Government Works: Federal Agency Actions on Energy Efficiency

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Executive Summary

President Barack Obama and his administration have increasingly focused on actions that federal agencies can take under existing legislative authority. On energy and climate, they are guided by the 2013 President's Climate Action Plan. Energy efficiency measures are critical to the plan because of their ability to strengthen the economy, the environment, and national security by saving consumers money, creating jobs, reducing greenhouse gas emissions and air pollution, and reducing oil use and imports.

We examined four sets of agency actions on energy efficiency: appliance standards, vehicle standards, power plant emissions standards, and select housing policies. Among this limited set of measures, we estimate that policies already issued since President Obama took office will save consumers $1.9 trillion. This figure represents the net present value (NPV) of savings after needed investments for the lifetime of measures taken through 2040. These policies that are already in place will reduce cumulative carbon dioxide emissions by 18 billion metric tons, roughly equal to the total emissions from fossil fuels in this country over three years. Additional actions, including a new standard for existing power plants, could save consumers another $0.7 trillion and reduce emissions by an additional 16 billion tons.

Potential Energy Efficiency Impacts of Obama Administration Agency Actions

- Save consumers **$2.6 trillion** (net after investments)
- Cut CO_2 emissions cumulatively by **34 billion metric tons**
- Reduce oil use by **3.3 million barrels a day** in 2030
- Reduce electricity use by **24%** in 2030

Appliance and equipment standards have been one of the most effective government tools to improve energy efficiency. The Department of Energy (DOE) has issued dozens of standards since President Obama took office and is working on many more. We estimate that recent and prospective standards could save consumers over $450 billion. However, reaching the president's goal of reducing carbon dioxide emissions by 3 billion metric tons by 2030 through these standards will likely require a more assertive response to a current appropriations provision that is preventing work on lighting standards.

Vehicle standards are equally important. The standard for cars and light trucks is the single most important energy-saving measure of the administration so far, and perhaps the greatest example of cooperation among agencies, state governments, and manufacturers. The Phase 2 standard for trucks and buses will be one of the most important pending actions if it takes advantage of the full suite of available savings. Together, the car and truck standards could save consumers $1.8 trillion and reduce oil use by over 3 million barrels a day by 2030 and over 4.5 million barrels a day by 2040.

The proposed Clean Power Plan could spur efficient electricity use throughout the nation if it uses the potential of lower customer demand to reduce power plant emissions. Utility efficiency programs, state building energy codes, and other state policies could slash emissions while reducing electric bills. We estimate that a strong standard could save consumers over $300 billion, and by 2030 cut electricity use by an additional 16% beyond what states are already achieving.

Housing efficiency policies could boost a transformation already underway in our homes. Unfortunately, both an efficiency standard for manufactured homes and efficiency requirements for new homes with federal loans are years behind schedule, and a Department of Agriculture program for loans for home energy upgrades also has been slow to launch. But once they are implemented, these programs will help reduce energy waste in the homes of those least able to afford higher bills. We estimate that they could save homeowners over $20 billion.

The combined energy savings that could be achieved from these policies are shown over time in figure ES1. By themselves these agency actions will not meet the president's ambitious goals to cut carbon dioxide emissions and double energy productivity (the economic output from a given amount of energy). But they will help the environment and boost the economy while also saving consumers money.

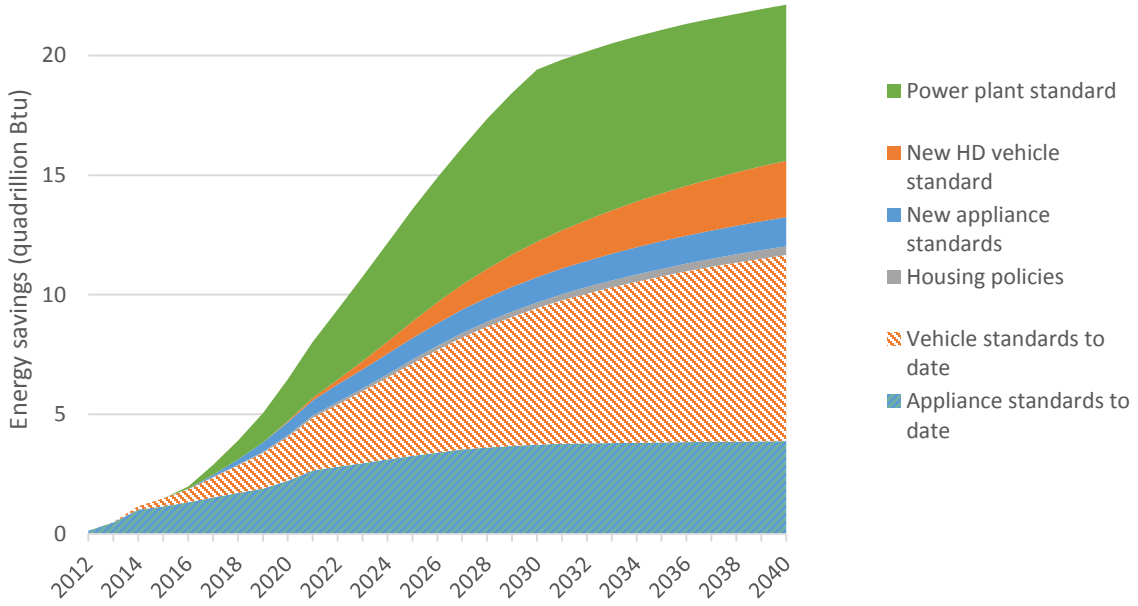

Figure ES1. Projected primary energy savings each year from recent and prospective agency actions. For comparison, the total savings in 2030 are 24% of projected energy use (the projection includes actions to date).

Introduction

In the face of partisan gridlock in Congress and the difficulty of passing legislation, President Barack Obama and his administration have turned increasingly to action by agencies under existing statutory authority in order to accomplish their goals. Toward the end of his first administration, executive orders and agency actions were branded under the slogan "We can't wait." In his second term, President Obama has repeatedly emphasized his ability to act independently of Congress by using the phrase, "I've got a pen, and I've got a phone." And starting in his State of the Union address, he has called 2014 "a year of action."

On environmental issues, after the demise of climate legislation in President Obama's first term, this strategy was consolidated in June 2013 in the *President's Climate Action Plan*, a collection of administration actions to combat and prepare for climate change (Executive Office of the President 2013).

Energy efficiency is a key part of this plan to reduce climate-altering greenhouse gas emissions while also promoting a healthy economy. The plan sets or reiterates three ambitious goals related to energy efficiency:

- Reduce U.S. greenhouse gas emissions to 17% below 2005 levels by 2020
- Double U.S. energy productivity (the amount of economic output achieved per unit of energy used) compared to 2010 levels by 2030
- Reduce carbon pollution by at least 3 billion metric tons cumulatively through 2030 with efficiency standards for appliances and federal buildings set in the president's first and second terms

The role of energy efficiency is not surprising. For three decades, efficiency policies have been an essential tool for government action to strengthen the economy, the environment, and national security. Federal and state appliance and equipment efficiency standards, building energy codes, fuel economy standards, customer energy efficiency programs, support for research and development, and other policies have saved consumers hundreds of billions of dollars, created hundreds of thousands of jobs, reduced air pollution and climate change, and dramatically cut our dependence on imported oil.

This paper looks at potential savings from four key sets of federal agency actions related to energy efficiency:

- Appliance and equipment efficiency standards
- Vehicle fuel economy standards
- Power plant greenhouse gas emissions standards
- Select housing efficiency standards and financing policies

In the next section, we estimate the potential savings for each set of policies and describe critical decisions needed to achieve those savings. The following section looks at potential combined impacts from these policies, including how far they could go toward achieving the administration's goals. Detailed results are found in Appendices A and B, and the analytical methodology is described in Appendix C.

Note, however, that this paper does not attempt a comprehensive examination of all agency actions on efficiency. Others, including broader reports from the U.S. Green Buildings Council (Carbonell, Fidler, and Smith 2010; USGBC 2012) and the Center for the New Energy Economy (CNEE 2014), have identified dozens of additional options for agency actions on energy efficiency. These include reducing energy waste from the federal government, building and appliance labeling, voluntary programs such as the Better Buildings Challenge, research and development, and many more areas.

The U.S. State Department reviews climate policies, including those on energy efficiency, in its periodic *Climate Action Report*, as required under the United Nations Framework Convention on Climate Change. The 2014 report includes a comprehensive list of recent actions and an overview of the Climate Action Plan (U.S. Department of State 2014). It includes 2020 carbon dioxide (CO_2) emissions reduction estimates for some current efficiency policies and programs, notably including large savings from ENERGY STAR® programs, and emissions projections based on the Energy Information Administration (EIA) *Annual Energy Outlook 2013*. With a narrower focus, we are able to provide more detail and quantitative impact estimates, including an overview of potential savings from multiple future agency actions.

Agency Actions

Although the administration and outside analysts have identified dozens of actions that agencies can take to further energy efficiency under existing laws, here we focus on four areas that have a particularly large potential for savings. Appliance and equipment efficiency standards have dramatically reduced the energy use of many kinds of home appliances and commercial equipment, and still have significant potential. Fuel economy standards for cars and light trucks, and more recently for heavy-duty trucks and buses, are helping to reduce oil use and imports. Forthcoming standards on CO_2 emissions from power plants could spur more widespread utility efficiency programs and state efficiency policies. And standards and financing for residential building efficiency have the potential to greatly improve new and existing homes.

APPLIANCE AND EQUIPMENT STANDARDS

Energy and water efficiency standards for appliances, equipment, and lighting have been among the most successful federal policies for cost-effective energy savings. DOE sets standards under the Energy Policy and Conservation Act (42 USC 6291-6317). Many of the standards were negotiated by manufacturers and efficiency and consumer advocates, and then set by Congress or by DOE, but DOE is directed to update the standards periodically and can also set new standards for significant consumer products and for specified commercial equipment. The federal standards preempt state efficiency standards on the same products.

The Appliance Standards Awareness Project and ACEEE estimated in 2012 that standards already in place under this program will save consumers more than $1 trillion through 2035, reduce total U.S. electricity use in that year by 14%—avoiding the need for hundreds of new power plants—and reduce CO_2 emissions in that year by 470 million metric tons (Lowenberger et al. 2012). In large part because of a series of standards, the average new

refrigerator uses about one-quarter the energy of a refrigerator 40 years ago; it also is larger, has more features, and costs less than half as much (ASAP 2011).

These remarkable savings have been achieved even though DOE historically has had great trouble setting standards, with years-long or decades-long delays. However the program has changed in recent years. DOE signed a consent decree in 2006 to settle a lawsuit over missed deadlines, and President Obama has placed a priority on appliance standards, starting with a presidential memo in February 2009. Since then, DOE has issued 17 standards in the first term (many of them based on consensus agreements) and another 8 thus far in the second term, in addition to 9 that were set in the Energy Independence and Security Act of 2007, referred to as EISA 2007 (ASAP 2014; a few of the standards are updates on the same products). See Appendix B for lists of recent standards and of prospective standards that we analyzed.

Scope

Residential equipment covered by standards (heating, cooling, refrigeration, washing, drying, cooking) accounts for 16% of total U.S. primary energy use. Commercial covered equipment accounts for another 11% of U.S. energy use, and some industrial equipment is covered as well. Most of the equipment uses electricity; covered residential and commercial equipment together accounts for 45% of U.S. electricity use (EIA 2014).

Recommendations

Stay on schedule. With more than 25 standards still to be issued by 2016 along with more than 20 test procedures, DOE will need to step up its pace even more, and the Office of Management and Budget (OMB) will need to complete timely reviews of the rules. Although OMB is supposed to review rules within 90 days, earlier in the administration OMB held some rules for as long as two years. OMB's timeliness on appliance standards has greatly improved, but in some cases the process still is taking longer than 90 days. Given the expected pace of DOE rules, OMB must review multiple rules in parallel and quickly approve them.

Set additional standards and capture greater savings. As discussed below, we do not believe DOE can reach the goal of reducing carbon dioxide emissions by 3 billion metric tons without setting standards for products beyond the many already underway. Products not already on DOE's schedule that would be good candidates for new standards include circulator pumps, pool pumps, unit heaters, faucets, and pre-rinse spray valves. For other products, DOE should make sure that any federal standard results in greater energy savings than more nimble state standards and the ENERGY STAR® program. Although DOE is generally setting appropriately strong standards, in some cases the agency could capture more savings with better metrics and test procedures that reflect new technologies and actual usage. For example, the efficiency metric for commercial rooftop air conditioners should reflect typical performance when running at less than full blast. The dryer test procedure should use a typical load of clothes, and a recent update to reflect automated control of drying times should be implemented.

Limit light bulb rider. A provision that has been added to appropriations bills since 2011 bans use of the funds to implement or enforce the current efficiency standards for regular light

bulbs. While those standards remain the law and are widely followed, DOE has interpreted the rider broadly to prevent work toward revised standards and toward standards for candelabra and "intermediate base" lamps and many incandescent reflector lamps. DOE should narrow its interpretation of the rider to allow technical work to proceed and should use all its authority to set standards that will save consumers money.

Savings

We estimate that the standards set during this administration so far will save consumers $375 billion (discounted net present value [NPV] for products sold through 2040). Roughly two-fifths of the savings are from standards that were set in EISA 2007 but only issued as regulations after President Obama took office.[1] Some additional savings were from standards agreed to by manufacturers and advocates and subsequently issued by DOE. We have projected that 18 prospective standards we have analyzed (including 13 on which DOE is working) could save consumers $83 billion more. The savings over time (before discounting or netting out costs) are illustrated in figure 1 below.

DOE estimates the standards issued through 2013 will reduce carbon dioxide emissions by 1.8 billion metric tons through 2030.[2] We estimate that standards issued so far this year, ones already in the pipeline, and a few more that could be set by 2016 should save about 0.80 billion metric tons more, achieving close to 90% of President Obama's goal of saving 3 billion metric tons. The difference could be made up in part by additional standards underway that we did not model, such as those for ceiling fans, compressors, dishwashers, portable air conditioners, and wine chillers, as well as standards for federal buildings. However, 143 million metric tons of the prospective savings are from lighting standards that DOE believes it cannot issue due to the legislative rider. If the rider and the interpretation remain, DOE will find it very hard to reach the goal.

[1] The estimate for light bulbs also includes a backstop for the follow-on standard that was in EISA 2007 but was not part of the rule. Although DOE believes it cannot work on the revised standard, the backstop is still in the law.

[2] Our own estimates for the standards, reflected in the other results presented in this paper, are slightly higher. However, because the administration will be using DOE estimates to measure against the benchmark, we use DOE's estimate here.

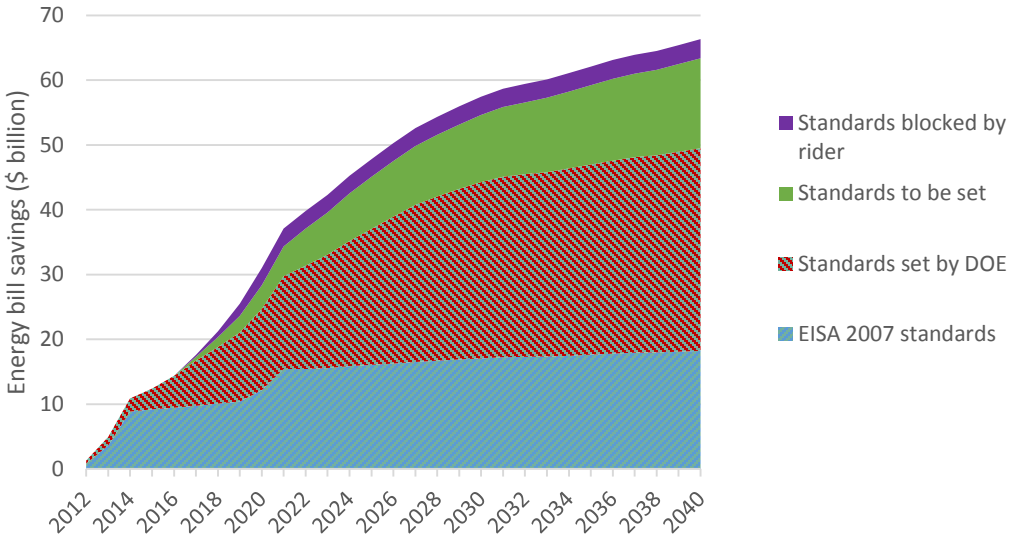

Figure 1. Energy savings each year from appliance standards. Note: This shows annual utility bill savings; most savings numbers in the text are discounted net cumulative savings.

VEHICLE STANDARDS

Corporate Average Fuel Economy (CAFE) standards helped achieve remarkable reductions in gasoline use in cars, with fuel economy jumping from 13 to 21 miles per gallon (mpg) from 1975 to 1982 (EPA 2013). Then both CAFE standards and fuel economy stalled in a political fight even as the number of minivans and then sport utility vehicles (SUVs) under more lenient standards skyrocketed, and the power and weight of cars steadily increased. Although preempted from setting fuel economy standards, California, joined by several other states, set tailpipe CO_2 emissions standards, which are met mostly through reduced fuel use. In Title I of EISA 2007, with fuel economy still at 21 mpg, Congress directed about a 40% increase in fuel economy by 2020, and for the first time authorized standards for medium- and heavy-duty trucks and buses.

The Obama administration not only implemented the EISA standards for cars and light trucks (SUVs, minivans, and pickup trucks) but also raised the stakes. In comprehensive agreements in 2009 and 2011, the U.S. Department of Transportation (DOT) set fuel economy standards for cars and light trucks through 2025, the U.S. Environmental Protection Agency (EPA) set new equivalent tailpipe carbon emission standards, California agreed to match state standards to the federal ones, and almost all the manufacturers agreed to meet rather than fight the standards. Under the standards, fuel economy of new vehicles is expected to increase to roughly 38 mpg in 2025 (EIA 2014), or about 70% higher than it was in 2011.[3]

[3] Note that fuel economy ratings used for CAFE standards are about 25% higher than the more realistic values estimated for labels that are used here; by law, car CAFE fuel economy is measured by outdated test procedures from 1975.

In 2011 DOT and EPA also set the first fuel economy and emissions standards for medium- and heavy-duty trucks and buses for 2014–18, again with broad support from manufacturers. These standards require only modest improvement in some vehicle categories, but require a 24% reduction in fuel use for over-the-road tractor-trailers, the largest fuel consumers. Early in 2014, President Obama directed that the second phase of standards should be drafted by March 2015 and finalized by March 2016 (Executive Office of the President 2014). Further large cost-effective savings are available for these vehicles; we estimate an average combined total of 40% savings can be achieved from the two phases (ACEEE et al. 2014).

Coupled with decreases in the amount of driving and increased domestic oil supply, the new standards are already having a profound impact. Fuel economy is rising, gasoline use is dropping, and oil imports are plummeting for the first time in decades (EIA 2014).

Scope

Cars and light trucks account for 16% of total U.S. primary energy use. Heavy-duty vehicles account for another 6% of U.S. energy use. Together they account for 58% of U.S. oil use (EIA 2014).

Recommendations

Set truck standards for full vehicles. The first phase of standards for heavy-duty vehicles mostly regulates the engines, aerodynamics, and tires separately (except for covered pickup trucks and vans). Setting standards for the whole vehicle will allow greater flexibility in improving fuel efficiency, including integrated design approaches. Transmission improvements, hybrid technology, and reduced powertrain size enabled by other efficiencies should all be able to contribute. In addition, unlike in the first phase, the standards should include the trailers in tractor-trailer trucks. However, because of limitations on accurate testing of full vehicles, and in order to provide direction in engine efficiency improvement, separate engine standards may also be needed for now. (Khan and Langer 2011; Khan and Langer 2014).

Prepare for light-duty midterm review. The CAFE standards for 2022–25 are not final (though the tailpipe emissions standards are), and DOT and EPA have committed to a midterm evaluation. Some manufacturers have pointed to limited consumer uptake of advanced vehicles, which suggests they may seek to weaken the standards. Although the review is not expected to be complete until 2018, the research and preparation are already underway. This preparation is critical to reaffirming the largest single action for energy efficiency undertaken so far in the Obama administration. We estimate, for example, that if fuel economy improvements are halted in 2021, about one-quarter of the expected savings will be lost, an amount almost equal to the entire savings we estimate from the Phase 2 heavy-duty vehicle standard.

Savings

We estimate that the standards for cars and light trucks through 2025 and the first phase of standards for larger trucks and buses through 2018 will save consumers about $1.6 trillion (discounted NPV, after increased purchase cost, for vehicles sold through 2040). Although part of the improvements were mandated in EISA 2007, DOT and EPA have implemented

standards considerably beyond the required levels. We project that heavy-duty vehicle standards that DOT and EPA expect to issue in 2016 could save $0.4 trillion more.

By 2030 we estimate that the existing standards will save 2.6 million barrels of oil a day (mbd). This is a key reason the EIA projects net crude oil and petroleum products imports will fall dramatically from 8.6 mbd in 2011 to 4.9 mbd in 2020 (EIA 2014). The Phase 2 heavy-duty standards could add another 0.7 mbd savings by 2030. By 2040, the existing standards should save 3.6 mbd and the forthcoming standard another 1.1 mbd. The fuel savings over time are illustrated in figure 2.

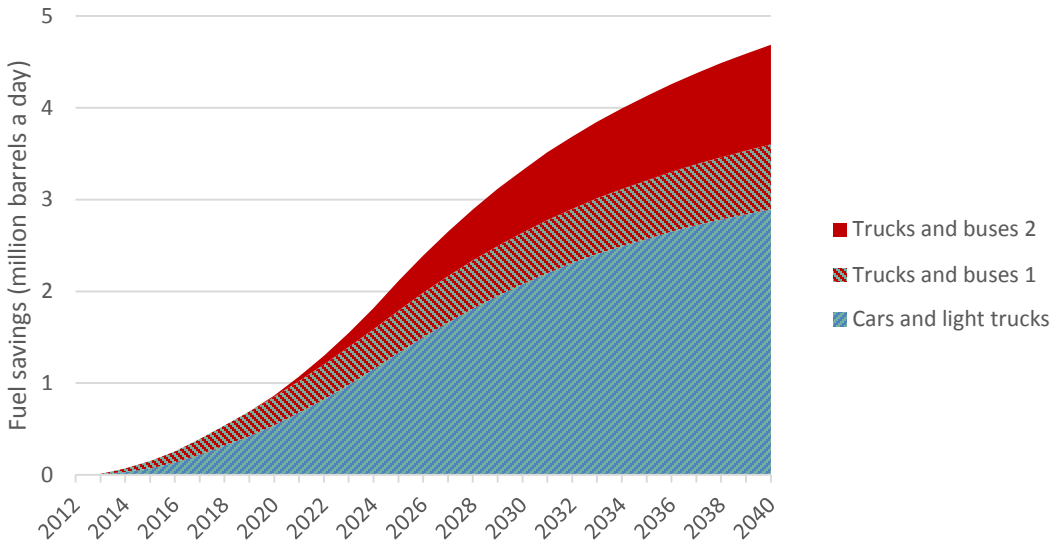

Figure 2. Fuel savings each year from vehicle standards

The vehicle standards are also a key climate policy. We estimate the existing standards will reduce tailpipe CO_2 emissions by a total of 13 billion metric tons, with the new heavy-duty vehicle standards potentially adding another 3 billion metric tons.

These savings do not include upstream reductions in energy use or CO_2 emissions from drilling, refining, and transporting the fuel, or reductions in other greenhouse gas emissions from vehicle air conditioners. We estimate that upstream impacts currently add about 20–30% to energy savings and emissions reductions. The percentages are likely to increase as vehicles become more efficient.

CLEAN POWER PLAN

The Clean Air Act, as interpreted by EPA and the courts, requires EPA to regulate the CO_2 emissions of new and existing power plants. As it is for vehicles, energy efficiency is a key way to reduce the amount of fuel burned and thus reduce emissions. EPA has proposed draft standards for *new* power plants, but the proposal does not address electricity use (and no analysis is included here).

Standards for *existing* power plants, proposed in June 2014 as the Clean Power Plan (EPA 2014b) and expected to be finalized in June 2015, could have much greater impacts on

energy efficiency.[4] Older plants tend to be less efficient and thus offer opportunities for on-site (supply-side) efficiency improvements, and transmission and distribution losses can be reduced. Moreover, even greater emissions abatement can be achieved by increasing customer (demand-side) energy efficiency, thus reducing the need to run these plants in the first place. Utility energy efficiency programs have helped customers achieve remarkable electricity savings much more cheaply than it would have cost to provide the electricity (Molina 2014). Other state policies, notably building energy codes, also can yield large emissions reductions as well as energy and monetary savings (Hayes et al. 2014).

How much energy efficiency will be realized by this rule is hard to predict. Although EPA sets the targets for emissions reductions, states decide how to meet them; the state compliance plans are scheduled to be due starting in June 2016. According to EPA's draft rule (79 FR 34829), states will be able to use utility energy efficiency programs, state efficiency policies such as building energy codes, and other efficiency programs that meet specified criteria. Typically the savings must be verified and enforceable. In addition to customer energy savings, states can also use power plant efficiency and cleaner power generation.

Scope

Fossil fuel power plants are expected to account for 26% of total U.S. primary energy use in 2014. They account for 39% of total energy-related CO_2 emissions, three-fourths of which are from coal-fueled plants (EIA 2014).

Recommendations

Set standards based on system-wide efficiencies. The electric grid is a complex system in which hundreds of power plants are dispatched to meet demand from millions of customers. Much greater emissions reductions can be achieved by managing the system to affect how much fossil-fuel power plants are used than can be wrung from the individual power plants considered in isolation from the grid. In the draft rule EPA estimates that 6% reductions in CO_2 emissions from coal power plants are available on average from efficiency at the plants. ACEEE estimated that by 2030, 25% savings from all power plants would be available through customer energy efficiency (Hayes et al. 2014). Thus, basing the standard in part on customer efficiency will result in much larger emissions reductions.

Help states use efficiency to meet the standard. EPA should provide states with road maps on how they can use energy efficiency to reduce emissions. EPA also should provide specific guidance on evaluation, measurement, and verification (EM&V) to ensure that the savings are real and reasonably well quantified but that the process is still administrable and not too onerous. EPA's draft standard is expressed in terms of emissions rates (pounds of CO_2 per megawatt-hour [MWh] generated), which in general do not register lower emissions due to less electricity demand. Thus states that use this metric will need to incorporate energy efficiency as an adjustment to the actual emissions rate (e.g., adding electricity saved to

[4] The draft rule uses section 111(d) of the Clean Air Act (42 USC 7411(d)) and hence is often referred to by that designation.

actual generation in the rate) and will need to ensure that the savings are carefully measured.[5] In addition, either state governments or other entities will need to be accountable for the efficiency savings, so they will need assurance on how the savings will be counted.

Savings

Here we consider only the potential impact of the standard on customer energy efficiency and energy demand, not fuel switching or power-plant or grid-efficiency improvements (except for comparison). Because the extent to which efficiency will be used to meet the standard is hard to predict (as it depends on state decisions), we give two estimates here. One, based roughly on EPA's assumed levels of efficiency, results in 9% electricity savings or 421 billion kilowatt-hours (kWh) in 2030 due to the standard. If all the savings are from utility programs to help customers save energy, we estimate that the energy savings due to the power plant standard could save consumers $143 billion (discounted NPV, after investment, for actions through 2040). The energy savings could reduce CO_2 emissions by a total of 4.9 billion metric tons.

A second estimate, roughly based on ACEEE's earlier analysis (Hayes et al. 2014), includes more utility programs and building energy codes, combined heat and power, and state-level appliance standards.[6] It yields twice the energy, carbon, and dollar savings. Savings due to the standard rise to 16% of electricity use, or 716 billion kWh, in 2030. Net savings to consumers would be $327 billion. And the savings due to the rule could reduce CO_2 emissions by 11 billion metric tons cumulatively.

The reduction in CO_2 emissions over time for both estimates is illustrated in figure 3. The baseline savings numbers shown there do not include all expected savings that might be counted toward meeting the standard, or what we think should be allowed to qualify for the standard; they are just rough estimates of the portion of the two savings estimates that are already included in the EIA base forecast (EIA 2014).

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[5] EPA would also allow states to use a mass-based standard instead (just tons of CO_2). Customer efficiency will be reflected in this metric, making after-the-fact adjustment unnecessary and consistent EM&V a bit less critical. But EPA will need to ensure that the electricity demand projections used to convert between the metrics are accurate.

[6] Savings numbers here differ from those in our earlier report (Hayes et al. 2014), and mentioned above, because they only include savings above those that states are already achieving and that are reflected in EIA's *Annual Energy Outlook* (EIA 2014), and because savings at 2030 levels are extended out to 2040.

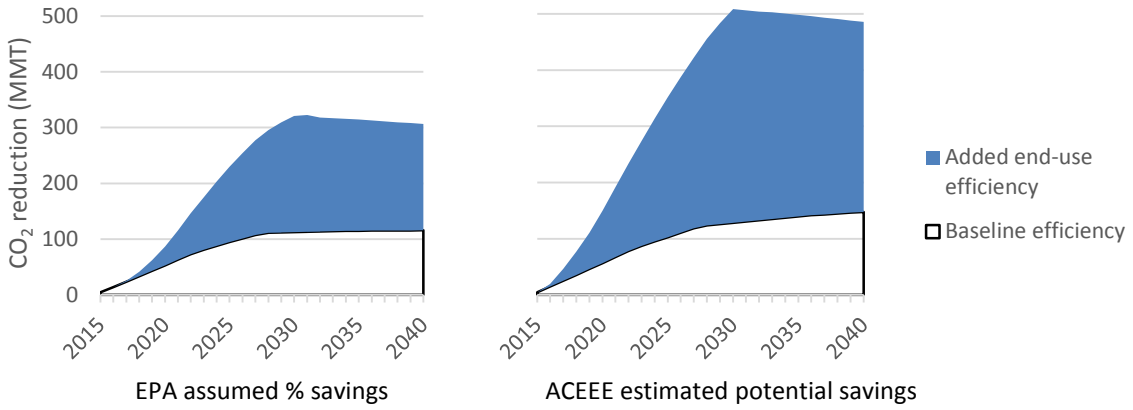

Figure 3. Two estimates of carbon dioxide emissions reductions each year from use of energy efficiency to meet the power plant standard. The white areas are baseline savings that states are already expected to achieve.

In the larger estimate, this standard would result in as much energy savings and consequent carbon reductions as any other Obama administration policy. Even the lower estimate is certainly the largest energy savings on the table for President Obama's second term. Although not the largest in terms of dollar savings, the resulting efficiency would still save consumers hundreds of billions of dollars.

For comparison, if regulated coal power plants achieve a 6% reduction in fuel use, as EPA believes is possible, that could save about 1 quadrillion Btu (quad) a year and reduce annual CO_2 emissions by almost 100 million metric tons (if the use of coal plants is not also reduced).

HOUSING EFFICIENCY POLICIES

The ways we construct, insulate, heat, cool, and light our homes present large opportunities for energy savings beyond the appliance standards and electric efficiency programs discussed above. Homes built to meet new building codes use almost a third less energy for heating and cooling than they would under codes of six years before (U.S. Department of Energy 2012), and whole-home retrofits can achieve significant savings in existing homes at a somewhat higher cost (Research into Action et al. 2013). Many of the key policies are implemented at a state or local level, including building energy codes and utility efficiency programs. But there are important federal policies as well. This section discusses three of them.

Manufactured housing standards. About 6–9% of new homes are made in a factory and shipped to the location of use (EIA 2014). Factory production provides unique opportunities for economies of scale, rapid innovation, and quality control. Despite these advantages, typical manufactured homes are less efficient than "stick-built" homes (Talbot 2012). Unlike site-built homes, manufactured homes are regulated by the federal government because one factory may ship to many states. Current energy requirements in federal standards set by the U.S. Department of Housing and Urban Development (referred to as the HUD code), have not been updated since 1994. Congress turned the energy standards over to DOE in

EISA 2007. DOE sent a draft standard to the OMB but then withdrew it; they now have begun a negotiated rulemaking process.

Codes and efficiency in federal mortgages. In 2013 about 16% of new single-family homes were purchased using Federal Housing Administration (FHA) loans (loans guaranteed by HUD), 8% with similar Department of Veterans Affairs (VA) loans for veterans, and a somewhat smaller number with U.S. Department of Agriculture (USDA) loans (Census 2014; HUD/USDA 2014). New homes with these federal loans are supposed to meet national model building energy codes, but the code reference was only recently updated to the 2006 International Energy Conservation Code (IECC) for FHA and USDA loans, and is the 1992 Model Energy Code for VA loans. In order to update the code, EISA 2007 requires HUD and USDA to determine that the update will not affect the availability or affordability of covered housing (42 USC 12709); they issued a preliminary determination on the 2009 IECC (and comparable ASHRAE Standard 90.1-2007 for multifamily housing) in May 2014.

Efficiency beyond the minimum code requirements is not currently considered in mortgage underwriting even though efficient homes are worth more and their owners can afford higher mortgage payments because they pay lower utility bills. HUD and other agencies could ensure that appraisals consider the extra value of efficient homes (or else add the value to appraisals), and modify income-based mortgage caps to account for energy costs just as they now account for taxes, homeowner's insurance, and other housing costs. A niche product, Energy Efficient Mortgages, does this in part, but it has not been well supported. There is a related legislative proposal known as the SAVE Act (S. 1106 in the 113th Congress), but agencies could improve their underwriting under existing law. Doing so would give builders and homeowners more confidence that they could recoup the initial cost of greater efficiency.

USDA Energy Efficiency and Conservation Loan Program. In December 2013, USDA finalized the Energy Efficiency and Conservation Loan Program (EECLP) (78 FR 73355), so that rural electric cooperatives could obtain low-interest loans from the USDA's Rural Utilities Service to finance loans to their customers for home energy efficiency upgrades and other customer energy measures. The program is modeled in part on a successful pilot in South Carolina that used low-interest loans with repayment added to utility bills (Keegan 2013). It aims in the first year to provide $250 million in financing for efficiency measures, and potentially more in later years. The program is under authority in the 2008 Farm Bill; the 2014 Farm Bill authorizes, but does not fund, a similar Rural Energy Savings Program.

Scope

While the market share of both manufactured homes and federal loans is highly volatile, the code requirements potentially cover more than a third of new homes nationwide and could affect standard building practices for other homes. Rural electric co-ops serve 12% of the U.S. population.

Recommendations

End delays on rules. The manufactured housing standard is already more than two years overdue, the loan code requirements will soon be three code cycles behind (2009, 2012, and 2015 IECC), and the USDA loan program took five years to set up. The inefficient homes

being built in the meantime will last for decades. The delays also set a bad example: the federal government has not fully adopted code updates that it expects states to adopt.

Improve agency cooperation. Agencies have recently been showing greater cooperation on housing energy policies. For example, the Rental Policy Working Group has tried to align energy criteria for rental housing (Rental Policy Working Group 2011), and DOE analysis is critical to the HUD–USDA determination on codes and federal loans. But better cooperation between HUD and DOE is needed on manufactured housing, particularly on enforcement of the new DOE standards.

Conduct implementation and training. The new and updated programs cannot help if they are ignored. Better training of builders, contractors, and others, and more focus on compliance, are needed to ensure that the potential savings from each of these policies are realized. Underwriting processes, documents, and software should facilitate consideration of energy savings.

Savings

We estimate that the USDA loan program could save consumers $3 billion (discounted NPV, after renovation costs, for lifetime of measures taken through 2040). The potential of the new building measures is greater: net savings of $20 billion. The savings over time (before discounting or netting out costs) are illustrated in figure 4. Reductions in CO_2 emissions would be 79 million metric tons (MMT) for the USDA program and 451 MMT for the new actions.

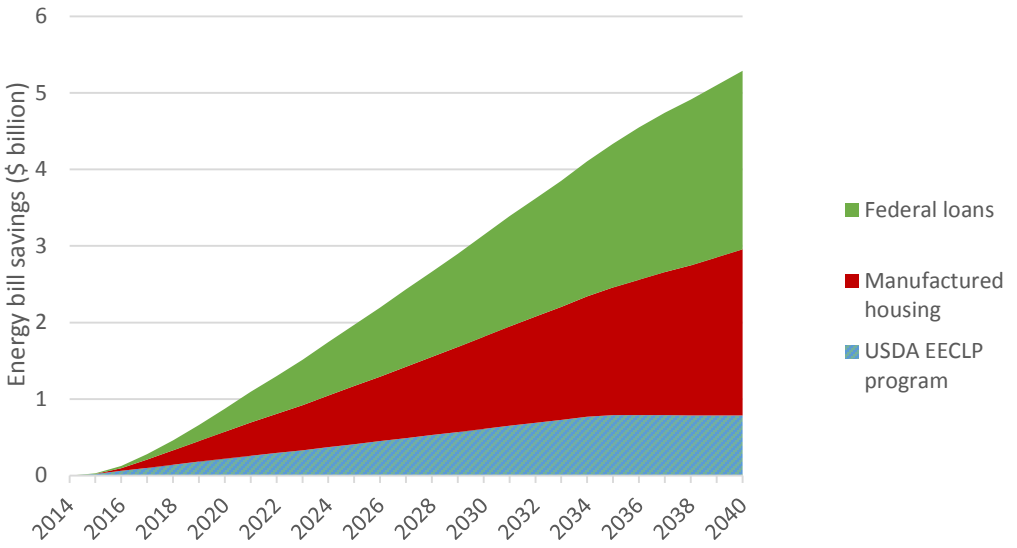

Figure 4. Energy bill savings each year from housing policies

Although these numbers are much smaller than the corresponding figures for appliance standards, vehicle standards, or power plant standards collectively, they are larger than for most of the individual appliance standards; each of these actions is comparable to an important appliance standard, though there are not as many of them. In addition, there is a

potential market transformation effect on construction practices for all homes, which we do not try to capture here.

Combined Impacts

Looking at the combined impacts of the four sets of agency actions described above will give a sense of how far our nation can go toward meeting our energy and related goals under existing legislation, even recognizing that other potential actions are not analyzed here. The impacts are tabulated in tables A1 and A2 in Appendix A, and the growth in energy savings from the policies is illustrated in figure 5.

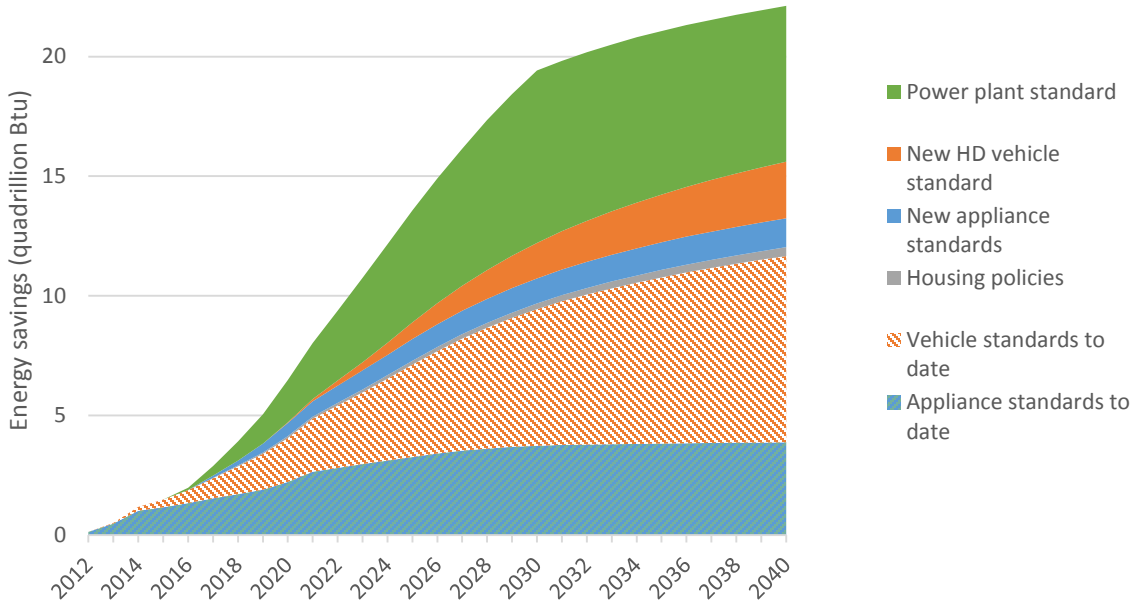

Figure 5. Energy savings each year from recent and prospective agency actions

We estimate that the policies analyzed here that have already been issued by the Obama administration (including standards that were set in EISA 2007) will save $1.9 trillion net after investment. In 2030, energy savings will be 9.5 quads, about 9% of expected energy use in that year. The vehicle standards already in place will save 2.6 mbd of oil in 2030, about 14% of total oil use. And the policies will reduce CO_2 emissions in 2030 by over 600 MMT, about 11% of energy-related emissions. The standards for cars and light trucks are clearly the largest contributor to these savings, but the truck and bus standard and the collective impact of the appliance standards are also significant.

Upcoming policies in the rest of the term could be equally important. Additional standards could save another net $700 million cumulatively. In 2030, added savings could be 9.9 quads of energy, 0.7 mbd of oil, and about 550 MMT of CO_2. If EPA acts effectively, the carbon emissions standard for existing power plants has the greatest potential, but the follow-on standard for trucks and buses and the collective appliance standards also have a large potential impact. Although the buildings policies are likely smaller, they still could save

consumers $20 billion and reduce cumulative CO_2 emissions by about 450 MMT, and thus are worth pursuing aggressively.

IMPACT ON ADMINISTRATION GOALS

Together these agency actions can have a significant impact on energy use and thus on the economy, the environment, and national security. But the energy savings will not be enough to achieve the goals the president has laid out. The progress the actions can make toward the goals, and the resulting U.S. energy use, energy productivity, and CO_2 emissions, are shown in table 1.

Table 1. Combined impact of agency actions

	Energy use (quads)	Energy productivity ($billion/quad)	% change from 2010	CO_2 emissions (MMT)	% change from 2005
2005	100.3	126		5,996	
2010	97.7	134		5,615	-6%
2014	96.6	147	10%	5,426	-10%
2020					
No agency action	104.6	160	20%	5,719	-5%
Policy	98.1	171	27%	5,338	-11%
2030					
No agency action	112.1	189	41%	6,117	2%
Policy	92.7	228	70%	4,941	-18%
2040					
No agency action	117.3	227	70%	6,347	6%
Policy	95.2	280	109%	4,974	-17%

As discussed above, the appliance standards DOE is setting could come close to reaching the goal for appliance and federal building standards of 3 billion MMT of CO_2 reductions. But the small gap will not be easy to fill. And if DOE continues to interpret the bar on implementing the light bulb standards broadly, the gap will be much wider.

On the goal of achieving 17% reductions in greenhouse gas emissions by 2020 compared to 2005, the good news is the progress that has already been made. The EIA estimates for 2014 suggest we have already reduced CO_2 emissions by 10%. But without the Obama administration's actions, we estimate based on EIA's projections that emissions would have gone back up more than halfway to 2005 levels. The actions analyzed here would just keep emissions flat, with an 11% reduction in 2020. However, power plant efficiency and fuel switching due to the power plant standard, as well as other agency actions, could contribute further emissions reductions.

The goal to double energy productivity (economic output per energy input) allows more time for savings—through 2030—but is a broader economic target. We estimate based on EIA's projections that without agency actions, we would increase energy productivity by 41% by 2030. With previous and prospective agency actions, we could increase energy productivity by 70%. This is a major improvement, though we do not appear likely to meet the goal fully without major legislation. The growth in energy productivity is illustrated in figure 6.

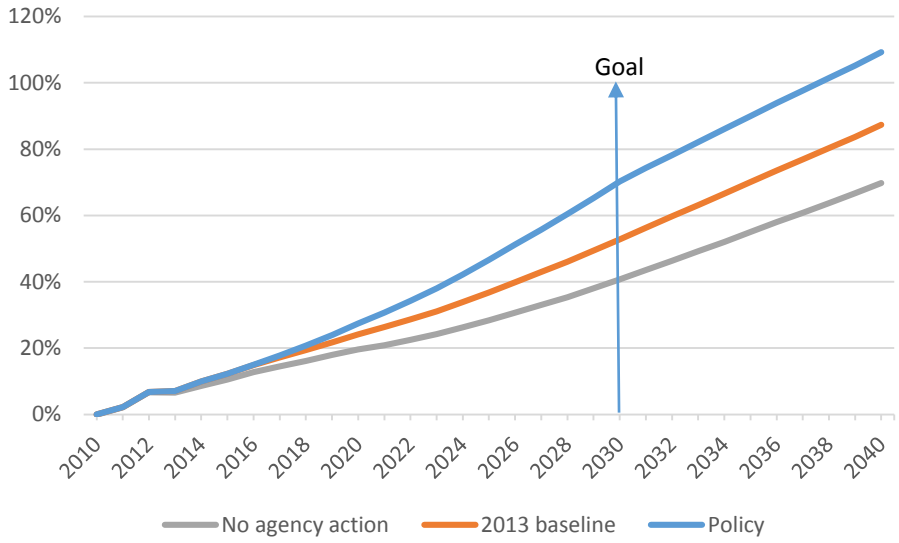

Figure 6. Energy productivity growth with and without agency actions

Conclusions

Although Congress is stymied, with even broadly supported bipartisan energy efficiency bills bottled up by larger political debates, previous Congresses have left plenty of unfinished business on energy efficiency for federal agencies to carry out. Agencies have broad authority over the efficiency of appliances and vehicles, and over power plant emissions. They also have limited authority over building efficiency beyond equipment standards.

The Obama administration has been energetic in implementing key policies, especially for priorities identified by the White House. Agency actions based on existing legislative authority are having a significant impact on energy efficiency and thus on our nation's economy, environment, and security. They are saving typical consumers thousands of dollars, reducing greenhouse gas emissions that cause global warming, and helping create a clean and resilient energy system.

But there still are important untapped efficiency opportunities for the agencies (including many actions outside the scope of this paper) and required actions that are years behind. The agencies are acting on key policies, including the power plant standard, truck and bus standard, and many appliance standards, but it is critical that agencies structure the rules in ways that allow all energy efficiency opportunities to contribute. Agencies have been less focused on other policies, such as lighting standards, manufactured housing, and federal

mortgages, so significant savings await action. Several important measures also require cooperation between agencies, which has been more notable in some cases than others.

Although energy efficiency actions under existing authorities are significant, they will not be enough to reach national goals. Additional federal legislation and action by states across the country are needed to reap the large potential of energy efficiency. Bipartisan legislation such as the SAVE Act and tested state policies such as utility energy efficiency savings targets and better building energy codes are ready; they just need more favorable political environments for adoption.

Finally, although this paper has focused on the Obama administration, most of the savings will depend on implementation in the next administration and beyond. Not only will the power plant standard be implemented largely after President Obama leaves office, but the greatest energy-saving measure to date, the car and light truck standard, could be reversed in the midterm review. Other policies also will need training, enforcement, and other actions. Perhaps future administrations will claim these savings as their own. Certainly there is enough credit to share for the trillions of dollars of savings to consumers these agency actions will bring.

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Appendix A. Detailed Results

Table A1. Annual impacts from agency actions

2020 Savings	Electricity (TWh)	Natural gas (Tbtu)	Oil (mbd)	Total energy use (quads)	CO_2 emissions (MMT)	Energy bill ($billion)
Appliance standards						
Issued to date	212	51	-	2.21	117	24.7
Prospective	52	15	0.00	0.55	29	6.3
Vehicle standards						
Issued to date	-	-	0.85	1.84	136	52.8
Prospective	-	-	0.02	0.03	3	0.9
Power plant standard						
Prospective	178	-47	-	1.77	93	18.0
Housing policies						
Issued to date	2	-	-	0.02	1	0.2
Prospective	4	7	0.00	0.05	3	0.7
Total						
Issued to date	214	51	0.85	4.07	254	77.7
Prospective	234	-27	0.02	2.39	127	25.7
2030 Savings	Electricity (TWh)	Natural gas (Tbtu)	Oil (mbd)	Total energy use (quads)	CO_2 emissions (MMT)	Energy bill ($billion)
Appliance standards						
Issued to date	364	108	-	3.73	196	44.2
Prospective	85	194	0.00	1.05	55	13.2
Vehicle standards						
Issued to date	-	-	2.64	5.71	425	186.4
Prospective	-	-	0.68	1.48	110	46.2
Power plant standard						
Prospective	716	120	-	7.26	381	77.5
Housing policies						
Issued to date	5	-	-	0.05	3	0.6
Prospective	16	27	0.00	0.19	10	2.5
Total						
Issued to date	368	108	2.64	9.49	623	231.2
Prospective	813	331	0.69	9.93	553	138.8

2040 Savings	Electricity (TWh)	Natural gas (Tbtu)	Oil (mbd)	Total energy use (quads)	CO_2 emissions (MMT)	Energy bill ($billion)
Appliance standards						
Issued to date	384	116	-	3.88	198	49.5
Prospective	86	357	0.01	1.21	63	16.8
Vehicle standards						
Issued to date	-	-	3.60	7.79	584	292.8
Prospective	-	-	1.09	2.37	175	83.3
Power plant standard						
Prospective	628	469	-	6.61	338	77.4
Housing policies						
Issued to date	6	-	-	0.06	3	0.8
Prospective	26	42	0.00	0.31	16	4.5
Total						
Issued to date	390	116	3.60	11.72	785	343.1
Prospective	733	852	1.09	10.40	588	180.7

Some of the totals are slightly lower than the sum of the policy impacts because some savings were removed to avoid double counting them (see Appendix C). This table and the following table include the second (ACEEE) estimate of potential savings from energy efficiency due to the power plant standard. Vehicle energy use and emissions do not include upstream impacts.

Table A2. Cumulative impacts from agency actions

	Net savings ($billion NPV)	Benefit-cost ratio	Cumulative CO_2 reductions (MMT)
Appliance standards			
Issued to date	375	3.6	5,411
Prospective	83	2.4	1,530
Vehicle standards			
Issued to date	1,535	3.9	12,902
Prospective	299	3.0	3,247
Power plant standard			
Prospective	327	1.8	10,836
Housing policies			
Issued to date	3	2.0	79
Prospective	20	2.3	451
Total			
Issued to date	1,914	3.8	18,392
Prospective	722	2.1	15,924

Appendix B. Appliance Standards

Table B1. Standards set to date in the Obama administration

Standards set in EISA 2007	Sector	Energy bill savings ($billion)
General service lamps	Residential	$157.28
Metal halide lamp fixtures	Comm./indust.	$20.24
Electric motors	Comm./indust.	$8.65
Walk-in coolers and freezers	Comm./indust.	$7.61
Incandescent reflector lamps (BR and R20)	Residential	$5.32
Boilers	Residential	$5.18
External power supplies	Residential	$3.10
Dehumidifiers	Residential	$2.22
Dishwashers	Residential	$1.63
Standards set by DOE	**Sector**	**Energy bill savings ($billion)**
General service fluorescent lamps	Comm./indust.	$35.11
Refrigerators and freezers	Residential	$33.00
Fluorescent lamp ballasts	Comm./indust.	$31.58
Clothes washers	Residential	$28.56
Water heaters	Residential	$21.39
Electric motors	Comm./indust.	$20.39
Central air conditioners and heat pumps	Residential	$17.25
Furnace fans	Residential	$16.85
Small motors	Comm./indust.	$14.04
Commercial refrigeration equipment	Comm./indust.	$12.08
Walk-in coolers and freezers	Comm./indust.	$11.65
Distribution transformers	Comm./indust.	$11.17
Incandescent reflector lamps	Comm./indust.	$9.33
Room air conditioners	Residential	$4.71
Clothes dryers	Residential	$3.32
Microwaves (standby mode)	Residential	$3.28
External power supplies	Residential	$3.04
Commercial boilers	Comm./indust.	$2.14
Metal halide lamp fixtures	Comm./indust.	$1.92
Beverage vending machines	Comm./indust.	$1.58
Ranges and ovens (gas)	Residential	$1.28
Commercial clothes washers	Comm./indust.	$1.05
Dishwashers	Residential	$0.81
Pool heaters	Residential	$0.12

Direct heating equipment	Residential	$0.10

The savings numbers are the present value of expected savings on energy bills, and on water bills for water-using products, for the lifetime of products sold through 2040 (without subtracting added costs). They are intended to convey the relative magnitude of the impact of the standards.

Table B2. Possible standards for which we have savings estimates

Standards to be set	Sector	Energy bill savings ($billion)
Furnaces	Residential	$21.23
General service fluorescent lamps	Comm./indust	$19.77
Battery chargers	Residential	$18.79
Computers	Residential	$15.10
Unit heaters	Comm./indust	$12.78
Fans	Comm./indust	$10.62
Commercial air conditioners	Comm./indust	$9.85
Dehumidifiers	Residential	$5.75
Boilers	Residential	$5.24
Faucets	Residential	$4.57
Pre-rinse spray valves	Comm./indust	$3.53
High-intensity discharge lamps	Comm./indust	$3.48
Commercial clothes washers	Comm./indust	$3.44
Pumps	Comm./indust	$3.04
Automatic ice makers	Comm./indust	$2.93
Commercial furnaces	Comm./indust	$0.82
Standards held up by the rider	**Sector**	**Energy bill savings ($billion)**
Incandescent reflector lamps	Residential	$29.94
Candelabra and intermediate base incandescent lamps	Residential	$8.40

Appendix C. Assumptions and Methodology

Appendix C briefly describes the methodology and key assumptions used in the impact estimates in this white paper. Cost and savings estimates for each of the agency actions are discussed below. They are assumed to be additive, except that the federal loan savings under housing policies are assumed to be included in the building code savings under the power plant standard. Note that both cost and savings are ACEEE estimates, except as noted, and may not match the agencies' own regulatory analyses.

The estimates are for the impact of the agency actions compared to business as usual (BAU) without the agency actions. Because the policies are adopted at different times, and the estimates use somewhat different methodologies, they do not share exactly the same BAU baseline. But generally the baselines are similar to the Energy Information Administration's Annual Energy Outlook (EIA's AEO) Reference Case.

We calculate impacts for products sold or measures taken through 2040; cumulative and cost-benefit numbers include savings through the lifetimes of those measures as late as 2080.

The energy prices by fuel, sector, and year, and the carbon intensity by fuel and in some cases year, are taken from the AEO 2014 (EIA 2014). For later years they are extrapolated from trends over 2021–40. NPVs and benefit-cost ratios are calculated using present values in 2013 with a real discount rate of 5%. The costs in some cases are financed (see details below). All monetary impacts are in constant 2012 dollars.

The estimates for future energy productivity and CO_2 emissions also use the AEO 2014 as a baseline. The AEO 2014 incorporates the car and light-truck standard, the first heavy-duty vehicle standard, and appliance standards issued through 2013. Although their impact estimates for these policies are not identical to ours, they are similar. For the BAU case, we subtract our impact estimates for these policies from the AEO 2014. For the policy case, we add our estimated impacts for the appliance standards issued in 2014 and the prospective policies.

APPLIANCE AND EQUIPMENT STANDARDS

The methodology used to estimate the impacts of appliance efficiency standards is largely the same as in *The Efficiency Boom* report (Lowenberger et al. 2012), where it is more fully described. Annual savings per piece of equipment are based on the estimated energy use of the average equipment that just meets the new or proposed standard compared to the previous standard or the least-efficient products when the standard is set. The savings are assumed to last for the average lifetime of the product. For water-using products, the monetary savings also include water bill savings. Average added consumer cost of the more efficient equipment also is estimated for each product. We assume no financing for the equipment. Shipments are assumed to be constant, and savings are discounted for the portion of shipments that already met the new standard. This static model neglects the fact that for most products, both efficiency and shipment levels rise over time; it assumes that those changes will cancel each other out.

VEHICLE STANDARDS

Impact estimates for both light- and heavy-duty vehicle standards use Argonne National Laboratory's VISION 2013 AEO Base Case model (Argonne National Laboratory 2014), which in turn is based on the AEO 2013. Although commercial light trucks (8,500–10,000 pounds) are included with light-duty vehicles in the VISION model, they are covered by heavy-duty vehicle standards, so we separated them from light-duty and added their savings to the heavy-duty vehicle oil savings. The savings for the existing light- and heavy-duty vehicle standards are based on fuel use under the standards compared to fuel use assuming constant fuel economies at the levels just before the standards were set. We believe this is a more accurate projection of fuel economy absent the standard than the AEO forecasts from before the standards. The savings from the Phase 2 truck standard are compared to vehicles under the Phase 1 standard; fuel savings are projected to be 15% under Phase 1 and a further 30% under Phase 2 (ACEEE et al. 2014). As noted in the text, we do not include impacts on upstream (e.g., refinery) energy use or CO_2 emissions.

Costs to meet the light-duty standard are based on EPA and DOT's per-vehicle cost estimate, rising to $2,290 in 2012 dollars. Costs to meet the heavy-duty vehicle standards are estimated at an average of $5,374 per truck for Phase 1 and $19,646 per truck for Phase 1 and 2 (ACEEE et al. 2014). For simplicity, we do not include any financing of these costs or any reduction in costs due to learning (though we expect both to occur).

CLEAN POWER PLAN

We use two different impact estimates for the power plant emissions standards. Note that both estimates focus solely on customer energy savings, and both (like all others in this paper) use a simple baseline average national carbon intensity for electricity for each year to estimate CO_2 emissions reductions. If the reduced electricity demand is targeted to reduce fossil fuel use in existing power plants, the emissions reductions could be greater.

One estimate is based on a national-level analysis and loosely on efficiency levels that EPA assumed in setting the draft standard. The analysis starts with the AEO 2014. Although the AEO does not explicitly include utility efficiency policies such as energy efficiency resource standards, it does calibrate to historical electricity use, and thus implicitly assumes that recent savings will continue, including new measures to keep up the savings (EPA 2014a). Based on reported incremental savings in 2008–12, we assume 0.47% incremental savings each year are included in the AEO (Nadel and Herndon 2014). We accept this as the BAU case.

Following the EPA draft rule, we assume that starting in 2017, this level of incremental savings ramps up by 0.2% a year until it reaches 1.5% per year (starting in 2022). As we are only counting savings due to the federal standard, however, not those that states would have achieved anyway, we only count savings above the BAU level. Hence, we count savings rising to 1.1% incremental savings per year. Because the AEO likely underestimates utility program savings (EPA 2014a), this level of added savings may require states to achieve somewhat higher total efficiency levels than EPA assumed in setting the targets. Based on previous work from ACEEE (Hayes et al. 2014), we also assume different measure lifetimes (8 years for residential measures and 13 years for commercial and industrial), which also increases savings.

Also based on our previous work, we assume that reductions by sector are proportional to sales. Although we do not assume what state-level policies achieve the reductions, the costs are roughly based on utility program cost data (Molina 2014), with a total utility and customer cost of $0.53 per incremental kWh, including a consumer cost of $0.30 (this is the cost divided by just one year of savings for savings that last several years). Twenty percent of the consumer costs are financed at 2% above the AEO's predicted 10-year Treasury bond interest rate for 30 years for residential measures and 4% above the Treasury rate for 7 years for commercial and industrial measures.

The second estimate uses state-level estimates for potential electricity savings from utility programs, building energy codes, combined heat and power, and state-level appliance standards taken from earlier work (Hayes et al. 2014). In addition to reductions in electricity use, here we include impacts on natural gas use, both savings due to building energy codes and increased use due to combined heat and power (CHP; these were included in the earlier analysis but not reported separately). Although the previous paper only included measures through 2030, this paper includes measures through 2040. The EPA draft rule continues the 2030 emissions targets indefinitely. To roughly approximate that, the 2030 savings levels and costs are extended out to 2040, and the subsequent tapering off shifted to begin in 2041. The utility program savings are adjusted to remove BAU savings included in the AEO, as in the first estimate. The CHP savings also are reduced to remove BAU savings in the AEO, based on the increase in end-use generation from natural gas in the AEO. We believe this may overestimate BAU CHP installations, but it would balance out underestimates of end-use efficiency. The utility program and CHP costs are reduced proportionally to the savings.

HOUSING EFFICIENCY POLICIES

We performed new analyses for each of the three housing policies.

Manufactured housing standards. The analysis uses AEO 2014 projections for the number of new manufactured homes (per the description of the residential module), rising to about 150,000 homes per year. Baseline energy use starts with EIA's 2009 Residential Energy Consumption Survey (RECS) results for manufactured homes; projections are then based on the change in use of each fuel for all homes in the AEO 2014. We assume that a standard could achieve 30% savings in total energy use of each fuel for new homes based in part on a study of the 2012 IECC compared to the HUD code for all-electric manufactured homes in Washington State (Salzberg et al. 2012). Because effective compliance should be feasible in the factories, we assume 95% of homes comply beginning in 2016. Savings last for 30 years. Estimated costs are based on an assumption of five-year simple payback, loosely based on the same study. We assume 75% of the homes are financed for 15 years at an interest rate 5% above the mortgage rate below, as most manufactured homes are financed with chattel loans.

Codes and efficiency in federal mortgages. Similar to the manufactured housing standard analysis, we use AEO 2104 projections for the number of single-family homes, 2009 RECS data for energy use in single-family homes and in homes constructed 2000-2009 compared to all homes, and AEO 2014 projections for changes in energy use in all homes. We assume the policy covers 29% of all new single-family homes based on recent market penetration of FHA, VA, and USDA loans. We estimate that it increases compliance with the IECC starting

in 2015, and ramping up to 33% of covered new homes (about 100,000 homes per year) through a combination of setting a requirement in states that have not adopted the code and improved compliance in states that have. This very rough estimate reflects a balance between how many homes will not already meet the model code due to state law and how effective the agencies could be with new compliance efforts. For those homes, total energy savings are estimated to be 20% at an initial cost of $3,250, based on DOE analysis of the 2012 IECC versus the 2006 IECC (except in 2015, for which we used smaller numbers for the 2009 IECC) (U.S. Department of Energy 2012). Savings last for 30 years, and all costs are financed in 30-year mortgages at 5% real interest. For existing homes, we estimate that the valuation of energy efficiency in mortgages spurs retrofits ramping up to 0.25% of all single-family homes each year. The retrofits save 10% of all energy use at a cost of $2,000, based on utility program experience. Savings last for 15 years, and since this is a mortgage policy, all costs are financed in 30-year mortgages at a rate 2% above the 10-year Treasury rate.

USDA Energy Efficiency and Conservation Loan Program. This analysis starts from an assumption of $250 million a year in loans to rural electric cooperatives under the program, based on the USDA planned first-year funding and the expectation that future-year funding will be higher. After 5% utility administrative costs (the cap under program rules), we assume the money will be used for low-interest loans to improve the efficiency of existing homes, as in the pilot program. The loans cover 100% of the retrofit cost, at a cost of $7,700 per home, based on the pilot (Keegan 2013), allowing for about 31,000 loans per year. The retrofits achieve 35% savings in total home energy use and a 20-year measure life, also based on the pilot. As these are rural homes, and all-electric in the pilot, we assume all-electric homes with the average electricity use found in the pilot (31,400 kWh/year), but the baseline electricity use for new retrofits declines over time based on AEO 2014 projections for household energy use. The modeled USDA loans to utilities are for 10 years at the 10-year Treasury rate, and the utility loans to customers are for 10 years at 1.5% above that rate, per law.