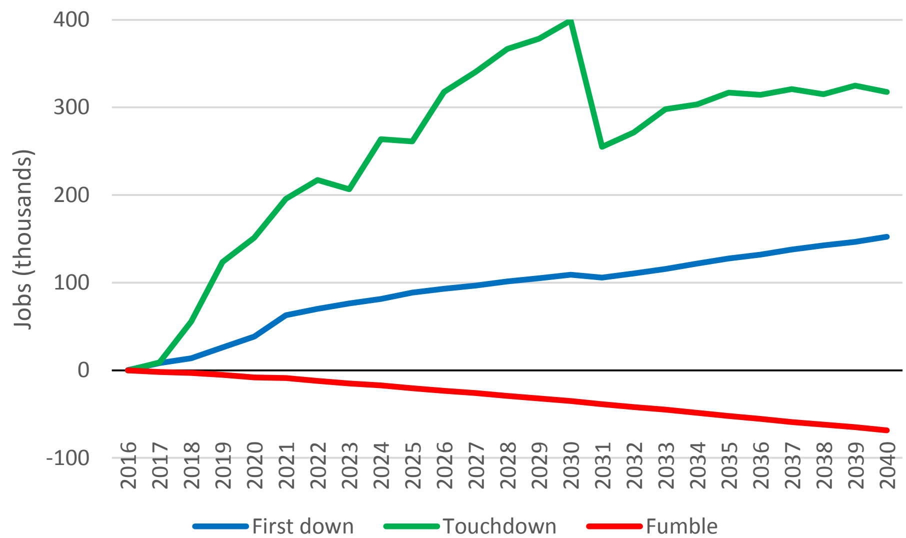

Figure 3. Net jobs created due to each of the three policy packages

Conclusion

The last time a broad energy bill was enacted was in 2007, with a Democratic House and Senate and a Republican president. The Energy Independence and Security Act of 2007 helped transform the markets for cars and trucks, develop new lighting technologies, and slash demand for oil and for electricity. Since 2007 advanced technologies have enabled intelligent control of buildings and factories; new homes and commercial buildings that meet the latest codes have reduced covered energy use by more than 30%; and home energy ratings and commercial building energy benchmarking have become widespread. These and other developments provide new avenues to save energy and improve the national economy.

Thus Congress has a tremendous opportunity for bipartisan energy efficiency legislation. The Senate bill with modest enhancements—and avoiding poison pills that would reverse some of the gains we have made—could create 110,000 jobs, reduce carbon dioxide emissions by almost 50 million metric tons, and save consumers almost $100 billion. We hope Congress will once again seize this opportunity to reap the benefits of energy efficiency.

References

Barbose, G. L., C. A. Goldman, I. M. Hoffman, and M. Billingsley. 2013. *The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025*. January. Berkeley: Lawrence Berkeley National Laboratory Environmental Energy Technologies Division. http://emp.lbl.gov/sites/all/files/lbnl-5803e.pdf.

Bayer. 2009. Energy and Environmental Impact Reduction Opportunities for Existing Buildings with Low-Slope Roofs. April. Pittsburgh, PA: Bayer Material Science.

BLS (Bureau of Labor Statistics). 2015. "Utilities: NAICS 22." Accessed July 25. http://www.bls.gov/iag/tgs/iag22.htm.

Cook, L. 2014. "Benchmarking with EPA's ENERGY STAR Portfolio Manager." Presentation at the 5th Annual Midwest Building Energy Codes & Benchmarking Conference. November 18. http://www.mwalliance.org/sites/default/files/uploads/MEEA_2014_BenchmkgConf-P2_EPA-Benchmarking-Tool-and-Data-Sharing-Update.pdf.

DOE (US Department of Energy). 2012. *National Energy and Cost Savings for New Single- and Multifamily Homes: A Comparison of the 2006, 2009, and 2012 Editions of the IECC*. Washington, DC: DOE. https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf.

———. 2014a. "Utility Savings Estimators." January 17. https://www.energycodes.gov/resource-center/utility-savings-estimators.

———. 2014b. *Regulatory Impact Analysis for Fossil Fuel Reduction Rule*. Prepared by Pacific Northwest National Laboratory. July. http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0031-0032.

———. 2015. "Comprehensive Annual Energy Data and Sustainability Performance." Accessed June 1. http://ctsedwweb.ee.doe.gov/Annual/Report/HistoricalFederalEnergyConsumptionDataByAgencyAndEnergyTypeFY1975ToPresent.aspx.

EIA (Energy Information Administration). 2008. *2003 Commercial Buildings Energy Consumption Survey Data: Building Characteristics*. September. Washington, DC: EIA. http://www.eia.gov/consumption/commercial/data/2003/#a1.

———. 2015a. *Annual Energy Outlook 2015 with Projections to 2040*. Washington, DC: EIA. http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf.

———. 2015b. *Analysis of the Impacts of the Clean Power Plan*. Washington, DC: EIA http://www.eia.gov/analysis/requests/powerplants/cleanplan/pdf/powerplant.pdf.

EPA (US Environmental Protection Agency). 2013. *ENERGY STAR Certified Homes, Version 3 Cost & Savings Estimates*. November 1. Washington, DC: EPA. https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/EstimatedCostandSavings.pdf.

——. 2015. "Portfolio Manager Data Trends." Accessed July. http://www.energystar.gov/buildings/about-us/research-and-reports/portfolio-manager-datatrends.

Hayes, S., L. Ungar, and G. Herndon, 2015. *The Role of Building Energy Codes in the Clean Power Plan.* Washington, DC: ACEEE. http://aceee.org/sites/default/files/building-codes-111d-1-22-15.pdf.

Hoffman, I. M., G. Rybka, G. Leventis, C. A. Goldman, L. Schwartz, M. Billingsley, and S. Schiller. 2015. *The Total Cost of Saving Electricity through Utility Customer-Funded Energy Efficiency Programs: Estimates at the National, State, Sector and Program Level.* Berkeley: Lawrence Berkeley National Laboratory Electricity Markets and Policy Group. http://emp.lbl.gov/sites/all/files/total-cost-of-saved-energy.pdf.

IMPLAN (Implan Group, LLC). 2015. IMPLAN System (data and software). www.IMPLAN.com.

Jacobsohn, E., G. Khowailed, and T. Grubbs. 2015. "Making Sense of the Home Performance Data." Presentation at DOE webinar: Findings from the 2014 HpwES Annual Report. June 29.

Lowenberger, A., J. Mauer, A. deLaski, M. DiMascio, J. Amann, and S. Nadel. 2012. *The Efficiency Boom: Cashing In on the Savings from Appliance Standards.* Washington, DC: ACEEE. http://aceee.org/research-report/a123.

Molina, M. 2014. *The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs*. Washington, DC: ACEEE. http://aceee.org/research-report/u1402.

Opower. 2015. "Results." Accessed July. http://www.opower.com/results.

PNNL (Pacific Northwest National Laboratory). 2013. "Commercial Standard 90.1 Cost Effectiveness Analysis and Results." Building Energy Codes Program. http://www.energycodes.gov/development/commercial/cost_effectiveness.

Research into Action. 2015. *Evaluation of the Better Buildings Neighborhood Program: Final Synthesis Report, Volume 1.* June. Prepared for US Department of Energy. http://www1.eere.energy.gov/analysis/pdfs/bbnp_volume_1_final_evaluation_072215.pdf.

RFF (Resources for the Future). 2015. *Can Benchmarking and Disclosure Laws Provide Incentives for Energy Efficiency Improvements in Buildings?* Washington, DC: RFF. http://www.rff.org/RFF/Documents/RFF-DP-15-09.pdf.

RMI (Rocky Mountain Institute). 2014. *360º Perspective on Federal Deep Energy Retrofits*. August. Boulder: RMI. http://www.rmi.org/cms/Download.aspx?id=11348&file=2014-28_360PerspectiveonFederalDeepEnergyRetrofit.pdf&title=360+Perspective+on+Federal+Deep+Energy+Retrofits.

Rogers, E., N. Elliott, S. Kwatra, D. Trombley, and V. Nadudur. 2013. *Intelligent Efficiency: Opportunities, Barriers, and Solutions*. Washington, DC: ACEEE. http://aceee.org/research-report/e13j.

Rutgers. 2015. Industrial Assessment Centers Database. Accessed July. http://iac.rutgers.edu/database/.

Shonder, J. 2014. *Energy Savings from GSA's National Deep Energy Retrofit Program*. September. Oak Ridge, TN: Oak Ridge National Laboratory. http://www.gsa.gov/portal/mediaId/198447/fileName/NDEREnergySavingsReport5.action.

SMLC (Smart Manufacturing Leadership Coalition). 2011. *Implementing 21st Century Smart Manufacturing: Workshop Summary Report*. Los Angeles: SMLC. https://smartmanufacturingcoalition.org/sites/default/files/implementing_21st_century_smart_manufacturing_report_2011_0.pdf.

Young, R., S. Hayes, S. Nadel, G. Herndon, and J. Barrett. 2013. *Economic Impacts of the Energy Efficiency Provisions in the Energy Savings and Industrial Competitiveness Act of 2013 and Select Amendments*. Washington, DC: ACEEE. http://aceee.org/sites/default/files/pdf/white-paper/shaheen-portman-2013.pdf.

Appendix A. Detailed Results by Provision and Package

Table A1 lists annual electric, natural gas, energy, and carbon savings for each provision and package in 2020, 2030, and 2040, along with energy bill savings, consumer spending, and federal spending in those years. The savings are the impact in that year from all measures taken through that year. The spending is after financing; where costs are financed it includes the loan payments rather than the initial costs. Total energy savings include a small amount of oil and propane savings as well as the electricity and natural gas shown here. Only direct natural gas savings, not gas savings due to reduced electricity use, are shown. In addition to the consumer and federal spending shown here, there also is program spending. Note that these are snapshots—to look at cost effectiveness, one should consider the cumulative impacts below. Fossil fuel standard repeal is shown twice because it is in two packages.

Table A1. Estimated impacts by provision in 2020, 2030, 2040

2020 Savings and spending							
Provision	Electricity (TWh)	Natural gas (Tbtu)	Total energy (quads)	CO_2 emissions (MMT)	Energy bill savings ($ billion)	Consumer spending ($ billion)	Federal spending ($ billion)
First down total	**20**	**37**	**0.25**	**13**	**2.4**	**1.9**	**0.0**
Building codes – PS	3	7	0.04	2	0.4	0.2	0.0
SAVE underwriting	1	2	0.01	1	0.1	0.0	-
E-Access	8	-	0.09	5	0.9	0.5	-
Commercial benchmarking	1	2	0.01	0	0.1	0.1	0.0
Smart buildings	4	-	0.04	2	0.4	0.5	-
Nonprofit retrofits	0	0	0.00	0	0.0	0.0	0.0
Federal building standards	0	1	0.01	0	0.1	-	0.2
Fossil fuel standard repeal	-0	-0	-0.00	-0	-0.0	-	-0.2
Federal deep retrofits	-	-	-	-	-	-	-
Industrial Assessment Centers	0	0	0.00	0	0.0	0.0	0.0
Smart manufacturing	3	24	0.05	3	0.4	0.6	-
Touchdown total	**46**	**264**	**0.74**	**39**	**7.1**	**13.4**	**-**
Energy efficiency standard	46	264	0.74	39	7.1	13.4	-
Fumble total	**-2**	**-3**	**-0.02**	**-1**	**-0.3**	**-0.2**	**-0.2**
Building codes – BS	-1	-3	-0.01	-1	-0.2	-0.1	-
Furnace standard conditions	-	-	-	-	-	-	-
Ceiling fan standard bar	-1	-	-0.01	-0	-0.1	-0.1	-
Fossil fuel standard repeal	-0	-0	-0.00	-0	-0.0	-	-0.2

2030 Savings and spending							
Provision	Electricity (TWh)	Natural gas (Tbtu)	Total energy (quads)	CO_2 emissions (MMT)	Energy bill savings ($ billion)	Consumer spending ($ billion)	Federal spending ($ billion)
First down total	**71**	**174**	**0.89**	**47**	**9.9**	**3.5**	**0.9**
Building codes – PS	32	74	0.39	20	4.6	2.0	-
SAVE underwriting	6	17	0.08	4	1.1	0.4	0.0
E-Access	13	-	0.13	7	1.5	0.3	-
Commercial benchmarking	1	3	0.01	1	0.2	0.1	-
Smart buildings	6	-	0.06	3	0.7	0.3	-
Nonprofit retrofits	0	0	0.00	0	0.0	-	-
Federal building standards	1	4	0.02	1	0.2	-	0.2
Fossil fuel standard repeal	-2	-1	-0.02	-1	-0.2	-	-0.2
Federal deep retrofits	5	15	0.07	4	0.8	-	0.9
Industrial assessment centers	1	2	0.01	1	0.1	0.0	0.0
Smart manufacturing	8	60	0.14	7	1.0	0.4	-
Touchdown total	**386**	**1,528**	**5.41**	**284**	**56.5**	**26.7**	**-**
Energy efficiency standard	386	1,528	5.41	284	56.5	26.7	-
Fumble total	**-10**	**-134**	**-0.23**	**-12**	**-3.4**	**-1.6**	**-0.2**
Building codes – BS	-11	-24	-0.14	-7	-1.6	-0.8	-
Furnace standard conditions	8	-109	-0.03	-2	-0.9	-0.7	-
Ceiling fan standard bar	-5	-	-0.05	-2	-0.6	-0.1	-
Fossil fuel standard repeal	-2	-1	-0.02	-1	-0.2	-	-0.2

2040 Savings and spending							
Provision	Electricity (TWh)	Natural gas (Tbtu)	Total energy (quads)	CO_2 emissions (MMT)	Energy bill savings ($ billion)	Consumer spending ($ billion)	Federal spending ($ billion)
First down total	**122**	**275**	**1.49**	**76**	**19.0**	**6.4**	**0.5**
Building codes – PS	83	182	1.01	51	12.9	5.3	-
SAVE underwriting	11	31	0.14	7	2.2	0.8	0.0
E-Access	14	-	0.14	7	1.7	0.4	-
Commercial benchmarking	1	3	0.01	1	0.2	0.1	-
Smart buildings	3	-	0.03	1	0.3	-0.1	-
Nonprofit retrofits	-	-	-	-	-	-	-
Federal building standards	2	5	0.02	1	0.3	-	0.1
Fossil fuel standard repeal	-3	-1	-0.03	-1	-0.3	-	-0.2
Federal deep retrofits	5	16	0.07	4	0.9	-	0.6
Industrial assessment centers	1	2	0.01	1	0.1	0.0	0.0
Smart manufacturing	5	39	0.09	4	0.7	0.0	-
Touchdown total	**398**	**1,447**	**5.39**	**275**	**63.5**	**18.6**	**-**
Energy efficiency standard	398	1,447	5.39	275	63.5	18.6	-
Fumble total	**-31**	**-241**	**-0.55**	**-28**	**-8.4**	**-3.2**	**-0.2**
Building codes – BS	-34	-67	-0.40	-21	-5.2	-2.3	-
Furnace standard conditions	11	-173	-0.06	-3	-2.0	-0.8	-
Ceiling fan standard bar	-5	-	-0.05	-3	-0.8	-0.1	-
Fossil fuel standard repeal	-3	-1	-0.03	-1	-0.3	-	-0.2

Table A2 summarizes cumulative energy savings and carbon dioxide emission reductions for each provision (total lifetime impacts for measures implemented through 2040). It also shows the discounted present value (PV) of lifetime energy bill savings, consumer spending, and federal spending (there also is program spending for some provisions, which is not shown). The full net savings are shown in table 2 in the main text.

Table A2. Estimated cumulative and discounted present value impacts by provision

	Cumulative savings				PV savings and spending		
Provision	Electricity (TWh)	Natural gas (Tbtu)	Total energy (quads)	CO_2 emissions (MMT)	Energy bill savings ($ billion)	Consumer spending ($ billion)	Federal spending ($ billion)
First down total	**3,707**	**8,348**	**45.00**	**2,276**	**161.7**	**56.2**	**7.4**
Building codes – PS	2,583	5,639	30.97	1,551	97.9	36.2	0.1
SAVE underwriting	350	936	4.42	225	18.2	6.1	0.0
E-Access	330	-	3.32	171	18.0	4.3	0.0
Commercial benchmarking	26	62	0.34	18	1.9	0.7	0.0
Smart buildings	131	-	1.32	69	7.5	3.7	-
Nonprofit retrofits	1	7	0.01	1	0.1	0.0	0.0
Federal building standards	56	136	0.70	36	2.8	-	2.3
Fossil fuel standard repeal	-79	-32	-0.81	-41	-2.8	-	-2.1
Federal deep retrofits	131	399	1.73	90	7.3	-	7.1
Industrial assessment centers	22	49	0.27	14	0.9	0.2	0.0
Smart manufacturing	157	1,150	2.73	143	9.9	4.9	0.0
Touchdown total	**8,894**	**39,611**	**128.37**	**6,629**	**531.4**	**228.3**	-
Energy efficiency standard	8,894	39,611	128.37	6,629	531.4	228.3	-
Fumble total	**-986**	**-6,187**	**-15.83**	**-804**	**-60.9**	**-23.5**	**-2.1**
Building codes – BS	-1,065	-2,102	-12.53	-626	-38.7	-15.4	-
Furnace standard conditions	279	-4,054	-1.28	-75	-13.0	-7.1	-
Ceiling fan standard bar	-121	-	-1.21	-62	-6.4	-1.0	-
Fossil fuel standard repeal	-79	-32	-0.81	-41	-2.8	-	-2.1

Table A3 summarizes macroeconomic impacts, net jobs created, and change in gross domestic product (GDP) in 2020, 2030, and 2040. The impacts are from investment in the efficiency measures (and loss of other uses of the funds) and energy savings.

Table A3. Estimated macroeconomic impacts from the packages

Net jobs created (thousands)			
Package	2020	2030	2040
First down	39	109	152
Touchdown	151	399	317
Fumble	-8	-35	-68
Net GDP growth ($ billion)			
Package	2020	2030	2040
First down	2.4	7.0	9.9
Touchdown	11.2	16.1	9.0
Fumble	-0.6	-2.1	-4.3

Appendix B. Provision Descriptions

The provisions analyzed in this paper are briefly described below. Several of the provisions are included in S.720, the *Energy Savings and Industrial Competitiveness Act of 2015*, introduced by Senators Rob Portman (R-OH) and Jeanne Shaheen (D-NH), as well as in the House version, H.R. 2177, by Representatives David McKinley (R-WV) and Peter Welch (D-VT). ACEEE analyzed (and summarized) an earlier version of that bill in 2013 (Young et al. 2013).

BUILDINGS

Building Codes: Portman-Shaheen

S.720, Sec. 101 (Portman-Shaheen): Greater energy efficiency in building codes

This provision, which has been introduced in various forms since 2007, seeks greater energy efficiency in homes and commercial buildings through building energy codes. It seeks to strengthen the current process of development of model codes by independent organizations, adoption mostly by states, and implementation and enforcement mostly by local governments. It authorizes $200 million for implementation. Further details are below:

CODE DEVELOPMENT

- Directs the Department of Energy (DOE) to set energy savings targets for the development of model energy codes at the maximum technologically feasible and life-cycle cost-effective level with a number of considerations
- Directs DOE to provide technical and financial assistance to code-development organizations, including proposing amendments to meet the targets; DOE is also to assist with stretch codes
- Directs DOE to determine not only whether new code versions save energy but also whether they meet the targets; if not, gives the organizations a second chance

CODE ADOPTION AND COMPLIANCE

- Requires states within two years of the determination to certify whether their codes meet or exceed the model codes and the targets.
- Requires states within three years of the certification to measure the rate of compliance and certify whether they have achieved full compliance (90% of buildings or not more than 5% excess energy use) or are on a path to full compliance
- Directs DOE to provide technical and financial assistance to the states (which may depend on states meeting the goals), and to validate the certifications

Building Codes: Blackburn-Schrader

H.R.1273, Sec.101 (Blackburn-Schrader): Energy Savings and Building Efficiency Act of 2015

This provision is derived from the Portman-Shaheen codes provision, but modifies it in many ways. It requires targets to be cost effective, adds a determination on whether model codes are technically feasible and cost effective, and limits DOE assistance to codes that meet those criteria. It bars DOE from providing technical assistance for any code provision or target with a simple payback greater than 10 years, and it requires DOE analysis using "simple payback methodology over a 3-, 5-, and 7-year period." It requires all DOE model code proposals to go through full rulemaking, appears to limit analysis of other proposals, and replaces stretch codes with voluntary programs. It bars DOE from "actions that advocate, promote or discourage" state adoption of any code provision or target, including funding to states and to third parties that engage in such actions. It gives states three years to report on codes updates, and it removes direction to demonstrate that they met goals, DOE verification, and all consequences. It also removes all mentions of financial assistance and all funding authorization.

SAVE Underwriting

S.720, Sec. 433 (Bennet-Isakson): Enhanced energy efficiency underwriting

The SAVE Act seeks to enable increased energy efficiency in new and existing homes by considering the financial savings when setting caps on the size of mortgages. It directs HUD to develop rules for federal mortgage agencies (which now include Fannie Mae and Freddie Mac) that apply to homes with a Home Energy Rating System (HERS) report or other energy efficiency rating. The agencies would consider the monthly energy bill savings of the home in the debt-to-income ratio that limits mortgages based on income, and the present value of lifetime energy bill savings in the loan-to-value ratio that limits mortgages based on home value. It also would require lenders to give additional efficiency information to home buyers.

E-Access

S.1044 (Markey): Access to Consumer Energy Information Act

S.1044 seeks to provide electric utility customers with easy access to their billing information in order to encourage and inform energy efficiency measures. It would direct DOE to develop voluntary guidelines for states with a model standard for utilities on providing customers access to their electric usage and pricing information. It would authorize financial assistance to states certified as meeting the guidelines and include such policies in the state energy plans. S.1044 authorizes $10 million.

Commercial Benchmarking

S.1052 (Franken): State and local performance benchmarking and disclosure

S.1052 promotes energy performance benchmarking and transparency of commercial and multifamily buildings. Building benchmarking such as ENERGY STAR Portfolio Manager allows building owners to assess the energy use of their buildings against that of similar buildings, and thus to identify needed changes. Part of the provision that is in the Portman-Shaheen bill was enacted earlier this year in S.535. This provision includes the rest, and would authorize grants to utilities, regulators, and their partners for providing aggregate information for multitenant buildings and grants to states and local governments for benchmarking and disclosure policies. S.1052 authorizes $10 million per year for 2016–2020.

Smart Buildings

S.1046 (Cantwell-Murkowski): Smart Building Acceleration Act

S.1046 supports the adoption of advanced energy management technologies in buildings. Use of automatic sensors and energy management software can improve building controls and cut waste. It authorizes a DOE program to conduct demonstrations in federal buildings and survey private smart buildings. It also directs DOE to create a smart buildings accelerator under the Better Buildings Challenge and to conduct research and development on smart buildings.

Nonprofit Retrofits

S.600 (Klobuchar): Energy efficiency retrofit pilot program

S.600 would help nonprofit organizations save energy through a pilot retrofit program. It authorizes a DOE program to provide matching grants to retrofit buildings owned by nonprofit organizations with energy efficiency improvements. S.600 authorizes $10 million per year for 2016-2020.

EQUIPMENT

Furnace Standards Conditions

S.1029 (Hoeven-Alexander): Prohibit amending the standards for furnaces

S.1029 would prevent a pending update of the appliance efficiency standards for home furnaces. It bars DOE from issuing revised standards until DOE convenes an advisory group of stakeholders, the group completes an analysis within one year, and the group determines whether a standard is technically feasible and economically justified. If the determination is negative, DOE is to set amended standards within 180 days through a negotiated rulemaking. If the advisory group does not complete the analysis or make the determination, or if the negotiated rulemaking fails, there is no specified path to update the standard.

Ceiling Fan Standards Bar

S.1048 (Alexander): Remove authority to amend standards for ceiling fans

S.1048 would prevent a pending update of the efficiency standards for ceiling fans. It would remove authorization for DOE to update standards for ceiling fan air circulation and light kits. However, the existing standard would continue to preempt any state regulation of ceiling fans.

FEDERAL BUILDINGS

Federal Building Standards and Fossil Fuel Standard Repeal

S.869 (Hoeven-Manchin): All-of-the-Above Federal Building Energy Conservation Act of 2015

S.869 would repeal a pending fossil fuel standard for federal buildings and replace it with enhanced energy efficiency requirements for federal buildings. It would repeal the fossil fuel standard in Section 433 of the Energy Independence and Security Act of 2007. This standard sets increasingly stringent limits on "fossil fuel-generated energy consumption" in new federal buildings and buildings with major renovations, reducing such consumption to zero by 2030.

The amendments to federal building standards and goals would extend energy intensity targets for existing federal buildings with further reductions of 3% in 2016 and 2017, strengthen requirements for energy audits in federal buildings, and extend federal building efficiency standards to cover renovations and alterations to existing buildings.

Federal Deep Retrofits

S.1055 (Franken): Deep energy retrofits in federal buildings

This bill requires deep energy retrofits to save 35–50% of energy use in half of federal buildings. It directs the General Services Administration to do deep retrofits in at least 100 buildings by 2020 and DOE to work with other agencies to do 50 more. Then it directs agencies to do deep retrofits in 5% of their building space each year for 2021–2030. At least one-third of the retrofits are to be aimed at achieving 50% savings and the rest at 35% savings compared to energy use in 2012. Based on the experience gained, DOE is to set goals for 2031-2040.

INDUSTRY

Smart Manufacturing

S.1054 (Shaheen-Alexander): Smart Manufacturing Leadership Act

S.1054 seeks to accelerate the adoption of sensor and control technologies for real-time energy management in manufacturing. It would call for DOE to develop a national smart manufacturing plan, make high performance computing facilities at national laboratories available to small and medium-sized manufacturers, provide competitive grants to states, and include smart manufacturing in Industrial Assessment Center technical assistance. S. 1054 authorizes $10 million per year for 2017–2020.

Industrial Assessment Centers

S.720, Sec.202 (Portman-Shaheen): Future of industry

This provision, in addition to other reforms to DOE's Advanced Manufacturing Office, seeks to increase the effectiveness of DOE's Industrial Assessment Centers (IACs), which train university students to conduct energy audits in small and medium-sized businesses. It would provide matching funds for internships to implement IAC recommendations, call for greater coordination with other programs, and direct the Small Business Administration to facilitate loans to implement IAC recommendations.

UTILITIES

Energy Efficiency Resource Standard (EERS)

S.1063 (Franken): American Energy Efficiency Act

S.1063 seeks to spur electricity and natural gas efficiency programs throughout the nation. It would set a performance standard for utilities to help their customers achieve energy savings. The standard would increase to 20% of total electricity use and 12% of natural gas use by 2030 (estimated savings in that year from all programs to that date), or 1.75% additional electric savings and 1% additional natural gas savings each year. DOE is to set measurement and verification requirements and further standards after 2030. States can enforce the standard and accept alternative compliance payments.

Appendix C. Energy and Financial Methodology

This appendix briefly describes the methodology and key assumptions used in the impact estimates in this report. Cost and savings estimates for individual measures are discussed below. They are assumed to be additive in the packages, as there is little overlap.

We estimate the most likely impact of implementing the selected provisions compared to a baseline if the provisions are not enacted. Funding authorizations require future appropriations; we assume that appropriations would be 50% of the authorized funding levels. We calculate impacts for measures taken through 2040; cumulative and cost-benefit numbers include savings through the lifetimes of those measures as late as 2080.

Energy prices by fuel, sector, and year; the carbon intensity by fuel and in some cases year; and many of the baseline projections are taken from the Annual Energy Outlook (AEO) 2015 base case (EIA 2015a). For later years they are extrapolated from trends over 2021–2040. Present values are calculated using a real discount rate of 5%; benefit-cost ratios are the ratios of the present values of positive to negative impacts (for a few policies that reduce efficiency, this would be reduced spending divided by increased energy bills). The costs in some cases are financed (see details below). All monetary impacts are in constant 2013 dollars.

For each provision, we defined a set of assumptions, including the following:

- What is the scope of the provision, for example the floor area of affected buildings, number of appliances, or share of the industry?
- In the baseline scenario if the provision is not enacted, what would be the estimated energy consumption by fuel?
- What would be the energy consumption if the policy were implemented, often based on savings from measures implemented each year and the lifetime of those measures?
- How much would these measures cost, including any significant administrative cost of implementing the policy?
- Who would pay the cost—consumers, utilities, or the federal government—and would they use financing?

For several of the provisions we had very limited data on which to base our assumptions. We had to rely on expert judgment of the authors, other ACEEE staff, and reviewers.

Note that there is some overlap with provisions analyzed in our 2013 paper on the then Shaheen-Portman bill (Young et al. 2013); although the overall methodology is similar, we completely revised the analyses, and the new estimates reflect changes in baseline energy use and state policies, available data, and approaches and assumptions—the estimates should not be compared.

Assumptions for specific provisions are discussed below; the methodology for estimating macroeconomic impacts is in Appendix D.

BUILDINGS

Building Codes: PS (S.720, Sec. 101) and Building Codes: BS (H.R. 1273, Sec. 101)

We considered impacts of the building codes provisions on the development of model building energy codes, the rate of adoption of the codes by states (or local governments), and the amount of potential savings lost due to noncompliance with the codes. We estimated the impacts for both residential and commercial buildings. The methodology is similar to our state-level analysis of building energy codes potential under the Clean Power Plan (Hayes, Ungar, and Herndon 2015). The key assumptions for the baseline case and the two policy cases are shown in table C1.

Table C1. Key assumptions for building energy codes provisions

	Baseline	Portman-Shaheen	Blackburn-Schrader
Model codes	In each three-year code cycle (through 2040): 3% savings in covered energy use for residential buildings, 5% savings in whole-building energy use for commercial buildings	5% residential/ 7% commercial savings each cycle	1% residential/ 3% commercial savings each cycle
Adoption	15% of states each year up to 70% (effective starting one year after IECC date–i.e. 2016 for 2015 IECC and 90.1-2013)	20% of states each year up to 80%	12% of states each year up to 60%
Compliance	Lose 20% of potential savings compared to 2009 IECC/90.1-2007	Gain 1% of potential savings each year until reach 12% loss	Gain 0.5% of potential savings each year until reach 16% loss

Energy use under recent model energy codes, the International Energy Conservation Code (IECC) for residential buildings and ASHRAE Standard 90.1 for commercial buildings, is based on building simulations done by Pacific Northwest National Laboratory (DOE 2014a). For construction volumes we used similar assumptions to theirs but updated them based on the 2015 AEO: for residential, new single family homes + 59% of multifamily units + 25% of new single family homes to account for additions; commercial includes the rest of multifamily at 1,150 square feet per unit. We assumed a 30-year lifetime for the savings.

Because we are projecting costs for codes that have not yet been set, we also used PNNL engineering estimates of the cost of meeting recent codes as a starting point for our cost estimates (PNNL 2013 and DOE 2012). We derived the cost per percentage point of savings for 2006 IECC to 2012 IECC and for 90.1-2004 to 90.1-2010 nationwide and used those for future code improvements (because the baseline energy use from which the percentage savings is taken decreases, the cost per saved Btu slowly rises). We also assumed an added government cost for enforcement of $50–100 per home and $0.075–0.15 per commercial square foot, and federal appropriations of $10 million per year for 2016–2025. We assumed 80% of the consumer cost is financed at mortgage terms (30 years at 2% above US Treasury rates projected in AEO 2015) for residential and commercial loan terms (30 years at 4% above US Treasury rates; although commercial loans are typically shorter with balloon payments, they are also typically refinanced).

SAVE Underwriting (S.720)

For the SAVE Act we estimated the impacts on both new and existing single family homes of allowing larger mortgages for efficient homes. Unfortunately, little data are available on that (other than from Energy-Efficient Mortgages, which have other barriers). To come up with a rough estimate, we first assumed 20% of new single family homes are "energy efficient" in the baseline (in 2014 14% were Energy Star New Homes and 24% were rated under the Home Energy Rating System). New homes projections are from AEO 2015. We also assumed 60% of homebuyers are constrained by mortgage caps, based on the number of homes with loan-to-value ratio of at least 80%. We roughly assumed that buyers who are constrained are one-third as likely to buy an efficient home as other buyers, but under SAVE would come up to the level of other buyers over time. The result is that an additional 13% of new homes would be efficient, phased in over five years. Based on Energy Star's estimates, we assumed efficient homes save 20% of energy at a cost of $2,300 (EPA 2013). We assumed a 30-year lifetime and 100% mortgage financing.

For an even rougher estimate for existing homes we assumed as a baseline that efficiency retrofits financed by mortgages are 1% of single family home sales, assumed to be 5% of the single family home stock, also taken from AEO 2015. Applying the other assumptions yields an additional 0.7% of sales, or 0.04% of existing home stock each year, also phased in. Based on recent program experience, we assumed the retrofits would save 20% of energy use at a cost of $6,000 (Jacobsohn, Khowailed, and Grubbs 2015; Research into Action 2015). We assumed a 15-year lifetime and 100% mortgage financing.

E-Access (S.1044)

We analyzed improved access to utility data based on its use in more widespread and consistent benchmarking applications, and in programs and initiatives to provide consumers with energy use information. We assumed that half the authorization ($5,000,000) would be appropriated in 2016, and assumed no financing.

In the residential sector we assumed that improved access to utility data would lead to 2% savings in electricity (about 274 kWh per household), based on average savings from low-cost and no-cost behavioral measures through Opower programs (Opower 2015). We assumed the provision would phase in over five years to cover 12% of the market (in addition to the roughly 40% already covered by Opower), and energy savings would phase out over 10 years after 2040. Cost to consumers from this program would be $0.002/kWh, and program administration cost would be $0.0285/kWh (Hoffman et al. 2015).

For commercial buildings we assumed E-Access will increase the number of benchmarked buildings and building owners interacting with their data, especially for small and medium-sized business owners. Currently, 40% of commercial building *floor space*, but only 6% (350,000) of 5.6 million commercial *buildings*, is benchmarked using ENERGY STAR Portfolio Manager. Only 26,000 of those 350,000 buildings receive their utility data via web services (Cook 2014). We assumed an additional 20% of commercial energy use would be covered, with 3% electricity savings based on an analysis of savings for buildings affected by benchmarking requirements, as well as ENERGY STAR studies (EPA 2015 and RFF 2015). Because we expect this information to affect primarily operations and quick payback investments, we based consumer costs on a two-year simple payback with an average measure lifetime of seven years and straight-line decay of savings.

Commercial Benchmarking (S.1052)

We assumed that this provision would spur 10 additional cities to institute benchmarking and transparency policies covering 115 million square feet of commercial buildings per city. For the energy baseline, we used the energy intensity of buildings with floor space greater than 50,000 square feet, obtained from the 2003 Commercial Buildings Energy Consumption Survey (CBECS) (EIA 2008). We assumed the policy would result in 6% savings in the total energy use of covered buildings; although one study found 3% savings in the first year, we estimated that these savings would double over time (RFF 2015). As for E-Access, we based costs on a two-year simple payback with a seven-year measure lifetime. In addition we assumed federal appropriations of $5 million per year from 2016-2020.

Smart Buildings (S.1046)

Market awareness of smart buildings is in its early stages. Unlike our assumptions below about smart manufacturing, which are based on a preliminary understanding of market penetration, assumptions about smart buildings are based on our examination of case studies. Energy savings would come from the faster adoption of advanced energy management technology in buildings. As the baseline case for this analysis, we assumed that 20% electricity savings will eventually be achieved in 50% of commercial sector energy use (Rogers et al. 2013 and SMLC 2011). The assumed rate of participation starts at 1% and increases by 0.5% per year for three years from 2017, and by 1.5% per year thereafter. The policy case accelerates this rate of adoption by three years. Since the participation rate increases by 4.5% every three years in the baseline case, the policy case stays 4.5% ahead. After 2035, the policy case increase in participation rate slows by 0.5% each year compared to the baseline case. We assumed that energy savings persist until 2040 and then ramp down over five years. Consumer costs are a combination of an initial capital cost and an ongoing operational cost. The initial cost is based on a simple payback of two years; the ongoing annual cost is 20% of the initial cost. We also assumed that the implementation of this provision would cost the federal government $6 million over three years and that local programs would spend an equal amount.

Nonprofit Retrofits (S.600)

This program would provide direct assistance to nonprofit organizations for building retrofits. We started with federal spending at half the authorized level, $5 million per year for 2017–2022, of which 90% would fund incentives and the rest administrative costs. We assumed the nonprofits would match total federal funding. For the retrofits that nonprofits would choose to do we assumed relatively low costs and short lifetimes. The measures would have five-year simple payback, yielding the incremental savings, and a lifetime of 15 years. We did not assume any financing.

EQUIPMENT

Furnace Standards Conditions (S.1029)

We assumed that in the absence of this provision, DOE would adopt final standards for residential furnaces equivalent to those proposed in its March 2010 notice of proposed rulemaking (NOPR). The baseline efficiency level is an annual fuel utilization efficiency

(AFUE) of 80%, and the assumed standard level is 92% AFUE. We assumed the new standards would take effect in 2021. We used estimates of annual fuel savings, additional electricity use (due to fuel switching), incremental costs, and fuel prices from DOE's analysis for the NOPR. Because the provision does not provide a way for DOE to set the standard without agreement from all stakeholders, we assumed that with the provision the standard is not updated, and the predicted savings are lost. However our estimates do not consider potential damage to the rest of the appliance standards program from the unprecedented action of Congress blocking a standard absent consensus support from all stakeholders.

Ceiling Fan Standards Bar (S.1048)

We assumed that in the absence of this provision DOE would adopt standards for ceiling fans that would reduce energy consumption by 40–60%, depending on the product type, relative to the least-efficient ceiling fans available now. We assumed the new standards would take effect in 2019. We estimated energy savings and incremental costs based on DOE's September 2014 preliminary technical support document (TSD) and a methodology described in ACEEE's Efficiency Boom report (Lowenberger et al. 2012). As the provision removes authorization for the update to the standard, we assumed that with the provision the current standard will remain in place.

FEDERAL BUILDINGS

As a baseline for federal buildings provisions we assumed that the total federal building floor space will stay at the same level as in 2014 (3.0 billion square feet) because of the lack of any clear trend in recent years and in consideration of the Freeze the Footprint mandate. We took new yearly building square footage (40.7 million) and major renovation square footage (12.8 million) from PNNL's analysis of DOE's rule for the fossil fuel standard (DOE 2014b). We assumed that the energy intensity of the overall federal building stock will continue to decline for each source at the same rate as in the last 10 years. We used federal building energy consumption data and square footage from DOE (DOE 2015). We assumed new buildings would have energy intensities 30% below the same estimates we used for commercial building codes in the base case (see above), three years after the year of the ASHRAE standard, and that buildings with major renovations would just meet the codes.

Federal Building Standards (in S.869)

For the provisions adding to federal building standards and goals, we analyzed only provisions applying standards to major renovations at 30% below code (if life-cycle cost effective) and to alterations at code. Although energy intensity targets are potentially significant, the targets in the bill do not clearly bring savings over those currently in place under an executive order.

Savings for major renovations are calculated as the additional energy saved by renovations meeting 30% below the ASHRAE standard, instead of meeting the ASHRAE standard. We assumed added costs would be halfway between what we assumed for the commercial codes provisions and what we assumed for deep energy retrofits. For 30% savings the cost is $5.5/square foot. We assumed that 50% of these costs would be financed through Energy Savings Performance Contracts (25 years at 2.5% above the US Treasury rate) and 50% paid through appropriations.

The only type of alteration we considered was adding insulation during roof replacements. We assumed 1/17th of all buildings undergo roof replacements in a year (Bayer 2009). We further assumed that 50% of federal buildings would be affected by this provision (the rest are either meeting code now, or still will not). For those buildings we estimated that the added insulation would save 5.7% of whole-building energy consumption for 30 years; the cost of this alteration was estimated to be $1.67/square foot in 2013 dollars (Bayer 2009). We assumed the cost would be paid out of appropriations.

Fossil Fuel Standard Repeal (in S.869)

The impacts of the fossil fuel standard repeal are simply the opposite of our estimate of the impact for the standard. We assumed that the standard would be met through improved energy efficiency to the extent feasible, and the balance through renewable energy; we only counted the efficiency savings. Following the draft rule, we assumed that "fossil fuel generated energy" includes both fuel consumed on site and fuel consumed through electricity used on site.

We assumed that new buildings under the standard would reduce their total source energy use compared to the federal building stock in 2003 (the year of the CBECS baseline in the bill) by the target percentages, with proportional reduction of each fuel, until they reached the 80% reduction in 2020; after that the remaining reductions would be met by renewables. But as we only counted savings below the 30% below code that also is required of federal buildings, there are no savings until 2020. For new buildings we assumed costs would be the same as under the building energy codes provisions above, paid using appropriations.

For major renovations, our assumptions were the same as those made for major renovations in federal building standards above, as there is no evidence renovations will reach zero net energy levels.

Federal Deep Retrofits (S.1055)

We neglected the 2020 goals in the bill for 150 federal buildings to undergo retrofits, as their floor space would likely add up to less than 0.5% of total federal floor space. We considered savings from the 2030–2040 goals, which require 5% of total federal building stock per year to undergo deep retrofits. We assumed that two-thirds of the buildings would achieve 35% less site energy intensity than the average 2012 federal building, with proportional reduction of each fuel, and the other third would achieve 45% less intensity (savings compared to baseline are less because the baseline buildings become more efficient; we assume the higher third will not quite reach the 50% target). We estimated the average cost of the retrofits to be $0.29 per percentage point of savings per square foot; this is 25% less (to account for learning) than a weighted average of results reported by the General Services Administration National Deep Energy Retrofits pilot program (RMI 2014; Shonder 2014). We assumed that 80% of these costs will be covered by energy savings performance contracts (ESPCs) and 20% through appropriations.

INDUSTRY

Smart Manufacturing (S.1054)

Over the past few years, market awareness and acceptance of smart manufacturing has been growing in the industry. While only about 20% of firms today are estimated to be aware of the benefits of smart manufacturing, already half of those firms (10%) have invested in these advanced technologies (Jim Davis, vice provost - information technology and chief academic technology officer, UCLA, pers. comm., July 28, 2015). Our assumptions about smart manufacturing are based on this preliminary understanding of market penetration.

We assumed that smart manufacturing can reduce industrial energy intensity by 20% per year (SMLC 2011; Rogers et al. 2013). We assume these savings occur for both electricity use and natural gas use. The baseline case assumes savings will occur in 80% of the industrial sector with a rate of participation starting at 10% of firms and increasing gradually over time (starting at a 0.5% increase in 2017, increasing by 1.5% per year in 2020 and thereafter). The savings for each plant are phased in over four years and continue until 2040, after which they decay over five years. The policy case assumes the same rate of participation occurs three years earlier.

Consumer costs include an initial cost to manufacturers to implement advanced controls (based on an estimated two-year simple payback) and ongoing costs for subscriptions for software service and maintenance (20% of initial investment annually). We also assumed a federal program cost of $15 million over three years, an equal local program cost, and no financing.

Industrial Assessment Centers (S.720, Sec. 202)

We assumed Section 202 will improve the implementation of energy savings recommendations resulting from audits completed by the Department of Energy's Industrial Assessment Center (IAC) program. As of 2014, the IACs conduct approximately 500 energy audits per year, providing recommendations to manufacturers to help them identify opportunities to improve productivity, reduce waste, and save energy. Using data from the IAC database (Rutgers 2015) hosted by Rutgers University, we estimated the energy saved per average audit per year. With reauthorization, increased coordination, and expedited Small Business Administration loans facilitated by Section 202, we assumed IACs will continue to conduct the same number of audits, but manufacturers will implement more recommendations and achieve greater energy savings based on a 50% net increase in the implementation rate of measures. Consumer costs are the investments made by small and medium-sized manufacturers to implement recommendations made by IACs. We assumed an average simple payback of 1.2 years. We also assumed a $2.5 million increase in federal appropriations each year.

Section 202 would also improve workforce training for students from participating IAC universities. Indirect savings resulting from improvements in the training of the next generation of energy engineers were difficult to attribute and were not included in our assumptions.

UTILITIES

Energy Efficiency Standard (EERS) (S.1063)

S.1063 sets energy savings requirements for electric and natural gas utility efficiency programs; existing programs and programs under state-level EERS qualify. We conservatively assumed the 2030 savings targets (20% of electricity and 12% of gas) would remain in place.

We estimated that 86% of electricity sales are covered under the provision, based on 2009 EIA data, and that current state-level EERS would achieve incremental (new) savings of 0.7% of covered US electric use each year (Barbose et al. 2013), of which the AEO incorporates 0.5% incremental savings each year (EIA 2015b). We then assumed sufficient additional incremental savings each year to meet the provision's annual savings targets (including savings from earlier measures) on a national basis, except that we capped total incremental savings at a rate that increases to 2.5% over five years. We did the analysis separately for residential buildings, commercial buildings, and industry. We assumed an average measure lifetime of 10.6 years in all economic sectors (Molina 2014), with straight-line decay of savings as the wide variety of programs can result in a wide range of measure lifetimes. We also assumed the same cost in each sector, with a program cost of $0.24 per incremental kilowatt-hour, and a customer cost 1.41 times the program cost ($0.34/kWh) (Molina 2014). We assumed that 30% of the program cost would be financed (five years at the utility bond rate from AEO 2015) and 20% of the customer cost (at mortgage terms for residential and commercial terms for commercial and industrial customers).

The analysis for natural gas savings is similar. We estimated that 94% of natural gas sales would be covered under the law, that the AEO projection includes 0.18% incremental savings each year, based on recent reported savings levels, and that absent a federal EERS states would achieve that level. We assumed added savings to meet the targets, but with a cap rising to 1.5% incremental savings. We assumed an average measure lifetime in all sectors of 16.1 years, again with straight-line decay. We assumed a program cost of $39/MMBtu, customer cost of 1.41 times program cost, and the same financing as for electricity measures (Molina 2014).

Appendix D. Methodology of the Macroeconomic Model

To evaluate the macroeconomic impacts of energy efficiency policies, we used the proprietary Dynamic Energy Efficiency Policy Evaluation Routine (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 quasi-dynamic input-output (I/O) model of the US economy. 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 macro-economy. DEEPER draws upon trade information from the IMPLAN Group LLC (IMPLAN 2015), energy use data from the AEO, and employment and labor data from the Bureau of Labor Statistics. The model functions as laid out in the flow diagram in figure D1.

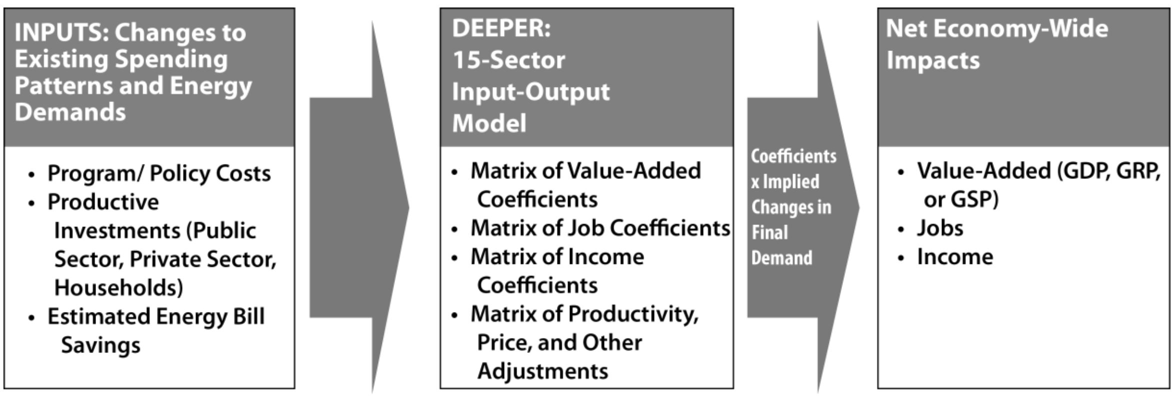

Figure D1. The DEEPER model

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 inputs are the changes in spending on efficiency measures and energy bills of residential, commercial, and industrial consumers, and of government; in program spending, revenue, and production of utilities; in investments in manufacturing, services, and multiple construction sectors, and in financial services. The end result is a net change between the reference and policy scenarios in jobs, income, and value added (the market value of all final goods and services), which is measured as gross domestic product (GDP).

Like all economic models, DEEPER has strengths and weaknesses. It is robust in comparison with 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 US economy. However, it is important to remember when interpreting results for the DEEPER model that the results rely heavily on the assumptions for the individual policies, and like any prediction of the future, they are subject to uncertainty.

More details on the DEEPER model are available in previous papers (Young et al. 2013).