Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans

Appendix J: Draft Methodology for EPA's Analysis of Existing State Energy Efficiency/Renewable Energy Policies

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SECTION J.1: INTRODUCTION

To help state, tribal and local agencies examine the role of energy efficiency/renewable energy (EE/RE) policies and programs in their State Implementation Plans/Tribal Implementation Plans (SIPs/TIPs), the U.S. Environmental Protection Agency (EPA) has developed a draft methodology for estimating the energy impacts of key EE/RE "on the books" policies that are not explicitly reflected in the Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2010 electricity projections. The EPA's draft methodology and associated analysis covers several state-level "on the books" EE/RE policies that are adopted in law and/or codified in rule or order. The EPA anticipates that the draft methodology may be useful to state, tribal and local agencies preparing SIP/TIP submittals to meet the National Ambient Air Quality Standards for ozone and other pollutants. (The EPA used this methodology to develop estimates of the energy impacts of EE/RE policies not accounted for in AEO2010.[1])

In conducting this analysis, EPA benefited from feedback from other federal and state agencies. The EPA plans to revisit its methods as new information becomes available and anticipates benefiting from the experience of other efforts aimed at accounting for the energy impacts of EE/RE policies in energy and environmental planning. In recognition of this opportunity to learn from new information, this version of the methodology is labeled *draft*.

SECTION J.2: STEPS OF THE ANALYSIS

The EPA undertook three steps to analyze the "on the books" EE/RE policies that are not explicitly accounted for in the reference case forecast currently used by EPA (e.g., AEO2010):

- Step 1: Understand policy assumptions in the current reference case forecast (e.g., AEO2010 Reference Case Forecast[2] (AEO2010)).
- Step 2: Identify key state-level EE/RE policies not explicitly included in the current reference case forecast (e.g., AEO2010) and collect relevant design details.
- Step 3: Develop analytical methods to estimate incremental[3] impacts of state-level EE/RE policies relative to the current reference case forecast (e.g., AEO2010).

These steps serve as an example for air agencies interested in revising an energy forecast (e.g., AEO2010) to reflect the EE/RE policies of interest.

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

To understand the EE/RE policy assumptions included in the AEO2010 forecast, EPA reviewed the EIA's documentation for the AEO2010 reference case forecast and consulted with EIA staff.

[1] For more information, go to: http://www.epa.gov/statelocalclimate/state/statepolicies.html.
[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, go to: http://www.eia.gov/analysis/.
[3] Incremental impacts of EE/RE policies relative to AEO2010 refers to the impacts not captured within AEO2010, taking into account any embedded impacts reflected in the forecast.

From the review, it is clear that AEO2010 explicitly includes the impacts of a number of existing EE/RE policies, including:

- Federal Appliance Standards[4]
  - Ten residential and ten commercial appliance categories
- Federal Funding for EE and related programs (e.g., through the American Recovery and Reinvestment Act)[5]
  - State Energy Program and Energy Efficiency Community Block Grant
  - Weatherization Program
  - Green Schools
  - Smart Grid expenditures
- Building Energy Codes[6]
  - All states adopt and enforce:
    - International Energy Conservation Code (IECC) 2006 (Residential Building Code) by 2011
    - IECC 2009 by 2018
    - American Society of Heating, Refrigerating and Air-Conditioning Engineers 90.1-2007 (Commercial Building Code) by 2018
- Renewable Portfolio Standards (RPS)[7]
  - 30 states and Washington, D.C. effective as of September 2009

Step 2: Identify and Review "On the Books" Energy Efficiency/Renewable Energy Policies not in the Reference Case

Based on its review, EPA identified four key "on the books" state-level EE/RE polices not explicitly included in the reference case forecast. The EPA focused its analysis on EE/RE policies that are currently in regulations, statutes, or state public utility commission (PUC) orders that require parties to acquire EE and/or RE or commit to funding levels for programs aimed at acquiring EE. The EE/RE policies listed below are the set of "on the books" state EE/RE policies EPA identified for this analysis.

State EE policies:

- Energy Efficiency Resource Standards (EERS)
- EE programs financed by Public Benefits Funds
- EE programs financed by the Regional Greenhouse Gas Initiative (RGGI)[8]

State RE policies:

- RPS policies adopted or updated between September 2009 and December 2010

[4] EIA (2010d), Appendix A, pp. 170-185.
[5] EIA (2010d), pp. 8-10.
[6] Ibid p. 8.
[7] EIA (2010a), pp. 14-17
[8] For more information, go to: http://www.rggi.org/.

After identifying the applicable EE/RE policies, EPA scanned the EE/RE policies of all 50 states to determine which states had adopted policies as of December 31, 2010. Once EPA identified which states had policies, EPA reviewed the relevant design details for each state EE/RE policy using publically available information, such as state legislation, state rules and regulations, PUC orders, and summary reports from the American Council for an Energy-Efficient Economy (ACEEE)[9], Lawrence Berkeley National Laboratory (LBNL)[10] and the Consortium for Energy Efficiency (CEE).[11]

Step 3: Develop Methods to Estimate Incremental Impacts of Energy Efficiency/Renewable Energy Policies Relative to the 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 impacts estimates: annual energy savings and generation for 2014-2030 and peak impacts and hourly load impact curves for 2015 and 2020.

SECTION J.3: OVERVIEW OF THE DRAFT METHODOLOGY AND ANALYTICAL STEPS

The EPA applied the following analytical steps to estimate the projected annual energy savings of EE Policies:

- Step 1: Generate a baseline (i.e., business as usual (BAU)) forecast of state electricity sales consistent with AEO2010 regional forecasts.
- Step 2: Estimate projected impacts of key state "on the books" EE policies already embedded in AEO2010 forecast of electricity sales.
- Step 3: Estimate projected EE savings from key state "on the books" EE policies
    - EERS (25 states)
    - EE programs financed by Public Benefits Funds (3 states)
    - RGGI allowance auction revenue for EE Programs (3 states)
- Step 4: Generate state-adjusted national energy forecast that reflects the energy savings not captured in (i.e., incremental to) the baseline forecast.

The EPA applied the following analytical steps to estimate peak demand savings for EE Policies (see Section J.4):

- Step 1: Estimate projected peak demand savings for the years 2010, 2012, 2015 and 2020.
- Step 2: Generate load impact curves that represent typical hourly changes in load from EE programs under consideration.

[9] ACEEE (2010).
[10] LBNL (2009).
[11] Consortium for Energy Efficiency (2010).

The EPA applied the following key analytical steps to estimate the projected annual energy impacts of RE policies (see Section J.5):

- Step 1: Estimate RE generation from RPS policies adopted or revised between September 2009 and December 2010.
- Step 2: Generate state-adjusted forecast and aggregate state-adjusted forecast to facilitate the energy modeling of regional RPS impacts.

Draft Methodology for Generating a Baseline Forecast of State Electricity Sales to Represent Annual Energy Outlook 2010 Regional Forecasts

State-level baseline sales[12] data were developed by first using 2010 historical state sales data from the EIA[13] and then applying the electricity sales growth rates from AEO2010. Annual Energy Outlook 2010-based "annual average growth rates" (AAGR) were calculated for each Electricity Market Module (EMM) region across the 2009-2035 forecast period. These regional growth rates were then applied to the 2010 historical sales for each state lying predominantly within the EMM region.[14] The 2009-2035 AAGR was used to forecast sales for 2011-2035. Table 1 shows the EMM region and the AAGRs used to forecast sales for each state.

Table 1: Electricity Market Module Region and Annual Energy Outlook 2010 Sales Growth Rates by States

State	Electricity Market Module Region	Average Annual Growth Rates (2009-2035)
Arizona	RA	1.4%
Arkansas	SERC	1.0%
California	CA	1.0%
Colorado	RA	1.4%
Connecticut	NE	1.3%
Delaware	MAAC	0.9%
Florida	FL	1.2%
Hawaii	HI	1.0%
Illinois	MAIN	1.0%
Indiana	ECAR	1.0%
Iowa	MAPP	1.1%
Maine	NE	1.3%
Maryland	MAAC	0.9%
Massachusetts	NE	1.3%
Michigan	ECAR	1.0%
Minnesota	MAPP	1.1%
Montana	NWP	1.1%

[12] Note that AEO2010 does not include state-level forecasts, so incremental impacts are calculated against the BAU electricity sales forecast developed as described in Section J.3.

[13] EIA (2011).

[14] EIA maps states to EMM regions for regional modeling of Renewable Portfolio Standards. The EPA followed this mapping approach where possible and assigned the remaining states to EMM regions based on population distributions.

State	Electricity Market Module Region	Average Annual Growth Rates (2009-2035)
Nebraska	MAPP	1.1%
New Hampshire	NE	1.3%
New Jersey	MAAC	0.9%
New Mexico	RA	1.4%
New York	NY	0.7%
Ohio	ECAR	1.0%
Oregon	NWP	1.1%
Pennsylvania	MAAC	0.9%
Rhode Island	NE	1.3%
Texas	ERCOT	0.9%
Vermont	NE	1.3%
Washington	NWP	1.1%
Wisconsin	MAPP	1.1%

Draft Methodology for Estimating Energy Savings of State Energy Efficiency Policies Embedded In Annual Energy Outlook 2010

The AEO2010 does not explicitly include the impacts of state EE policies such as EERSs, public benefit funded EE programs and RGGI-funded EE programs. However, AEO2010 results could implicitly reflect these programs to the extent that the forecast is based on historical data that was affected by state EE programs. The AEO2010 also accounts for future EE improvements, which could be partly attributed to these key state EE policies. Some portion of the savings from EE policies may, therefore, be embedded in the AEO2010 forecast and the AEO2010-based state-level BAU forecast. The EPA estimated the embedded savings for each state. The EPA then subtracted the savings from the state's total EE policy savings and estimated the impacts that are incremental to AEO2010. The EPA only applied embedded savings for years in which states see savings from EE policies. To the extent possible, EPA only calculated savings for entities that are required to implement the EE policies under consideration.

The EPA estimated embedded savings using a methodology similar to the method LBNL used in its analysis of ratepayer-funded EE,[15] which, lacking better information, assumes that the growth rates derived from the AEO forecast implicitly account for a continuation of 50 percent of historical levels of reported energy savings. The EPA quantified embedded energy savings for each state using the following three steps:

Step 1: Estimate historical savings for entities that implement key state EE policies[16]

- Total first-year electricity savings[17] from existing and new programs in 2007, 2008 and 2009 were obtained from the ACEEE.[18]

[15] LBNL (2009).
[16] Key state policies consist of: EERS, public benefit funded EE programs and RGGI-funded EE programs.

- For states that have EERSs with a total sales basis, or have only ratepayer- or RGGI-funded EE programs, savings from EE policies were taken to be equal to total incremental savings for each historical year.
- For states that have EERSs with a basis other than total sales, savings from EE policies were estimated as follows:
  - The EPA used EIA-861 utility-level data to identify utilities not affected by an EE policy in each state and their savings for 2007, 2008 and 2009.[19]
  - If these utilities had service areas in only one state, EPA assumed all the savings would occur in that state.
  - If these utilities had service areas in multiple states and they were either (a) affected by EE policies in all states, or (b) not affected by EE policies in any state in which they had a service area, EPA apportioned the savings to states based on 2009 utility sales in each state.
  - If the identified utilities had service areas in multiple states and they were affected by these policies in some but not all states in which they had a service area, EPA assumed all savings would occur in the states with EE policies. The EPA apportioned savings to these states based on 2009 utility sales in each state.[20]
  - The EPA estimated savings for entities that implement EE policies as the total first-year electricity savings for the state minus any other savings apportioned to the state.

Step 2: Estimating the weighted average of historical savings as a share of sales for 2007-2009

- The EPA divided historical savings by historical sales to estimate a weighted average savings rate. Annual electricity sales data for 2007-2009 for each state were obtained from EIA-861 state-level datasets.[21] The weighted average (m) of historical savings for entities that implement EE policies as a share of state sales was calculated as:

$$m = \Sigma X(t) / \Sigma Y(t)$$

Where:
t goes from 2007 to 2009,
X is the savings for entities that implement EE policies, and

[17] "First-year savings" is a common metric for characterizing savings associated with energy-efficient initiatives. For example, if a piece of highly efficient equipment is expected to save 10 MWh per year (as compared to one of average efficiency), and have a lifetime of 10 years, the first-year savings are 10 MWh, and the cumulative savings are 100 MWh (10 MWh/year * 10 years).
[18] ACEEE estimates state-level EE savings using utility-level data from EIA-861 and information from a state-by-state survey conducted by ACEEE. ACEEE (2009b, 2010, 2011b).
[19] Some utilities not affected by a state EE policy nonetheless may offer EE programs to their customers. EIA (2008a, 2009a, 2010c).
[20] EIA (2010e).
[21] EIA (2008b, 2009b, 2010e).

Y is the annual electricity sales.

Step 3: Estimating embedded savings for each future year

The weighted average of historical savings as a share of sales for 2007-2009 (*m*) is multiplied by 50 percent to yield embedded savings as a share (*n*) of baseline sales for each future year:

$n = m * 50\%$

Table 2 presents the estimated embedded savings as shares of baseline sales. Embedded savings were calculated as:

$F(t) = n * B(t)$
$E(t) = F(t) + F(t-1) + \ldots + F(t-L+1)$

Where:
F is the annual first-year embedded energy savings,
B is the baseline total sales, *L* is the measure lifetime, and
E is the cumulative embedded energy savings.

Table 2: Energy Efficiency Savings Estimated to be Embedded in Annual Energy Outlook 2010[22]

State	Savings Estimated to be Embedded in AEO2010 (percent of BAU Sales in Each Year)
Arizona	0.20
Arkansas	0.04
California	0.50
Colorado	0.18
Connecticut	0.51
Delaware	0.00
Florida	0.07
Hawaii	0.71
Illinois	0.06
Indiana	0.01
Iowa	0.38
Maine	0.40
Maryland	0.09
Massachusetts	0.40
Michigan	0.06
Minnesota	0.41
Montana	0.17
Nebraska	0.05

[22] ACEEE (2009b), Table 6; ACEEE (2010), Table 8; ACEEE (2010), Table 8; EIA (2008a), File3; EIA (2009a), File3; EIA (2009a), File3; EIA (2008b), Table 2; EIA (2009b), Table 2; EIA (2010e), Table 2.

State	Savings Estimated to be Embedded in AEO2010 (percent of BAU Sales in Each Year)
New Hampshire	0.33
New Jersey	0.24
New Mexico	0.10
New York	0.23
Ohio	0.07
Oregon	0.32
Pennsylvania	0.03
Rhode Island	0.44
Texas	0.07
Vermont	1.01
Washington	0.35
Wisconsin	0.38

Draft Methodology for Estimating Projected Energy Efficiency Savings from Energy Efficiency Policies

The EPA estimated state-level EE savings from EERSs, public benefit funded EE programs, and RGGI-funded EE programs. 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 and RGGI-funded programs. The EPA found that qualifying individual programs were not incremental to the EERS target, so each state with reported savings has either EERS savings, or ratepayer- and/or RGGI-funded savings.[23]

For each policy category EPA estimated first-year electricity savings for each year, and cumulative savings from EE measures implemented in the current year and past years. The EPA calculated cumulative savings using state-specific measure lifetimes (see Table 3 below) and assuming no decay of savings over the life of the measures. The EPA used a default lifetime of 13 years where state-specific assumptions were not available. The EPA did not estimate first-year savings beyond the requirements of each state's policy period. So, therefore, the forecast reverts to the AEO2010, which includes improved technology and efficiency in the long term.

Table 3: Measure Lifetime by State[24]

State	Measure Lifetime (Yrs)
Connecticut	13
Iowa	15
Massachusetts	13
Minnesota	13
Nevada	13
New Jersey	14
New Mexico	9
New York	15

[23] For more information, go to: http://www.epa.gov/statelocalclimate/state/statepolicies.html.
[24] ACEEE (2009a), Table 1.

State	Measure Lifetime (Yrs)
Oregon	12
Rhode Island	11
Texas	13
Vermont	13
Wisconsin	12
Default	13

Energy Efficiency Resource Standards

An energy efficiency resource standard (EERS) is a policy mechanism that sets targets for energy savings over a specified time frame from end-use EE programs operated by utilities or other program administrators. State-level screening revealed that states typically specify annual first-year or cumulative targets as percentages of electricity sales or as absolute energy savings. They use different bases for specifying EERS goals: some states specify goals based on sales from investor-owned utilities, while others have mandated targets based on total sales or some other subset of total sales.

The EPA estimated energy savings for each state using formulas specific to the state's EERS, as shown below. The EPA identified the appropriate sales basis for each state and, if the basis was not total sales, EPA used 2009 utility-level sales data from EIA[25] and AEO2010-based growth rates to develop baseline forecasts of sales of affected utilities (see Table 1). Because 2010 utility-level sales data were not available from EIA at the time of this analysis, EPA used the ratio of affected utility sales to total sales in 2009 to estimate the affected utility sales as a share of total sales for 2010. For most states, EPA assumes full achievement of EERS targets for all years in the compliance period. For some states, EPA does not assume full achievement of EERS targets in all years because of the way the programs are designed. One example of such a program is EERSs that have cost/rate caps or other design features (e.g., permitting counting of savings from building energy codes or historical EE programs) that may not lead to incremental energy savings consistent with the EERS targets.[26] Additionally, savings were not estimated for purely voluntary EERSs.

The general formulas used to estimate annual first-year and cumulative energy savings for each year (t) were:

1) <u>EERS with Annual First-Year EE Savings Targets Specified in Percent Terms</u>

$$A(t) = r(t) * Z(t-1)$$
$$C(t) = A(t) + A(t-1) + \ldots + A(t-L+1)$$
$$I(t) = C(t) - E(t)$$
$$Z(t) = B(t) - I(t)$$

Where:

[25] EIA (2010c).
[26] For more information, go to: http://www.epa.gov/statelocalclimate/state/statepolicies.html.

r is the annual first-year percent savings target,
A is the annual first-year energy savings,
L is the measure lifetime,
B is the baseline sales of utilities affected by these specific policies,
C is the cumulative energy savings,
E is the cumulative savings embedded in the AEO2010 forecast,
I is the cumulative savings incremental to AEO2010 forecast, and
Z is the adjusted sales after application of cumulative incremental savings.

2) EERS with Annual First-Year EE Savings Targets Specified in Absolute Terms

$C(t) = A(t) + A(t-1) + \ldots + A(t-L+1)$
$I(t) = C(t) - E(t)$
$Z(t) = B(t) - I(t)$

Where:
A is the annual first-year energy savings target,
L is the measure lifetime,
B is the baseline sales of utilities affected by these specific policies,
C is the cumulative energy savings,
E is the cumulative savings embedded in the AEO2010 forecast,
I is the cumulative savings incremental to AEO2010 forecast, and
Z is the adjusted sales after application of cumulative incremental savings.

3) EERS with Cumulative EE Savings Targets Specified in Percent Terms

$A(t) = C(t) - C(t-1) + A(t-L)$

If $r(t)$ available,
$C(t) = r(t) * B(t)$
$I(t) = C(t) - E(t)$
$Z(t) = B(t) - I(t)$

If $r(t)$ not available,
$Z(t)$ calculated by interpolation
$I(t) = B(t) - Z(t)$
$C(t) = I(t) + E(t)$

Where:
r is the cumulative percent savings target,
A is the annual first-year energy savings,
L is the measure lifetime,
B is the baseline sales of utilities affected by these specific policies,
C is the cumulative energy savings,

E is the cumulative savings embedded in the AEO2010 forecast,
I is the cumulative savings incremental to AEO2010 forecast, and
Z is the adjusted sales after application of cumulative incremental savings.

4) EERS with Cumulative EE Savings Targets Specified in Absolute Terms

$A(t) = C(t) - C(t-1) + A(t-L)$

If $C(t)$ available,
$I(t) = C(t) - E(t)$
$Z(t) = B(t) - I(t)$

If $C(t)$ not available,
$Z(t)$ calculated by interpolation
$I(t) = B(t) - Z(t)$
$C(t) = I(t) + E(t)$

Where:
C is the cumulative energy savings target,
A is the annual first-year energy savings,
L is the measure lifetime,
B is the baseline sales of utilities affected by these specific policies,
E is the cumulative savings embedded in the AEO2010 forecast,
I is the cumulative savings incremental to AEO2010 forecast, and
Z is the adjusted sales after application of cumulative incremental savings.

Some special considerations that warranted adjustments to the general formulas were:

1) 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 on RE to meet RPS requirements. For RPS policies explicitly included in AEO2010, no energy savings were estimated and RPS compliance is modeled through RE resources.

2) Compliance Type and Cost/Rate Caps: Several states have EERSs that use cost-containment provisions or other design features (e.g., allowing counting of energy savings driven by building energy codes) that may constrain the ability of EE program administrators to meet the EERS targets with incremental savings. The EPA identified seven states with such design features – Arizona, Illinois, Maryland, Michigan, Minnesota, Ohio, and Texas – and relied on available, state-specific academic reports[27],

[27] Satchwell (2011).

integrated resource plans[28], and other studies[29] to make downward adjustments to the nominal EERS targets to reflect these design features.[30]

3) "All Cost-effective EE" Targets: Seven states – Connecticut, Maine, Massachusetts, New Mexico, 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. In states with an "all cost effective EE" target without an EERS target through 2020, EPA estimated savings based on utility plans[31] and EE resource potential studies[32].

4) 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.[33]

Public Benefit Funded Energy Efficiency Programs

The EPA estimated EE savings for public benefit funded EE programs. Data for these EE programs are mainly available in terms of program expenditures, so 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 for 2010 from state publications[34] or utility surveys,[35] and projected funding for each future year as equal to the funding for 2010.[36] Estimates of levelized costs of saved energy (LCSE) were available for some states from ACEEE (2009a). These are presented in Table 4. 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. In such cases, ACEEE calculates LCSE as:

$$LCSE = (F * CRF)/A$$
$$CRF = (d*(1+d)^{L})/((1+d)^{L} -1)$$

[28] AEP TCC (2010), AEP TNC (2010), Ameren Illinois (2010), CenterPoint (2010), ComEd (2010), EPE (2010), Entergy (2010), Oncor (2010), SWEPCO (2010), TNMP (2010), Xcel (2010).
[29] Good Company Associates (2010).
[30] For more information, go to: http://www.epa.gov/statelocalclimate/state/statepolicies.html.
[31] CT Utilities (2010), MDPU (2010), National Grid (2008), EERMC (2010), VEIC (2009).
[32] KEMA (2010), NWPCC (2010)
[33] For more information, go to: http://www.epa.gov/statelocalclimate/state/statepolicies.html
[34] NHEU (2009), NJ BPU (2009).
[35] CEE (2010).
[36] In the case of New Jersey, total funding data for the NJ Clean Energy Program™ were available for 2010, 2011 and 2012. Though the share of total program funding projected to be spent on EE ranged from about 77 percent to 85 percent in these three years (NJ BPU 2008), EPA made a conservative assumption that only 50 percent of total funding will be allocated to EE programs. The EPA projected energy efficiency funding for each future year as equal to the funding for 2012.

Where:
A is the annual first-year energy savings,
F is the annual program funding,
CRF is the Capital Recovery Factor,
L is the measure lifetime, and
d is the discount rate.

ACEEE uses a real discount rate of five percent to calculate the Capitol Recovery Factor, and estimates that the average LCSE across the states included in the report is $0.025/kilowatt hour (kWh). To apply ACEEE's LCSE estimates in a manner that is consistent with the methodology by which they were calculated, this analysis also used a discount rate of five percent.[37] The average LCSE of $0.025/kWh was used as the default LCSE where state-specific estimates were not available. The EPA did not assume a decay of savings during the measure life, so savings for each year are equal to the lifetime savings averaged over the measure lifetime.

Table 4: Levelized Cost by State[38]

State	Levelized Cost of Saved Energy[39]
California	$0.029
Connecticut	$0.028
Iowa	$0.017
Massachusetts	$0.031
Minnesota	$0.021
Nevada	$0.019
New Jersey	$0.026
New Mexico	$0.033
New York	$0.019
Oregon	$0.016
Rhode Island	$0.030
Texas	$0.017
Vermont	$0.027
Wisconsin	$0.033
Default (simple average)	$0.025

The EPA estimated energy savings from ratepayer-funded programs in each year (t) using the following formulas:

$$CRF = (d * (1+d)^{L}) / ((1+d)^{L} - 1)$$

[37] A five percent discount rate is also the average of the two rates (i.e., 3 percent and 7 percent) that EPA currently uses when performing economic analysis as a part of its rule development; for more information, go to: http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.
[38] Source: ACEEE (2009a), Table 1.
[39] LCSE is based on program administrator costs, not on total resource costs.

$A(t)$[40] = ($F(t)$ * CRF)/$LCSE(t)$
$C(t) = A(t) + A(t\text{-}1) + \ldots + A(t\text{-}L\text{+}1)$

Where:
CRF is the Capital Recovery Factor,
L is the measure lifetime,
d is the discount rate,
A is the annual first-year energy savings,
F is the annual program funding,
LCSE is the levelized cost of saved energy, and
C is the cumulative energy savings.

Energy Efficiency Programs Funded by the Regional Greenhouse Gas Initiative

The EPA estimated savings from Regional Greenhouse Gas Initiative (RGGI)-funded EE programs for the states of Delaware, New Hampshire and New Jersey.[41] The seven other RGGI states have EERSs and RGGI-funded EE improvements count towards their EERS goals.

The EPA also estimated RGGI-funded savings using state-level estimates of program funding and costs of saved energy. The EPA estimated total RGGI proceeds available to each state in each year during the policy period by using forecasted allowance prices and carbon dioxide emissions.[42] RGGI states have agreed to allocate at least 25 percent of their shares of RGGI auction proceeds to a consumer benefit or a strategic energy purpose.[43] To date, states have allocated 52 percent of proceeds to improve EE.[44] Proceeds are allocated according to state laws, and the States of Delaware, New Hampshire and New Jersey have explicitly adjustable allocations[45] or have recently diverted RGGI proceeds for purposes other than RE, EE and direct consumer assistance.[46]

The EPA made a conservative assumption that 25 percent of each state's proceeds in each year are used to fund EE programs. Based on information from ACEEE,[47] EPA used an LCSE of $0.026/kWh for the New Jersey.

Consistent with the assumptions used to estimate savings from ratepayer-funded programs, EPA used a default LCSE of $0.025/kWh for the States of Delaware and New Hampshire, and a

[40] In the case of New Hampshire, NHEU (2009) makes lifetime savings estimates, so EPA did not estimate them using this formula.
[41] The New Jersey Department of Environmental Protection notified RGGI Inc. in May 2011 that NJ would withdraw from RGGI effective December 31, 2011 and not participate in allowance auctions post 2011. As a result, annual incremental savings associated with NJ's participation in RGGI allowance auctions terminate after 2011. See http://www.rggi.org/docs/New_Jersey_Letter.pdf.
[42] ICF (2010).
[43] RGGI (2005).
[44] RGGI (2011).
[45] Delaware State Senate (2008).
[46] Nashua Telegraph (2010).
[47] ACEEE (2009a).

discount rate of five percent for all states. The EPA did not assume decay of savings during measure life, so savings for each year are equal to the lifetime savings averaged over the measure lifetime.

The EPA estimated energy savings from RGGI-funded programs in each year (t) using the following formulas:

$$CRF = (d*(1+d)^{L})/((1+d)^{L}-1)$$
$$A(t) = (F(t) * CRF)/LCSE(t)$$
$$C(t) = A(t) + A(t-1) + \ldots + A(t-L+1)$$

Where:
CRF is the capital recovery factor,
L is the measure lifetime,
d is the discount rate,
A is the annual first-year energy savings,
F is the annual program funding,
LCSE is the levelized cost of saved energy, and
C is the cumulative energy savings.

Draft Methodology for Generating State-Adjusted Forecast that Reflects Incremental Energy Savings

The EPA estimated energy savings that are incremental to the reference case (AEO2010) by subtracting cumulative savings embedded in AEO2010 from total savings from EERSs, ratepayer-funded programs and RGGI-funded programs:

$$I(t) = C(t) - E(t)$$

Where:
C is the cumulative energy savings,
E is the cumulative savings embedded in the AEO2010 forecast and
I is the cumulative savings incremental to AEO2010 forecast.

The state-adjusted electricity sales forecast includes the impact of EE savings that are incremental to the BAU reference case. State-level adjusted sales (*Z*) are calculated as:

$$Z(t) = B(t) - I(t)$$

Where:
B is the baseline total sales and
I is the cumulative savings incremental to AEO2010 forecast.

Important Sources of Uncertainty in the Analysis

In conducting this analysis, EPA used the best available information and generally adopted conservative assumptions in order to reduce the likelihood of overstating the impacts of the EE/RE policies. The 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/RE policies in energy and environmental planning.

At this point, EPA would like to highlight two sources of uncertainty that are important to keep in mind when utilizing these estimates and employing similar methods:

- The impacts of state EE policies embedded in the AEO reference case, and
- PUC approval of EE program budgets necessary to meet the EERS targets.

As discussed in Section J.3, the AEO reference case likely includes the impacts of some programs that are not explicitly listed. In this analysis, EPA assumes embedded impacts of state programs are approximately half of the historical impacts reported to EIA over the latest 3 years for which data are available. In order to understand how this assumption influenced the results, EPA conducted a sensitivity analysis in which the Agency varied the assumption about what percentage of historical reported results are embedded in the AEO2010 reference case. The core analysis, which assumed 50 percent of historical savings were embedded, estimated cumulative, national, incremental energy savings of 2.8 percent in 2020. Under the sensitivity analysis, EPA utilized the following alternative assumptions: 0 percent, 25 percent, 75 percent, 100 percent of historical savings were embedded. Under these alternative assumptions, cumulative, national, incremental savings in 2020 are 4.0 percent, 3.4 percent, 2.2 percent, and 1.7 percent, respectively. At the state level, this assumption is influential for states with a history of reporting significant EE program savings and less influential in other states.

Another source of uncertainty relates to PUC approval of EE program budgets necessary to meet the adopted targets. The EE policy that drives the core results of this analysis – EERS – depends on PUC approval of EE program budgets necessary to meet the targets. As discussed in Section J.3, several states' EERS legislation includes explicit cost or rate impact caps that may constrain the ability of EE program administrators to meet the nominal EERS targets and EPA attempts to account for this design feature in its analysis. However, even in states without specific cost or rate impact caps, PUCs generally have authority over EE program budgets and as the EERS targets increase in stringency (necessitating larger EE program budgets), there is uncertainty over whether PUCs will continue to approve the budgets necessary to achieve the EERS targets. While recent reports have documented steadily increasing EE program budgets[48] and generally good progress with states reporting achievement of EERS targets,[49] this will be an issue EPA tracks in the future as EERS targets increase.

[48] CEE (2010).
[49] ACEEE (2011).

SECTION J.4: DRAFT METHODOLOGY FOR ESTIMATING PROJECTED PEAK DEMAND SAVINGS OF ENERGY EFFICIENCY POLICIES

The EPA estimated state-level peak savings as the hourly load impact of EE programs during the hour of a state's peak energy use.[50] In the absence of state-specific information on the timing of the peak, EPA used the peak hour for each state that was assumed to be the same as the peak hour from the Integrated Planning Model™ (IPM) region[51] in which a state is located (based on population) in EPA's Base Case.

Table 5 presents the state-to-IPM-region mapping that was used. Since the load shape data used in EPA's Base Case were available for 2007, the peak hour for each year of interest was also shifted based on the first day of the year in the same manner as described in Step 3 ("Shift Based on First Day of the Year and Accounting for Leap Years") of the "Draft Methodology for Generating Load Impact Curves of Energy Efficiency Policies" below. For each state, EPA identified the peak hour for each year on the load impact curve for that year, and took the corresponding hourly impact as the peak savings.

Table 5: EPA Base Case Regional Mapping for Integrated Planning Model[52]

State	IPM Region
Arizona	AZNM
Arkansas	ENTG
California	CA-S
Colorado	RMPA
Connecticut	NENG
Delaware	MACE
Florida	FRCC
Hawaii	HAWI
Illinois	COMD
Indiana	RFCO
Iowa	MRO
Maine	NENG
Maryland	MACS
Massachusetts	NENG
Michigan	MECS
Minnesota	MRO
Montana	NWPE
Nebraska	MRO
New Hampshire	NENG

[50] The EPA assumed that EE programs do not shift the peak. The EPA did not perform a dynamic analysis of peak demand.

[51] "Model region" refers to the geographic regions defined for the "EPA Base Case using IPM® v.4.10," a projection of electricity sector activity that takes into account only those federal and state air emission laws and regulations whose provisions were either in effect or enacted and clearly delineated at the time the base case was finalized in August 2010. The peak hour is taken from load shapes used in EPA's Base Case using IPM®, which are compiled by aggregating FERC-714 data to the model region level.

[52] US EPA (2010), Introduction.

State	IPM Region
New Jersey	MACE
New Mexico	AZNM
New York	NYC
Ohio	RFCO
Oregon	PNW
Pennsylvania	MACE
Rhode Island	NENG
Texas	ERCT
Vermont	NENG
Washington	PNW
Wisconsin	WUMS

Draft Methodology for Generating Load Impact Curves of Energy Efficiency Policies

The EPA developed regional load impact shapes by sector to represent typical hourly load impacts from EE programs. The EPA estimated residential sector and commercial sector impact shapes for each of the nine U.S. Census Divisions and industrial sector impact shapes for each of the four U.S. Census Regions. The EPA based the shapes of the impacts on region- and sector-specific EE program mixes that were developed independently.[53] These program mixes were not intended to represent any particular set of programs in place, but were generic, driven by considerations including cost-effectiveness to the consumer, which varied mainly due to regional building population and climate.[54]

The EPA scaled the regional EE load impact shapes by sector previously developed based on state savings shares and total incremental savings by sector in order to develop load impact curves for this analysis. The implicit assumption was that the EE measures being modeled in aggregate mirror the bundled measures underlying the original load shapes. The EPA developed load impact curves for each state for 2010, 2012, 2015 and 2020 using the following steps.

1) Estimating Shares by Sector of EE Savings
   - The EPA calculated the average (O) of national savings by sector[55] (X) as a share of national sales by sector[56] (Y) for 2007-2009 for the residential (r), commercial (c) and industrial (i) sectors.

$$O_{r,n} = ((X_{r,n,2007}/Y_{r,n,2007}) + (X_{r,n,2008}/Y_{r,n,2008}) + (X_{r,n,2009}/Y_{r,n,2009}))/3$$
$$O_{c,n} = ((X_{c,n,2007}/Y_{c,n,2007}) + (X_{c,n,2008}/Y_{c,n,2008}) + (X_{c,n,2009}/Y_{c,n,2009}))/3$$
$$O_{i,n} = ((X_{i,n,2007}/Y_{i,n,2007}) + (X_{i,n,2008}/Y_{i,n,2008}) + (X_{i,n,2009}/Y_{i,n,2009}))/3$$

[53] Load shapes were developed using the Building Energy Analysis Console (Beacon™), ICF's proprietary model for simulating energy consumption by buildings.
[54] For more information, go to: http://www.epa.gov/statelocalclimate/state/statepolicies.html.
[55] EIA (2008a, 2009a, 2010c).
[56] EIA (2008b, 2009b, 2010e).

- The EPA calculated sales by sector (Y) in 2009 as a share (P) of total residential, commercial and industrial sales for each state (s).

$$P_{r,s} = Y_{r,s,2009}/(Y_{r,s,2009} + Y_{c,s,2009} + Y_{i,s,2009})$$
$$P_{c,s} = Y_{c,s,2009}/(Y_{r,s,2009} + Y_{c,s,2009} + Y_{i,s,2009})$$
$$P_{i,s} = Y_{i,s,2009}/(Y_{r,s,2009} + Y_{c,s,2009} + Y_{i,s,2009})$$

- The EPA calculated shares by sector of EE savings (Q) in each state as:

$$Q_{r,s} = (P_{r,s} * O_{r,n})/(P_{r,s} * O_{r,n} + P_{c,s} * O_{c,n} + P_{i,s} * O_{i,n})$$
$$Q_{c,s} = (P_{c,s} * O_{c,n})/(P_{r,s} * O_{r,n} + P_{c,s} * O_{c,n} + P_{i,s} * O_{i,n})$$
$$Q_{i,s} = (P_{i,s} * O_{i,n})/(P_{r,s} * O_{r,n} + P_{c,s} * O_{c,n} + P_{i,s} * O_{i,n})$$

Table 6 shows savings shares for each state.

Table 6: Shares of Savings by Sector[57]

State	Share of Savings (percent)		
	Residential	Commercial	Industrial
Arizona	50.6	43.3	6.1
Arkansas	51.2	33.0	15.8
California	40.4	52.0	7.6
Colorado	42.1	46.2	11.7
Connecticut	47.4	47.7	4.9
Delaware	46.6	43.0	10.5
Florida	55.1	42.0	2.9
Hawaii	40.2	42.6	17.2
Illinois	41.4	44.9	13.8
Indiana	46.2	32.1	21.7
Iowa	43.7	35.6	20.6
Maine	47.1	42.0	10.9
Maryland	47.0	49.7	3.3
Massachusetts	45.9	40.0	14.0
Michigan	41.7	45.9	12.4
Minnesota	43.8	42.3	13.9
Montana	43.3	41.4	15.4
Nebraska	44.0	40.6	15.4
New Hampshire	47.5	45.5	7.0
New Jersey	40.7	55.0	4.3
New Mexico	38.0	48.7	13.3
New York	38.6	57.6	3.8
Ohio	45.8	38.6	15.7
Oregon	50.5	38.9	10.7
Pennsylvania	46.9	39.3	13.7

[57] EIA (2008a), File3; EIA (2009a), File3; EIA (2010c), File3; EIA (2008b), Table 2; EIA (2009b), Table 2; EIA (2010e), Table 2.

State	Share of Savings (percent)		
	Residential	Commercial	Industrial
Rhode Island	43.1	51.7	5.2
Texas	46.8	40.8	12.4
Vermont	47.0	42.1	10.9
Washington	49.8	38.9	11.3
Wisconsin	42.1	42.2	15.6

2) Scale Based on Savings Shares by Sector for Each State
   - The EPA selected the regional residential and commercial hourly EE impact shapes for the U.S. Census Division and the industrial shape for the U.S. Census Region in which the state lies.
   - The EPA scaled the regional load impact shapes by sector using the appropriate shares of EE savings by sector (*Q*) estimated in Step 1 to develop scaled 8,760 hourly load impacts by sector for each state.
   - The EPA summed the scaled residential, commercial and industrial 8,760-hour load impacts by hour to get the total hourly load impact shape of energy savings for the state (this is still normalized to base 1).

3) Shift Based on First Day of the Year and Accounting for Leap Years
   - The original load impact shapes were developed for a year that began on a Sunday.
   - The EPA identified the first day of each year of interest, and reconciled the load impact shapes by determining the least number of days between that day and Sunday.
     - For example, the year 2010 begins on a Friday, and Friday is two days before Sunday. The year 2020 begins on a Wednesday, and Wednesday is three days after Sunday.
   - For each year of interest, EPA shifted the total hourly load impact shape for a state ahead or behind by the least number of days to ensure that the first day of the load impact shape corresponded with the first day of the year.
   - Two years of interest, 2012 and 2020, are leap years. The EPA did not include the last day of each of these years in the analysis to ensure consistency across years.

4) Scale based on Total Incremental Savings for Each State
   - For each year, EPA scaled the shifted and scaled hourly load impacts once more by multiplying them by the total cumulative incremental savings estimated for that year. The resulting 8,760 hourly load impacts sum to the total cumulative incremental savings and represent the load impact shape for the year.

SECTION J.5: DRAFT METHODOLOGY FOR ESTIMATING RENEWABLE ENERGY SALES FROM RENEWABLE PORTFOLIO STANDARDS BEYOND WHAT IS CAPTURED IN ANNUAL ENERGY OUTLOOK 2010

The AEO2010 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 (e.g., California, New York), AEO assumes utilities comply with RPS requirements only to the extent that state funding allows, as described in both the AEO2010 and AEO2011 assumptions documents.[58]

This analysis maintains consistency with these limiting assumptions. The EPA included the RPS policies for five states (California, Colorado, Delaware, Hawaii, and New York) in this analysis because they were known to have been excluded from AEO2010 (e.g., Hawaii) or revised since the time of AEO2010 forecast development. In this analysis, EPA assumes the incremental RPS requirements set by these five states are fully achieved, with the noted exception of California and New York. This analysis captures those limits by adopting the AEO forecast of renewable generation for the corresponding regions instead of the RPS policies themselves. Specifically, EPA compared the AEO2010 RPS target for California (which was not subject to limiting assumptions) and AEO2010 renewable generation for New York (used in place of the RPS policy target because of limiting assumptions) to the corresponding regional renewable generation in AEO2011[59] (where both states were subject to limiting assumptions). The EIA did not identify funding limitations for Colorado or Delaware, and EPA assumed their full RPS targets would be achieved.[60] Table 7 presents final RPS targets used in this analysis for the five states for which EPA identified updated RPS requirements.

The RPS targets as a percent of total sales were available for each year in the policy period for the States of Colorado and Delaware. The EPA applied these to the State-Adjusted Electricity Sales Forecasts for the respective states to estimate required RE sales. In the case of Hawaii, where RPS targets were only available for 2010, 2015, 2020 and 2030, EPA estimated sales in intervening years by interpolation.

Because RPS targets for California and New York were limited by EIA assumptions as described above, the table below reflects their targets as equal to the corresponding regional renewable generation from AEO2011. For all states, RPS requirements were frozen in percent terms for the years after the RPS policy period.

[58] "The California and New York programs require state funding, and these programs are assumed to be complied with only to the extent that state funding allows." EIA 2010d, page 169.

[59] AEO2011 was used instead of AEO2010 because the state RPS policies that were revised after AEO2010's completion were subsequently captured in AEO2011, meaning that the AEO2011 forecast will have taken into account both the higher RPS targets and the state funding limitations.

[60] While Delaware is situated in the RFC-East region, which did not have sufficient renewable generation to meet its combined RPS target in AEO2011, EIA considers the RPS target to have been satisfied via interregional trading.

Table 7: Renewable Portfolio Standard Assumptions Made in This Analysis

State	State RPS Generation (1,000 GWh)	
	2015	**2020**
California	28.37	34.85
Colorado	6.94	10.75
Delaware	1.56	2.49
Hawaii[61]	1.43	2.28
New York	4.83	4.93

[61] AEO2010 provides a forecast for the continental U.S. only, so impacts of Hawaii's RPS are not included in AEO2010.

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