Forecasting the Impacts of State Energy-Efficiency Policies for Use in NAAQS Planning

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ABSTRACT

Air regulators in many states report that they have already – or have nearly – exhausted their tried-and-true strategies for improving ambient air quality, such as ozone and particulate matter pollution. With SIP planners on the lookout for new approaches, the significant expansion of EE/RE policies and programs in recent years presents an opportunity. To help these jurisdictions capture the benefits of energy efficiency policies in SIPs, EPA is providing two new analytic resources. First, EPA has developed a draft methodology for estimating the energy impacts of key energy efficiency and renewable energy (EE/RE) policies that are "on the books", but are not explicitly reflected in a state's electricity sales forecasts. This generalized methodology can be applied by states interested in including EE/RE policies in their SIP baseline emissions projections, regardless of the specific electricity sales forecast used in air quality modeling. Second, EPA has applied its methodology to develop numeric projections of the energy impacts of EE/RE policies not accounted for in the Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) 2013 forecast for the period 2013-2030. These policies include energy efficiency resource standards (EERS) and dedicated sources of EE program funding that are adopted in state law, and/or codified in rule or order. This paper describes these new EPA resources, and presents the Agency's state-by-state energy and demand impacts.

Introduction

States, tribal and local agencies with "non-attainment" areas for air pollutants regulated under the National Ambient Air Quality Standards (NAAQS) are required to submit State Implementation Plans (SIPs) to the U.S. Environmental Protection Agency (EPA) that describe how they will attain the NAAQS by a certain date. To help these agencies examine the role that energy efficiency and renewable energy (EE/RE) policies and programs can play in SIPs, EPA has developed a generalized methodology for estimating the energy impacts of key EE/RE policies that are "on the books", but not explicitly reflected in a state's electricity sales projection. EPA has also applied its methodology to develop numeric projections of the energy impacts of EE/RE policies not accounted for in the Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) 2013 forecast for the period 2013-2030. These policies include energy efficiency resource standards (EERS), dedicated sources of EE program funding that are adopted in state law, and/or codified in rule or order, and renewable portfolio standards (RPS)[1].

Both of EPA's new resources are intended for use by state and local agencies responsible for developing SIPs for ozone and other criteria air pollutants regulated under the NAAQS. These agencies can use EPA's generalized methodology to modify their state-specific electricity sales forecast to account for EE/RE policies, and then include this information in their baseline emissions modeling completed as part of the state's SIP. Alternatively, agencies can adopt

[1] More information is available at: http://www.epa.gov/statelocalclimate/state/statepolicies.html.

EPA's numeric impact projections – and associated revisions to the AEO forecast – and plug this information directly into their baseline emissions modeling. Jurisdictions that are not currently preparing a SIP, but are interested in better understanding the energy and emissions impacts of EE/RE policies, can likewise use EPA's methodology and numeric estimates to identify strategies for staying in attainment with the NAAQS.

Generalized Methodology for Revising a Baseline Electricity Sales Forecast

EPA identified three key steps for analyzing the "on the books" EE/RE policies that are not explicitly accounted for in a baseline electricity sales forecast. EPA focused on the AEO forecast, in particular, since the Agency and many state air quality departments use it as the starting point for estimating electric power sector SIP baseline emission projections. However, states can apply these steps to an alternate sales forecast (i.e. other than AEO), as appropriate.

Step 1: Understand Energy Efficiency/Renewable Energy Policy Assumptions in the Current Reference Case Forecast

EPA reviewed the EIA's documentation for the AEO 2013 reference case forecast and consulted with EIA staff[2] (EIA 2013a). From the review, it is clear that AEO 2013 explicitly includes the impacts of several existing EE/RE policies, including:

- federal appliance and equipment standards for residential and commercial categories;
- lighting efficiency standards for various types of lighting technologies;
- tax credits for EE appliances and equipment, and investment tax credits for EE/RE technologies;
- federal EE programs and funding;
- building energy codes for residential and commercial new construction; and
- state Renewable Portfolio Standards (RPS)—30 states and Washington, D.C. effective as of October 2012[3] (EIA 2013b).

Step 2: Identify and Review "On the Books" Energy Efficiency/Renewable Energy Policies That Are Not In the Reference Case

Based on its review, EPA identified three key state-level EE/RE polices that are "on the books", but are *not explicitly included* in the reference case forecast. EPA focused its analysis on EE/RE policies that are currently codified in regulations, statutes, or state public utility commission (PUC) orders, and that that require parties to achieve minimum levels of EE and/or RE, or to fund programs. The EE/RE policies listed below are the set of "on the books" state policies EPA identified for this analysis.

[2] The reference case is a business-as-usual projection that generally assumes that laws and regulations remain unchanged throughout the projection period. For more information, see http://www.eia.gov/analysis/.
[3] This discussion highlights several of the most important policies, but is not intended as a comprehensive review of AEO assumptions. See http://www.eia.gov/forecasts/aeo/assumptions/pdf/appendix_a.pdf for further information.

- State EE policies:
  - Energy Efficiency Resource Standards (EERS) adopted or updated as of June 201 (25 states)
  - Funding for EE Programs adopted or updated as of June 2013 (5 states)
    - EE programs funded by Public Benefits Funds (PBFs)
    - EE programs funded by the Regional Greenhouse Gas Initiative (RGGI)
    - EE programs funded by revenues from Forward Capacity Market (FCM)
- State RE policies:
  - RPS policies adopted or updated between October 2012 and June 2013 (2 states)

After identifying the applicable EE/RE policies, EPA scanned all 50 states to determine which had adopted one or more of these policies, as of June 2013. The number of states, by policy, are identified by EPA are presented in parenthesis above.

Step 3: Develop Methods to Estimate Incremental Impacts of Energy Efficiency and Renewable Energy Policies Relative to a Reference Case

Once EPA understood the state-level policy characteristics, EPA developed analytical methods to estimate the impacts of the "on the books" EE/RE policies. These analytical methods produced the following incremental impact estimates relative to the reference case: annual energy savings and generation for 2014-2030.

For states using an alternative to AEO, each of the three steps described above can be applied in a similar manner.

Steps for Estimating the Impacts of State EE/RE Policies Incremental to AEO 2013

This section discusses the steps EPA developed and applied to estimate the incremental (and embedded) annual energy savings from EE polices, as well as the incremental RPS generation in two states.

Annual Energy Savings from EE Policies

EPA applied the generalized methodology above to estimate the projected annual incremental energy savings of EE/RE policies incremental to AEO 2013.

Step 1: Generate a Baseline (i.e. business as usual (BAU)) Forecast of State Electricity Sales Consistent with AEO 2013 Regional Forecasts

State-level baseline sales data were developed by first using historical state sales data for 2012 from the EIA, and then applying the electricity sales growth rates from AEO 2013. "Annual average growth rates" (AAGR) based on AEO 2013 were calculated for each Electricity Market Module (EMM) region across the 2012-2040 forecast period. These regional growth rates were then applied to the 2012 historical sales for each state.

Step 2: Estimate Projected Impacts of Key State EE Policies that are "On the Books" and Already Embedded in the AEO 2013 Forecast of Electricity Sales

A key step in EPA's analysis is to produce numeric estimates of state EE/RE policies not accounted for, or "embedded," in the AEO 2013 forecast. Embedded savings are subtracted from estimates of the total EE and RE policy impacts for the state, to yield the incremental savings effects on the baseline, thus avoiding potential double counting. While the AEO 2013 does not explicitly include the impacts of state EE policies, the forecast is understood to implicitly represent the impacts of EE policies implemented at the state level. This implicit representation of energy efficiency occurs in two key ways:

- The AEO forecast incorporates historical data that reflect energy consumption levels and trends influenced by state-level EE policies in place at that time. The effects of these existing policies lower the sales level in the last historic year (e.g., if 2011 is the last historical year of data in AEO 2013, then the 2011 energy demand was lower than it would have been in the absence of existing EE policies) and may also affect AEO's near-term growth rates, which are partially derived from recent historic demand growth trends (which otherwise would have been expected to be higher in the absence of existing EE policies).
- The AEO forecast assumes an ongoing and persistent level of savings from energy efficiency policies and programs that expire after a defined period of time, or "average measure lifetime" for a portfolio of EE programs. Typically, the impacts of EE programs are estimated in terms of first-year savings, plus the persistent savings realized from that program (or EE measure) over an assumed "measure lifetime" (a 13-year lifetime is used for this analysis). EPA's assessment of the AEO forecast, however, is that it does not identify the expected end of these persistent savings (i.e. does not identify a consequent increase in energy intensity that should accompany the end of an EE savings stream). This leads to the conclusion that the AEO forecast assumes an ongoing stream of savings beyond the lifetime of the efficiency measure.

Embedded savings. Recognizing that AEO is implicitly affected by these historic and persistent effects of state EE policies and programs, EPA concludes that some portion of the total EE savings induced by policies and programs are embedded in the AEO 2013 regional forecast and state-level BAU forecast (Synapse Energy Economics 2012). EPA therefore developed a methodology for estimating these embedded savings for each state (Synapse Energy Economics 2013).

This methodology involves two steps: (a) estimating national savings from energy efficiency; and (b) allocating these national savings to the states covered in the analysis.

For national savings, reported cumulative energy efficiency savings from programs implemented in prior years[4] are divided by reported electricity sales[5]. This calculation yields national average energy efficiency savings as a percentage of sales within the given year. Because the national average savings is calculated from the most recent year's total cumulative

[4] Reported as "annual effects" via EIA-861, and as aggregated in EIA's Electric Power Annual for the residential, commercial, and industrial sectors.

[5] Also reported via EIA-861, and as aggregated in EIA's Electric Power Monthly, retail sales of electricity by state by sector by provider.

savings, this value is divided by the average energy-efficiency "measure lifetime," here assumed to be 13 years. This yields a figure that represents the ongoing annual effects of energy efficiency that are embedded in the AEO forecast (0.29%).

Allocating the national average embedded savings to the individual states in this analysis uses state-specific data for first-year energy efficiency savings reported by the American Council for an Energy-Efficient Economy (ACEEE) (Downs 2013). Assuming that cumulative savings are generally proportional to first-year savings, we divided the national average percentage of embedded (0.29%) by ACEEE's national estimate of average first-year savings (0.62%) to define the relationship between the embedded savings and first-year savings data (0.47). The resulting relationship is then multiplied by the state's first year savings percentage to calculate the embedded savings for the state as a percentage of sales.

EPA estimates embedded savings for each state by multiplying the percentages shown in Table 1 by the BAU sales for that state. For example, estimating the embedded savings for Arizona in 2013 involves multiplying the percentage from Table 1 (0.64%) by the BAU sales for 2013 (75,898 GWh) to yield 486 GWh of embedded savings in that year, and then subtracting the cumulative total of the state's embedded savings from the state's total EE policy savings to yield the impacts that are incremental to AEO 2013. EPA only estimated embedded savings for years in which states achieve savings from EE policies and, to the extent possible, for the segments of state electricity load to which the EE/RE policies apply. Step 3 of this paper includes an explanation of how the cumulative total of the state's embedded savings is subtracted from the state's total EE policy savings to yield the impacts that are incremental to AEO 2013.

Table 1. Energy Efficiency savings estimated to be embedded in AEO 2013 (partial list)

State	Savings Estimated to be Embedded in AEO2013 (percent of BAU Sales in Each Year)
Alabama	0.04
Alaska	0.01
Arizona	0.64
Arkansas	0.06
California	0.63
Colorado	0.30
Connecticut	0.61
Delaware	0.08
District of Columbia	0.00
Florida	0.12
Georgia	0.05
Hawaii	0.61
Idaho	0.38
Illinois	0.31
Indiana	0.27
Iowa	0.48

State	Savings Estimated to be Embedded in AEO2013
Kansas	0.04
Kentucky	0.12
Louisiana	0.01
Maine	0.49
Maryland	0.27
Massachusetts	0.67
Michigan	0.47
Minnesota	0.56
Mississippi	0.07

Step 3. Estimate Projected Total EE Savings from Key State EE Policies that are "On the Books"

The EPA estimated state-level EE savings from EERS policies (25 states) and dedicated sources of EE program funding—including dedicated funding from PBFs, RGGI and FCM revenues (5 states) —that are adopted in state law and/or codified in rule or order. Because these categories are not mutually exclusive, EPA took steps to avoid double-counting of energy savings for states with EERSs by treating EERS targets as overall goals that include savings from individual public benefit funded programs, RGGI-funded programs, and FCM revenues (in the states that have them).

For each policy category, EPA estimated annual first-year electricity savings (i.e. savings achieved in a given year from programs implemented during that year), and cumulative savings from EE measures implemented in the current year and past years. The EPA calculated cumulative savings using state-specific average measure lifetimes for a typical program portfolio, and assuming no decay of savings over the life of the measures. EPA used a default average measure lifetime of 13 years[6] where state-specific assumptions were not available, as shown in Table 2 (Friedrich 2009). The EPA did not estimate first-year savings beyond the requirements of each state's policy period, except for a limited set of states whose policy indicated a continuation of savings beyond the policy period. For the majority of states, however, the forecast reverts to the AEO 2013 forecast based on the reference case after the EE policy period ends.

[6] For this analysis, EPA assumed an average measure lifetime of 13 years in cases where state-specific data were not available. This value represents a portfolio of EE programs targeting a representative set of technologies and end-uses. It is adopted from Table 1 of ACEEE's 2009 report, *Saving Energy Cost-Effectively: A National Review of the Cost of Energy Saved Through Utility-Sector Energy Efficiency Program* (cited in this paper as "Friedrich 2009").

Table 2. Average measure lifetime of EE portfolios by state

State	Measure Lifetime (Years)
Connecticut	13
Iowa	15
Massachusetts	13
Minnesota	13
Nevada	13
New Jersey	14
New Mexico	9
New York	15
Oregon	12
Rhode Island	11
Texas	13
Vermont	13
Wisconsin	12
Default	13

In some cases, when examining Energy Efficiency Resource Standards (EERS), EPA identified special considerations that warranted adjustments to the general formulas, including the following:

- *An RPS that defines EE as a qualifying resource*: The States of Nevada and North Carolina have RPSs that treat EE as a qualifying resource, subject to a quantitative limit. The National Energy Modeling System (NEMS), which is used to produce the AEO, does not currently have the capability to evaluate tradeoffs between EE and RE in cases where both are eligible RPS resources; so, it relies only on RE to meet RPS requirements. For RPS policies that are explicitly included in AEO 2013, no incremental energy savings were estimated.
- *Caps on Compliance Type and Cost/Rates*: Several states have EERSs that use cost-containment provisions or other design features that may constrain the ability of EE program administrators to meet the EERS targets with incremental savings relative to the AEO. The EPA identified six states with such design features – Arizona, Illinois[7], Minnesota, Ohio, and Texas – and relied upon available, state-specific academic reports, integrated resource plans, and other studies to make downward adjustments to the nominal EERS targets to reflect these design features.

[7] For example, the Illinois EERS includes a feature that limits rate increases for customers to 0.5% of the total 'per kWh' charge in the first year and increased to 2.0% in 2012. If the rate impact cap is reached, the energy savings goals will be relaxed to the maximum savings that can be achieved within the rate impact cap.

- *Targets that specify "All Cost-effective EE"*: Six states—Connecticut, Maine, Massachusetts, Rhode Island, Vermont and Washington—require utilities (or other EE program administrators) to implement all cost-effective EE. In states with an "all cost-effective EE" requirement and EERS targets, EPA used the EERS targets to the policy sunset date, and then assumed first-year savings equivalent to the last policy year, going forward. In states with an "all cost effective EE" target without an EERS target through 2020, EPA estimated savings based on utility plans and EE resource potential studies.
- *State Legislature or PUC Disapproval of EE Program Budgets Necessary to Meet EERS Targets*: Two states – Florida and Wisconsin – did not approve requests for EE program budget increases necessary to meet growing EERS targets, opting instead to maintain current EE program offerings. In these states, EPA reduced the EERS nominal targets to levels achieved with approved EE program budgets.

For Energy Efficiency Program Funding (in states without an EERS policy but with one or more sources of EE funding), EPA developed an approach for estimating savings from public benefit funds (PBFs), funding from the proceeds of Regional Greenhouse Gas Initiative (RGGI) allowance auctions, and funding from Forward Capacity Market (FCM) payments. Since the main type of data available for these EE programs was related to program administrator expenditures (i.e. costs to the utility of administering EE programs, exclusive of customer costs), EPA calculated savings based on estimates of energy savings per program dollar spent.

For each state with qualifying programs, EPA obtained information on annual program funding from state or utility publications, and projected funding for each future year as equal to the funding for the year for which the latest information is available. The funding information consists of either actual or committed expenditures, depending on the data source. Estimates of the levelized costs of saved energy (LCSE) were available for some states from ACEEE (Friedrich 2009). These are presented in Table 3. The ACEEE report presents costs of saved energy as reported by programs, except in cases where the methods used by program administrators to estimate the LCSE were different from ACEEE's standard approach.

Table 3. Levelized cost by state for 2007 and 2011

State	Levelized Cost of Saved Energy[42] (2007$/kWh)	Levelized Cost of Saved Energy (2011$/kWh)
California	$0.029	$0.031
Connecticut	$0.028	$0.030
Iowa	$0.017	$0.018
Massachusetts	$0.031	$0.033
Minnesota	$0.021	$0.022
Nevada	$0.019	$0.020
New Jersey	$0.026	$0.028
New Mexico	$0.033	$0.035
New York	$0.019	$0.020
Oregon	$0.016	$0.017
Rhode Island	$0.030	$0.032
Texas	$0.017	$0.018
Vermont	$0.027	$0.029

State	Levelized Cost of Saved Energy[42] (2007$/kWh)	Levelized Cost of Saved Energy (2011$/kWh)
Wisconsin	$0.033	$0.035
Default (simple average)	$0.025	$0.027

For this analysis, the EPA did not estimate the magnitude of savings from EE programs funded by dedicated funding sources (e.g., RGGI and FCMs) separately, but instead incorporated their funds in the EE Program Funding category. This decision was motivated by the availability of state-level program budget information data that aggregated the funding sources.

Step 4. Generate State-adjusted National Energy Forecast that Reflects the Energy Savings Not Captured in (i.e. that are incremental to) the Baseline Forecast

EPA estimated energy savings that are incremental to the reference case (AEO 2013) by subtracting cumulative savings embedded in AEO 2013 from total savings from EERSs, programs funded by public benefit funds and other program funding sources (e.g., RGGI and FCM).

Renewable Energy Generation

The AEO 2013 Reference Case incorporates RPS policies or substantively similar laws in place at the time of forecast development. In general, the AEO assumes that utilities will meet the RPS targets; however, where states have explicitly limited state funding for RPS implementation, the AEO assumes that utilities will comply with RPS requirements only to the extent that state funding allows, as described in the AEO assumptions documents.

This analysis maintains consistency with these limiting assumptions. In this current version, the EPA included the RPS policies for only two states, Hawaii and Minnesota. The RPS-related energy production in Hawaii is considered incremental to the AEO forecast because the state is excluded from AEO 2013 modeling. Minnesota was added because its RPS target was changed after the analysis underlying the AEO assumptions was performed. The expected increase of 1.5% to the RPS targets for certain utility types after 2020 counts as incremental to AEO.

The EIA did not identify funding limitations for either state, and EPA assumed their full RPS targets would be achieved. Table 3 presents final RPS targets used in this analysis for the two states for which EPA identified updated RPS requirements.

Since the RPS targets for Hawaii were only available for 2015, 2020 and 2030, EPA estimated sales in intervening years by interpolation. Similarly, the Minnesota targets for 2016, 2020 and 2025 were used to interpolate expected sales levels for all years.

Table 3. Renewable portfolio standard assumptions made in this analysis

State	State RPS Generation (1,000 GWh)		
	2015	2020	2030
Hawaii[56]	1.39	2.16	3.43
Minnesota	0.00	0.64	0.65

RPS requirements were frozen in percent terms for the years after the RPS policy period. A summary of the key analytical steps to estimate the projected annual energy impacts follows:

Step 1. Estimate RE generation from RPS policies adopted or revised between October 2012, when the AEO 2013 RPS assumptions were formulated, and June 2013, when this analysis was released in draft form. (Minnesota and Hawaii)

Step 2. Generate state-adjusted forecast reflecting the policy changes.

Results: Annual Energy Savings from EE Policies

Figure 1 below shows the expected annual impacts (incremental and embedded) of state EE policies in 2025, relative to AEO 2013, which is shown in the solid line. The top line represents a hypothetical forecast that excludes embedded savings, which is essentially an electricity-sales forecast without state EE policies. The lower-most line, represents a revised national sales forecast that accounts for incremental EE policies—the incremental savings represent 2.3% of electricity sales in 2025.

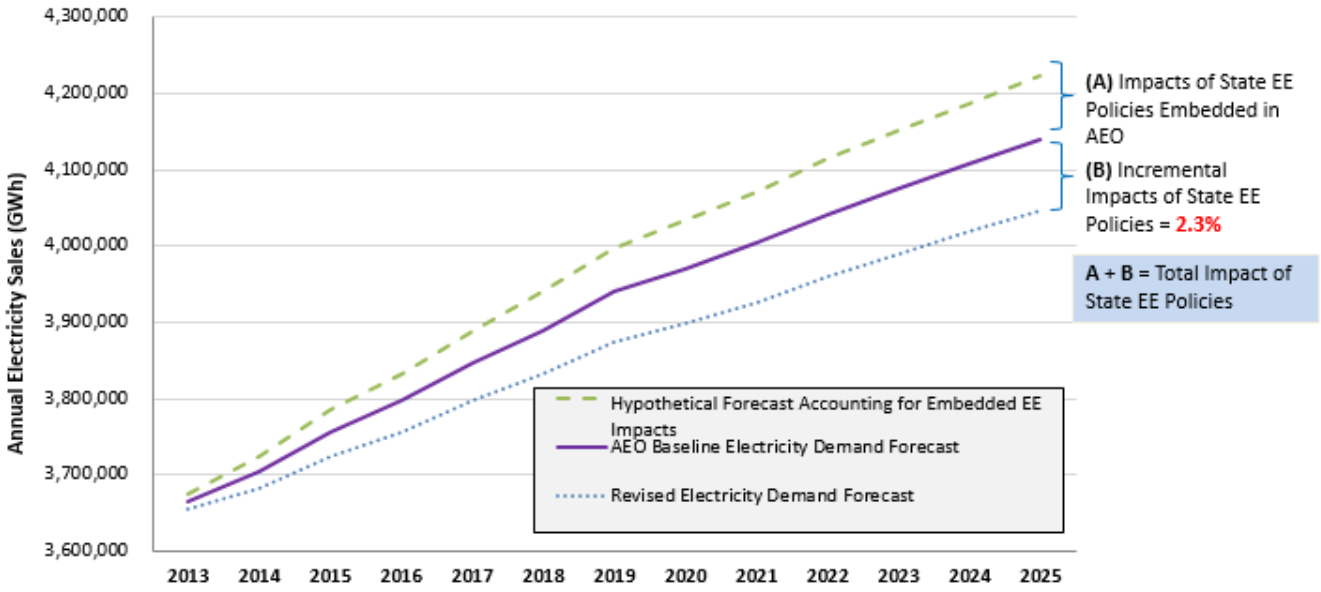

Figure 1. Draft state EE policy effects on the AEO 2013 national forecast.

Figure 2 (below) shows annual incremental savings, or savings additional to the AEO2013 forecast. These values vary significantly by state, depending primarily upon a state's history of EE investment, and the rate at which savings have ramped up. The methodology applied by EPA produces less incremental savings as a state over time develops stable and consistent EE investment levels. Similarly, it produces more incremental savings if a state has recently made new EE investments, or if it has ramped up its EE investments compared to past levels.

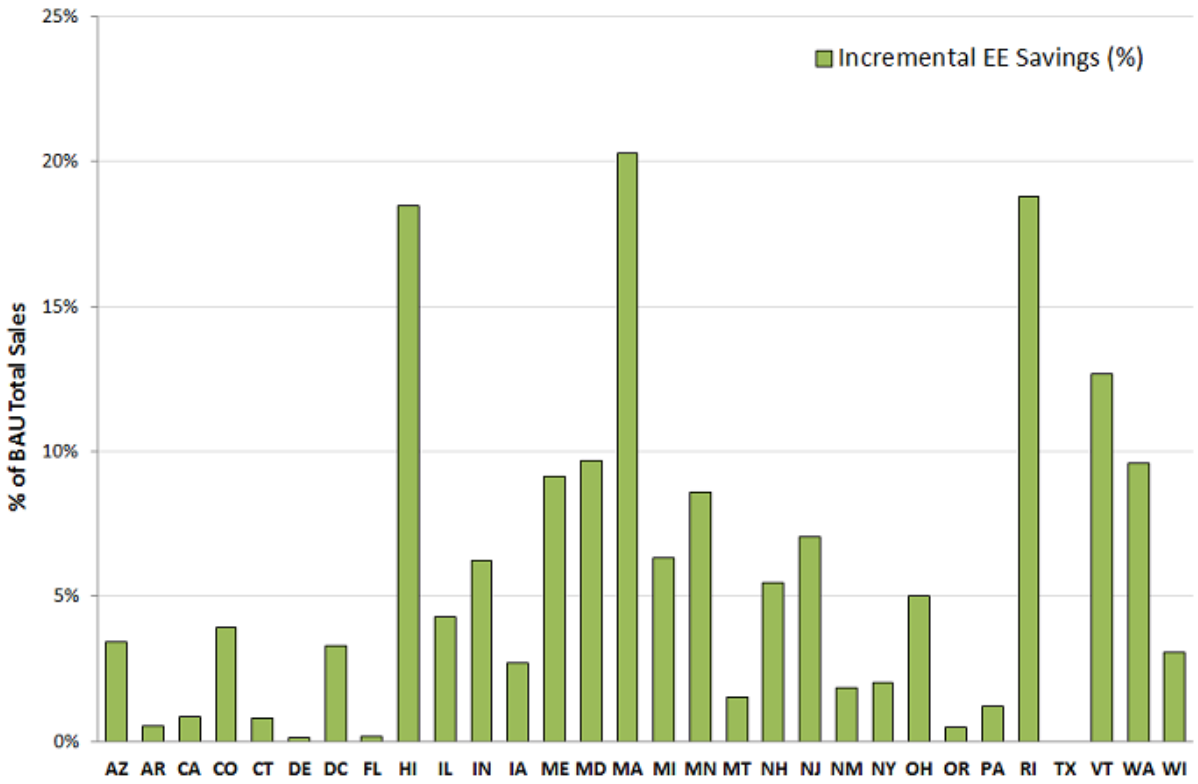

Figure 2. Draft annual incremental EE savings in 2025 relative to AEO 2013.

For this analysis, EPA identified the set of EE/RE policies that it believes contribute the majority of energy savings not accounted for in the AEO. However, we recognize that our analysis does not capture the full set of EE/RE policies and activities that states have implemented, are additional to the AEO2013, and that may be creditable in a NAAQS SIP. For example, many states in regulated utility markets have implemented EE/RE through an Integrated Resource Plan (IRP) or similar process. EPA did not examine these policies due to resource constraints and the varying level of certainty associated with EE/RE programs implemented in this way[8].

[8] In some states IRP prescribes or authorizes specific actions, while in others IRP serves only as a guide for the utility and the public utility commission when evaluating acquisition or implementation of specific utility resources or programs. In such cases, the specific resource or program is approved through a PUC order that authorizes or requires actions and identifies performance obligations. These orders may or may not be fully consistent with provisions in an IRP.

Key Sources of Uncertainty in the Analysis

EPA is highlighting three sources of uncertainty with this analysis that states can consider:

- The impacts of state EE policies embedded in the AEO reference case
- PUC approval of EE program budgets necessary to meet the EERS targets
- Variations in state approaches for evaluating and reporting EE savings

It should be noted that, to the extent feasible, EPA used the best available information and adopted assumptions intended to reduce the likelihood of overstating the impacts of the states' EE and RE policies. EPA plans to revisit its methods as new information becomes available and anticipates benefiting from the experience of parallel efforts aimed at accounting for the impacts of EE and RE policies in energy and environmental planning.

Conclusions

Air regulators in many states report that they have already—or have nearly—exhausted their tried-and-true strategies for improving ambient air quality, such as ozone and particulate matter pollution. With SIP planners on the lookout for new approaches, the significant expansion of EE and RE policies and programs in recent years presents an opportunity for states out of attainment for one or more regulated pollutants to achieve the NAAQS, and for states nearing these levels to remain in attainment. In fact, in many cases the emissions impacts from these policies are already occurring, and just need to be accounted in state emissions baseline forecasts. EPA believes its new resources described above can help. However, as states get started with SIP planning using planned impacts from EE and RE initiatives, EPA is encouraging agencies to initiate an internal planning and coordination process that supports their SIP-related analytic efforts. A growing number of states are finding that agencies with separate jurisdiction over air quality regulation and EE and RE policy implementation can benefit from coordinating, sharing information, and addressing common objectives. For example, air regulators can work with their Public Utility Commission (PUC) and State Energy Office (SEO) counterparts to identify sources of EE and RE data, and to test and validate the policy assumptions and numeric estimates developed by EPA. This coordination between energy and air quality regulators is a key step towards successfully utilizing EPA's new resources and ultimately including EE/RE policies in plans for attaining the NAAQS.

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