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ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY

Incorporating Energy Efficiency into Western Interconnection Transmission Planning

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Environmental Energy Technologies Division

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Acronyms and Abbreviations

ACEEE – American Council for an Energy-Efficient Economy
AEO – Annual Energy Outlook
AESO – Alberta Electric System Operator
APS – Arizona Public Service Company
ARRA – American Recovery and Reinvestment Act
ASAP – Appliance Standards Awareness Project
AVA – Avista Corporation
BA – balancing authority
BCTC – British Columbia Transmission Corporation
BPA – Bonneville Power Administration
CFE – Comision Federal de Electricidad
CHPD – Public Utility District No. 1 of Chelan County
DOE – Department of Energy
DOPD – Public Utility District No. 1 of Douglas County
DG – distributed generation
DR – demand response
DSM – demand-side management
EE – energy efficiency
EIA – Energy Information Administration
EISA - Energy Independence and Security Act
EPE – El Paso Electric Company
FAR_EAST – Idaho Power Company, Far East load zone
FERC – Federal Energy Regulatory Commission
GCPD – Public Utility District No. 2 of Grant County
IID – Imperial Irrigation District
IPCO – Idaho Power Company
IRP – Integrated Resource Plan
LBNL – Lawrence Berkeley National Laboratory
LDWP – Los Angeles Department of Water and Power
LRS – Loads and Resources Subcommittee
MAGIC_VLY – Idaho Power Company, Magic Valley load zone
NEMS – National Energy Modeling System
NERC - North American Electric Reliability Corporation
NEVP – Nevada Power Company
NPCC – Northwest Power and Conservation Council
NWMT – NorthWestern Energy
PACE _ID – PacifiCorp East – Idaho
PACE_UT – PacifiCorp East – Utah
PACE_WY – PacifiCorp East – Wyoming
PACW – PacifiCorp West
PGE – Pacific Gas & Electric
PGE_BAY – Pacific Gas & Electric, San Francisco Bay load zone
PGE_VLY – Pacific Gas & Electric, Central Valley load zone
PGN – Portland General Electric

PNM – Public Service Company of New Mexico
PSC – Public Service Company of Colorado
PSE – Puget Sound Energy
RTEP - Regional Transmission Expansion Planning
SCE – Southern California Edison
SCL – Seattle City Light
SDGE – San Diego Gas & Electric
SMUD – Sacramento Municipal Utility District
SPP – Sierra Pacific Power Company
SPSC – State-Provincial Steering Committee
SRP – Salt River Project
TEP – Tucson Electric Power Company
TEPPC – Transmission Expansion Planning and Policy Committee
TIDC – Turlock Irrigation District
TPWR – Tacoma Power
TREAS_VLY – Idaho Power Company, Treasure Valley load zone
WACM – Western Area Power Administration, Colorado-Missouri Region
WALC – Western Area Power Administration, Lower Colorado Region
WAUW – Western Area Power Administration, Upper Great Plains West
WECC – Western Electricity Coordinating Council
WGA – Western Governors' Association

1. Introduction

The Western Electricity Coordinating Council (WECC) conducts transmission planning studies through its Transmission Expansion Planning and Policy Committee (TEPPC). In recent years, WECC's transmission planning process has been substantially expanded and enhanced with funding from the U. S. Department of Energy provided under the American Recovery and Reinvestment Act (ARRA) of 2009. This expanded effort, designated the *Regional Transmission Expansion Planning* (RTEP) project, entails the development of biennial 10- and 20-year transmission plans that serve to identify future transmission expansion needs and options for meeting those needs. The analysis conducted for each plan evaluates numerous stakeholder-driven "study cases" (i.e., scenarios) using production cost modeling and capacity expansion modeling tools. These study cases are selected through WECC's annual study request process, whereby stakeholder groups can recommend specific study cases for analysis during the annual study cycle. State regulators and energy agencies provide input to WECC's transmission planning analyses via (among other channels) the State -Provincial Steering Committee (SPSC), an entity formed by the Western Governors' Association (WGA), which participates in the annual study request process.

Lawrence Berkeley National Laboratory (LBNL) provides technical assistance to the SPSC and WECC with the development of demand-side management (DSM)-related assumptions and modeling inputs for WECC's transmission planning analyses. In this capacity, LBNL's work to-date has largely revolved around the implementation of specific SPSC study requests for both the 10-year and 20-year plans. In particular, these study requests have included (a) "reference cases" that incorporate the expected impacts of current DSM-related policies and plans and (b) "High DSM" study cases that entail higher levels of DSM impacts than anticipated in the reference case. This activity has occurred under the auspices of the SPSC DSM Work Group. Participants in that group, including state regulatory and energy agency staff, utilities, and regional DSM experts, have vetted and provided input on key assumptions and methodologies. Critical review and input has also been provided by the TEPPC DSM Task Force, the TEPPC Data Work Group, and other key participant groups within the TEPPC process.

This report documents the energy efficiency-related analyses developed by LBNL and its contractors have conducted within the 2011 and 2012 TEPPC study cycles. This includes three distinct study cases: the 10-Year Reference Case (termed the WECC 10-Year Common Case), the 10-Year SPSC High DSM/DG Case, and the 20-Year SPSC High DSM/DG Case. Each of those study cases included assumptions and analyses for three types of DSM resources: energy efficiency, demand response (DR), and distributed generation (DG). This report focuses specifically on energy efficiency; the DR and DG components of the study cases are addressed in separate reports (Satchwell et al., 2013; Olson and Schlag, 2013). For each study case, model inputs were developed for each of the 39 individual load zones used within WECC's modeling tools; these load zones correspond roughly to the set of balancing authorities (BAs) shown in Figure 1.[1]

[1] The TEPPC load zones and the BA regions differ in several respects. First, several BAs consist of a number of smaller TEPPC load zones; in particular, the CISO BA consists of four load zones (PG&E_BAY, PG&E_VLY, SCE, and SDGE), and the PACE BA consists of three load zones (PACE_ID, PACE_UT, and PACE_WY). Second,

This report is targeted primarily for participants in WECC's transmission planning process, and is intended to serve as a reference document to inform future transmission planning efforts within the Western Interconnection. In addition, the methods described herein for modeling energy efficiency impacts within WECC's recent transmission planning analyses may also have broader application: e.g., for regional transmission planning organizations engaged in FERC Order 1000 compliance activities, for individual utilities conducting integrated resource planning, and for interconnection-wide transmission planning efforts in other regions.

The report is organized as follows. In Chapter 2, we describe the energy efficiency assumptions and analysis for the WECC 10-Year Common Case, which was developed during TEPPC's 2011 study cycle and formed the basis for WECC's first 10-Year Transmission Plan. Chapter 3 presents the corresponding information for the SPSC 10-Year High DSM Case, also developed within the 2011 study cycle. Chapter 4 moves to the 20-year planning horizon, and describes in detail the analysis and assumptions employed in developing the SPSC 20-Year High DSM Case during TEPPC's 2012 study cycle. Finally, Chapter 5 contains our recommendations identifying potential data, modeling, and process improvements for future TEPPC study cycles.

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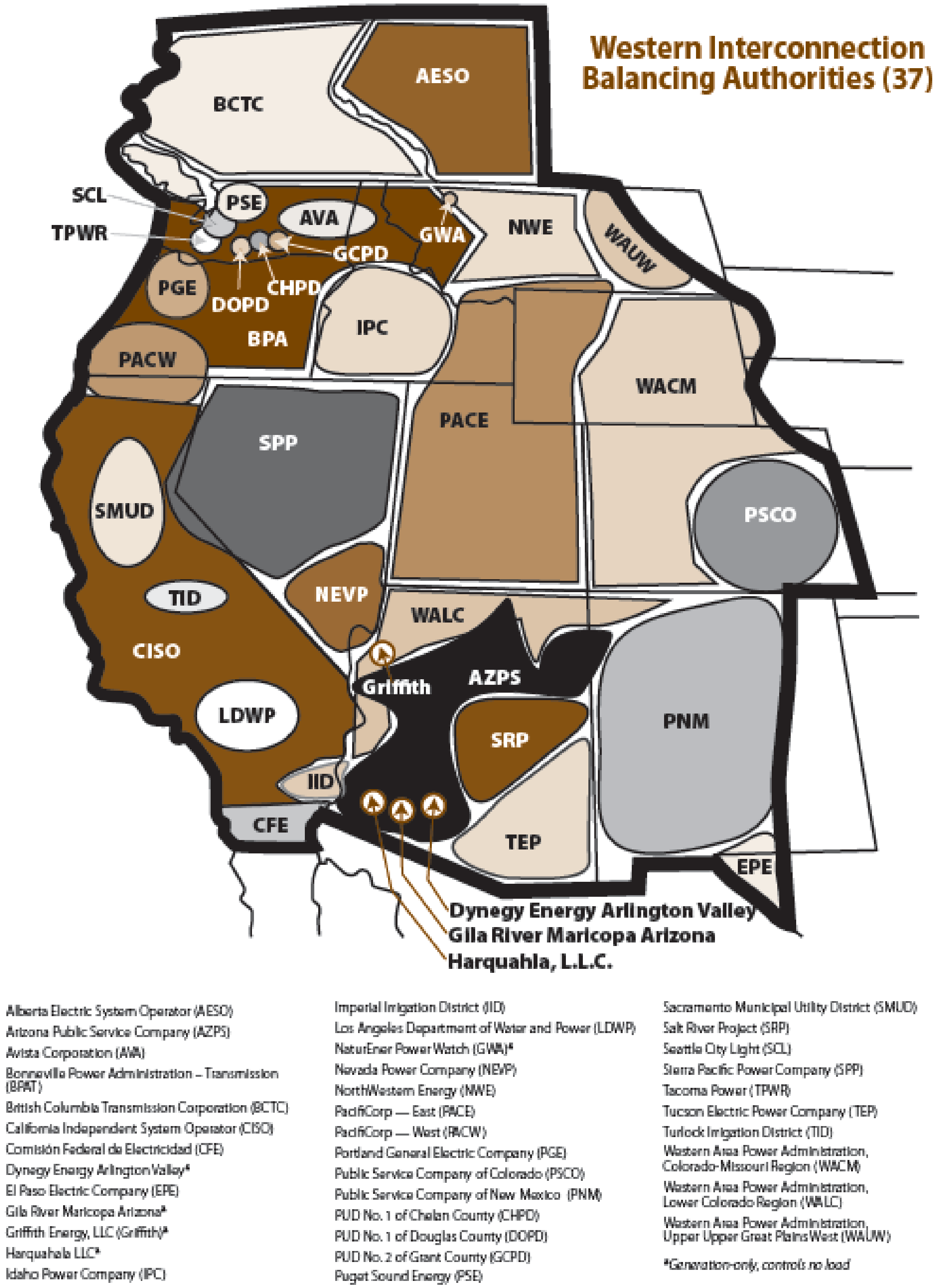
five BAs are generation-only (GWA, Dynegy, Gila River, Griffith, and Harquahla), and thus have no corresponding TEPPC load zone.



Source: WECC

Figure 1. WECC Balancing Authorities (circa 2011)

2. WECC 10-Year Common Case

The 10-year study cases within TEPCC's 2011 and 2012 study cycles were focused on the horizon year 2022. The reference point for these study cases was a single study case, termed the WECC Common Case, which is intended to reflect expected (i.e., 1-in-2) loads, generation, and transmission over the 10-year study horizon. This chapter describes the process used to develop the Common Case load forecasts, focusing on a set of adjustments made to the load forecasts in order to capture the expected impact of energy efficiency programs and policies implemented over the study period.

The load forecasts for the WECC Common Case were developed by starting with the load forecasts that BAs submitted in response to WECC's 2011 LRS data request (henceforth referred to as the *LRS load forecasts*), which cover the period 2011-2021. The SPSC DSM Work Group determined – with extensive input from BA load forecasting staff and review by the TEPPC Data Work Group – the extent to which the LRS load forecasts fully capture the expected impact of existing energy efficiency policies and program plans implemented over the forecast period. To the extent that the forecasts were determined to not fully capture the expected those energy efficiency policy impacts, they were adjusted downward accordingly, yielding the WECC Common Case load forecast for the year 2021. This basic process is illustrated schematically in Figure 2. The 2021 forecasts were then extrapolated to 2022, the horizon year for WECC's 10-Year study during its 2011 study cycle, using the average annual growth rate over the 2010-2021 period.

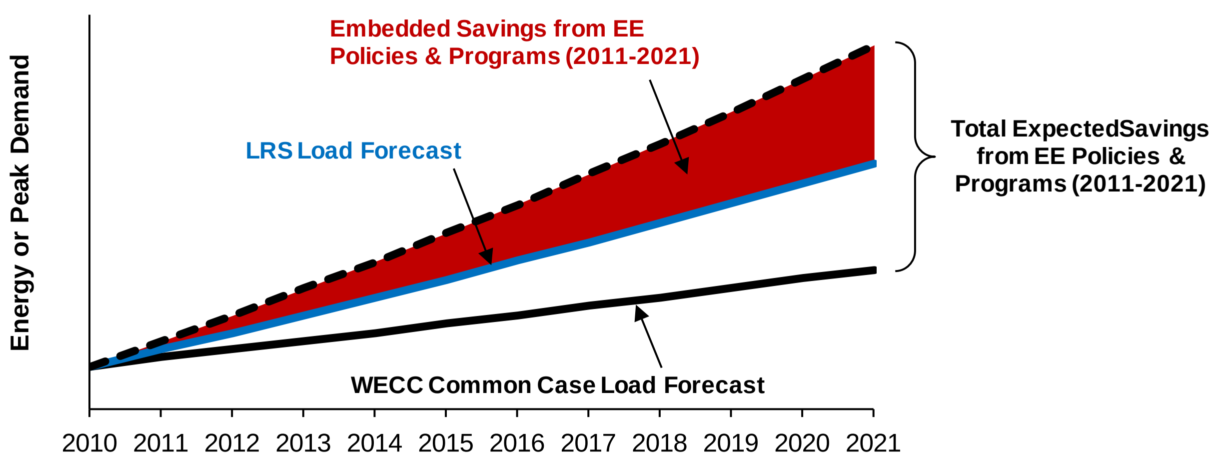


Figure 2. Illustration of Energy Efficiency Adjustment for the WECC Common Case Load Forecasts

In developing projections of expected energy efficiency savings and the associated adjustments to the LRS load forecasts, two classes of energy efficiency policies were of primary interest: (1) customer-funded energy efficiency programs[2] and (2) federal minimum efficiency standards for appliances, lighting, and other end-use equipment (henceforth referred to simply as "federal

[2] *Customer-funded energy efficiency programs*, also referred to as *ratepayer-funded energy efficiency programs*, refer to the class of energy efficiency programs that are funded by utility ratepayers and administered either by the utility or by an independent program administrator.

standards"). The DSM Work Group focused on these two classes of policies on the grounds that they are likely to be the most significant source of policy-driven energy efficiency savings over the forecast period, and thereby ignored other energy efficiency policies and programs, such as state appliance efficiency standards, state building codes, and ARRA-funded efficiency programs. This narrow focus is one among several "conservatisms" built into the analysis.

In addition, the analysis focused on specific timeframes. For customer-funded efficiency programs, the analysis focused on the impact of programs implemented over the 2011-2021 period; it was assumed that the LRS load forecasts adequately captured residual savings from historical programs implemented prior to 2011, and therefore no further accounting was conducted for historical programs. For federal standards, the DSM Work Group focused specifically on standards adopted and updates to existing standards scheduled to occur through January 2013. This is another conservatism in the methodology, as DOE is required to continue updating standards regularly after that date.[3]

2.1 Customer-Funded Energy Efficiency Programs

Customer-funded energy efficiency programs have been implemented in the United States for more than three decades and, in many states and regions, have accelerated rapidly in recent years as a result of new or increased policy support. The WECC Common Case load forecasts are intended to fully reflect the expected savings from customer-funded programs implemented over the LRS load forecast period (2011-2021), given current policies and utility resource plans.

As part of the 2011 LRS data request, BAs were asked to provide projections of the energy efficiency program savings incorporated into their LRS load forecast.[4] LBNL reviewed these energy efficiency savings projections and, with input from SPSC DSM Work Group participants and other state and regional energy efficiency experts, assessed the consistency of these savings projections with applicable statutory and regulatory policies, recent utility integrated resource plans, and utility DSM program plans.

LBNL then communicated with load forecasting staff at many of the individual balancing authorities in order to: (a) clarify any ambiguities in the savings projections submitted through the LRS request, (b) discuss any apparent discrepancies between the submitted savings projection and what would be expected under current policies and program plans, and (c) confirm whether the 2011 LRS load forecasts fully account for the expected energy efficiency program savings. If the savings projection provided by a BA differed significantly from the expected amount, or if the load forecast did not fully account for the BA's savings projection,

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[3] The decision to focus only on scheduled updates through January 2013 was justified on the grounds that standards adopted at later dates would likely have minimal impacts on loads in 2022, given the lag between the conclusion of rulemakings and the date that standards go into effect, and given the pace of equipment stock turnover. If, however, adjustments were being made over a longer time horizon, such as for WECC's 20-Year study, some consideration of continued updates to federal standard over time may be warranted in order to ensure that the forecasts reflect reasonable assumptions about the likely impacts of federal standards.

[4] This was a new element in the LRS data request for 2011. Responses to this question, however, were not mandatory, and therefore not all BAs provided this data. Moreover, many BAs evidently did not interpret the question as intended, and therefore the submitted savings projections were of widely varying quality, requiring a significant amount of follow-up with BA staff.

then the LRS load forecast was adjusted downward accordingly. As shown in Table 1, such adjustments were made for 11 BAs. Further details describing the underlying basis of the projected savings for each BA, as well as the savings projections themselves, are summarized in Appendix A.

Table 1. Adjustments to 2011 LRS Load Forecasts for Customer-Funded Efficiency Programs

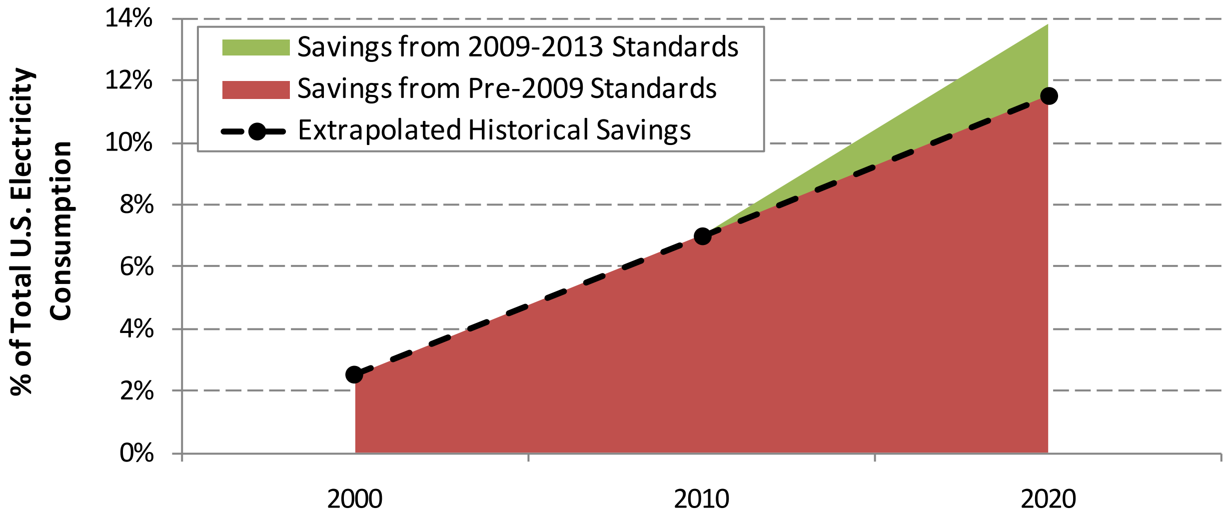
AVA	The LRS load forecast only accounts for savings from existing efficiency programs, but not for any of the planned new programs within Avista's most recent IRP. As such, the forecast was adjusted downward based on the IRP savings projection for new efficiency programs.
CISO	The LRS load forecast accounts only for "committed" energy efficiency savings, and therefore excludes "uncommitted" savings associated with IOU programs implemented after 2012, savings from POU programs implemented after 2010, and savings from other future changes to codes/standards. The forecast was therefore adjusted downward based on the sum of: (a) the incremental uncommitted savings assumed by the CPUC within the IOUs' long-term procurement proceeding and (b) the estimated savings from EE programs implemented by POUs within the CISO footprint, based on those utilities' most recent long-term EE savings targets.
IPC	The LRS load forecast accounts for only existing programs in Idaho Power's 2011 IRP, but not for the projected savings from planned new programs identified within the IRP. The forecast was therefore adjusted downward based on the IRP savings projection for new efficiency programs.
NWMT	The LRS load forecast accounts for a continuation of energy efficiency programs at NorthWestern Energy's historical rate of savings. The load forecast was therefore adjusted downward based on the difference between the utility's planned savings level, as projected within its 2009 Electric Default Supply Procurement Plan, and the utility's historical rate of savings.
PACE & PACW	The LRS load forecast assumes a level of savings based on the target from PacifiCorp's 2008 IRP Update rather than the updated efficiency targets in the utility's 2011 IRP. Therefore, the PACE and PACW load forecasts were adjusted downward by an amount equal to the difference between the savings targets in the 2011 IRP and the 2008 IRP Update.
PSCO	The LRS load forecast assumes a level of savings based on an earlier set of long-term savings targets established under Docket. 08-0560. The forecast was therefore adjusted downward slightly in order to account for the higher level of savings required under the updated savings goals adopted in March 2011 (Decision No. C11-0442).
PNM	The LRS load forecast does not include any impacts from future energy efficiency programs, and was therefore adjusted downward based on the savings required of PNM to comply with New Mexico's energy efficiency resource standard.
SRP	The LRS load forecast roughly accounts for the level of savings required to meet SRP's Sustainable Portfolio Plan savings targets through 2017, but does not include any savings from programs implemented in subsequent years. The load forecast was therefore adjusted downward to account for the expected savings needed to meet the Sustainable Portfolio Plan savings targets in 2018-2021.
TEP	The LRS load forecast partially accounts for the effects of planned customer-funded energy efficiency programs over the forecast period, but not at the level necessary to meet the Arizona Energy Efficiency Standard. As such, the load forecast was adjusted downward based on the additional amount of savings required of Tucson Electric and Unisource to comply with standard.
WACM	The load forecast that Colorado Springs Utilities (CSU) provided to WAPA, which is then rolled up into the LRS load forecast for the WACM balancing authority, does not account for the impacts of any future energy efficiency programs. As such, the WACM forecast was adjusted downward based on the energy efficiency savings projection provided by CSU.

2.2 Federal Appliance, Lighting, and Equipment Standards

The U.S. federal government establishes minimum efficiency standards for a wide variety of consumer appliances, lighting technologies, and other end-use equipment. For most of these products, DOE is responsible for setting the standard level and is required to conduct periodic rulemakings to evaluate potential updates to the standard. For a number of other products, Congress has instead established the initial minimum efficiency standard directly through legislation. A notable example is the federal standard for general service lamps enacted through the 2007 Energy Independence and Security Act (EISA), which mandates a phase-out of traditional incandescent light bulbs.

Figure 3 shows the projected total U.S. savings over time from federal standards adopted or updated through January 2013, based on analysis conducted by the American Council for an Energy Efficient Economy (ACEEE) and the Appliance Standards Awareness Project (ASAP).[5] The projected savings are separated into two components:

- Savings from standards established prior to 2009 (some of which don't go into effect until some number of years afterwards, such as the EISA lighting standard, which was phased-in starting in 2012)
- Savings from standards adopted or updated over the 2009-2013 timeframe (listed in Table 2), including a number of updates that had not yet occurred at the time of this analysis, but that DOE had committed to updating by January 2013



Source: Derived from estimates reported in ACEEE/ASAP report, "KaBOOM: The Power of Appliance Standards Opportunities for New Federal Appliance and Equipment Standards" (July 2009).

Figure 3. Projected Cumulative Savings from Federal Standards

As indicated in Figure 3, savings from the set of standards established prior to 2009—which represent the bulk of the total projected savings—accumulate over the 2010-2020 period at the same rate as over the 2000-2010 period. This growth in savings occurs as a result of stock turn-over, as old inefficient equipment is replaced with more-efficient models that comply with the existing federal standard. Additional savings from updates issued during 2009-2013 also accumulate over the 2010-2020 period, and represent an *acceleration* in the rate of savings from federal standards relative to the historical rate of growth. As described below, the fact that the 2009-2013 updates represent an acceleration in savings is central to the DSM Work Group's process of adjusting the LRS forecasts to reflect the expected impact of federal standards.

[5] Note that the ACEEE/ASAP study was conducted in 2009, and therefore the savings projections for standards adopted between then and January 2013 were based on assumptions about the standard level that DOE would adopt.

Table 2. Federal Standards Expected to be Adopted over 2009-2013

	Product	Planned Final Rule Date*	Compliance Date
Residential	Battery chargers	Jul-11	2014
	Central AC and heat pumps	Jun-11	2014
	Clothes dryers	Jun-11	2014
	Clothes washers	Dec-11	2015
	External power suppliers	Jul-11	2014
	Furnace fans	Jan-13	2016
	Microwave ovens	Mar-11	2014
	Refrigerators	Dec-10	2013
	Room AC	Jun-11	2014
	Water heaters	Mar-10	2013
Commercial	Beverage vending machines	Aug-09	2012
	Commercial clothes washers	Jan-10	2013
	Fluorescent ballasts	Jun-11	2014
	Fluorescent lamps	Jun-09	2012
	Incandescent reflector lamps	Jun-09	2012
	BR/exempted reflector lamps	Jan-10	2013
	Liquid-immersed transformers	Jan-13	2016
	Low volt. dry-type transformers	Jan-13	2016
	Metal halide lamp fixtures	Jan-12	2015
	Reach-in refrigerators & freezers	Jan-13	2016
	Small electric motors	Feb-10	2013
	Walk-in coolers & freezers	Jan-12	2015

* Planned final rule date, as of the time that the analysis for the WECC Common Case was being conducted

LBNL made adjustments to the LRS load forecasts to account for the expected impact of all federal standards adopted and all updates to existing standards scheduled to occur through January 2013. To so, LBNL sought information from the load forecasting staff of individual balancing authorities regarding the manner in which their forecasts model the impact of federal standards. Based on the information received, one of two potential standardized methods was used for most BAs in order to adjust the LRS forecasts to account for the expected impact of federal standards (see Table 3 for a summary, and see Appendix A for BA-specific details):

Method 1. Many BAs indicated that their load forecasts do not explicitly model the impact of federal standards. The default assumption in these cases is that, by virtue of the underlying econometric models, these load forecasts implicitly extrapolate into the future the historical rate of savings from federal standards, and that they *therefore fully capture the savings from pre-2009 federal standards, but do not capture any of the expected savings from 2009-2013 standards*. These load forecasts were therefore adjusted downward based on the projected savings from the 2009-2013 updates (i.e., the olive-colored “wedge” in Figure 3). For each BA, the expected savings from 2009-2013 standards was estimated from the state-level projections presented in Table 4, by pro-rating the state-level savings based on the portion of the statewide load within the BA; the LRS load forecast was then adjusted downward by that amount.

Method 2. In other instances, BAs reported that their load forecasts were based on end-use models or included statistical adjustments that are able to capture the impact of specified federal standards. In practice, these load forecasts generally capture the impact of all federal standards adopted as of the date that the forecast was prepared, but do not model the impact of *scheduled* updates to federal standards. For these BAs, the load forecasts were assumed to capture the both the impact of pre-2009 standards (as in Method 1) as well as the impact of standards adopted between 2009 and year-end 2010 (i.e., a *portion* of the olive-colored "wedge" in Figure 3). These load forecasts were therefore adjusted downward based on the expected impact of only those standards that had not yet been adopted at the time that the forecasts were prepared but for which DOE has scheduled an update by January 2013. For each BA, the expected savings from prospective standards scheduled for adoption by January 2013 was estimated from the state-level projections for "Prospective" standards presented in Table 4, by pro-rating the state-level savings based on the portion of the statewide load within the BA; the load forecast was then adjusted downward by this amount.

For three other BAs (CISO, PACE, and PACW), neither Method 1 nor Method 2 was applied. The adjustments to the LRS load forecasts for these BAs addressed multiple energy efficiency policies simultaneously, including federal standards, and therefore no separate adjustment for federal standards was required. Specifically, in the case of CISO, the LRS forecast was adjusted downward based on the Energy Commission's estimate of the "incremental uncommitted" savings associated with achievement of the state's savings goals for the IOUs, as discussed previously in Section 2.1. The incremental uncommitted savings was assumed to largely capture the impact of the 2009-2013 updates to federal standards, and therefore no separate adjustment was applied to the CISO forecast for federal standards. Similarly, for PACE and PACW, the adjustment made to the LRS forecast was based on the savings projection in PacifiCorp's IRP, and that savings projection (according to PacifiCorp staff) was inclusive of savings from future federal standards.

For the remaining BAs, no adjustments to the LRS forecasts were made for federal standards, though the reasons for this treatment vary. For BPA and most of the northwestern public utility district BAs (CHPD, DOPD, GCPD, and TPWR), the LRS load forecasts were determined to be net of the NPCC's conservation targets, and those targets were assumed to largely capture the savings from recent and future federal standards updates; therefore, no adjustment to the LRS forecasts was made in these cases. For the three non-U.S. BAs (AESO, BCTC, and CFE), no adjustment was made because these regions are not directly subject to U.S. federal efficiency standards (though provincial standards exist in BC[6], and spillover in efficiency impacts from U.S. standards could occur across borders into all three regions). Finally, for WALC and WAUW, no adjustments were made simply due to a lack of information about how the LRS load forecasts were prepared.

[6] Information was sought from BCTC to determine whether the load forecast submitted to WECC reflects the expected impact of provincial efficiency standards, but a response was not received within the required timeframe for this analysis.

Table 3. Approaches Used to Adjust LRS Forecasts to Account for the Impact of Federal Standards

Adjustment Approach	Balancing Authorities
Method 1	APS, EPE, IID, IPC, NWMT, PGE, PNM, PSE, SCL, SMUD, SRP, TEP, TID
Method 2	AVA, LADWP, NEVP, PSCO, SPP
Federal standards impact included in broader adjustment	CISO, PACE, PACW
No adjustment	BPA, CHPD, DOPD, GCPD, TPWR: Impact of federal standards captured in LRS forecast AESO, BCTC, CFE: U.S. federal standards not applicable WALC, WAUW: Insufficient information

Table 4. Projected Savings in 2021 from Federal Standard Updates Issued from 2009-2013

State	Energy Savings (GWh)			Peak Demand Savings (MW)		
	Already Adopted (2009-2010)	Prospective (2011-Jan. 2013)	**Total**	Already Adopted (2009-2010)	Prospective (2011-Jan. 2013)	**Total**
AZ	967	1,395	**2,362**	304	475	**778**
CA	4,377	6,183	**10,560**	966	1,472	**2,438**
CO	688	1,051	**1,739**	126	191	**317**
ID	206	314	**520**	40	60	**100**
MT	141	221	**362**	26	39	**65**
NV	365	592	**956**	104	159	**263**
NM	286	421	**707**	62	95	**158**
OR	515	764	**1,279**	94	143	**237**
UT	305	466	**771**	63	96	**159**
WA	878	1,315	**2,193**	158	242	**400**
WY	79	129	**208**	14	24	**38**
TOTAL	8,806	12,851	**21,657**	1,956	2,998	**4,954**

Sources: DOE Technical Support Documentation accompanying adopted standards (for "Already Adopted" standards); ACEEE/ASAP "KaBOOM: The Power of Appliance Standards Opportunities for New Federal Appliance and Equipment Standards" (for "Prospective" standards with final rules scheduled by January 2013).

2.3 Expected Energy Efficiency Savings

The 10-Year Common Case load forecasts are intended to reflect the expected impact of customer-funded energy efficiency programs and federal standards. The projected savings from these two sets of policies are summarized in Figure 4 (annual energy) and Figure 5 (annual peak demand), focusing specifically on the savings from customer-funded energy efficiency programs implemented over the 2011-2021 and the savings from new federal standards or updates to existing standards issued from January 2009 to January 2013. Savings are expressed in terms of the percentage reduction in 2021 loads for each BA and for WECC as a whole. Note that for a number of BAs, the underlying policies or data sources do not distinguish between the savings from customer-funded programs and from federal standards, in which case the figures present only the combined impact (the green bars). Refer to Appendix A for further details, including energy and peak savings projections expressed in absolute GWh and MW terms, and details on the underlying policies and data sources used to develop the projections for each BA.

As shown, the set of energy efficiency policies considered for the 10-Year Common Case are expected to reduce WECC-wide annual energy requirements by roughly 10% in 2021, and aggregate non-coincident peak demand by 12%. Naturally, the impacts vary considerably across individual BAs, reflecting differing degrees of underlying policy support, as well as differences in customer mix, climate, end-uses, and other factors.

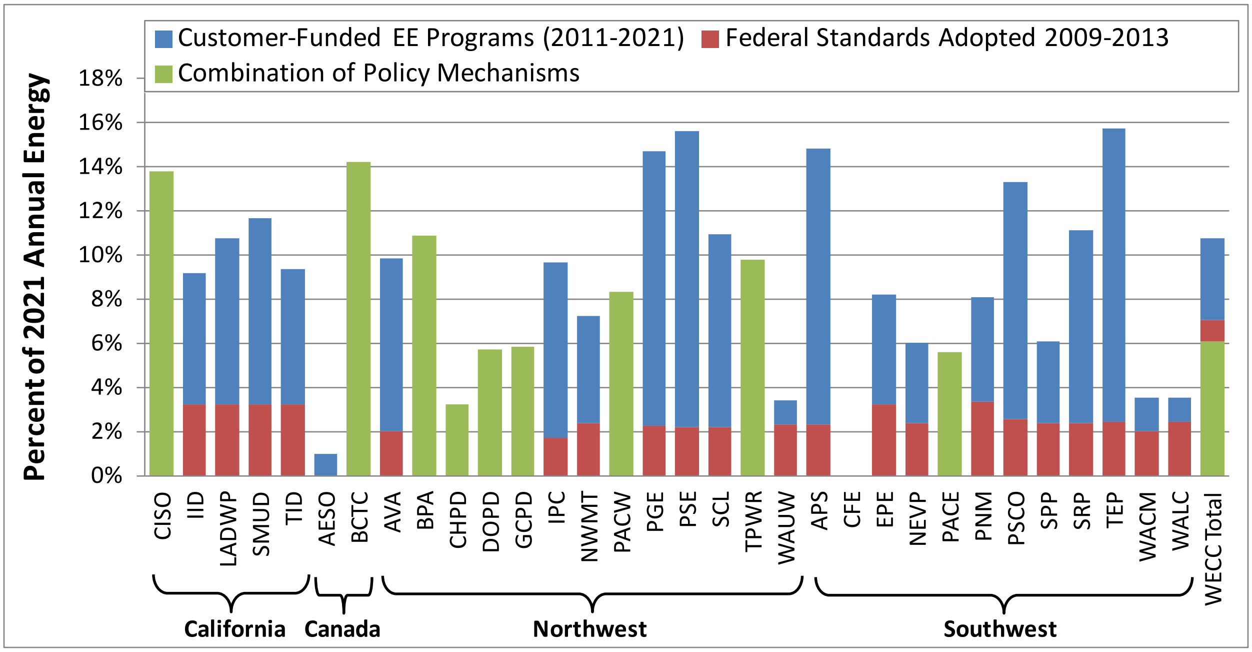


Figure 4. Expected Energy Efficiency Savings for the 10-Year Common Case: Annual Energy

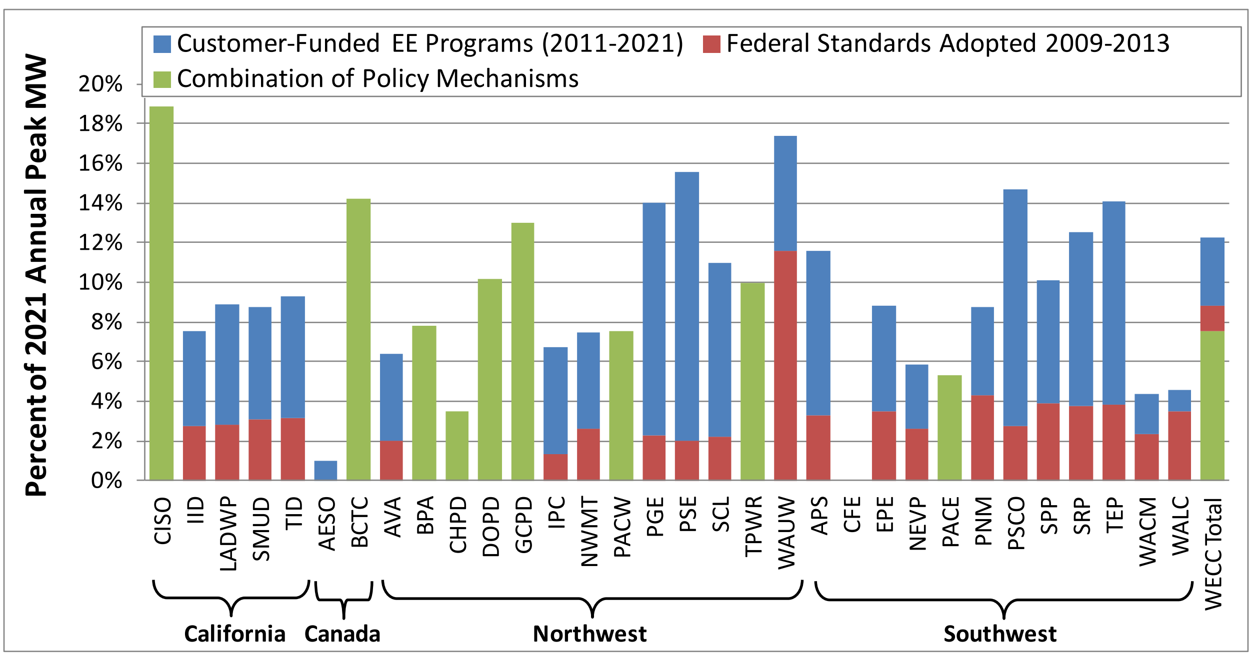


Figure 5. Expected Energy Efficiency Savings for the 10-Year Common Case: Non-Coincident Peak

2.4 Adjustments to LRS Load Forecasts

To the extent that the LRS load forecasts submitted by the BAs were determined to not fully capture the expected impacts of current energy efficiency policies and program plans, they were adjusted downward accordingly. These adjustments are summarized in Figure 6 (annual energy) and Figure 7 (peak demand), in terms of the percentage reduction to the annual energy and peak demand in 2021. See Appendix A for the corresponding adjustments expressed in absolute GWh and MW terms on a monthly basis. As noted previously, adjustments were defined for the year 2021, as that was the terminal year of the LRS load forecasts; once the adjustments were made, the forecasts were then extrapolated out to 2022, the horizon year of WECC's 10-Year study.

As shown, no adjustments were made for ten BAs (i.e., the WECC Common Case load forecasts for those BAs are simply equal to the original LRS load forecasts submitted to WECC). The remaining 22 BA load forecasts were all adjusted downward, at a minimum, to account for the expected acceleration in savings from federal standards. The magnitude of this individual adjustment ranges from roughly 1-3% of annual energy and 1-4% of non-coincident peak demand, depending on the extent to which the LRS load forecast accounts for updates to federal standards scheduled to occur through January 2013. In addition, the forecasts for 11 BAs were adjusted downward to account for the expected impact of customer-funded efficiency programs. Those adjustments were quite sizeable in the case of several BAs where existing policies mandate substantial efficiency savings that are not fully captured within the LRS forecasts.

In aggregate, WECC-wide load in 2021 was adjusted downward by 3.2% for annual energy and by 5.0% for peak demand. More than half of the overall WECC-wide adjustment consists of the adjustment to the CISO forecast, which, as noted previously in Table 1, did not account for a large portion of expected savings from efficiency programs and policies over the forecast period.

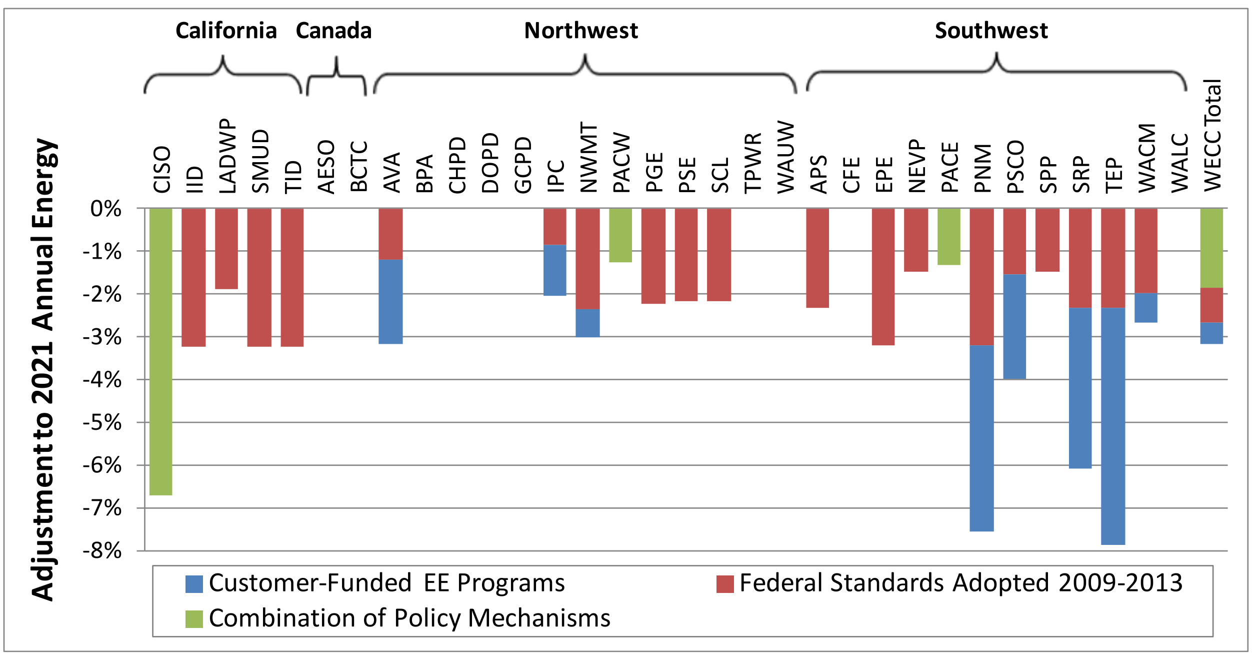


Figure 6. Adjustments to LRS Load Forecasts (Annual Energy)

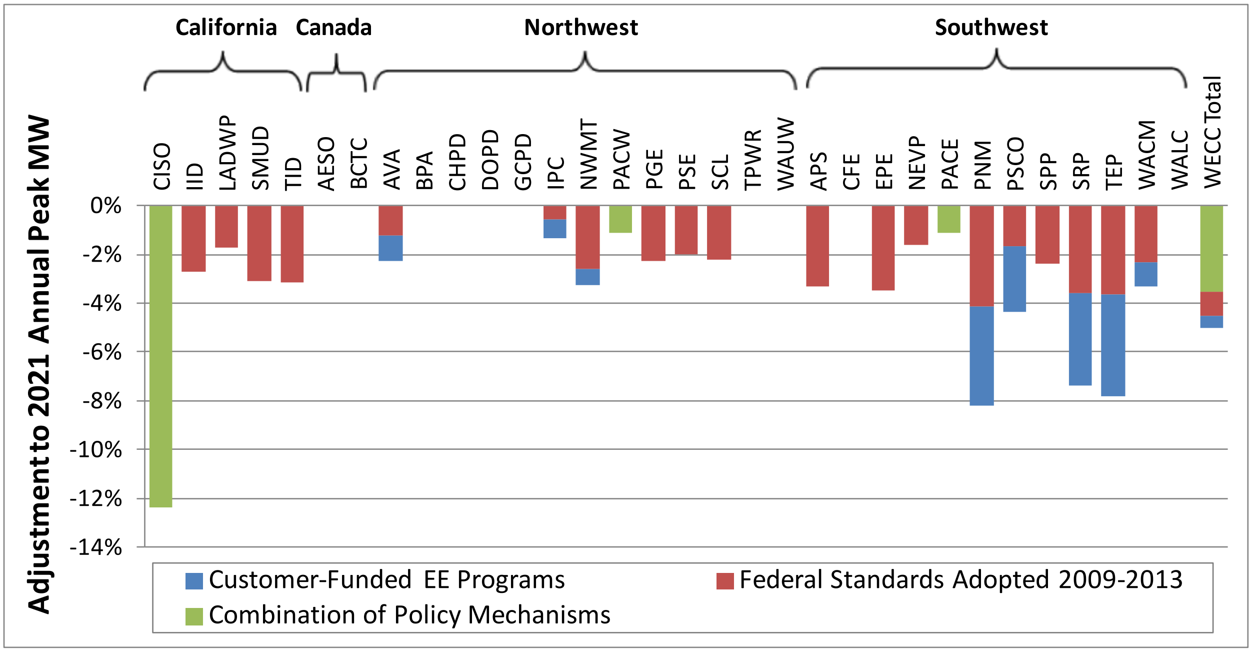


Figure 7. Adjustments to LRS Load Forecasts (Non-Coincident Peak)

2.5 WECC Common Case Load Forecasts

The WECC Common Case load forecasts are based on the LRS load forecasts submitted by each BA, adjusted downward in many cases to reflect the expected impact of current energy efficiency policies and program plans. Figure 8 and Figure 9 present the WECC Common Case load forecasts for each BA in terms of its compound annual growth rate (CAGR) over the 2010-2022 period. The figures also show the impact of the energy efficiency adjustments identified in Section 2.4, in terms of the associated reduction in CAGR for each BA. The total height of the stacked bars in Figure 8 and Figure 9 therefore indicate the CAGR of the original LRS load forecasts.

Across the entire WECC footprint, load growth in the Common Case occurs at a CAGR of 1.4% per year in terms of annual energy, and 1.3% in terms of aggregate non-coincident peak demand. The energy efficiency adjustments reduced forecasted WECC-wide growth rate by 0.3% per year for annual energy and by 0.5% per year for aggregate non-coincident peak. As to be expected, growth rates vary considerably across BAs, ranging from 0.3% to 4.0% per year for annual energy and from -0.2% to 4.0% per year for non-coincident peak demand. Variation in growth rates across BAs largely reflects differences in the original LRS load forecasts submitted by the BAs. However, the energy efficiency adjustments made by the DSM Work Group also differed across BAs, and therefore variation in the Common Case growth rates across BAs also reflects differences in the size of the energy efficiency adjustments. Of particular note, given its size, the growth rate for the CISO balancing authority was reduced from 1.5% to 0.8% per year for annual energy, and from 1.5% to 0.3% per year for peak demand.

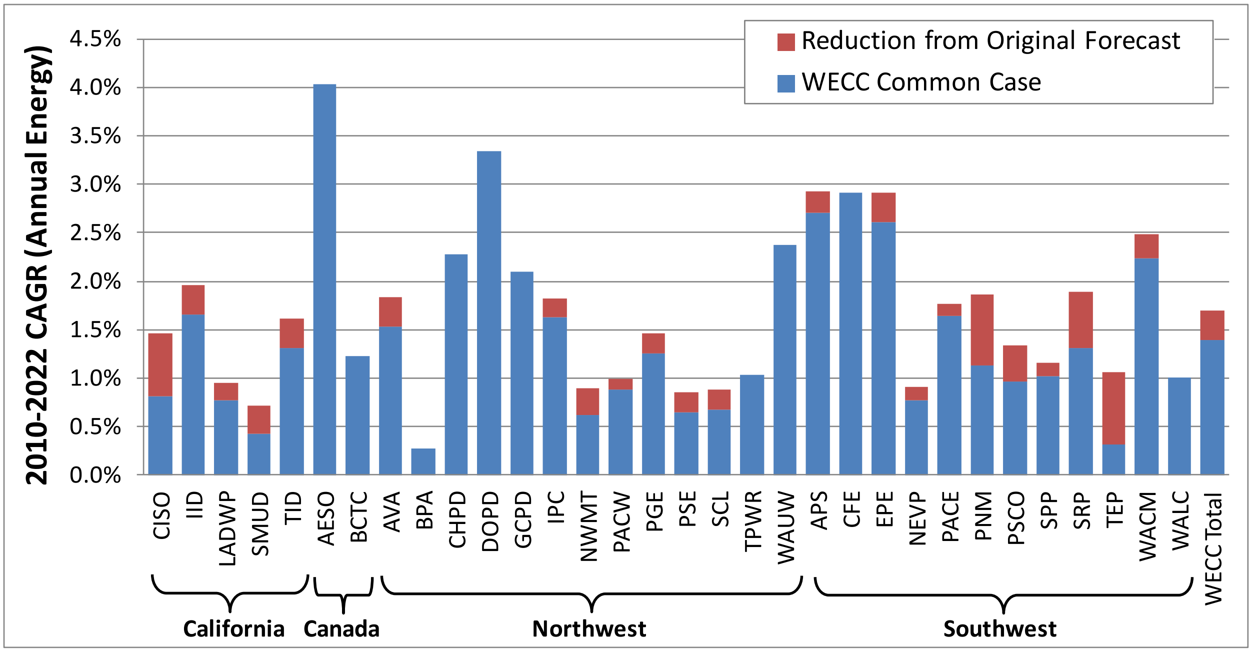


Figure 8. WECC 10-Year Common Case Load Forecast Growth Rates (Annual Energy)

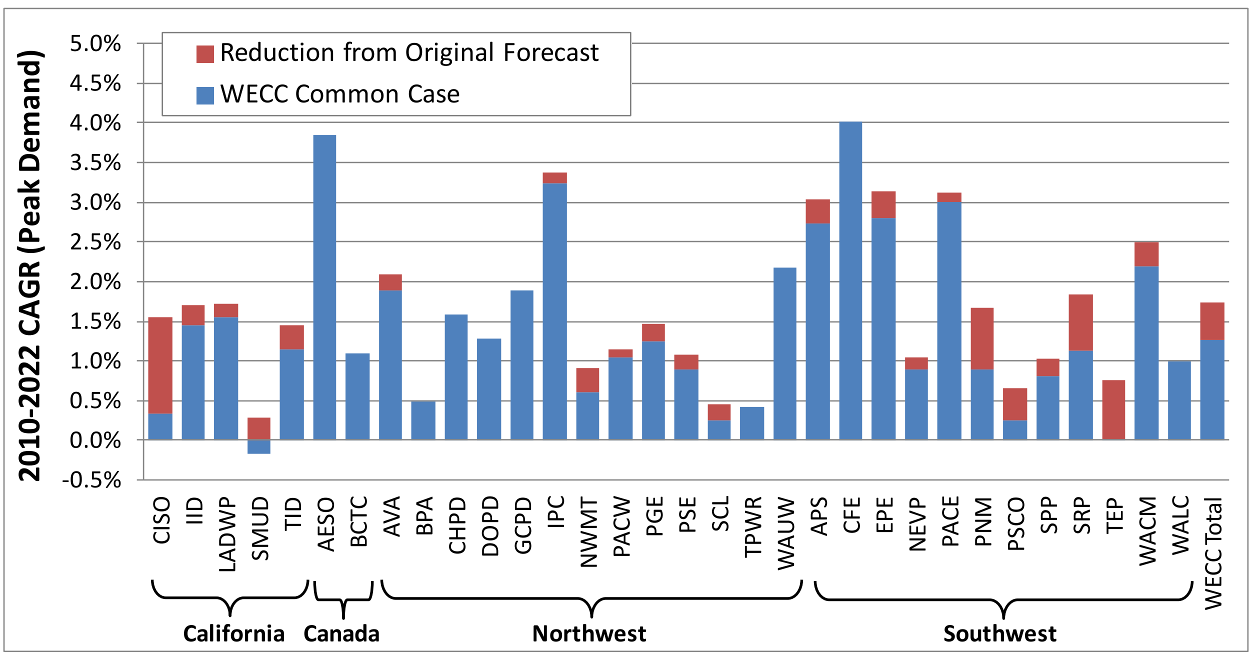


Figure 9. WECC 10-Year Common Case Load Forecast Growth Rates (Non-Coincident Peak)

3. SPSC 10-Year High DSM Case

Pursuant to SPSC's 2011 study request, the 10-Year High DSM/DR Case is intended to reflect a future with higher levels energy efficiency savings than in the Common Case (as well as higher levels of demand response and distributed generation, which are not discussed within this report). The SPSC DSM Work Group defined the efficiency benchmark for the High DSM/DR Case – hereafter referred to simply as the "High DSM Case" – to be *all cost-effective energy efficiency* available over the course of the 10-year forecast period.

This cost-effectiveness criterion corresponds to what is commonly referred to as the "economic potential" in efficiency potential analysis, as illustrated in Figure 10. The economic potential is a subset of the "technical potential," which represents the energy efficiency savings that would occur by upgrading all technologies (e.g., light bulbs, motors, windows, etc.) to the most-efficient model available, irrespective of cost. The economic potential is thus that portion of the technical potential that is determined to be cost-effective, given the cost of each individual efficiency measure and its benefits (e.g., avoided fuel and generation capacity costs). The "program achievable potential", on the other hand, is a subset of the economic potential, and represents the savings that would be achieved through a specific program or set of programs, given specified incentive levels and other program design features. The SPSC 10-year High DSM Case is intended as a "bounding analysis" indicating the savings that might be achieved through very aggressive energy efficiency efforts across WECC, but does not stipulate the particular mix of policies and programs (codes, standards, customer-funded DSM, etc.) that could achieve these savings. Thus, economic potential was deemed to represent the most appropriate benchmark to define the High DSM Case energy efficiency savings.

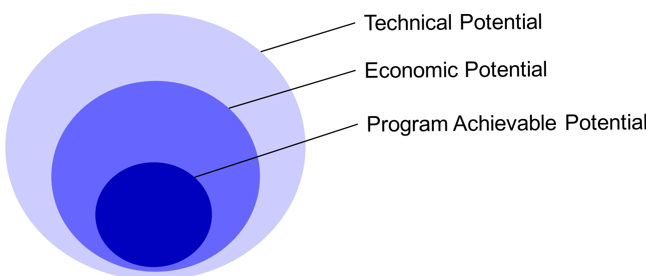


Figure 10. Types of Energy Efficiency Potential

The High DSM Case load forecast for each BA was constructed by building off the analysis that was conducted for the WECC Common Case, as illustrated in Figure 11. As described in the previous chapter, the analysis for the WECC Common Case involved developing adjustments to the LRS load forecast for each BA. Those adjustments were intended to reflect the energy efficiency savings projected to occur under current policies and program plans, to the extent that those savings were not already captured within the LRS forecast. For the High DSM Case, an additional set of adjustments were then applied to the Common Case forecasts, to reflect the difference between the estimated economic potential and the energy efficiency savings in the Common Case. As in the analysis for the Common Case, these adjustments were applied to the load forecast for the year 2021 (the terminal year in the underlying LRS load forecasts), and the resulting High DSM load forecasts were then extrapolated to 2022, the horizon year for WECC's 10-Year study.

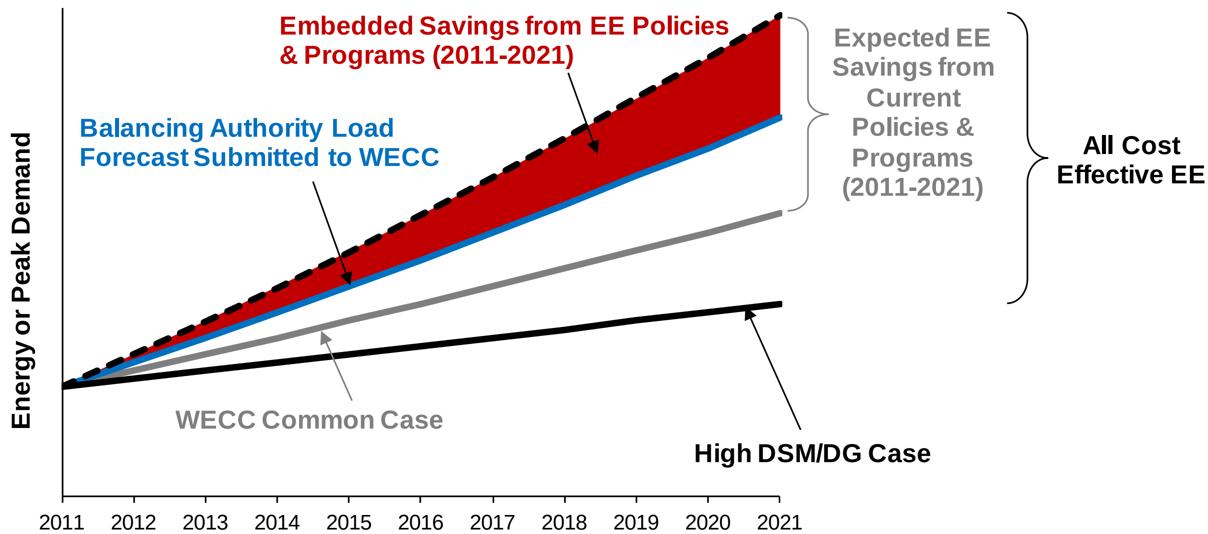


Figure 11. Illustration of Energy Efficiency Adjustment for the SPSC 10-Year High DSM Case

3.1 Data Sources and Assumptions

The central analytical component to the development of the High DSM load forecasts was to estimate the economic potential (i.e., all cost-effective energy efficiency savings) for each BA. To the extent possible, this analysis relied upon the most recent energy efficiency potential studies conducted for utilities and regions within WECC (as of the time that the analysis for the High DSM study case was conducted, circa October 2011). The set of energy efficiency potential studies utilized for this effort are listed in Table 5. In the case of states or BAs for which no recent potential studies existed, economic potential estimates were estimated by extrapolating the results from potential studies in similar or nearby regions.

Table 5. Energy Efficiency Potential Studies Used for the SPSC 10-Year High DSM Case

Region	Utilities	Studies
Mountain	PSCo	KEMA. 2010. *Colorado DSM Market Potential Assessment: Final Report.* Prepared for Xcel Energy.
	Tri-State	Nexant. 2010. *System Wide Electric Energy Efficiency Potential Study*
	Colorado Springs	Summit Blue Consulting. 2010. *Colorado Springs Utilities Demand-Side Management Potential Study and Plans.*
	Alberta	Canadian Manufacturers and Exporters Association. 2010. *Improving Energy Efficiency for Alberta's Industrial and Manufacturing Sectors.*
Pacific Northwest	N/A (region-wide)	Northwest Power and Conservation Council. 2010. *6th Power Plan*.
	BC Hydro	Marbek & Associates. 2007. *BC Hydro 2007 Conservation Potential Review*.
	Idaho Power	Nexant. 2009. *Idaho Power Demand Side Management Potential Study*.
	Northwestern	Nexant. 2010. *NorthWestern Energy Assessment of Energy Efficiency Potentials (2010-2029).*
	Pacific Power	Quantec. 2007. *PacifiCorp Assessment of Long-Term, System-Wide Potential for Demand-Side and Other Supplemental Resource* Cadmus. 2011. *Assessment of Long-Term System-wide Potential for Demand-Side and Other Supplemental Resources*.

Southwest	Rocky Mountain Power	See Pacific Power
	Arizona Public Service	ICF. 2007. *Arizona Public Service Energy Efficiency Potential Study*.
	Public Service New Mexico	Itron. 2006. *Public Service New Mexico Electric Energy Efficiency Potential Study*.
	Salt River Project	Cadmus. 2010. Salt River Project 2012-2017 Energy Efficiency Plan, Final Report.
California	Investor-owned utilities	California Energy Commission. 2010. *Incremental Impacts of Energy Efficiency Policy Initiatives Relative to the 2009 Integrated Energy Policy Report Adopted Demand Forecast*.
		Itron. 2008. *California Energy Efficiency Potential Study*.

Applying the results of recent energy efficiency studies to develop savings projections for each BA for the SPSC High DSM Case typically required a range of additional assumptions and analytical steps (e.g., adjusting the potential estimates based on the difference between the baseline for the potential study and the baseline for the Common Case savings projection, grossing up potential estimates from the customer-meter to the bus-bar, estimating peak demand savings from energy savings, extrapolating efficiency potential estimates from an individual utility to a larger region, etc.). These additional elements of the analysis are detailed in Appendix B, and are summarized below for each state/province (with the exception of the Pacific Northwest states, which are summarized together):

- **Alberta**: Economic potential estimates from a recent Alberta industrial/manufacturing sector potential study from the Canadian Manufacturers and Exporters (CME), and other potential studies for neighboring utilities/states, were applied to AESO's LRS load forecast for 2020. Oil-sands industry potential was estimated indirectly based upon petroleum refining sector potential estimate from the CME study.

- **Arizona**: Economic potential estimates from a recent study conducted for SRP by Cadmus were used. Results were grossed up to the bus-bar to account for T&D losses. Peak demand savings, which were not included in SRP study, were estimated based on stipulated peak-energy ratios using peak estimates from recent potential studies for neighboring states. SRP results were extrapolated to other Arizona BAs, on a sectoral basis, based upon 2008 retail sales for each customer sector.

- **British Columbia**: Economic potential estimation for BCTC were based on the results of a 2007 BC Hydro potential study. Results were grossed up to the bus-bar level to account for T&D losses. Estimates were extrapolated from BC Hydro service territory to the entire balancing authority in proportion to retail sales.

- **California**: The savings projection for CAISO was based on the California Energy Commission's 2010 "incremental uncommitted savings" report. Economic potential results for investor-owned utilities grossed up to account for T&D losses, and extrapolated to the remainder of CAISO BA. Savings projection for the other California balancing authorities were constructed by extrapolating the potential estimate for the IOUs', in proportion to each balancing authority's net energy for load. Peak demand savings for each non-CAISO balancing authority were calculated based on the peak-to-energy savings ratio implied by the Common Case savings assumption for the same balancing authority (in part to maintain greater consistency with the underlying load shapes inherent in each balancing authority's Common Case forecast).

- **Colorado**: High DSM assumptions for the PSCO balancing authority were based on the 2010 potential study for PSCo, the utility, by KEMA. That study's "net economic potential" estimates (excluding naturally occurring efficiency) were used. Avoided T&D losses were added to the net economic potential estimate, and PSCo service territory savings potential estimates were extrapolated to the entire PSCO balancing authority. High DSM scenario savings estimates for the WACM balancing authority were based on the results of two recent energy efficiency studies conducted for utilities in the region: A 2009 study for Colorado Springs Utilities and a 2010 study for Tri-State Generation and Transmission Cooperative. The economic potential estimate for Colorado Springs was adjusted to account for naturally-occurring savings, and the potential estimates from both studies were grossed up to the bus-bar to account for avoided T&D losses. The results were then extrapolated to the entire Colorado portion of the WACM balancing authority.

- **Nevada**: No recent efficiency potential studies for Nevada utilities were available, so the savings projections for the 10-year High DSM case were developed by extrapolating the results of two recent economic potential studies for other utilities in the desert southwest: a 2010 potential study for Salt River Project and a 2007 potential study for Rocky Mountain Power (RMP). The potential study results were extrapolated to the two Nevada balancing authorities in Nevada, on a sector-by-sector basis, in proportion to the 2008 retail sales in each balancing authority. Because the SRP and RMP potential studies did not analyze peak demand savings, peak savings associated with achieving the economic potential were estimated by applying a stipulated peak-to-energy savings ratio for each sector, based on findings from other potential studies conducted for utilities in the Southwest.

- **Pacific Northwest States**: 10-year High DSM Case efficiency savings projections were developed for each state, and these state-level savings then allocated to the balancing authorities in the PNW. The savings projections were based on the conservation potential assessment conducted by the Northwest Power and Conservation Council (NPCC) for its 6^{th} Power Plan. At the request of the SPSC DSM Work Group, NPCC staff provided an estimate of the "total economic potential" in 2020, for the NPCC planning area as a whole. This estimate assumed greater achievement of potential, and fewer constraints on efficiency program implementation, than the regional conservation target in the 6^{th} Plan, and therefore the efficiency projection for the SPSC High DSM Case were greater than the conservation target in the 6^{th} Plan. The ratio of this total economic potential to the NPCC's conservation potential for the entire NPCC planning area was applied to each NPCC state (Idaho, Oregon, Washington, and Western Montana) to yield state-specific estimates of the total economic potential. These state-level potential estimates were then allocated to individual balancing authorities in proportion to retail sales.

- **Utah**: The savings projection for the PACE balancing authority was based in part on the Cadmus 2011 energy efficiency potential study for PacifiCorp, which estimated technical potential in the year 2030 for the Utah portion of PacifiCorp's service territory. These results were applied to estimate the technical potential for the year 2021. An economic potential estimate was then derived from the technical potential estimate, and finally the results were extrapolated to the entire Utah portion of the PACE balancing authority.

- **Wyoming**: As with Utah, the savings projection for the PACE balancing authority was based in part on the Cadmus 2011 energy efficiency potential study for PacifiCorp, which estimated technical potential in the year 2030 for the Wyoming portion of PacifiCorp's service territory. These results were applied to estimate the technical potential for the year 2021. An economic potential estimate was then derived from the technical potential estimate, and finally the results were extrapolated to the entire Utah portion of the PACE balancing authority. High DSM scenario savings estimate for the WACM balancing authority were based on a 2010 energy efficiency potential study for Tri-State Generation and Transmission Cooperative, conducted by Nexant. For the High DSM scenario, it was assumed that the full economic potential is achieved in the Wyoming portion of the WACM balancing authority region. Avoided T&D losses were then added to the economic potential estimates, and the potential study results were extrapolated to the entire Wyoming portion of the WACM balancing authority.

3.2 High DSM Case Savings Projections

The 10-Year High DSM Case savings projections are intended to reflect the achievement of all cost-effective efficiency potential available over the forecast period, and are based on recent energy efficiency potential studies conducted for western utilities. These savings projections are summarized in Figure 12 (annual energy) and Figure 13 (annual peak demand), along with the corresponding savings projections for the WECC Common Case, for comparison. Savings are expressed in terms of the percentage reduction in 2021 loads for each BA and for WECC as a whole. Refer to Table B - 1 and Table B - 2 in Appendix B for further details, including energy and peak demand savings expressed in absolute GWh and MW terms.

As shown, the energy efficiency savings projections for the 10-Year High DSM Case reduce WECC-wide annual energy requirements by roughly 18% in 2021, and aggregate non-coincident peak demand by 21%. These impacts are almost double those of the efficiency savings in the Common Case (a 10% reduction in annual energy and a 12% reduction in peak demand).

Naturally, the High DSM Case savings projections vary considerably across individual BAs, typically ranging from a 15-25% reduction in annual energy and a similar range for peak demand reductions. These variations reflect differences in such things as customer mix, climate, end-uses, and other factors. For example, because energy efficiency potential for the industrial sector is typically lower than for residential and commercial customers, those BAs that have relatively large amounts of industrial load (such as NWMT) have relatively low energy efficiency savings in the High DSM Case. There are also sizable differences across BAs in terms of the incremental savings in the High DSM Case relative to Common Case, which partially reflects differences in the aggressiveness of energy efficiency policies assumed within the Common Case. For example, for CISO, where energy efficiency savings in the Common Case are relatively large, the High DSM Case savings equate to only an additional 1.5% reduction in annual energy in 2021, whereas for AESO, which has negligible efficiency policies in the Common Case, the High DSM Case equates to an additional 19% reduction in load.

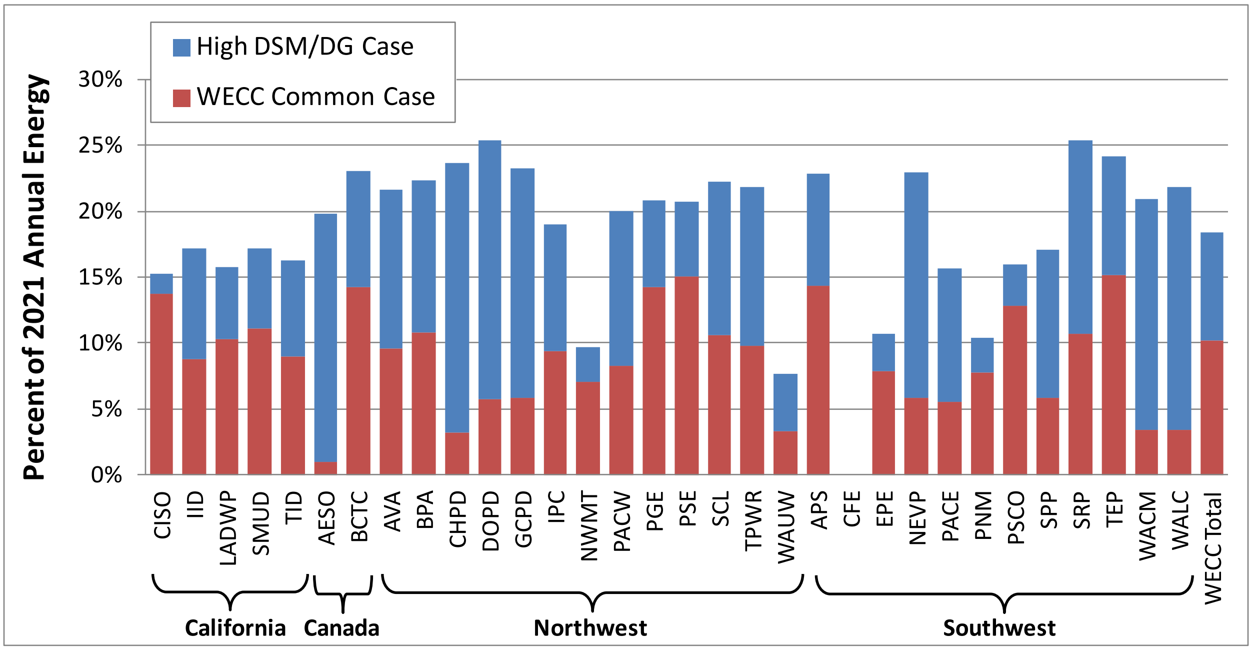


Figure 12. Energy Efficiency Savings for the 10-Year High DSM Case: Annual Energy

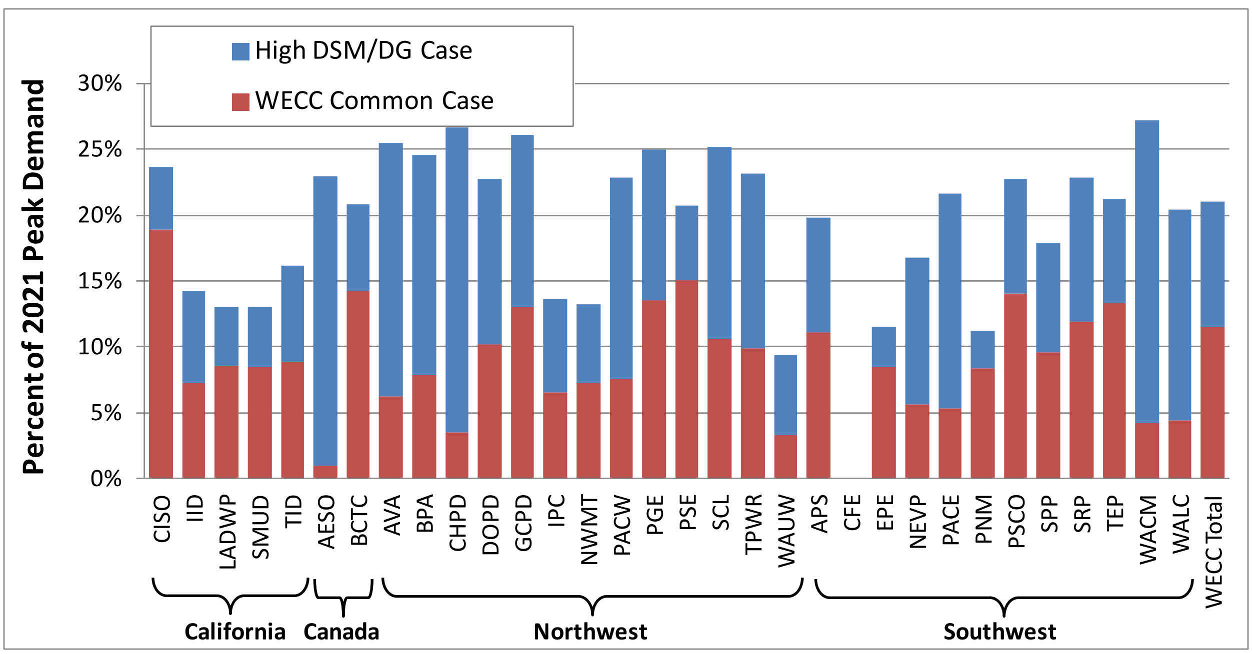


Figure 13. Energy Efficiency Savings for the 10-Year High DSM Case: Non-Coincident Peak

3.3 High DSM Case Load Forecasts

As described at the beginning of this chapter, the SPSC 10-Year High DSM Case load forecasts are built off the WECC Common Case forecasts, adjusted downward to reflect the additional savings in the High DSM Case beyond what is captured within the Common Case forecasts (i.e., beyond the expected savings from current energy efficiency policies and program plans). Figure 14 and Figure 15 present the SPSC 10-Year High DSM Case load forecast for each BA in terms of its CAGR over the 2010-2022 period, compared to the corresponding CAGR for the Common Case. Refer to Table B - 1 and Table B - 2 in Appendix B for further details, including the forecasted values for energy and peak demand savings in 2021, expressed in absolute GWh and MW terms.

In effect, the energy efficiency savings assumed in the High DSM Case largely flatten load growth for WECC as a whole. Within the High DSM Case, WECC-wide load grows at a rate of 0.5% per year in terms of annual energy and 0.3% per year in terms of aggregate non-coincident peak demand. This compares to growth rates of 1.4% and 1.3% per year in the Common Case, for annual energy and peak demand, respectively. The additional savings achieved in the High DSM Case thus serve to shave reduce WECC-wide growth rates by about 1% per year. As in the Common Case, growth rates in the High DSM Case vary considerably across BAs, ranging from -1.1% to 2.3% per year for annual energy and from -1.3% to 2.5% per year for non-coincident peak demand (excluding CFE, for which no savings projections were made for the High DSM Case). This variation is partly a reflection of the underlying variation in growth rates for the Common Case, as well as reflecting differences in the size of the energy efficiency potential estimated for the High DSM Case.

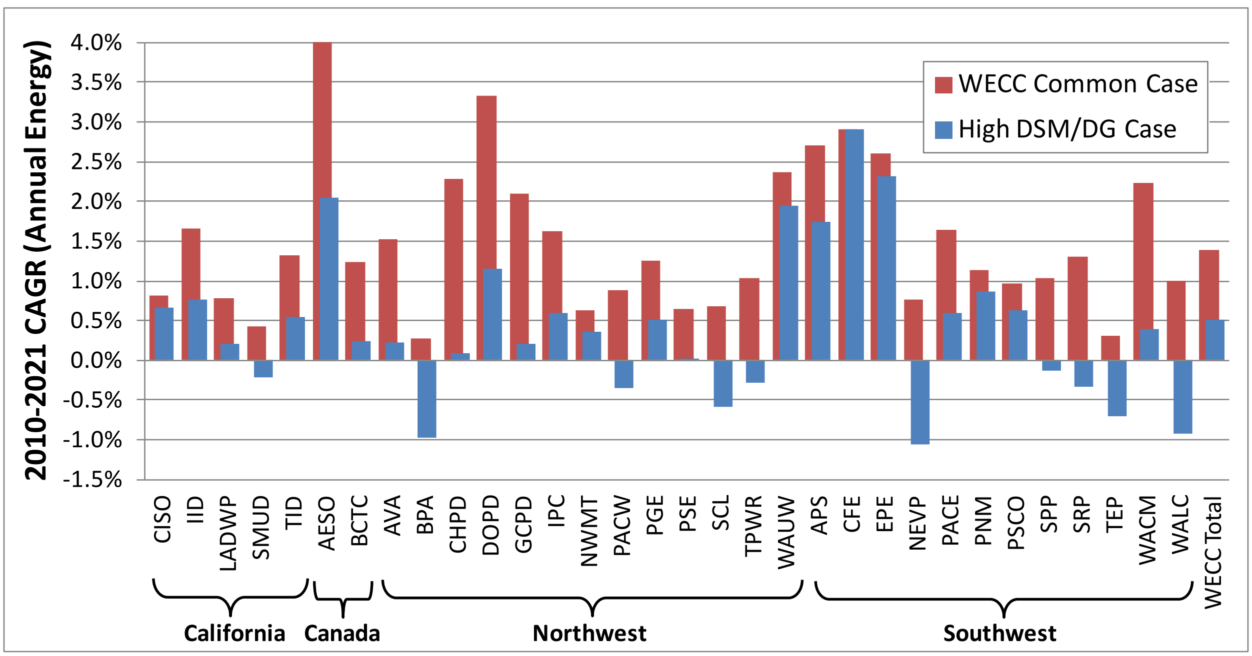


Figure 14. SPSC 10-Year High DSM Case Load Forecast Growth Rates (Annual Energy)

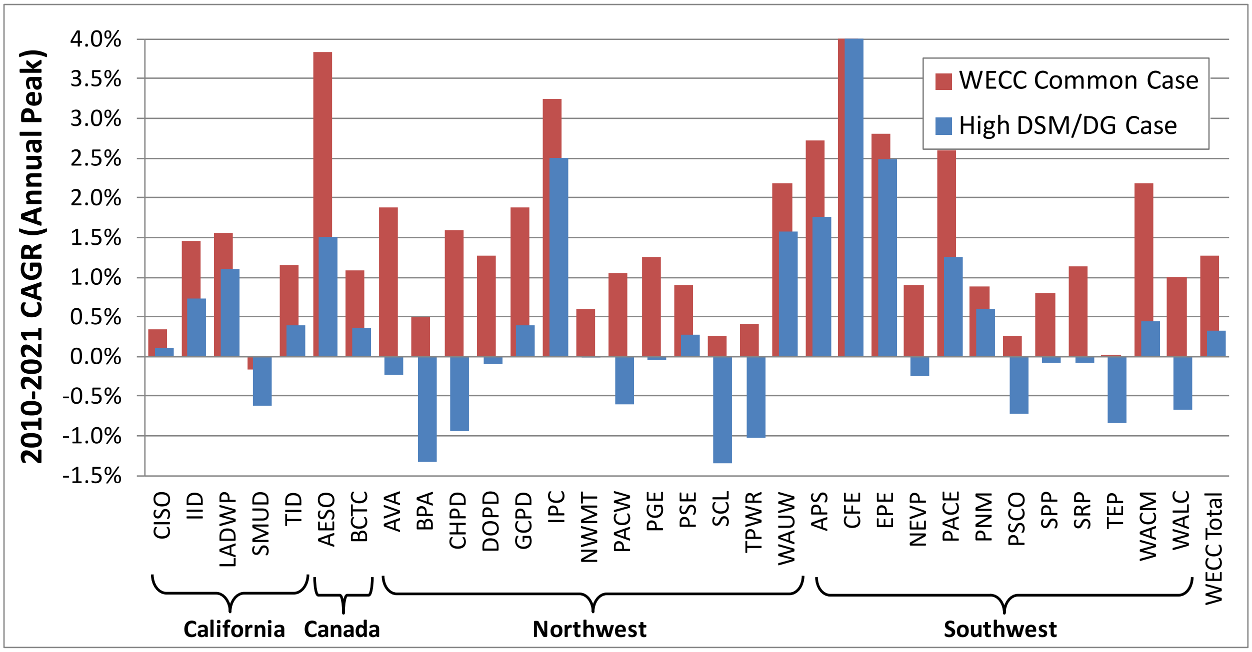


Figure 15. SPSC 10-Year High DSM Case Load Forecast Growth Rates (Non-Coincident Peak)

4. SPSC 20-Year High DSM Case

The basic principle for SPSC's 20-year High DSM study case was to develop a load forecast that reflects significantly higher energy efficiency levels than in the WECC Reference Case. For this purpose, LBNL and its contractor, Itron, created a set of forecasts using Itron's Statistically Adjusted End-Use (SAE) load forecasting framework and modeling tool, which allows the specification of end-use efficiency levels for 30 individual residential and commercial end-use categories.

This approach differs considerably from that used for the 10-year High DSM analysis, and was intended to offer a greater degree of internal consistency and transparency. In particular, unlike the 10-year High DSM study case, which relied on a disparate set of energy efficiency potential studies with varying methodologies and scopes, the 20-year High DSM study case is based on a common methodological framework and scope of end-use measures across all regions. In addition, whereas the 10-year High DSM study case required the application of energy efficiency potential study results to load forecasts developed independently by the various BAs – leading to possible double-counting or under-counting of energy efficiency savings – the 20-year High DSM study case was built upon an initial set of load forecasts developed using the Itron SAE framework, allowing for more-explicit and internally consistent accounting of energy efficiency impacts.

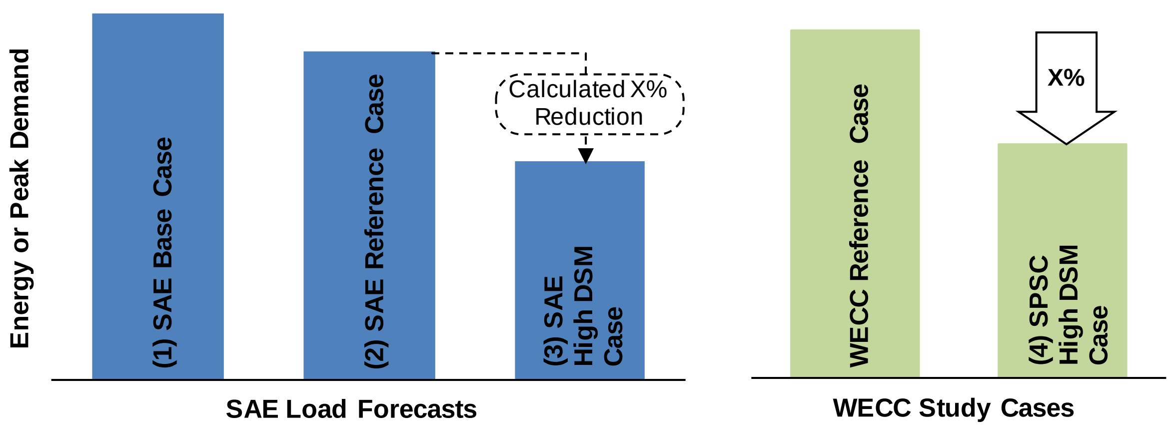


Figure 16. Application of the SAE Load Forecasting Model for the SPSC High DSM Study Case

The analysis for the 20-year High DSM study case proceeded in the following steps, which are illustrated schematically in Figure 16. First, we used the SAE model to develop an initial set of load forecasts, termed the "SAE Base Case" forecasts, which reflect regional assumptions about end-use efficiency trends based primarily upon those of the U. S. Energy Information Administration (EIA)'s National Energy Modeling System (NEMS). These Base Case forecasts were then the starting point for developing the "SAE Reference Case" forecasts, which incorporated state-specific assumptions about future DSM program savings under current policies and program plans. The SAE Base Case forecasts were also the starting point for developing the "SAE High DSM Case" forecasts, which are based on stipulated increases in end-use efficiency, relative to the Base Case. Finally, the SPSC 20-year High DSM Case forecast was calculated by, in effect, calibrating the SAE High DSM Case to the WECC Reference Case.

This step was necessitated by the fact that the 2032 WECC Reference Case was developed independently from the SAE load forecast effort, by simply extrapolating the 2022 Common Case forecasts out an additional 10 years. The calibration of the SAE High DSM forecast simply entailed taking the percentage load reduction from the SAE Reference Case to the SAE High DSM Case – identified generically in Figure 16 as an "X% Reduction" – and then applying that percentage reduction to the WECC Reference Case forecast.

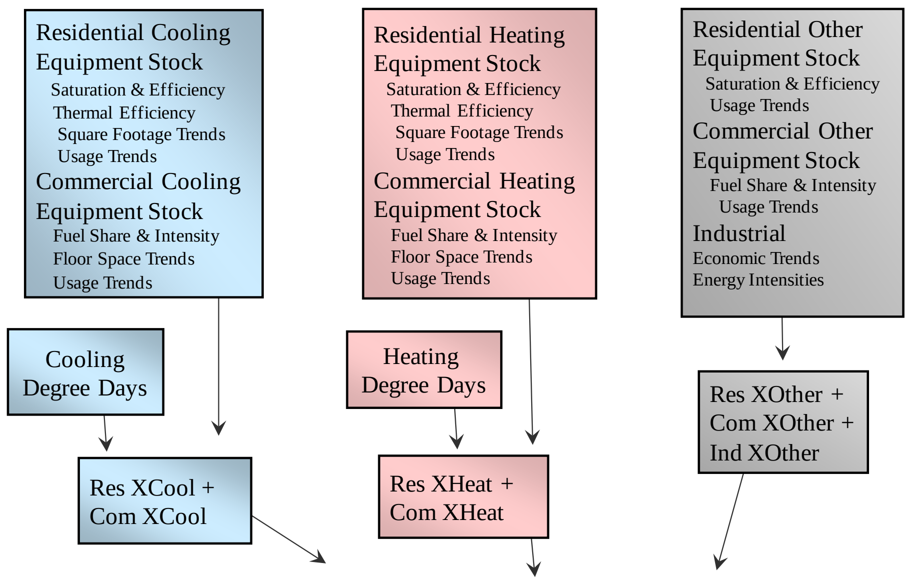
This chapter is organized as follows. In the next section, we describe the Itron SAE framework and the key input assumptions for the SAE Base Case. In Section 4.2, we discuss conceptually how DSM impacts are captured within the SAE load forecasting framework. In Section 4.3, we then summarize the methodology for and present the numerical results of the SAE Reference Case load forecast. In Section 4.4 we describe the approach to the SAE High DSM Case, including the underlying assumptions, data sources for the projected efficiency improvements, key calculations, and numerical results. Sections 4.5 and 4.6 present the details of the SAE High DSM incremental energy savings (relative to the SAE Reference Case) and the SPSC High DSM WECC load forecasts, respectively. Further details about the SAE load forecasting model and about the assumptions employed in developing the SAE load forecasts are contained within Appendix C, and are referenced throughout the relevant sections of this chapter.

4.1 The SAE Load Forecasting Framework and Base Case Assumptions

As its name suggests, the statistically-adjusted end-use approach is a hybrid framework, combining end-use technology detail with statistical estimation. It was developed to extend the standard utility econometric load forecasting methodologies in order to incorporate information on DSM programs to account for the effects of these programs on loads, including the potential effects of new or changed programs. Previous applications of the Itron SAE tool have included modeling the effects of federal policies and regulations – such as those for energy-efficient lighting – at the utility service territory level, and multi-utility, multi-jurisdictional, long-run forecasting of hourly loads as well as peak demands.

The core of the SAE framework is an econometric model of the form shown in Figure 17. Here, energy consumption (*Energy*) is represented as a function of a set of indices (*XCool*, *XHeat*, and *XOther)* constructed from detailed end-use and building stock data, as shown in the boxes above the formula.[7] For this analysis, models of this functional form were estimated for monthly energy use and monthly peak demand within each BA.

[7] The other terms in the regression formula, e_m, and a, are the error term and the y-intercept, respectively.

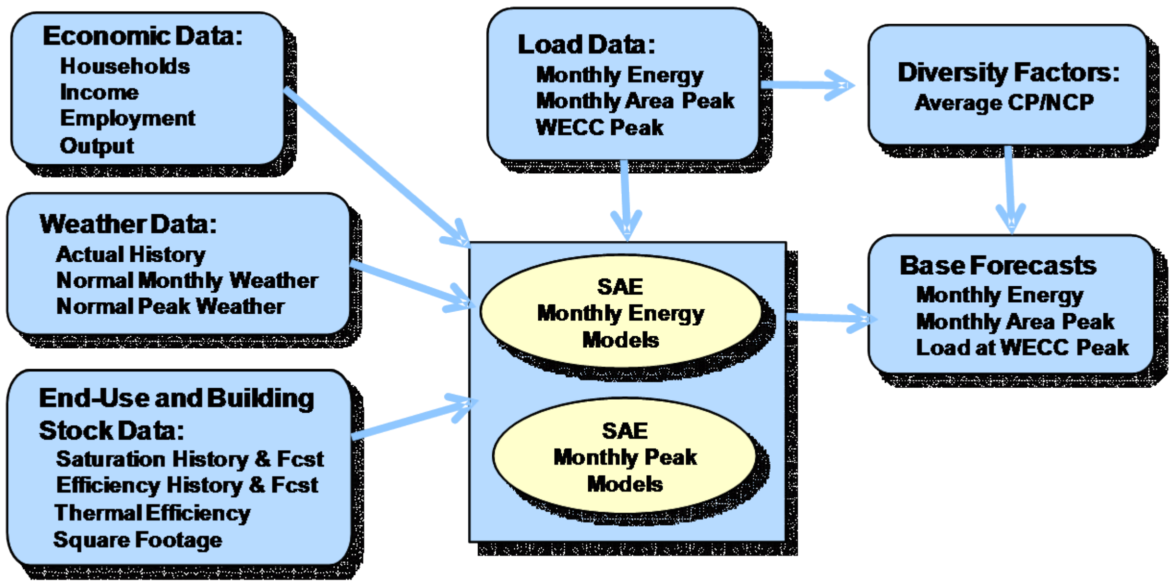


$$Energy_m = a + b_c \times XCool_m + b_h \times XHeat_m + b_o \times XOther_m + e_m$$

Source: Itron

Figure 17. SAE Econometric Framework

Developing the econometric models required a wide variety of data inputs, as illustrated in Figure 18. Load data, which were provided by WECC, consisted of historical hourly load data for each BA, extending over the period 1998-2010; for the purpose of estimating the model, these data were transformed into monthly energy and peak loads. The economic and demographic data, obtained from Moody's Analytics (a subscription service), included both historical and forecasted data for the number of households, population, income, employment, and gross state product. These economic and demographic data were provided for each U.S. state in the Western Interconnection and for the three primary urban areas (Vancouver, Calgary, and Edmonton) within the two Canadian provinces in WECC. Historical weather data were obtained from DTN (a subscription service), consisting of daily average dry bulb temperatures for 100 weather stations dispersed throughout WECC, for the period 1991-2011. From those data, average weather conditions (cooling degree days, heating degree days, and peak producing weather) were computed for each BA and month, and were used as the basis for the load forecasts. See Section C.1 in Appendix C for further information about the economic and weather data.



Source: Adapted from Itron

Figure 18. Data Inputs and Outputs for the SAE Model

The final – and critical – set of inputs for the SAE model is the building stock and end-use data. The end-use data include historical data and forecasts for the saturation and average stock efficiency levels of 30 separate residential and commercial end-uses, as listed in Table 6. These definitions of end-use categories, as well as the units used to characterize efficiency, are taken with some variations directly from those used in the Energy Information Administration (EIA)'s National Energy Modeling System (NEMS).

Table 6. End Uses Included in SAE Model

Residential		Commercial
Furnace	Cooking	Heating
Heat Pump	Refrigerator	Cooling
Ground Source Heat Pump	Second Refrigerator	Ventilation
Secondary Heat	Freezer	Waste Heat
Furnace Fan	Dish Washer	Cooking
Central Air-Conditioning	Clothes Washer	Refrigeration
Heat Pump Cooling	Dryer	Outside Lighting
Ground Source Heat Pump Cooling	Television	Inside Lighting
Room Air-Conditioning	Lighting	Office Equipment
Waste Heat	Miscellaneous	Miscellaneous

Source: Adapted from Itron.

As a default, end-use saturation and average efficiency values used for each BA were based on the EIA's 2012 *Annual Energy Outlook* (*AEO*) reference case, which includes historical data and forecasts for each end-use, specified at the U.S. Census region level. Where possible, however, state- or utility-specific data were used in lieu of the EIA Census region data and projections. These alternative data sources included: the U.S. Census, FERC, Northwest Power and Conservation Council, the California Energy Commission, National Research Council Canada, and a variety of utility-specific energy efficiency potential studies. Details on which data sources were used for each end-use and BA can be found within Section C.3 in Appendix C. As discussed later in Section 4.4, the SAE High DSM load forecasts were developed by modifying these stock efficiency assumptions.

4.2 Accounting for Energy Efficiency Impacts within the SAE Framework

Energy efficiency policy and program impacts are embedded in several aspects of the SAE load forecasting model. First and most obviously, efficiency improvements are captured in the stock efficiency data and projections used to develop the SAE end-use indices (i.e., the right-hand side of the regression equation in Figure 17). In addition, when the SAE model is estimated from historical load data, the effects of historical DSM programs embedded in such data will be reflected in the resulting model. To the extent that historical energy efficiency gains are greater (or less) than what is reflected in the historical stock efficiency data used to estimate the model, any load forecasts developed with the model will reflect a continuation of those historically higher (or lower) gains in energy efficiency, relative to the stock efficiency projection used to develop the load forecast.

Within the remainder of this section, we provide further details on the degree to which the SAE Base Case load forecasts reflect the expected impacts of energy efficiency policies and programs over the forecast period, and describe the methods that can be used to adjust the load forecasts to reflect higher or lower energy efficiency impacts.

4.2.1 Energy Efficiency Impacts in the EIA-AEO Reference Case Stock Efficiency Forecasts

As described in Section 4.1, the SAE Base Case forecast relies on end-use stock efficiency projections from EIA's 2012 *AEO* Reference Case. Those stock efficiency projections partially capture future energy efficiency policy impacts[8], and thus by extension, so do the SAE Base Case load forecasts. The details of how different efficiency policies and programs are represented in the *AEO* Reference Case, however, vary as a consequence of the internal structure of NEMS.

Federal appliance standards are represented explicitly by assigning appropriate values to model parameters governing available end-use technology characteristics. Specifically, the NEMS residential module's internal selection procedure for new appliance purchases involves life-cycle cost minimizing choices from a "menu" consisting of appliances providing a given end-use energy service (such as refrigeration or clothes washing) but having different efficiencies and purchase costs. Thus, a federal appliance standard can be represented by removing from this menu all units with efficiencies below the standard level. Within the 2012 AEO Reference Case, all federal appliance standards that had been established as of the date that the forecast was

[8] EIA is required by the U. S. Congress to be "policy-neutral" and therefore, in its Reference Case projection, attempts to incorporate the effects of federal, state and local policies and programs that are already in place at the time of the projection, or that have been both enacted and have had any required enabling legislation and/or funding appropriations put into effect. Energy and environmental policies, programs, and regulations (including but not limited to those affecting efficiency specifically) that may be under consideration or development, but have not been enacted, enabled and funded, are not represented in the EIA Reference Case. However, EIA regularly produces "side cases" of the *AEO* that analyze the prospective effects of such measures, in addition to side cases that reflect different assumptions on the values of key exogenous inputs such as energy prices and rates of economic growth.

prepared (circa June 2012) are reflected within the end-use stock efficiency projections, but no future updates to existing standards are included.

By contrast, NEMS accounts for state and local DSM programs (as well as other state and local energy efficiency policies and programs) only *indirectly*, through the calibration to historical equipment shipments data.[9] By virtue of that calibration, the AEO Reference Case stock efficiency projections implicitly reflect a continuation of DSM program activity at roughly the rate that has historically occurred (nationally). Thus, to the extent that future DSM program activity within a given BA region is similar to historical national trends, the stock efficiency assumptions used within the SAE Base Case will capture the impact of that future DSM program activity reasonably well. If, however, the expected future DSM program activity within a given BA is more aggressive than historical national trends (as could be expected for most BAs within WECC), then the stock efficiency assumptions used within the SAE Base Case for that BA will under-state future DSM program impacts.

4.2.2 DSM Adjustments within the SAE Framework

In general, load forecasts developed using the SAE model capture future DSM program impacts through two mechanisms: (a) the initial stock efficiency projections embedded in the X variables of the model and (b) the relationship between actual the historical load data and the end-use driven X variables. For the SAE Base Case load forecasts in particular, the use of EIA regional stock efficiency projections for many end-uses and BAs ensures that the load forecasts will reflect a continuation of historical trends in national DSM program savings impacts. In addition, the calibration of the model to historical load data for each BA will then ensure that the load forecasts also reflect a continuation of any historical difference between the rate of DSM savings for that particular BA and the national average.

In many cases – such as in the analysis conducted for the SPSC High DSM study case – it is necessary to develop load forecasts that reflect some higher or lower degree of DSM program activity than is embedded in the regional SAE inputs. The SAE approach allows for several alternative approaches, depending on data availability and quality:[10]

(1) *Add-Back*: Under this approach, the historical load data are modified by removing the impact of past DSM programs, and the model is econometrically estimated from those

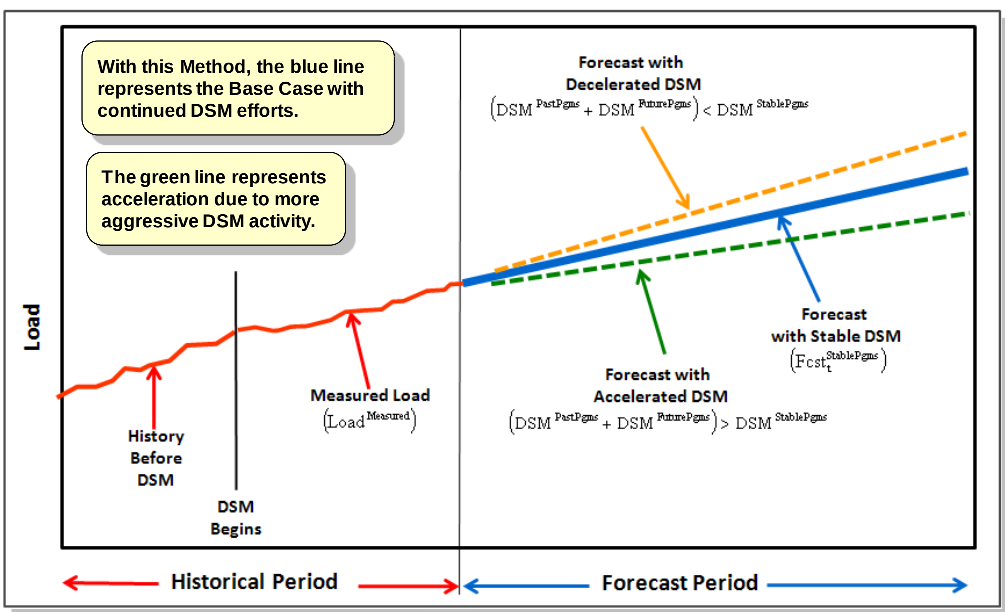
[9] This is in part because NEMS is disaggregated only to the U. S. Census region level, so that the model cannot explicitly capture details of state and local programs or policies, and in part because of general limitations on data and empirical research that would enable the effects of state and local policies and programs to be reasonably well represented across the U. S. The calibration of the NEMS residential and commercial modules for the *AEO* Reference Case is accomplished by setting a small number of key parameters so that the model's projections of residential and commercial energy use are consistent with historical trends in energy use and appliance shipment data. In both modules, the most important such parameters are the "hurdle rates" that govern end-use technology adoption by life-cycle cost minimization; the calibration adjusts these hurdle rates to a level consistent with historical energy use and appliance shipment data. In addition, in the residential module calibration, both costs and absolute bounds are imposed upon certain end-use technology replacement and fuel switching decisions; in the commercial module, direct switching costs are not imposed but other limitations are placed on the pace and extent to which new technologies – including higher-efficiency types – can penetrate the market. These details are discussed at greater length in Auffhammer and Sanstad (2011).

[10] These methods are described in greater detail in McMenamin and Quan (2010).

hypothetical historical loads. The load forecast generated with the model therefore represents projected loads without future DSM programs. That forecast is then adjusted downward ex post based on the projected cumulative savings from both historical and future DSM programs. This method is most appropriate when there is a relatively short history of DSM program activity, and program data allow for accurate estimation of their past and future effects at the requisite level of granularity.

(2) *DSM Variable*: DSM program savings are incorporated explicitly as an independent variable in the regression model (i.e., among the set of "Other" variable on the right-hand side of the equation in Figure 17). The data requirements for this method are similar to the Add-Back method, but further require that historical DSM program impacts of been large enough to be able to detect a statistically significant effect on historical loads.

(3) *DSM Trend*: With this approach, the econometric model is estimated on actual historical data without any modification. Forecasts from the estimated model assume continuation of programs at the average historical activity level. If future DSM programs are expected to either accelerate or decelerate relative to the estimated historical trends, an *ex post* adjustment is made to the initial load forecast. The size of the adjustment reflects the expected difference between cumulative DSM impacts expected to occur with existing programs and cumulative impacts expected to occur with accelerated or decelerated programs. This method, which is illustrated in Figure 19, is appropriate when a relatively long history of DSM effects in present in the data, and when the forecast horizon is itself relatively long.



Source: McMenamin and Quan (2010).

Figure 19. Adjusting SAE Load Forecasts Using the DSM Trend Method

The SAE Reference Case and SAE High DSM load forecasts were both developed by starting with the SAE Base Case forecasts and then making a set of adjustments to reflect higher levels of assumed energy efficiency impacts. For the SAE Reference Case forecasts, the DSM Trend method (i.e., the third of three general approaches outlined above) was generally used. This technique was the simplest and most appropriate given the data available for most of the WECC BAs. Further details on the EE adjustments for the SAE Reference Case are given in the next section. For the SAE High DSM Case load forecasts, an entirely different technique from the three general approaches described above was used. This approach, which is described in great detail in Section 4.4, involved a form of *ex post* adjustments applied at the individual end-use level, based on stipulated increases in average stock efficiency.

4.3 SAE Reference Case

The SAE forecasting framework was used to develop a set of reference case load forecasts *intended to reflect the expected impact of current policies and program plans over the 20-year forecast period*. As mentioned above, this required making adjustments to the SAE Base Case load forecast for many BAs, in order to capture the effects of higher EE program-induced savings relative to historical trends. Important to note is that the SAE Reference Case forecasts are wholly distinct from the official WECC Reference Case forecasts used in the 20-year study.[11] The SAE Reference Case forecasts were not directly used or modeled within WECC's 20-year study, but instead, provide the baseline from which to measure the incremental impacts of the High DSM Case (as illustrated in the earlier schematic, Figure 16).

4.3.1 Reference Case EE Adjustments

For BAs outside of California, the process for developing the reference case EE adjustments involved the following series of steps (consistent with the DSM Trend method described in the previous section):

(1) The historical average annual incremental savings from EE programs was calculated for the period 1998-2010 (i.e., the historical period over which the SAE model was estimated). EIA Form-861 was the default data source used for this step, but historical savings data obtained directly from utilities, state PUCs, or regional energy efficiency organizations was used instead, if available.

(2) A projection of the expected EE program savings under current policies and program plans was developed for the 2011-2032 period, largely extending the analysis and assumptions utilized for the 10-Year WECC Common Case (see Section 2.1).

(3) The SAE Base Case forecast for 2032 was then adjusted downward based on the *difference* between the expected cumulative savings from EE programs implemented over the 2011-2032 period (step 2) and the cumulative savings that would occur under a simple extrapolation of historical trends (step 1). The EE adjustment for each BA is further allocated across the end-use level energy and peak demand forecasts, yielding the SAE Reference Case load forecast disaggregated by end-use.

Further details about both the adjustments for non-California BAs, including the assumptions about historical and expected EE program savings, are provided in Section C.4 of Appendix C.

[11] WECC developed its own 20-year reference case by extrapolating the 10-year WECC Common Case forecasts.

For the California BAs, the SAE Reference Case load forecasts were, instead, developed by directly modifying the initial end-use efficiency assumptions. Specifically, within the SAE modeling framework, projections of end-use saturation and stock efficiencies were translated into projections of Energy Intensity (EI), which is typically denominated in units of kWh per household per year (for residential end uses) or kWh per square foot per year (for commercial end uses). In the case of the California BAs, it was possible to directly specify EI projections that reflect achievement of the state's most recent long-term energy efficiency goals, using the results of a recent energy efficiency potential study conducted for the CPUC (Navigant 2012). These EI projections were then used (in lieu of the EI projections used for the SAE Base Case forecasts) to generate a new set of load forecasts for the California BAs. Using this approach, the expected impact of future EE programs was captured via the SAE model inputs, rather than as an *ex post* adjustment to the Base Case forecasts.

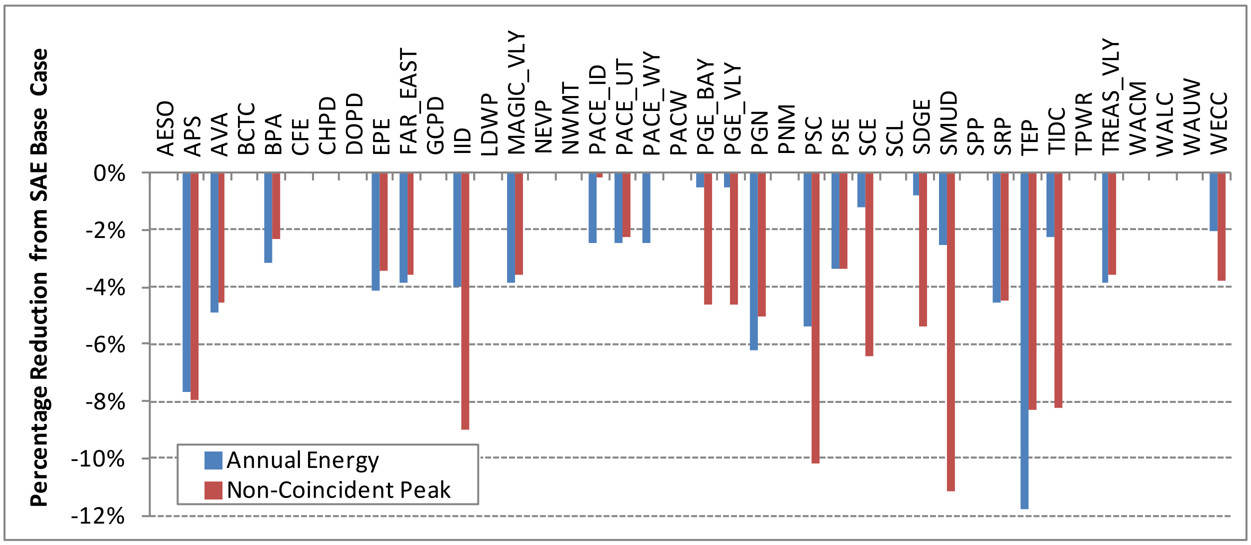


Figure 20. SAE Reference Case DSM Adjustments

As shown in Figure 20, DSM adjustments for the SAE Reference Case forecasts were made for 22 of the 39 load zones, where the size of the adjustment (expressed as a percentage of the SAE Base Case forecast for 2032) ranged from 0-12% of annual energy consumption and 0-11% of annual peak demand. See Section C.4 of Appendix C for data on these DSM adjustments expressed in absolute GWh and MW terms. For the remaining load zones, where no DSM adjustments were made relative to the Base Case, the expected cumulative DSM program savings under current policies and program plans was generally deemed to be similar to what would occur under a continuation of historical trends.

4.3.2 SAE Reference Case Load Forecasts

The SAE Reference Case load forecasts, produced by applying BA-specific DSM adjustments to the SAE Base Case forecasts, are depicted in Figure 21 in terms of the CAGR over the 2010-2032 period, for both annual energy and non-coincident peak demand. See Section C.5 of Appendix C for forecast data expressed in terms of GWh and MW. Across the entire WECC footprint, load growth in the SAE Reference Case occurs at a CAGR of 1.4% per year (annual energy) and 1.2% per year (aggregate non-coincident peak demand). As to be expected, growth rates vary considerably across BAs, ranging from -0.3% to 2.7% per year for annual energy and from -0.8% to 2.6% per year for non-coincident peak demand.[12] Variation in growth rates across BAs reflects differences in the underlying load growth drivers (e.g., population and economic growth) as well as differences in the intensity of expected DSM program activity over the forecast period.

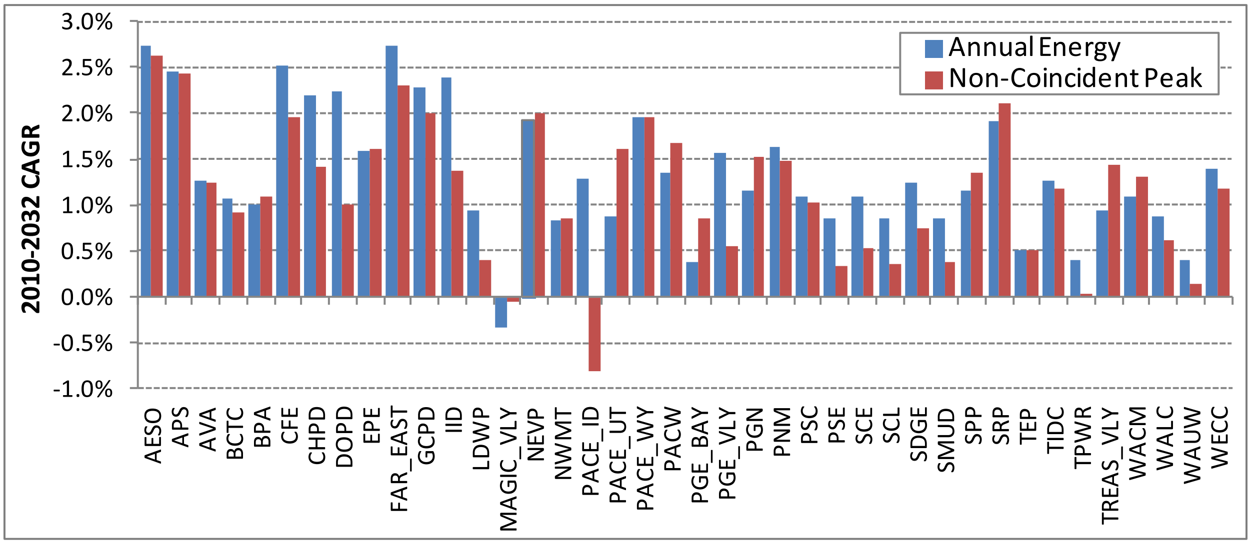


Figure 21. SAE Reference Case Load Forecast Growth Rates (2010-2032)

As noted previously, the SAE Reference Case forecasts are not used directly within WECC's 20-year study, but rather serve as the reference point from which to measure the incremental savings in the SAE High DSM load forecasts. Instead, WECC's 20-year study relies on a separate set of reference case forecasts – termed the *WECC Reference Case* – that were derived by extrapolating the WECC 10-Year Common Case load forecasts. As a cross-check on both forecasts, it is instructive to compare the 20-year WECC Reference Case forecasts with the SAE Reference Case forecasts. As shown in Figure 22, which focuses specifically on projected growth rates in annual energy consumption, the SAE Reference Case and WECC Reference Case forecasts are generally quite consistent, with relatively small differences for most BAs. Of particular note, the projected growth across WECC, as a whole, is identical between the two forecasts (1.4% per year, as shown on the far right-hand side of the x-axis).

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[12] A peculiarity in the forecasted growth rates for the PACE_ID load zone is apparent, where annual energy is forecasted to grow at a rate of 1.3% per year, whereas peak demand is forecasted to decline at -0.8% per year. Although further investigations would be needed to identify the precise cause, we suspect that it may be due to the way the PACE load forecast was disaggregated into its three constituent load zones (which similarly might explain why, for PACE_UT, the forecasted growth in peak demand is significantly higher than growth in energy). Given the manner in which the SAE Reference Case load forecasts are used (i.e., only as a benchmark against which to measure the incremental impacts of energy efficiency savings the High DSM case), this potential issue has limited material consequence for WECC's modeling of the SPSC High DSM study case. Nevertheless, any future iterations of this analysis should examine and seek to resolve this peculiarity.

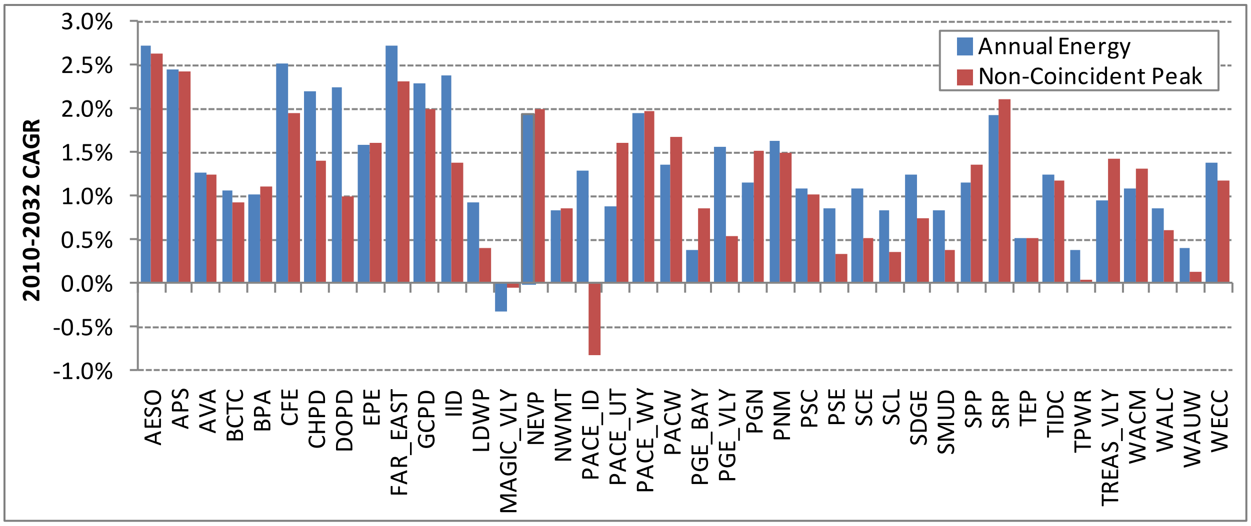

Figure 22. Comparison of SAE Reference Case and WECC Reference Case Load Forecasts

One important feature of the SAE forecasting framework is that it allows load forecasts to be disaggregated by customer segment and end-use. Indeed it is this feature that lends the SAE framework to modeling the impact of energy efficiency programs and policies. Figure 23 decomposes the SAE Reference Case load forecast into the three constituent customer segments, for WECC as a whole as well as for each of three main geographical regions within WECC (the Northwest, the Southwest, and California).[13] As shown, residential and commercial loads represent the bulk of annual electricity consumption within WECC, with industrial load constituting the remaining 22% of total WECC energy. The same pattern is similar across the three regions, but is most pronounced in California (where industrial load constitutes just 14% of annual electricity demand) and least pronounced in the Northwest (where industrial load constitutes 28% of the total load).

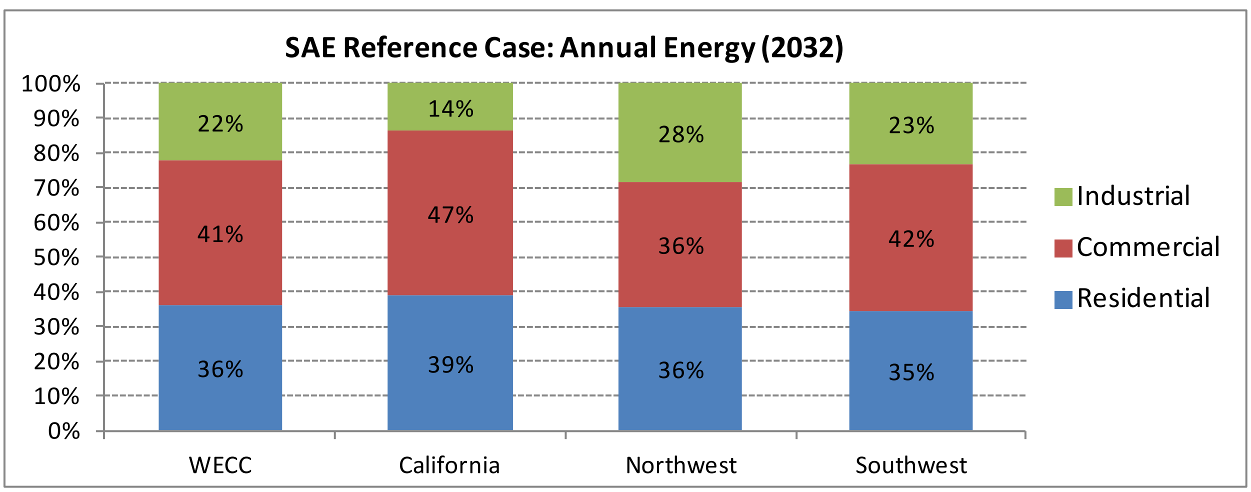

Figure 23. SAE Reference Case Load Forecasts by Customer Segment

[13] For our purposes here, the Pacific Northwest includes all BAs in Oregon, Washington, Idaho, Montana, British Columbia, and Alberta; and the Southwest includes all BAs in all remaining states other than California.

Residential and commercial loads within the SAE forecasts are further disaggregated into 30 separate end-uses (no end-use detail exists for industrial load). To illustrate the relative significance of the various end-uses and to provide context for the end-use level adjustments applied in the High DSM case, Figure 24 decomposes the SAE Reference Case forecast of annual energy for residential and commercial loads into ten end-use “groups” (where, for simplicity, the 30 separate end-uses in the SAE model have been collapsed into a smaller number of categories). Clearly there are many different end-uses that constitute a significant portion of load. Within WECC overall, the three largest end-use groups are Commercial Miscellaneous, Residential Miscellaneous & TV, and Commercial Lighting, together representing just over 50% of all residential and commercial load. These three groups are also the largest or among the largest within each of the three regions. As to be expected, the relative significance of heating and cooling-related end-use groups vary across regions depending on climate; for example, Residential Cooling represents 10% of electricity usage in the Southwest but only 2% in the Northwest. In contrast, Residential Space & Water Heating represents 16% of usage in the Northwest but only 8% in the Southwest and 2% in California. This reflects the relatively high saturation of electricity for these end-uses as well as colder winter weather in the Northwest region. See Section C.5 of Appendix C for additional numerical details.

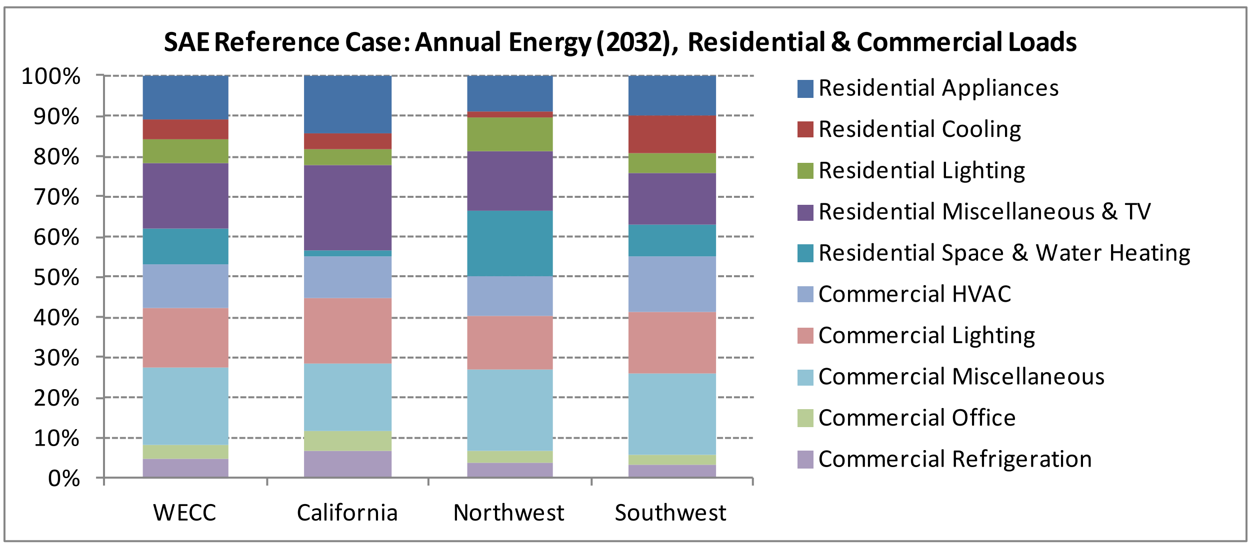

Figure 24. SAE Reference Case Load Forecasts (Residential & Commercial) by End-Use Group

4.4 High DSM Case Approach and Assumptions

4.4.1 Overview and Rationale

The High DSM study case focuses on a single year, 2032, which is the end of the planning horizon. This case stipulates average stock efficiencies for each end-use in that year, and then adjusts the SAE Base Case load forecast for each end-use based on the efficiency improvements relative to the average stock efficiencies from the Base Case forecasts. The average stock efficiencies stipulated for the High DSM case are intended to represent the most efficient equipment *presently* commercially available, i.e., circa 2012. That is, for the High DSM Case **we assume that the average stock efficiency for each end-use increases to the upper bound**

of technology in today's markets.[14] This assumption was selected on the basis of three criteria: namely, to develop efficiency assumptions for the High DSM Case that are aggressive (thus providing a "stress test" for the transmission planning exercise), that are grounded in verifiable data, and that are easy to communicate to and be understood by a diverse stakeholder audience.[15]

The approach to developing the High DSM load forecasts is akin to assuming achievement of the full "technical potential" for energy efficiency, based on current commercially available technologies.[16] While the mechanisms driving these efficiency increases are not specified, we implicitly presume that utility DSM programs, as well as codes and standards and other potential market forces or policy interventions, may contribute. Because the SAE Base Case forecast already captures some future energy efficiency savings (as discussed in Section 4.2), the load reductions from the SAE Base Case to the SAE High DSM Case therefore do not represent the totality of all energy efficiency impacts over the forecast period, but rather represent only the *incremental energy efficiency savings* to those already captured within the SAE Base Case forecast.

For the residential and commercial sectors, the basic calculations to create the SAE High DSM case were as follows:

(1) For each end-use, specify the most efficient model currently commercially available.
(2) Calculate the percentage efficiency gain associated with moving from the average stock efficiency in the SAE Base Case load forecast for 2032 to the most efficient model currently commercially available
(3) Apply the associated percentage energy savings to the SAE Base Case end-use loads to calculate the SAE High DSM Case load for that end-use
(4) Sum across end-uses to calculate the total load for each BA

We provide further details on these steps below, following a summary description of information sources for, and assumptions regarding, equipment efficiencies.

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[14] While we are using presently-available "best" technologies to define our 2032 high efficiency benchmarks, it is important to note that our approach is consistent with the emergence of even higher-efficiency units than the current best-on-market becoming available and being adopted over the next two decades. Because we are focusing on stock *averages*, the posited increases in the latter implicitly assume a corresponding increase in the high ends of efficiency ranges. Inasmuch as the current best-on-market is assumed to become the average in 2032, these high ends would be achieved with technologies that are either currently-existing but not yet commercially available, emerging, or as yet to be conceived and developed.

[15] A more complex approach might, instead, specify particular policy and programmatic assumptions for the High DSM case, and then translate those assumptions into stock efficiency projections for each end use and BA. Alternatively, one might attempt to develop economic potential estimates for each region, and translate those estimates into specific stock efficiency projections. Either approach would have required a substantially greater number of assumptions and judgments, as well as a significant expansion to the analytical and data requirements.

[16] Our analysis is analogous to a standard technical potential scenario in that it posits a large increase in efficiency levels relative to a baseline without addressing costs or cost-effectiveness explicitly. However, the SAE framework differs from the highly-detailed stock accounting-based methodologies that are typically applied to efficiency potential studies. It is, among other differences, at a considerably higher level of aggregation with respect to end-use details, and does not represent the specifics of building types. In addition, our approach to High DSM incremental energy savings does not account for interactions among end-uses that are typically dealt with in detailed, "bottom-up" efficiency potential studies.

For industrial load, a simpler procedure was used. In contrast to the engineering-economics philosophy of the NEMS residential and commercial modules, the NEMS industrial module is based on a much simpler econometric forecasting structure; in particular, this module does not represent technologies, technology types, or end-use detail specifically. For industrial load forecasting, the Itron SAE framework reflects the NEMS structure. Thus, our approach to defining 2032 High DSM industrial efficiency targets also differed from that taken for residential and commercial. We simply stipulated a percentage reduction of 10% from the SAE Base Case industrial load. This simple stipulated adjustment was based on a review of recent energy efficiency potential studies; further details are provided in Section C.6 of Appendix C.

4.4.2 Stock efficiency data sources and assumptions

The 30 residential and commercial end-uses within the SAE load forecasting model largely correspond to those used within EIA's NEMS. For each end-use, NEMS requires information about the range of efficiency levels currently available and projected to be available in the future. To develop stock efficiency assumptions for the High DSM Case, we relied primarily upon studies conducted for the EIA by Navigant Consulting on present and future end-use technology characteristics (Navigant, 2007; Navigant, 2008; Navigant & SAIC, 2011a; Navigant & SAIC, 2011b). For most residential and commercial end-uses, these studies identify the present-day (e.g., year 2010) commercially-available high efficiency option, and these are the default values used to define average stock efficiency levels for the High DSM case.[17]

Some of the end uses included within the SAE model, however, have not been included in recent Navigant analyses. In a number of other cases, the Navigant 2010 high efficiency option is lower than the projected 2032 stock efficiency in the base case. And in several cases, the SAE definitions of categories – i.e., the technologies within them – differ from their counterparts in NEMS. In these instances, where possible we used Navigant's projected high efficiency option for a future year (rather than for 2010). In other cases, however, it was necessary to develop the High DSM case stock efficiency assumption from other sources, including LBNL's recent "MaxTech" report and technical support documents from the U. S. DOE appliance standards program (Desroches & Garbesi, 2011).

The specific data sources used for each end-use and balancing authority are identified in Section C.6 of Appendix C, along with details of any required additional calculations.

4.5 High DSM Case Energy Efficiency Savings

The SAE High DSM Case load forecasts can be compared to the SAE Reference Case forecasts in order to illustrate the incremental savings in the High DSM Case relative to what is expected to occur under the current set of energy efficiency policies and program plans. As shown in Figure 25, WECC-wide annual energy consumption in the High DSM Case is 21.6% lower than

[17] Current high-efficiency levels on the market are steadily increasing for a number of end uses, and at any given time, estimates as to what this level is for a given end use may vary. Thus, we are not interpreting the Navigant estimates as being definitive. Rather, they are reasonably comprehensive and in addition were constructed in such a way as to conform with the structure of the NEMS model, upon which the SAE framework is based. Both these aspects motivated the use of the Navigant studies as our primary source.

in the Reference Case, and aggregate non-coincident peak demand is 22.1% lower. Incremental savings vary across the BAs, in most cases ranging from 15-25% of the Reference Case load forecast, reflecting differences in end-use characteristics across BAs and regions.

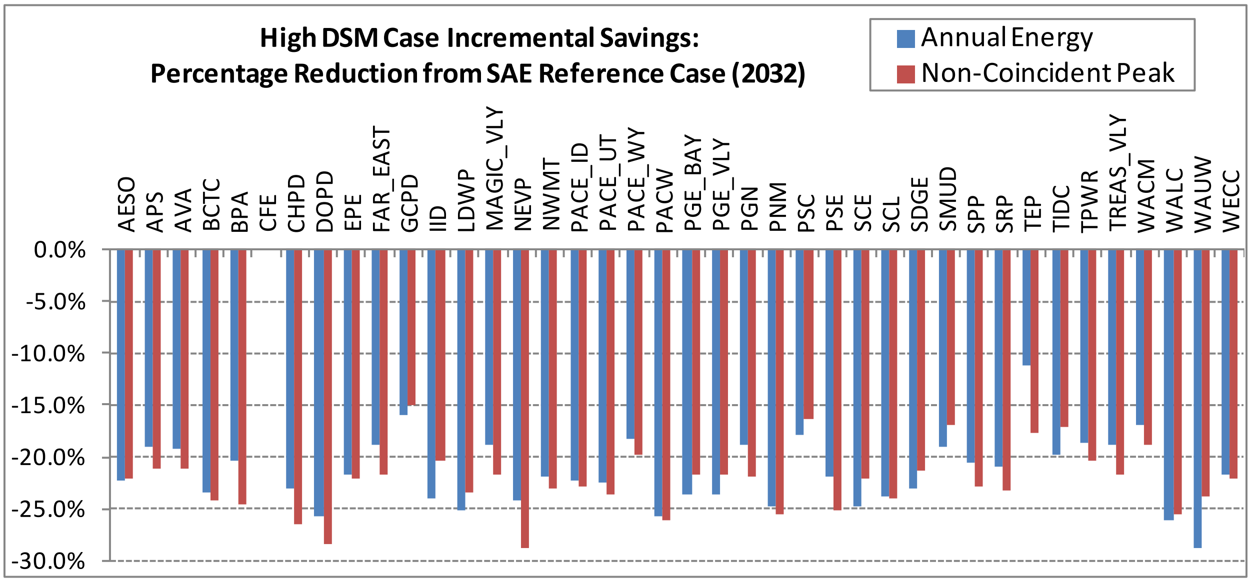

Figure 25. SAE High DSM Case Incremental Savings Relative to SAE Reference Case

The residential and the commercial sectors together represent the overwhelming majority of incremental savings relative to the Reference Case, as shown in Figure 26, which decomposes the savings by customer sector, for WECC as a whole as well as for each of three geographical regions. Compared to the residential and commercial sectors, the savings for the industrial sector was relatively low in the High DSM Case (i.e., a 10% reduction relative to the Reference Case), and as a result, the industrial sector represents a disproportionately small part of the overall incremental savings. Between the residential and commercial sectors, each represents similar proportions of the total incremental savings, with savings in California and the Southwest skewed slightly towards the commercial sector and savings in the Northwest skewed slightly towards the residential sector.

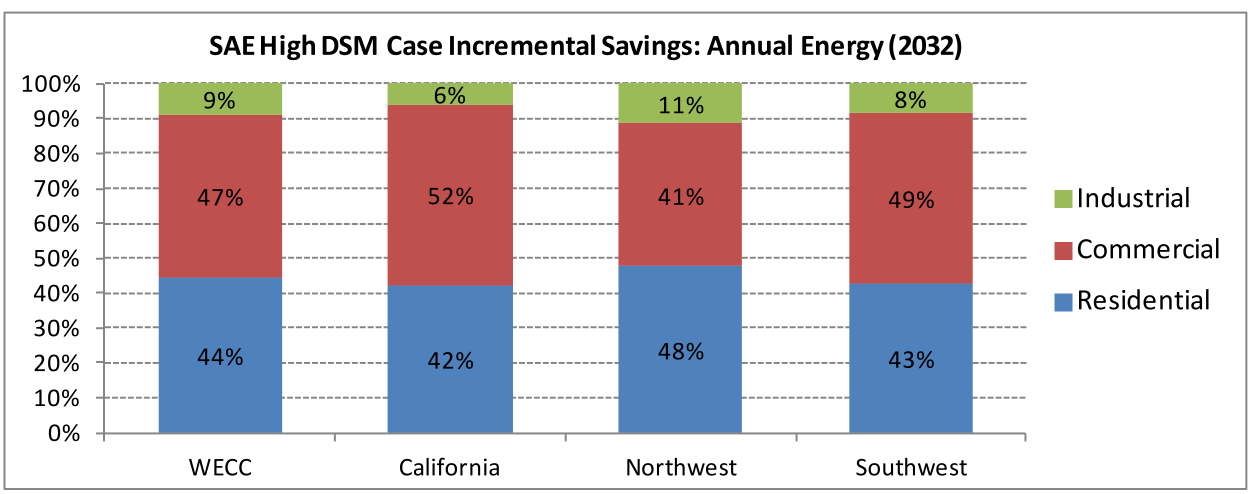

Figure 26. SAE High DSM Case Incremental Savings by Customer Sector

The residential and commercial sector savings can be further decomposed by end-use, as shown in Figure 27, which presents the distribution in residential and commercial sector savings across the 10 end-use groups introduced previously in Section 4.3.2. In general, the contribution from any individual end-use is a function of both its share of total load in the Reference Case (see Figure 24) and the specified efficiency improvement between the Reference Case and High DSM Case (see Section C.8 of Appendix C). The net effect of these underlying drivers, as shown in Figure 27, is that the savings are somewhat evenly distributed across end-uses, with six of the ten end-use groups each constituting 10-20% of the WECC-wide incremental savings. Commercial HVAC is largest source of incremental energy savings for WECC as a whole (20% of the total), and either the largest or among the largest for each of the three regions (ranging from 15-26%). The significance of most other end-uses varies regionally, reflecting differences in regional climate and end-use saturation trends. For example, as to be expected, Residential Cooling is a major contributor to total incremental for BAs in the Southwest, while Residential Space & Water Heating is a major contributor in the Northwest.

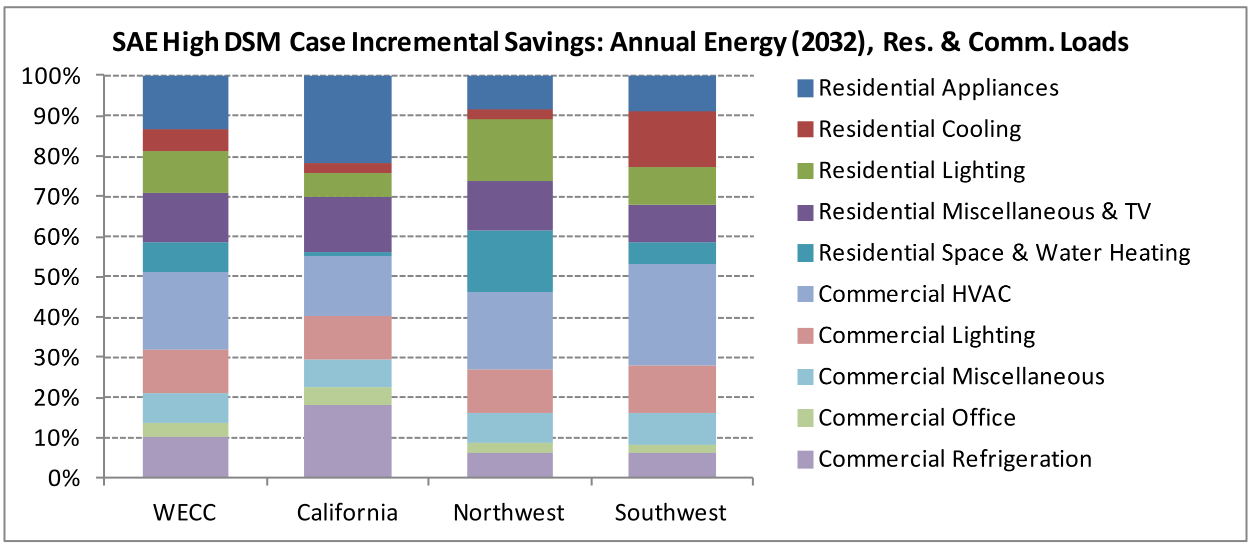

Figure 27. SAE High DSM Case Incremental Savings by End-Use Group

4.6 High DSM Case Load Forecasts

Section 4.4.1 described the process used to develop the SAE High DSM load forecasts. As noted at the beginning of this chapter, the SPSC High DSM Case load forecast for each BA was then derived by taking the percentage reduction in load between the SAE Reference Case and SAE High DSM Case, and then applying that percentage load reduction to the WECC Reference Case forecast. This additional step served, in effect, to calibrate the High DSM load forecasts to the WECC Reference Case, so that meaningful comparisons could be made between the results of WECC’s transmission planning model for the two study cases.

Figure 28 and Figure 29 show the SPSC High DSM load forecast growth rates (2010-2032) for annual energy and non-coincident peak, respectively, by BA and for WECC as a whole. For comparison, the figures also show the corresponding growth rates for the WECC Reference Case. Further information on the High DSM forecasts, including detailed tables, is provided in

Section C.9 of Appendix C. As shown in the figures, average annual growth rates are substantially lower in the SPSC High DSM Case than in the WECC Reference Case. WECC-wide, growth in annual energy is nearly flat in the High DSM Case (an annual growth rate of 0.3%/yr), compared to a 1.4% growth rate in the Reference Case. The aggregate non-coincident peak demand across WECC (i.e., the sum of all BAs' individual peak demands) actually declines slightly over time in the High DSM Case, with a negative growth rate of -0.1%/yr, compared to a positive growth rate of 1.0%/yr in the WECC Reference Case.

As to be expected, growth rates in the High DSM Case vary considerably across BAs, mirroring the variability in growth rates within the WECC Reference Case. In terms of annual energy, average annual growth rates range from -1.1% to 2.9%/yr, with almost half of all BAs registering negative growth (i.e., declining loads) over the 2010-2032 period. Growth rates for peak demand range from -2.1% to 3.4%/yr across the BAs, with negative growth for almost two-thirds of BAs.

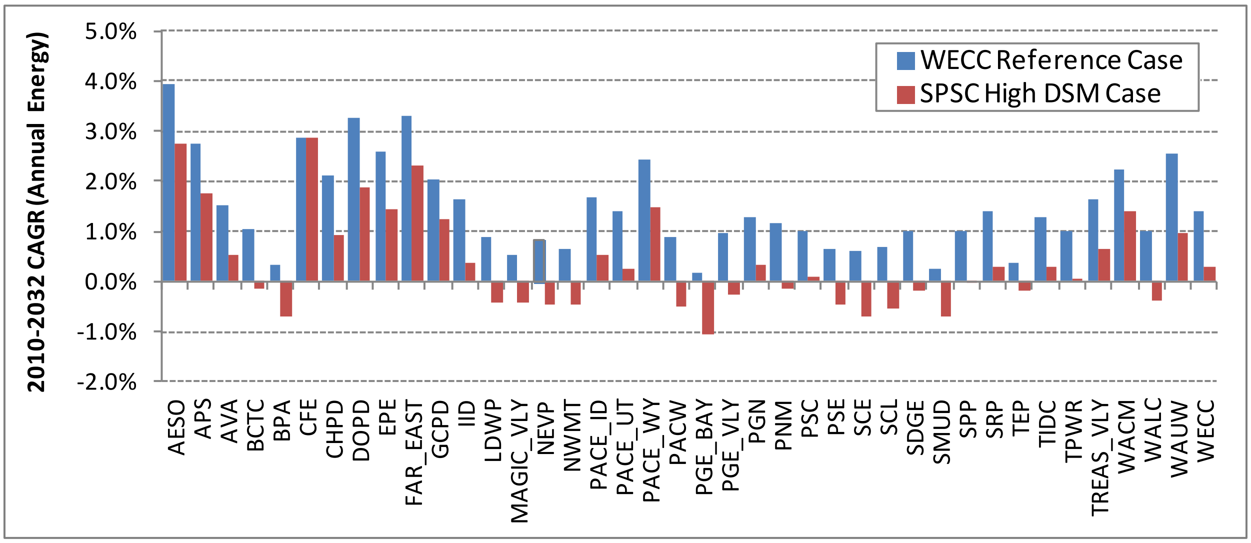

Figure 28. Growth Rates for SPSC High DSM Case and WECC Reference Case (Annual Energy)

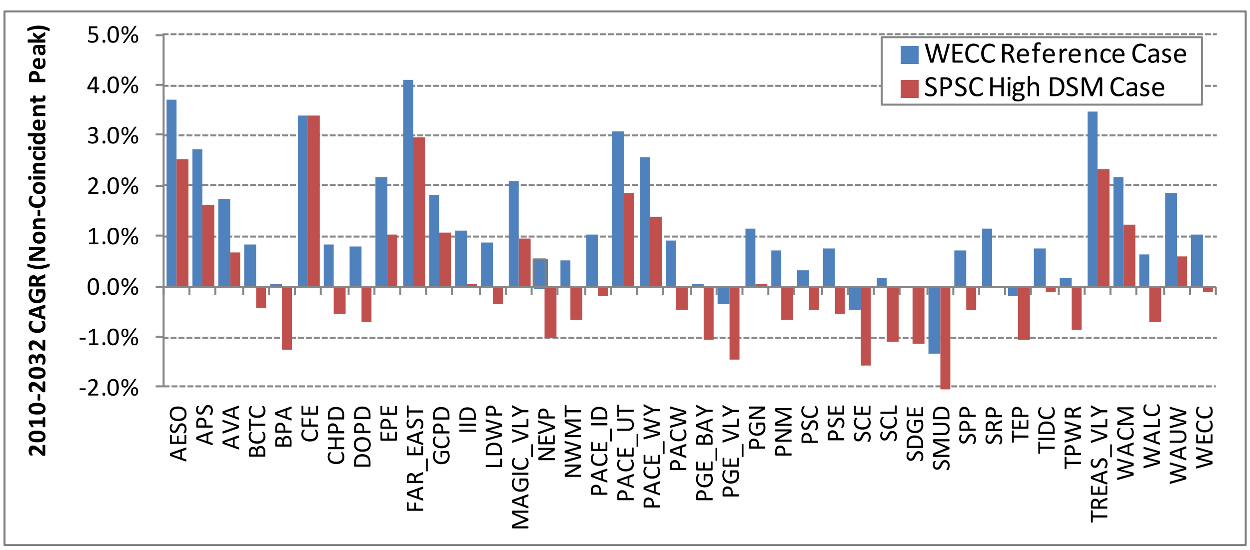

Figure 29. Growth Rates for SPSC High DSM Case and WECC Reference Case (Peak Demand)

5. Recommendations: Potential Improvements to Data, Methodology, and Process for Future TEPPC Study Cycles

Energy efficiency has become an increasingly prominent element within individual utility resource plans throughout the Western Interconnection, with many utilities planning to offset much of their (otherwise) forecasted load growth through customer energy efficiency programs. Energy efficiency has accordingly also become an integral element to the TEPPC studies, with efforts both to ensure that current efficiency policies are adequately captured within the Common Case load forecasts, and to examine alternate study cases with varying assumptions about future energy efficiency trends.

Historically, WECC has had limited needs for data on energy efficiency historical or planned energy efficiency impacts. Important strides in the course of the past TEPPC study cycles have been made to improve data collection and analysis related to energy efficiency impacts on BA load forecasts. Further opportunities exists, however, to streamline those processes, and to improve their consistency and rigor.

We offer a number of recommendations for WECC (and WIEB SPSC) to consider that may improve energy efficiency data collection and analysis for future TEPPC study cycles. In general, these recommendations are targeted to TEPPC participants in general, though in some instances, they may be oriented more narrowly towards WECC staff and TEPPC leadership.

(1) Request that BAs submit secondary load forecasts with no future energy efficiency programs[18]

If LRS load forecasts will continue to be used as the foundation for the TEPPC study case load forecasts, TEPPC stakeholders must be able to determine the impacts embedded in the forecasts from ratepayer-funded efficiency programs implemented over the forecast period (i.e., the red shaded area in Figure 2).[19] As past study cycles have shown, tremendous variability exists among BAs in terms of how, and the extent to which, planned energy efficiency program savings are incorporated into the LRS load forecasts (see Table 1, for example). Several efforts have been made during previous TEPPC study cycles to improve data collection related to energy efficiency program impacts embedded in the LRS forecast – including a supplementary survey sent to LSEs during the 2010 study cycle, and several voluntary questions added to the LRS data request form in 2012. Although both efforts were valuable, neither obviated the need for follow-up communications by LBNL staff with individual BA load forecasting staff.

The challenges to collecting consistent data on embedded energy efficiency impacts are several-fold. First, some of the required energy efficiency terminology and concepts may be unfamiliar or prone to misinterpretation by transmission and/or resource planners, more broadly – for example, the distinctions between "new" vs. "existing" efficiency programs or between

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[18] Although distributed generation (DG) is not the subject of the present report, the same recommendation could be made regarding DG impacts embedded within the LRS load forecasts.

[19] This information is needed for two discrete purposes: first, to ensure that the Common Case forecasts reflect the expected impact of current energy efficiency policies and utility plans; and second, to allow for the development of alternate study cases with varying assumptions about future energy efficiency trends and policy impacts.

"incremental" and "cumulative" savings. Second, there is tremendous variability across BAs in terms of the underlying load forecasting methodology and the accounting of energy efficiency program impacts. The way in which questions about embedded energy efficiency savings are formulated must therefore often be tailored to the specific load forecasting techniques used. Consequently, much of the individual follow-up with BAs has revolved around reframing the questions into terms that are more applicable for the particular BA's forecasting approach.

In order to circumvent these challenges, *we suggest that WECC request that BAs submit a secondary load forecast with no future ratepayer-funded energy efficiency programs*.[20] The delta between this forecast and the primary LRS load forecast would therefore represent the embedded energy efficiency savings in the LRS forecast. This approach should be relatively easy to communicate to BAs in a standardized manner, regardless of their particular load forecasting method, and without requiring ambiguous terminology. Some BAs may of course indicate that they are unable to provide such a secondary forecast; however, that challenge is no different than the one currently faced, where some BAs are unable to provide information about the amount of energy efficiency savings that is embedded in their LRS forecast. We believe that reframing the question in the manner suggested above would likely increase the response rate and consistency across the data provided, relative to the current approach.

Ideally, the secondary load forecasts would be requested as part of WECC's annual LRS data collection process, in order to minimize administrative burdens and duplication. If this suggested alternative load forecast approach proves untenable, then we would recommend that TEPPC develop and implement a separate, parallel data collection instrument and process, similar to the approach used in the 2010 TEPPC study cycle. A separate, stand-alone instrument would also allow for broader or more in-depth data collection than is feasible through the LRS process, and thus might actually be preferable if additional information about demand-side resources was determined to be needed.

(2) Retain capabilities within the TEPPC process to track and quantify the expected impact of energy efficiency programs and policies

Future energy efficiency trends will be driven to a significant degree by various policies and programmatic efforts at the federal, state, and utility levels. Developing TEPPC study cases requires an independent capability to track these policies and estimate their impacts (not unlike the need to track and quantify the impacts of state RPS policies or EPA air pollutant regulations on future generation build-out). This capability is needed both to ensure that the 10-year Common Case and 20-year Reference Case forecasts are consistent with current policies and program plans and to inform alternate study cases with varying energy efficiency policy assumptions.

This function has thus far been served primarily by the SPSC DSM Work Group and to some extent by the TEPPC DSM Task Force and Data Work Group. As the organizations surrounding the TEPPC studies continue to evolve, we recommend that WECC staff and TEPPC leadership

[20] For practical reasons, we suggest focusing on ratepayer-funded energy efficiency programs. Although other types of energy efficiency policies (e.g., codes and standards) can also yield significant impacts on loads, BAs are less likely to be able to precisely estimate the embedded impact of those policies within their forecasts.

actively consider where this function ought to reside over the long-term (e.g., as part of SPSC, SPSG, DWG, WECC staff, etc.) and how best to staff it. Wherever it resides, this function should include at least the following activities:

- Reviewing and compiling data from utility IRPs and utility DSM or EE program plans on planned energy efficiency program savings;
- Tracking state energy efficiency resource standards (EERS) and developing projections of the associated energy efficiency savings;
- Tracking and compiling data on actual utility energy efficiency program savings from recent historical years, to provide benchmarks for projections; and
- Engaging regional energy efficiency experts and utility energy efficiency program staff to review and inform assumptions about current policy and program impacts.

(3) Consider alternative load forecast shaping methods, in order capture the impact of end-use efficiency trends on hourly load profiles

The TEPPC studies require hourly load forecasts, which have been created by applying historical hourly load shapes for each BA to forecasted monthly energy and peak demand. When alternative energy efficiency study cases are developed, adjustments to the monthly energy and peak load forecasts are made, and the same historical hourly load profiles are then applied to the adjusted monthly energy and peak loads. This approach to creating hourly load forecasts precludes any ability to model changes in hourly load shapes that may occur as a result of changes in end-use efficiency (or saturation) over time, either in the Common Case or in alternative study cases, such as the High DSM study case. For example, a dramatic improvement in the efficiency of space cooling end-uses (e.g., residential central air conditioning) could result in a significant flattening of summer-month load shape in some load zones, while widespread fuel switching from electric to gas space heating could significantly flatten winter-month load shapes in other regions. The ability to adequately capture such changes to hourly load shapes may become even more important in order to reliably model and plan for the integration needs associated increasing amounts of variable generation.

We recommend that WECC staff and TEPPC participants consider an alternative approach to developing hourly load forecasts that would partially[21] account for changes to hourly load shapes over time associated with changes in end-use energy efficiency levels. Under this approach, the first step would involve applying historical hourly load profiles to monthly energy and peak load forecasts that assume *no future energy efficiency programs*. These are the "secondary" load forecasts that, under recommendation (1), we suggest be requested directly from BAs. However, if not obtained directly from the BAs, they could be derived by "adding back" the energy efficiency program savings that are embedded in the LRS forecasts. This step would yield hourly load forecasts for each BA that reflect an assumption of no future energy efficiency program savings. Those hourly load forecasts would then be decremented in each hour using hourly energy efficiency savings profiles developed for each BA that reflect the specific amount and composition of end-use energy efficiency savings assumed in the given study case.

[21] The approach recommended here would only account for hourly load shape impacts associated with ratepayer-funded energy efficiency programs, but not other energy efficiency policies (such as federal equipment standards). Furthermore, it would not account for hourly load shape impacts associated with changes in equipment saturation.

Implementing this alternative approach would require additional data collection (or otherwise additional assumptions and estimations):

- *A break-down of energy efficiency program savings into end-use categories for each BA.* For the Common Case, this information could potentially be requested from BAs, in conjunction with the load forecasts, though the level of granularity and category definitions will undoubtedly vary considerably across BAs and utilities. For High DSM load forecasts that rely on energy efficiency potential studies, like the 10-year High DSM study case described in Section 3, the potential studies themselves will generally contain information about the end-use composition of the potential estimate – though, again, the granularity and categories will often differ across studies. Thus, a relatively simple end-use categorization would likely be required, or generic assumptions would need to be employed in order to disaggregate the savings projections into more-refined end-use categories.

- *End-use hourly load profiles by region.* Hourly load shapes by end-use and region could likely be purchased from companies that conduct end-use load forecasting or energy efficiency potential studies, if not publically available. These end-use load shapes would then be applied to the end-use level savings projections in order to create the hourly energy efficiency savings profiles for each BA that reflect the specific mix of end-uses in that BA's projected energy efficiency program portfolio. Therefore, a consistent set of end-use categories would be needed for both the savings projections and the load profiles. Special attention would be required for BAs that span distinct climate zones, in order to ensure that appropriate load profiles were applied to each end-use.

Given the level of effort that might potentially be required in order to adopt the hourly load forecasting approach recommended above, we suggest that WECC staff and TEPPC participants first conduct a scoping analysis to evaluate the potential impact of a more-refined approach on load shapes and TEPPC modeling results (e.g., by selecting several representative load zones and comparing hourly load shapes using the current approach and using a more-refined approach), and to further assess data availability and quality.

(4) Consider commissioning a WECC-wide energy efficiency potential study or tool

As described in Section 3, the 10-year High DSM case was based on a large number of energy efficiency potential studies conducted for utilities throughout the Western Interconnection. Naturally, the scope, assumptions, and methods of those studies varied considerably; and extrapolations were required for BAs without a recent potential study.

TEPPC participants may wish to consider the value of commissioning a single WECC-wide energy efficiency potential that could be used to inform future High DSM study cases. The advantage of such a study is that would provide a consistent (and potentially more transparent) basis for estimating economic potential and achievable potential across the interconnection. However, such an endeavor could also prove contentious, as different stakeholders may disagree over appropriate assumptions and study design, and inconsistencies would inevitably arise between the study results for particular regions and the results from separate potential studies for those regions. One potential alternative might be to commission the development of an energy efficiency potential spreadsheet tool – like the one developed by the Brattle Group to estimate DR potential – that would enable TEPPC participants to create alternative energy efficiency potential estimates, and that could potentially be updated over time. Such a tool might be used to develop energy efficiency potential estimates only for those regions without recent studies or, if used to develop potential estimates for all regions, could be calibrated to recent potential studies based on more sophisticated techniques and data.

(5) If WECC adopts the SAE load forecasting tool, we recommend leveraging the techniques described in this report, as well as consideration of several additional data collection activities and analytical refinements

WECC has considered procuring Itron's SAE load forecasting software for use in developing load forecasts for TEPPC study cases. The framework is a powerful tool for integrating end-use detail with other information in load forecasting, and its applicability to long-term forecasting for transmission planning is demonstrated in this report. We strongly encourage WECC staff to leverage some of the specific techniques and data sources described within this report. In particular, we recommend the use of the "DSM adjustment method" to develop reference case forecasts, and that High DSM load forecasts be developed using the same kind of stock efficiency-based adjustments as described at length in Section 4.

To support and enhance its usefulness for this purpose going forward, we also offer a number of additional recommendations and potential areas for improvement:

(a) Request data from BAs and utilities on end-use saturation and stock efficiency

The SAE model requires historical data and projections for stock efficiency and saturation of 30 residential and commercial end-uses. As a default, the *EIA Annual Energy Outlook* is used to populate these data inputs. Those data, however, are disaggregated into only two census regions in the Western Interconnection. The analysis reported in this study included a concentrated effort to identify and assemble BA-specific data on end-use stock efficiency and saturation, drawing on a variety of public sources (see Section 4.1).

As WECC progresses in its use of the SAE forecasting system, we recommend that WECC staff reach out to BA load forecasting staff for additional BA-specific data on end-use efficiency or saturation levels. Many individual utilities may have developed more accurate end-use saturation and stock efficiency assumptions for their own load forecasting efforts, based on customer surveys or other non-public research. In fact, many utilities use the SAE platform for their load forecasts, and maintain these saturation and stock efficiency assumptions in exactly the same format as WECC would need. Although utilities are generally reluctant to share this information with outside parties, they may be more willing to provide this information to WECC staff directly, particularly if provided under some protection of confidentiality.

As a first step, we would suggest that WECC identify which utilities use the SAE forecasting system, and reach out to those entities to assess whether they would be willing to provide the requisite end-use data inputs. For other utilities/BAs, we recommend that WECC staff pre-populate the end-use data inputs using the default EIA data and public data sources obtained for the 20-year High DSM study, and then send those input sheets to utility/BA load forecasting staff for review.

(b) Refine peak demand savings impacts for specific end-uses

As described in Section 4, High DSM load forecasts were developed with the SAE model by first stipulating increases in average stock efficiency for each end-use. Those stock efficiency improvements were translated into an equivalent percentage reduction in energy use for the corresponding end-use, and those savings percentages were then applied to the Base Case energy forecast for that end-use in order to derive the High DSM case energy forecast. The same end-use savings percentages were then applied to the peak demand forecast for each end-use in order to derive the High DSM case peak load forecast. For most end-uses, this approach is reasonable. However, for some end-uses, the percentage savings in energy and in peak demand could differ significantly from one another. For example, for HVAC end-uses, energy savings may arise partially through the introduction of variable speed drives that reduce energy consumption under part-load conditions. For future applications of the SAE model to develop High DSM load forecasts, we recommend refining the peak demand savings estimates to better capture the hourly savings profile specific to those end-uses where the stipulated stock efficiency improvement would not simply reduce load proportionally across all hours.

(c) Consider options for modeling building shell improvements and behavioral efficiency in future High DSM studies

The 20-year High DSM study case presented in this report considered only changes to average stock efficiencies as a source of future energy efficiency savings. Many efficiency programs and policies (e.g., building codes) also target improvements in building shell characteristics, as well as changes to consumer behavior, and those kinds of measures could potentially be included in future applications of the SAE model for High DSM load forecasts. Building shell efficiency measures, in particular, could be readily modeled within the SAE framework, as building thermal efficiency is among the required data inputs. For behavioral efficiency programs, a considerable amount of judgment would likely be required in order to translate those program impacts into a form that could be readily input into the SAE model.

(d) Refine methods for extrapolating industrial efficiency potential estimates

As discussed in Section 4.4.1, the SAE forecasting model does not contain end-use level detail for the industrial sector. The 20-year High DSM load forecasts were developed by reviewing recent energy efficiency potential studies, and based on those studies, stipulating a 10% reduction in industrial load relative to the Base Case for each BA. For future applications of the SAE model to create High DSM forecasts, we recommend that energy efficiency potential estimates for specific industrial sub-sectors be compiled from recent energy potential studies. Those potential estimates can then be extrapolated to other regions based on the specific industrial mix of each BA (or state), drawing on economic data published by the Department of Commerce's Bureau of Economic Analysis.

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Appendix A. WECC 10-Year Common Case: Additional Details on the Energy Efficiency Assumptions and Adjustments

This appendix provides further details on the assumptions employed to develop the WECC Common Case. Presented first are a series of summary tables containing additional details on the results presented within Sections 2.3 through 2.5:

- Table A - 1 and Table A - 2 summarize the DSM Work Group's projections for the amount of savings expected to occur as a result of current policies and program plans, as well as estimates for the amount of savings embedded within LRS load forecasts. As described and explained further within Section 2, the analysis focused principally on two classes of energy efficiency policies: customer-funded energy efficiency programs and (2) federal minimum efficiency standards. For customer-funded efficiency programs, the analysis focused on the impact of programs implemented over the 2011-2021 period, and for federal standards, the Work Group focused specifically on standards adopted and updates to existing standards scheduled to occur through January 2013.

- Table A - 3 summarizes the adjustments to the LRS load forecast for each BA. These adjustments are equal to the difference between the expected savings and embedded savings shown in Table A - 1 and Table A - 2.

- Table A - 4 and Table A - 5 summarize the WECC Common Case load forecasts for 2021 and corresponding growth rates for each BA, compared to the LRS load forecast. The difference between the forecasts for each BA reflects the adjustments in Table A - 3.

Following the summary tables are a series of narrative summaries describing the energy efficiency assumptions and adjustments for each BA. These narrative summaries provide an overview of the specific policies and data sources used to construct the WECC Common Case, and document the findings from communications with BA load forecasting staff.

A.1 Summary Tables on Efficiency Adjustments for WECC 10-Year Common Case

Table A - 1. Embedded and Expected Energy Efficiency Savings (Annual GWh, 2021)

Region	Balancing Authority	Embedded Savings in LRS Forecast			Expected Savings for Common Case		
		Customer Funded	Federal Standards	Total	Customer Funded	Federal Standards	Total
California	CISO	n/a	n/a	21,890	n/a	n/a	39,884
	IID	269	0	269	269	143	412
	LADWP	2,519	421	2,940	2,519	1,016	3,535
	SMUD	1,649	0	1,649	1,649	601	2,251
	TID	185	0	185	185	95	279
Canada	AESO	1,107	0	1,107	1,107	0	1,107
	BCTC	n/a	n/a	11,076	n/a	n/a	11,076
Northwest	AVA	939	118	1,056	1,235	295	1,530
	BPA	n/a	n/a	6,504	n/a	n/a	6,504
	CHPD	n/a	n/a	135	n/a	n/a	135
	DOPD	n/a	n/a	117	n/a	n/a	117
	GCPD	n/a	n/a	314	n/a	n/a	314
	IPC	1,455	165	1,620	1,690	334	2,025
	NWMT	501	0	501	578	272	851
	PACW	n/a	n/a	1,769	n/a	n/a	2,061
	PGE	3,289	0	3,289	3,289	526	3,816
	PSE	4,081	0	4,081	4,081	586	4,667
	SCL	1,021	0	1,021	1,021	237	1,258
	TPWR	n/a	n/a	588	n/a	n/a	588
	WAUW	n/a	n/a	n/a	9	19	28
Southwest	APS	5,940	0	5,940	5,940	979	6,919
	CFE	0	0	0	0	0	0
	EPE	561	0	561	561	353	914
	NEVP	1,011	247	1,258	1,011	648	1,659
	PACE	n/a	n/a	2,544	n/a	n/a	3,283
	PNM	40	0	40	833	585	1,419
	PSCO	4,415	483	4,898	5,604	1,221	6,826
	SPP	486	118	604	486	308	795
	SRP	1,949	0	1,949	3,368	867	4,235
	TEP	1,381	0	1,381	2,277	372	2,649
	WACM	249	0	249	457	606	1,063
	WALC	83	186	269	83	186	269
WECC Total		**33,129**	**1,737**	**79,804**	**38,253**	**10,250**	**112,466**

Notes: Values represent the reduction in 2021 demand from customer-funded programs implemented over the 2011-2021 period and from new or updated federal standards issued from 2009-2013. "n/a" is used if the data sources or underlying policies, themselves, do not distinguish between the savings from these two types of policies, in which case only the combined total savings is identified.

Table A - 2. Embedded and Expected Energy Efficiency Savings (Non-Coincident Peak MW, 2021)

Region	Balancing Authority	Embedded Savings in LRS Forecast			Expected Savings for Common Case		
		Customer Funded	Federal Standards	Total	Customer Funded	Federal Standards	Total
California	CISO	n/a	n/a	4,517	n/a	n/a	11,469
	IID	60	0	60	60	33	92
	LADWP	515	93	608	515	235	750
	SMUD	262	0	262	262	139	401
	TID	44	0	44	44	22	65
Canada	AESO	154	0	154	154	0	154
	BCTC	n/a	n/a	2,000	n/a	n/a	2,000
Northwest	AVA	93	22	115	123	55	178
	BPA	n/a	n/a	880	n/a	n/a	880
	CHPD	n/a	n/a	26	n/a	n/a	26
	DOPD	n/a	n/a	47	n/a	n/a	47
	GCPD	n/a	n/a	127	n/a	n/a	127
	IPC	236	36	272	274	64	338
	NWMT	81	0	81	94	49	142
	PACW	n/a	n/a	297	n/a	n/a	346
	PGE	552	0	552	552	98	650
	PSE	836	0	836	836	107	943
	SCL	182	0	182	182	43	225
	TPWR	n/a	n/a	114	n/a	n/a	114
	WAUW	n/a	n/a	5	9	19	5
Southwest	APS	855	0	855	855	323	1,178
	CFE	0	0	0	0	0	0
	EPE	124	0	124	124	79	203
	NEVP	223	70	294	223	178	402
	PACE	n/a	n/a	492	n/a	n/a	616
	PNM	6	0	6	136	131	267
	PSCO	832	89	920	1,056	223	1,278
	SPP	139	33	173	139	85	224
	SRP	413	0	413	714	286	999
	TEP	215	0	215	354	123	477
	WACM	47	0	47	95	111	206
	WALC	17	57	74	17	57	74
WECC Total		**5,885**	**400**	**14,790**	**6,816**	**2,457**	**24,874**

Notes: Values represent the reduction in 2021 demand from customer-funded programs implemented over the 2011-2021 period and from new or updated federal standards issued from 2009-2013. "n/a" is used if the data sources or underlying policies, themselves, do not distinguish between the savings from these two types of policies, in which case only the combined total savings is identified.

Table A - 3. Adjustments to the LRS Load Forecasts (2021)

Region	Balancing Authority	Annual Energy		Non-Coincident Peak	
		GWh	% Reduction to LRS	MW	% Reduction to LRS
California	CISO	-17,994	-6.7%	-6,952	-12.4%
	IID	-143	-3.2%	-33	-2.7%
	LADWP	-595	-1.9%	-142	-1.7%
	SMUD	-601	-3.2%	-139	-3.1%
	TID	-95	-3.2%	-22	-3.2%
Canada	AESO	0	0.0%	0	0.0%
	BCTC	0	0.0%	0	0.0%
Northwest	AVA	-474	-3.2%	-63	-2.3%
	BPA	0	0.0%	0	0.0%
	CHPD	0	0.0%	0	0.0%
	DOPD	0	0.0%	0	0.0%
	GCPD	0	0.0%	0	0.0%
	IPC	-404	-2.0%	-66	-1.4%
	NWMT	-350	-3.0%	-61	-3.2%
	PACW	-292	-1.3%	-49	-1.1%
	PGE	-526	-2.2%	-98	-2.3%
	PSE	-586	-2.2%	-107	-2.0%
	SCL	-237	-2.2%	-43	-2.2%
	TPWR	0	0.0%	0	0.0%
	WAUW	0	0.0%	0	0.0%
Southwest	APS	-979	-2.3%	-323	-3.3%
	CFE	0	0.0%	0	0.0%
	EPE	-353	-3.2%	-79	-3.5%
	NEVP	-401	-1.5%	-108	-1.6%
	PACE	-739	-1.3%	-124	-1.1%
	PNM	-1,379	-7.6%	-260	-8.2%
	PSCO	-1,928	-4.0%	-358	-4.4%
	SPP	-191	-1.5%	-51	-2.4%
	SRP	-2,286	-6.1%	-586	-7.4%
	TEP	-1,268	-7.9%	-262	-7.8%
	WACM	-813	-2.7%	-159	-3.3%
	WALC	0	0.0%	0	0.0%
WECC Total		**-32,633**	**-3.2%**	**-10,084**	**-5.0%**

Table A - 4. Comparison of LRS and WECC Common Case Forecasts (Annual GWh)

Region	Balancing Authority	2010	LRS Load Forecast		WECC Common Case		
			2021	CAGR	2021	CAGR	Reduction in CAGR from LRS
California	CISO	228,435	267,850	1.5%	249,856	0.8%	0.6%
	IID	3,558	4,403	2.0%	4,260	1.7%	0.3%
	LADWP	28,278	31,384	1.0%	30,789	0.8%	0.2%
	SMUD	17,162	18,576	0.7%	17,975	0.4%	0.3%
	TID	2,450	2,924	1.6%	2,829	1.3%	0.3%
Canada	AESO	71,722	110,704	4.0%	110,704	4.0%	0.0%
	BCTC	58,457	66,892	1.2%	66,892	1.2%	0.0%
Northwest	AVA	12,238	14,939	1.8%	14,465	1.5%	0.3%
	BPA	51,876	53,450	0.3%	53,450	0.3%	0.0%
	CHPD	3,151	4,037	2.3%	4,037	2.3%	0.0%
	DOPD	1,346	1,931	3.3%	1,931	3.3%	0.0%
	GCPD	4,064	5,103	2.1%	5,103	2.1%	0.0%
	IPC	16,359	19,944	1.8%	19,540	1.6%	0.2%
	NWMT	10,525	11,618	0.9%	11,268	0.6%	0.3%
	PACW	20,654	23,041	1.0%	22,749	0.9%	0.1%
	PGE	20,103	23,593	1.5%	23,067	1.3%	0.2%
	PSE	24,536	26,926	0.8%	26,340	0.6%	0.2%
	SCL	9,899	10,899	0.9%	10,662	0.7%	0.2%
	TPWR	4,863	5,443	1.0%	5,443	1.0%	0.0%
	WAUW	634	821	2.4%	821	2.4%	0.0%
Southwest	APS	30,900	42,423	2.9%	41,444	2.7%	0.2%
	CFE	10,649	14,606	2.9%	14,606	2.9%	0.0%
	EPE	8,049	11,033	2.9%	10,679	2.6%	0.3%
	NEVP	24,502	27,066	0.9%	26,665	0.8%	0.1%
	PACE	46,410	56,226	1.8%	55,487	1.6%	0.1%
	PNM	14,920	18,267	1.9%	16,887	1.1%	0.7%
	PSCO	41,865	48,480	1.3%	46,552	1.0%	0.4%
	SPP	11,345	12,885	1.2%	12,694	1.0%	0.1%
	SRP	30,590	37,569	1.9%	35,283	1.3%	0.6%
	TEP	14,356	16,126	1.1%	14,857	0.3%	0.7%
	WACM	23,381	30,644	2.5%	29,831	2.2%	0.3%
	WALC	6,766	7,549	1.0%	7,549	1.0%	0.0%
WECC Total		**854,043**	**1,027,348**	**1.7%**	**994,715**	**1.40%**	**0.30%**

Table A - 5. Comparison of LRS and WECC Common Case Forecasts (Non-Coincident Peak MW)

Region	Balancing Authority	2010	LRS Load Forecast		WECC Common Case		
			2021	CAGR	2021	CAGR	Reduction in CAGR from LRS
California	CISO	47,535	56,276	1.5%	49,324	0.3%	1.2%
	IID	1,004	1,209	1.7%	1,176	1.4%	0.3%
	LADWP	6,785	8,186	1.7%	8,044	1.6%	0.2%
	SMUD	4,436	4,496	0.1%	4,357	-0.2%	0.3%
	TID	588	689	1.5%	667	1.2%	0.3%
Canada	AESO	10,196	15,437	3.8%	15,437	3.8%	0.0%
	BCTC	10,716	12,077	1.1%	12,077	1.1%	0.0%
Northwest	AVA	2,179	2,738	2.1%	2,675	1.9%	0.2%
	BPA	9,826	10,376	0.5%	10,376	0.5%	0.0%
	CHPD	603	717	1.6%	717	1.6%	0.0%
	DOPD	361	415	1.3%	415	1.3%	0.0%
	GCPD	689	846	1.9%	846	1.9%	0.0%
	IPC	3,372	4,854	3.4%	4,788	3.2%	0.1%
	NWMT	1,704	1,881	0.9%	1,820	0.6%	0.3%
	PACW	3,779	4,287	1.2%	4,238	1.0%	0.1%
	PGE	3,627	4,257	1.5%	4,159	1.3%	0.2%
	PSE	4,810	5,410	1.1%	5,303	0.9%	0.2%
	SCL	1,845	1,941	0.5%	1,898	0.3%	0.2%
	TPWR	989	1,035	0.4%	1,035	0.4%	0.0%
	WAUW	116	147	2.2%	147	2.2%	0.0%
Southwest	APS	7,046	9,796	3.0%	9,473	2.7%	0.3%
	CFE	2,174	3,353	4.0%	3,353	4.0%	0.0%
	EPE	1,616	2,270	3.1%	2,191	2.8%	0.3%
	NEVP	6,034	6,767	1.0%	6,659	0.9%	0.1%
	PACE	7,948	11,139	3.1%	11,015	3.0%	0.1%
	PNM	2,636	3,166	1.7%	2,905	0.9%	0.8%
	PSCO	7,608	8,179	0.7%	7,821	0.3%	0.4%
	SPP	1,925	2,153	1.0%	2,102	0.8%	0.2%
	SRP	6,513	7,960	1.8%	7,373	1.1%	0.7%
	TEP	3,088	3,358	0.8%	3,096	0.0%	0.7%
	WACM	3,630	4,764	2.5%	4,605	2.2%	0.3%
	WALC	1,421	1,585	1.0%	1,585	1.0%	0.0%
WECC Total		**166,799**	**201,762**	**1.7%**	**191,678**	**1.27%**	**0.5%**

A.2 BA-Specific Energy Efficiency Assumptions and Adjustments: Narrative Summaries

AESO

Based on guidance from provincial representatives for last year's study, it was determined that savings currently being achieved through customer-funded energy efficiency programs are relatively negligible and that there were no policies in place that would require a significant ramp-up in program activity. It was therefore assumed that savings from customer-funded programs would accumulate at a rate of 0.1% of retail sales per year over the forecast period, and that this level of savings was fully captured (albeit implicitly) by the LRS load forecast. This is the generic assumption used by the DSM Work Group throughout its analysis for utilities with little or no history of administering significant energy efficiency program portfolios, and where no specific data were available regarding planned energy efficiency program activity.

APS

Customer-Funded EE Programs: APS staff confirmed that the load forecast submitted to WECC is net of planned savings from customer-funded energy efficiency programs implemented over the 2011-2021 period, and that the level of savings assumed would meet or exceed the amount required to comply with Arizona's Energy Efficiency Rule. Therefore, no adjustment was made for customer-funded energy efficiency program savings.

Federal Standards: APS staff also indicated that the load forecast does explicitly model federal standards for residential refrigeration and A/C, but not other end-uses (lighting) or customer segments (commercial or industrial), and that only existing standards are modeled. It is therefore unlikely that the load forecast submitted to WECC in March 2011 captures the impact of federal standards updated over the 2009-2013 period, and therefore the standardized "Method 1" adjustment was made to the load forecast in order to capture the impact of those standards, as described in Section 2.2.

AVA

Customer-Funded EE Programs: Avista staff indicated that the AVA load forecast submitted to WECC is net of only the expected impact of pre-existing programs, but does not account for the incremental impact of planned new programs specified in the 2011 IRP. Avista staff provided LBNL with information that was used to estimate the 2011 IRP savings targets, segmented into savings associated with existing programs and savings associated with new programs. The forecast was then adjusted downward based on the planned savings from new programs. It is assumed that savings from NEEA regional market transformation programs implemented over the forecast period are captured within the initial load forecast, under the presumption that NEEA program savings continue to accumulate at more-or-less their historical rate.

Federal Standards: The expected savings from federal standards adopted over the 2009-2013 timeframe was estimated by pro-rating the statewide savings for each state in which AVA overlaps, in proportion to the portion of statewide load within the balancing authority. Avista staff confirmed that the AVA load forecast submitted to WECC does account for all historical changes to federal standards, but does not account for any planned updates. Savings associated with federal standards already adopted since January 2009 were therefore assumed to be embedded within the load forecast, and the load forecast was adjusted based on the standard “Method 2” adjustment described in Section 2.2.

BPA

BPA Staff confirmed that the load forecast submitted to WECC this year is net of the balancing authority's pro-rated share of the 6th plan conservation targets (in contrast to last year's forecast, which accounted for conservation savings only at the historical rate). Therefore, no adjustment to the BPA forecast is required for the WECC Common Case. Note that the 6th plan conservation targets are not specific to any individual policy mechanism, and therefore the projections of embedded and expected savings in the table below are not disaggregated into customer-funded EE programs and federal standards. It is also assumed that savings from regional NEEA market transformation programs are included within the Council's conservation targets.

BCTC

<u>BC Hydro Retail Load</u>: BC Hydro provided to WECC a projection of the total expected savings from customer-funded energy efficiency programs and from codes/standards. LBNL is currently awaiting confirmation from BC Hydro that this savings amount has already been netted off of the load forecast submitted to WECC, and on what basis the savings projections were derived. In the interim, the savings projection provided to WECC is assumed to be fully captured in the load forecast and is assumed to represent the level of savings expected based on current policies and program plans (as was the case in last year's BC Hydro load forecast). Note that the savings projection provided to WECC aggregates the impact of customer-funded programs and provincial codes/standards; therefore the table below reports only the combined amount. Note also that the savings projection provided WECC represents savings at the customer-meter; these values were therefore grossed up to the bus-bar by adding an assumed 7% T&D losses.

<u>FortisBC Retail Load</u>: The BCTC balancing authority also includes the retail load of FortisBC. The expected savings from FortisBC customer-funded EE programs is based on the DSM savings projection in the utility's 2012 Long-Term Demand Side Management Plan. Pending further information from BC Hydro, it is assumed that the balancing authority load forecast submitted to WECC fully captures the expected impact of FortisBC's programs.

CHPD

CHPD Staff confirmed that the load forecast submitted to WECC is "net" of planned energy efficiency savings and that the savings projection that Chelan provided to WECC represents the planned energy efficiency savings levels netted off the forecast. Those savings levels are based on a pro-rata share of the regional conservation goals found in the Council's 5th Power Plan, which Chelan used for its latest I937 conservation goals. Thus, no adjustments were made to the load forecast submitted to WECC. Note that the Council's conservation targets are not specific to any individual policy mechanism; therefore, the projections of embedded and expected savings in the table below are not disaggregated into customer-funded EE programs and federal standards. It is also assumed that savings from regional NEEA market transformation programs are included within the Council's conservation targets.

CISO

The CISO load forecast submitted to WECC was prepared by the CEC and is a modified version of the CEC's December 2009 Demand Forecast (the 2009 IEPR forecast). That forecast accounts only for "committed" energy efficiency savings, and therefore excludes "uncommitted" savings associated with IOU programs implemented after 2012, savings from POU programs implemented after 2010, and savings from other future changes to codes/standards. The forecast was therefore adjusted downward based on the sum of: (a) the uncommitted savings projection developed by the CPUC for the IOUs' long-term procurement proceeding and (b) the estimated cumulative savings from municipal utility customer-funded EE programs within the CISO footprint, based on those utilities' most recent long-term EE savings targets. Note that the committed and uncommitted savings estimates developed by the CEC span a somewhat broader set of policies than just customer-funded programs and federal standards; therefore only total embedded and expected savings projections are shown in the table below, rather than as separate projections for customer-funded programs and federal standards. Note also that further discussions with CEC staff may result in changes to the assumed level of "committed" savings; however, any changes to that assumption will affect the embedded and expected savings projections by an equal amount, and therefore will not result in any change to the proposed WECC Common Case load forecast.

DOPD

The expected savings are equal to Douglas PUD’s pro-rated share of the Council's 6th plan conservation targets. DOPD staff confirmed that the load forecast submitted to WECC is "net" of the savings target identified within the utility’s last IRP plus expected savings from the state’s low income weatherization program, and we assume that the total assumed savings are roughly consistent with the utility’s pro-rated share of the Council's 6th plan targets. Note that the Council's conservation targets are not specific to any individual policy mechanism; therefore, the projections of embedded and expected savings in the table below are not disaggregated into customer-funded EE programs and federal standards. It is also assumed that savings from regional NEEA market transformation programs are included within the Council's conservation targets.

EPE

<u>Customer-Funded EE Programs</u>: EPE staff confirmed that the load forecast submitted to WECC is net of energy efficiency and DG requirements, and that energy efficiency savings projection provided to WECC is based on compliance with New Mexico's and Texas' energy efficiency resource standards. Therefore, no adjustment was made for customer-funded energy efficiency program savings.

Federal Standards: EPE staff also confirmed that the load forecast submitted to WECC does not model any changes to federal lighting/appliance/equipment standards. Therefore the standardized "Method 1" adjustment was made to the load forecast in order to capture the impact of those standards, as described in Section 2.2.

IID

Customer-Funded Energy Efficiency Programs: Like all California municipal utilities, IID is required to establish 10-year savings targets for customer-funded EE programs. The most recent set of targets were reported to the CEC in a March 2011 compliance filing. IID staff confirmed that the load forecast submitted to WECC does not explicitly consider the impact of customer-funded energy efficiency programs, although it does implicitly assume a continuation of savings at historical levels. Insufficient data is available to assess IID's historical savings or how that level of savings compares to its current long-term goals; therefore, for simplicity, the load forecast is assumed to fully capture IID's long term savings goals.

Federal Standards: IID staff confirmed that the load forecast submitted to WECC does not explicitly consider the impact of federal standards. Therefore the standardized "Method 1" adjustment was made to the load forecast in order to capture the impact of those standards, as described in Section 2.2.

IPC

Customer-Funded EE Programs: IPC staff confirmed that the load forecast submitted to WECC is net of *only* the existing, committed programs in the 2011 IRP, but that it does not account for the savings from the new planned programs identified in the IRP. Therefore, the IPC load forecast provided to WECC in 2011 is adjusted downward based on the projected savings from new programs identified in Idaho Power's 2011 IRP. Savings from NEEA regional market transformation programs implemented over the forecast period are assumed to be captured in the load forecast, under the presumption that NEEA program savings will continue to accumulate at more-or-less their historical rate; therefore, the embedded and expected savings projections for customer-funded energy efficiency programs include the projected savings from NEEA programs, in addition to the IRP savings projections (which exclude NEEA program savings).

Federal Standards: Idaho Power staff indicated that the company's current load forecasting model does include statistical end-use adjustments for residential load, and captures all *historical* changes to federal standards for residential end-uses as well as *future* updates to federal standards for residential end-uses, based on consensus forecasts of future implementation of standard levels from the American Council for an Energy-Efficient Economy, and the Association of Home Appliance Manufacturers. However, IPC staff confirmed that the load forecast does not model any changes to federal standards for commercial customers, although the company is planning to do so in the future. For the purpose of the WECC Common Case forecast, it was assumed that the IPC load forecast originally submitted to WECC accounts for all 2009-2013 federal standards targeting residential end uses, but does not account for any of the 2009-2013 standards targeting commercial end uses. The forecast was therefore adjusted downward based on the projected impact of those 2009-2013 federal standards targeting commercial end-uses.

GCPD

The expected savings are equal to GCPD's pro-rated share of the Council's 6th plan targets. Pending confirmation from GCPD staff, it is assumed that the load forecast submitted to WECC is already "net" of this level of savings. Note that the Council's conservation targets are not specific to any individual policy mechanism; therefore, the projections of embedded and expected savings in the table below are not disaggregated into customer-funded EE programs and federal standards. It is also assumed that savings from regional NEEA market transformation programs are included within the Council's conservation targets.

LDWP

Customer-Funded EE Programs: The LADWP balancing authority consists of three utilities (LADWP, Burbank, and Glendale), each of which is required to establish 10-year energy efficiency savings targets. LADWP staff confirmed that the load forecast submitted to WECC is "net" of savings from planned customer-funded energy efficiency programs, based on each utility's' most recently approved set of targets. (Note, though, that the current targets for LADWP terminate in 2016, and thus the utility used the 2010 IRP savings projections for years thereafter, which taper off significantly after 2016). Given that the utilities' savings targets are fully captured by the load forecast submitted to WECC, no adjustments were made for customer-funded energy efficiency programs.

Federal Standards: LADWP staff indicated that the load forecast submitted to WECC does contain an adjustment to account for the impact of the Huffman lighting standards, but not for any future standards. The forecast therefore likely captures some or all of the savings associated with the lighting standard update adopted by DOE in 2009. For simplicity, we assume that savings associated with all federal standards already adopted since January 2009 are embedded within the load forecast (as the lighting standard represents the bulk of the total expected savings from federal standards updates since January 2009), and apply the standard "Method 2" adjustment described in Section 2.2in order to account for the expected savings from prospective standards scheduled for adoption by January 2013.

NEVP

Customer-Funded EE Programs: NV Energy staff confirmed that the NEVP load forecast submitted to WECC is net of planned energy efficiency savings, based on the savings targets assumed within the company's 2010 Energy Supply Plan, as provided to WECC. Note that these savings targets are net of measure decay, and are therefore significantly lower than what one would derive by simply extrapolating the most recent 2011-2013 DSM Plan annual savings acquisition rates out over the entire forecast period. Because the load forecast submitted to WECC fully captures NV Energy's currently planned savings targets, no adjustment was made to the forecast.

Federal Standards: The expected savings from federal standards adopted over the 2009-2013 timeframe was estimated by pro-rating the statewide savings, in proportion to the portion of statewide load within the balancing authority. NV Energy staff confirmed that the NEVP load forecast does account for historical changes to federal standards, but does not account for any planned updates. Savings associated with federal standards already adopted since January 2009 were therefore assumed to be embedded within the load forecast, and the standard "Method 2" adjustment described in Section 2.2 was applied in order to account for the expected savings from prospective standards scheduled for adoption by January 2013.

NWMT

Customer-Funded EE Programs: NorthWestern Energy staff indicated that the load forecast submitted to WECC is net of energy efficiency program savings, based only on the historical rate of savings. NorthWestern's 2009 Electric Default Supply Procurement Plan indicates that, from 2006-2009, the utility achieved average annual incremental savings of 5.2 aMW per year. In contrast, the Plan proposes to acquire savings at an average annual rate of 6.0 aMW over the forecast period. Therefore, the load forecast submitted to WECC was adjusted downward based on the difference between the planned savings level and the savings level that was achieved over the 2006-2009 period.

Federal Standards: NorthWestern Energy staff could not confirm whether the load forecast submitted to WECC explicitly considers the impact of federal standards. Given the manner in which the forecast accounts for savings from customer-funded programs (i.e., accounting for future savings only at the historical rate), it was similarly assumed that the forecast does not account for any increase in the rate of savings accumulation from federal standards, and the standardized "Method 1" adjustment was made to the load forecast in order to capture the impact of those standards, as described in Section 2.2.

PACE

Customer-Funded EE Programs (PacifiCorp): PacifiCorp staff confirmed that the PACE load forecast submitted to WECC accounted for the planned energy efficiency program savings from the 2008 IRP Update (issued in 2010). The savings targets in the more-recent 2011 IRP (issued March 31, 2011) are somewhat higher than the targets in the 2008 IRP Update. Therefore, to develop the WECC Common Case forecast, the original PACE forecast was decremented by an amount equal to the difference between the savings targets in the 2011 IRP and the 2008 IRP Update.

Customer-Funded EE Programs (Other Utilities in PACE): In addition to PacifiCorp, the PACE balancing authority also includes all of the municipal utilities and cooperatives in Utah, as well as Montana-Dakota Utilities in Wyoming (representing, in aggregate, about 15% of the balancing authority load). The DSM Work Group's projection of expected savings from MDU's programs are based on the most recent 3-year DSM plan, and assume that the average annual incremental savings in that plan continue over the entirety of the 2011-2021 forecast period. The expected savings from Utah municipal utilities and cooperatives are based on the assumption that savings accumulate at a rate of 0.1% of retail sales per year. This is the generic conservative assumption used by the DSM Work Group throughout its analysis for small utilities with little or no history of administering significant energy efficiency program portfolios and/or where no specific data were available regarding planned energy efficiency program activity. No information was provided to WECC or to LBNL regarding the extent to which the load forecast submitted to WECC accounted for expected savings from customer-funded programs by MDU or by the Utah municipal utilities and cooperatives. For simplicity, given the relatively small portion of the overall PACE load represented by these utilities, it was assumed that the original load forecast submitted to WECC fully captures the expected savings from those utilities' programs.

Federal Standards: The expected savings from federal standards adopted over the 2009-2013 timeframe was estimated by pro-rating the statewide savings, for each state in which PACE overlaps, in proportion to the portion of statewide load within the balancing authority. PacifiCorp staff confirmed that the PACE load forecast does account for all historical changes to federal standards, but does not account for any planned updates. Savings associated with federal standards already adopted since January 2009 was therefore assumed to be embedded within the load forecast, and the standard "Method 2" adjustment described in Section 2.2 was applied in order to account for the expected savings from prospective standards scheduled for adoption by January 2013.

PACW

Customer-Funded EE Programs: PacifiCorp staff confirmed that the PACW load forecast submitted to WECC accounted for the planned energy efficiency program savings from the 2008 IRP Update (issued in 2010). The savings targets in the more-recent 2011 IRP (issued March 31, 2011) are somewhat higher than the targets in the 2008 IRP Update. Therefore, to develop the WECC Common Case forecast, the original PACW forecast was decremented by an amount equal to the difference between the savings targets in the 2011 IRP and the 2008 IRP Update. PacifiCorp staff confirmed that the EE targets for Oregon contained within the 2011 IRP were provided to PacifiCorp by the Oregon Energy Trust, and are intended to reflect all achievable cost-effective efficiency, based on the Trust's current planning assumptions.

Federal Standards: The expected savings from federal standards adopted over the 2009-2013 timeframe was estimated by pro-rating the statewide savings, for each state in which PACW overlaps, in proportion to the portion of statewide load within the balancing authority. PacifiCorp staff confirmed that the PACW load forecast does account for all historical changes to federal standards, but does not account for any planned updates. Savings associated with federal standards already adopted since January 2009 were therefore assumed to be embedded within the load forecast, and the standard "Method 2" adjustment described in Section 2.2 was applied in order to account for the expected savings from prospective standards scheduled for adoption by January 2013.

PGE

Customer-Funded EE Programs: PGE staff confirmed that the PGE load forecast is net of the savings from all planned energy efficiency programs, and is based on a savings projection provided to PGE by the Energy Trust. Therefore, no adjustment to the initial forecast was made for customer-funded energy efficiency program savings. The savings projection provided to PGE extends only through 2017, and PGE staff indicated that for the 2018-2021 period, they assumed that savings would continue at the same rate as prior to 2017.

Federal Standards: PGE staff also confirmed that the PGE load forecast does not model any changes to federal lighting/appliance/equipment standards. Therefore, the standardized "Method 1" adjustment was made to the load forecast in order to capture the impact of standards adopted over the 2009-2013 period, as described in Section 2.2.

PNM

Customer-Funded EE Programs (PNM utility): PNM Staff confirmed that the load forecast submitted to WECC does not capture the expected impact of PNM customer-funded energy efficiency programs -- that is, it is a "pre-energy efficiency" forecast. PNM provided WECC with its forecast of planned savings from customer-funded energy efficiency programs, which complies with New Mexico's energy efficiency resource standard. The load forecast that PNM provided to WECC was therefore reduced by an amount equal to PNM's projected energy efficiency savings.

Customer-Funded EE Programs (other utilities in the PNM balancing authority): The PNM balancing authority includes several municipal utilities and a number of cooperatives served by Tri-State G&T; together, these utilities constitute roughly 26% of the total PNM balancing authority load. Information was not readily available regarding the planned energy efficiency savings by these entities or the amount of savings already embedded in the overall balancing authority forecast. Lacking such information, the DSM Work Group assumes that customer-funded energy efficiency programs implemented by these entities will yield annual incremental savings equal to 0.1% of retail sales per year (a relatively modest level, though not atypical for small public utilities), and that this level of savings is captured within the load forecast by virtue of the econometric methods used to develop the forecast.

Federal Standards: PNM staff also confirmed that the PNM load forecast does not model any changes to federal lighting/appliance/equipment standards. Therefore, the standardized "Method 1" adjustment was made to the load forecast in order to capture the impact of standards adopted over the 2009-2013 period, as described in Section 2.2.

PSCO

Customer-Funded EE Programs (Xcel): Xcel staff indicated that the load forecast provided to WECC is net of the previous set of long-term savings goals established under Docket. 08-0560. The forecast was therefore adjusted downward slightly in order to account for the higher level of savings required under the updated goals adopted in March 2011 (Decision No. C11-0442).

Customer-Funded EE Programs (other utilities in PSCO balancing authority): The PSCO balancing authority also includes a number of other utilities, including Black Hills, the municipal utilities served by Platte River (Fort Collins and several smaller utilities), a number of cooperatives served by Tri-State, as well as cooperatives served by the Arkansas River Power Authority and Municipal Energy Agency of Nebraska. According to PSCO staff, those utilities provide their own load forecasts to PSCO, and did not provide any information about whether those forecasts are "net" of planned energy efficiency savings. For simplicity (given the relatively small size of those other utilities compared to PSCO and the time and resources required for independent validation), we assume that the load forecasts for those smaller entities do fully account for the expected impact of their customer-funded energy efficiency programs. For Black Hills, the expected savings is based on the long-term savings targets approved by the commission in Docket No. 08A-518E. For Platte River Power Authority (PRPA), the expected savings is based on the savings projection provided by PRPA to WECC, which is somewhat below the saving level currently being achieved by Fort Collins. For the Tri-State, ARPA, and MEAN cooperatives within the PSCO balancing authority, expected savings are based on a stipulated annual incremental savings of 0.1% of retail sales per year; this is the generic assumption used by the DSM Work Group throughout its analysis, for utilities with little or no history of administering significant energy efficiency program portfolios, and where no specific data were available regarding planned energy efficiency program activity.

Federal Standards: PSCO staff confirmed that the utility's load forecast does account for all historical changes to federal standards, but does not account for any planned updates. Savings associated with federal standards already adopted since January 2009 were therefore assumed to be embedded within the load forecast, and the standard "Method 2" adjustment described in Section 2.2 was applied in order to account for the expected savings from prospective standards scheduled for adoption by January 2013.

PSE

Customer-Funded EE Programs: PSE staff confirmed that the load forecast submitted to WECC is net of planned energy efficiency savings, though they have not yet confirmed whether the amount of savings assumed is consistent with the savings projections in their 2011 IRP. Pending confirmation from PSE, it is assumed that the load forecast provided to WECC fully accounts for the level of savings identified in the utility's 2011 IRP. Therefore, no adjustment to the forecast is currently made for customer-funded EE programs.

Federal Standards: PSE staff confirmed that the load forecast submitted to WECC does not explicitly consider the impact of recent or scheduled updates to federal standards through 2013 (although the utility did explicitly model the impact of the EISA lighting standard established in 2007). Therefore, the standardized "Method 1" adjustment was made to the load forecast in order to capture the expected impact of standards adopted over the 2009-2013 period, as described in Section 2.2.

SCL

Customer-Funded EE Programs: The savings projection that SCL provided to WECC is consistent with the conservation targets identified in Seattle City Light's 2010 IRP. Seattle City Light staff has not yet confirmed that the load forecast submitted to WECC is already net of this level of savings. Pending confirmation from the utility, it is assumed that the forecast is net of this expected savings level, and therefore no adjustments were made to the forecast for customer-funded programs.

Federal Standards: Seattle City Light staff have not yet indicated whether the load forecast submitted to WECC explicitly considers the impact of federal standards. Pending confirmation from the utility, the standardized “Method 1” adjustment was made to the load forecast in order to capture the expected impact of standards adopted over the 2009-2013 period, as described in Section 2.2

SMUD

Customer-Funded EE Programs (SMUD): SMUD staff confirmed that the load forecast submitted to WECC is net of assumed savings from SMUD customer-funded energy efficiency programs over the 2011-2021 period. However, the assumed energy efficiency savings through 2017 are equal to about 70% of the long-term targets established by the SMUD Board (which currently extend only through 2017), and in years after 2017, the assumed savings in SMUD's load forecast are about 40% of the SMUD Board-approved target for 2017. SMUD staff indicated that the assumed savings reflect near-term EE program forecasts through 2014 and the Itron potential study estimates for years after 2014, rather than the SMUD Board-approved goals, because of the uncertainty surrounding both the unmanaged forecast and EE program effectiveness. In deference to the judgment of SMUD's planning team, the SPSC DSM Work Group’s projection of expected savings from SMUD customer-funded EE program savings is equal to the level assumed by SMUD when developing their load forecast, and no adjustment to the forecast was made.

Customer-Funded EE Programs (other utilities in the SMUD balancing authority): The SMUD balancing authority includes several other municipal utilities (Modesto, Redding, or Roseville); like all municipal utilities in California, these three utilities are also required to establish long-term savings goals and to report those targets to the CEC. SMUD staff could not confirm whether the forecast also accounted for the expected impacts from planned energy efficiency programs by those utilities. For simplicity, given the relatively small size of those utilities compared to SMUD, it was assumed that the long-term savings targets for those utilities were also fully captured by the balancing authority load forecast.

Federal Standards: SMUD staff also confirmed that the load forecast submitted to WECC does not model any changes to federal lighting/appliance/equipment standards. Therefore, the standardized “Method 1” adjustment was made to the load forecast in order to capture the expected impact of standards adopted over the 2009-2013 period, as described in Section 2.2. SMUD staff, however, did indicate that the company is testing Itron's statistically-adjusted end-use model for future load forecasting, and this model would allow federal standards to be explicitly modeled in future years.

SPP

Customer-Funded EE Programs: NV Energy staff confirmed that the SPP load forecast submitted to WECC is net of planned energy efficiency savings, based on the savings targets assumed within the company's 2010 Integrated Resource Plan, as provided to WECC. Note that these savings targets are net of measure decay, and are therefore significantly lower than what one would derive by simply extrapolating the most recent 2011-2013 DSM Plan annual savings acquisition rates out over the entire forecast period. Because the load forecast submitted to WECC fully captures NV Energy's currently planned savings targets, no adjustment was made to the forecast.

Federal Standards: The expected savings from federal standards adopted over the 2009-2013 timeframe was estimated by pro-rating the statewide savings, in proportion to the portion of statewide load within the balancing authority. NV Energy staff confirmed that the SPPC load forecast does account for historical changes to federal standards, but does not account for any planned updates. Savings associated with federal standards already adopted since January 2009 were therefore assumed to be embedded within the load forecast, and the standard "Method 2" adjustment described in Section 2.2 was applied in order to account for the expected savings from prospective standards scheduled for adoption by January 2013.

SRP

Customer-Funded EE Programs: SRP staff confirmed that the load forecast submitted to WECC is net of the planned savings levels as of last summer, which extend only through 2017. The expected savings from customer-funded programs are, instead, based on the recently adopted Sustainable Portfolio Plan target levels. According to SRP staff, the planned savings levels in the forecast are roughly in line with the utility's current expectations for the savings levels needed to meet the Sustainable Portfolio Plan savings targets through 2017 (due, in part, to the recent downward revision to their load forecast, which in turn reduces the amount of savings required to meet the percentage targets under the Sustainable Portfolio Plan). Thus, the load forecast was adjusted only to account for the expected savings needed to meet the Sustainable Portfolio Plan savings targets in the years 2018-2021. In calculating the cumulative embedded and expected savings, it was assumed that 48% of the annual incremental savings from SRP's EE program portfolio is associated with the M-Power program, and that the savings from that program do not persist beyond the first year. The 48% assumption is based on SRP's forecast of EE program savings for FY11.

Federal Standards: SRP staff have not yet confirmed whether the load forecast submitted to WECC explicitly considers the impact of federal standards. Pending further information, the standardized "Method 1" adjustment was made to the load forecast in order to capture the expected impact of standards adopted over the 2009-2013 period, as described in Section 2.2.

TEP

Customer-Funded EE Programs: TEP/UNS staff indicated that the load forecast submitted to WECC partially accounts for the effects of planned customer-funded energy efficiency programs over the forecast period, but not at the level necessary to meet the Arizona Energy Efficiency Standard. The program savings forecast that TEP originally submitted to WECC represents the cumulative savings required to comply with the Arizona Energy Efficiency Rule, of which only a portion is captured within the load forecast. TEP staff provided a separate table to LBNL identifying the level of savings that was captured by the original forecast. To construct the WECC Common Case forecast, TEP's original load forecast was therefore reduced by an amount equal to the difference between the level of savings required to meet the EE standard (as indicated by TEP) and the amount already incorporated into the forecast.

Federal Standards: TEP staff confirmed that the load forecast submitted to WECC does not model any changes to federal lighting/appliance/equipment standards. Therefore, the standardized "Method 1" adjustment was made to the load forecast in order to capture the expected impact of standards adopted over the 2009-2013 period, as described in Section 2.2.

TID

Customer-Funded Energy Efficiency Programs: Like all California municipal utilities, TID is required to establish 10-year savings targets for customer-funded EE programs. The most recent set of targets were reported to the CEC in a March 2011 compliance filing. The SPSC DSM Work Group was unable to confirm with TID staff whether their forecast is net of planned energy efficiency savings, and if so, by how much. Given the lack of information available, the same assumptions were employed for TID as for IID. Namely, the forecast was assumed to fully capture planned energy efficiency savings, based on the utility's most-recent 10-year savings targets.

Federal Standards: The SPSC DSM Work Group was unable to confirm with TID staff whether/how the forecast accounts for savings from federal standards. Given the lack of information available, it was assumed that the forecast does not explicitly model the impact of federal standards; and therefore, the standardized "Method 1" adjustment was made to the load forecast in order to capture the expected impact of standards adopted over the 2009-2013 period, as described in Section 2.2.

TPWR

Tacoma Power staff indicated that the forecast prepared by the utility is net of planned conservation, and that the planned energy efficiency savings are based on the Council's conservation targets, which the utility then incorporates into its IRP. Thus, no adjustments were made to the load forecast submitted to WECC. Note that the Council's conservation targets are not specific to any individual policy mechanism; therefore, the projection of embedded and expected savings in the table below are not disaggregated into customer-funded EE programs and federal standards. It is also assumed that savings from regional NEEA market transformation programs are included within the Council's conservation targets.

WACM

Customer-Funded EE Programs (Colorado Springs Utilities): The WACM balancing authority consists of a large number of municipal utilities and cooperatives located in Colorado and Wyoming, the largest of which being Colorado Springs Utilities (CSU), and most others are served by Tri-State or the Municipal Energy Agency of Nebraska. CSU staff provided LBNL with the utility's current projection of savings from customer-funded EE programs, and indicated that the load forecast that CSU provided to WACM does not account for the impacts of DSM programs. As such, the WACM forecast was adjusted downward based on the savings projection provided by CSU.

Customer-Funded EE Programs (all other utilities in WACM): All other utilities in the balancing authority are assumed to achieve savings of 0.1% per year (or 1% cumulatively over the forecast period); this is the generic conservative assumption used by the DSM Work Group for utilities with little or no history of administering significant energy efficiency program portfolios, and where no specific data were available regarding planned energy efficiency program activity. WAPA staff indicated that the forecast was developed by extrapolating prior years' load, without explicitly accounting for the impacts of energy efficiency programs. As such, the savings from all utilities other than CSU were assumed to be fully captured within the WACM load forecast, by virtue of the fact that no significant increase in program savings from those utilities is expected.

Federal Standards: Given the manner in which the load forecast was constructed, it was assumed that the forecast does not capture the expected impact of federal standards adopted over the 2009-2013 timeframe. Therefore, the standardized "Method 1" adjustment was made to the load forecast in order to capture the expected impact of standards adopted over the 2009-2013 period, as described in Section 2.2.

WALC

The WALC balancing authority consists of a large number of municipal utilities and cooperatives located in Arizona and New Mexico. The expected savings from customer-funded EE programs was estimated based on an assumed annual incremental savings of 0.1% of load per year; this is the generic conservative assumption used by the DSM Work Group for utilities with little or no history of administering significant energy efficiency program portfolios, and where no specific data were readily available regarding planned energy efficiency program activity. The expected savings from 2009-2013 federal standards over the forecast period was estimated based on the standard method of pro-rating expected statewide savings based on the proportion of 2021 statewide load within the balancing authority, for each of the states with which WALC overlaps. Western Area Power Administration (WAPA) prepares the load forecast for the region, and WAPA staff indicated that the WALC load forecast submitted to WECC was constructed simply by applying a stipulated 1% growth rate to the previous year's actual peak load, as a 1% load growth is the minimum required by WECC's L&R program that avoids triggering a load growth alarm. Given the simplified method of developing the load forecast, it is practically infeasible to specify the degree to which the forecast accounts for the expected savings from current energy efficiency policies and program plans, and therefore no adjustment was made to the forecast originally submitted to WECC.

WAUW

The WAUW balancing authority consists of a relatively small amount of load in eastern Montana. The expected savings from customer-funded EE programs was estimated based on an assumed annual incremental savings of 0.1% of load per year; this is the generic conservative assumption used by the DSM Work Group for utilities with little or no history of administering significant energy efficiency program portfolios, and where no specific data were readily available regarding planned energy efficiency program activity. The expected savings from 2009-2013 federal standards over the forecast period was estimated based on the standard method of pro-rating expected statewide savings based on the proportion of 2021 statewide load within the balancing authority. Western Area Power Administration (WAPA) prepares the load forecast for the region, but did not provide any information regarding the degree to which the load forecast captures the expected savings from customer-funded EE programs or federal standards. Given the lack of information available, and given the arguably negligible size of the WAUW load, no adjustment was made to the original load forecast submitted to WECC.

Appendix B. SPSC 10-Year High DSM Case: State-by-State Analyses

As described in Chapter 3, the SPSC DSM Work Group decided that 10-year High DSM case would be based on achievement of all cost-effective energy efficiency savings (i.e., the "economic potential") in each balancing authority. This appendix provides details on the development of the efficiency savings projections for each state and BA. Table B - 1 and Table B - 2 first summarizes the energy and peak demand savings projections and High DSM Case forecasts across all states and provinces. The remainder of the appendix consists of a series of state or province-specific sections providing details on the development of the High DSM Case efficiency projections and load forecast for each BA in the respective state/province. (Note that all BAs in Pacific Northwest states are addressed within a single section.)

Table B - 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption

Balancing Authority	Cumulative EE Savings (GWh)		Annual Energy in 2021 (GWh)		Cumulative Savings (% of 2021 Load)		CAGR (2010-2021)	
	Common Case	High DSM	Common Case	High DSM	Common Case	High DSM	Common Case	High DSM
CISO	39,884	44,288	249,856	245,452	13.8%	15.3%	0.8%	0.7%
IID	412	804	4,260	3,868	8.8%	17.2%	1.7%	0.8%
LADWP	3,535	5,403	30,789	28,920	10.3%	15.7%	0.8%	0.2%
SMUD	2,251	3,467	17,975	16,758	11.1%	17.1%	0.4%	-0.2%
TID	279	507	2,829	2,602	9.0%	16.3%	1.3%	0.5%
AESO	1,107	22,141	110,704	89,670	1.0%	19.8%	4.0%	2.1%
BCTC	11,076	17,931	66,892	60,037	14.2%	23.0%	1.2%	0.2%
AVA	1,530	3,453	14,465	12,542	9.6%	21.6%	1.5%	0.2%
BPA	6,504	13,370	53,450	46,585	10.8%	22.3%	0.3%	-1.0%
CHPD	135	987	4,037	3,185	3.2%	23.7%	2.3%	0.1%
DOPD	117	520	1,931	1,528	5.7%	25.4%	3.3%	1.2%
GCPD	314	1,258	5,103	4,160	5.8%	23.2%	2.1%	0.2%
IPC	2,025	4,097	19,540	17,467	9.4%	19.0%	1.6%	0.6%
NWMT	851	1,173	11,268	10,946	7.0%	9.7%	0.6%	0.4%
PACW	2,061	4,951	22,749	19,859	8.3%	20.0%	0.9%	-0.4%
PGE	3,816	5,600	23,067	21,283	14.2%	20.8%	1.3%	0.5%
PSE	4,667	6,407	26,340	24,600	15.1%	20.7%	0.6%	0.0%
SCL	1,258	2,644	10,662	9,275	10.6%	22.2%	0.7%	-0.6%
TPWR	588	1,316	5,443	4,715	9.7%	21.8%	1.0%	-0.3%
WAUW	28	65	821	784	3.3%	7.6%	2.4%	1.9%
APS	6,919	11,022	41,444	37,341	14.3%	22.8%	2.7%	1.7%
CFE	0	0	14,606	14,606	0.0%	0.0%	2.9%	2.9%
EPE	914	1,239	10,679	10,354	7.9%	10.7%	2.6%	2.3%
NEVP	1,659	6,509	26,665	21,815	5.9%	23.0%	0.8%	-1.1%
PACE	3,283	9,226	55,487	49,544	5.6%	15.7%	1.6%	0.6%
PNM	1,419	1,899	16,887	16,407	7.8%	10.4%	1.1%	0.9%
PSCO	6,826	8,542	46,552	44,836	12.8%	16.0%	1.0%	0.6%
SPP	795	2,297	12,694	11,191	5.9%	17.0%	1.0%	-0.1%
SRP	4,235	10,011	35,283	29,506	10.7%	25.3%	1.3%	-0.3%
TEP	2,649	4,221	14,857	13,286	15.1%	24.1%	0.3%	-0.7%
WACM	1,063	6,467	29,831	24,426	3.4%	20.9%	2.2%	0.4%
WALC	269	1,709	7,549	6,109	3.4%	21.9%	1.0%	-0.9%
WECC	**112,466**	**203,525**	**994,715**	**903,656**	**10.2%**	**18.4%**	**1.4%**	**0.5%**

Table B - 2. High DSM Load Forecasts for 2021: Annual Non-Coincident Peak Demand

Balancing Authority	Cumulative EE Savings (MW)		Annual Energy in 2021 (MW)		Cumulative Savings (% of 2021 Load)		CAGR (2010-2021)	
	Common Case	High DSM	Common Case	High DSM	Common Case	High DSM	Common Case	High DSM
CISO	11,469	12,736	49,324	48,057	18.9%	20.9%	0.3%	0.1%
IID	92	180	1,176	1,088	7.3%	14.2%	1.4%	0.7%
LADWP	750	1,146	8,044	7,648	8.5%	13.0%	1.6%	1.1%
SMUD	401	617	4,357	4,140	8.4%	13.0%	-0.2%	-0.6%
TID	65	119	667	614	8.9%	16.2%	1.2%	0.4%
AESO	154	3,572	15,437	12,019	1.0%	22.9%	3.8%	1.5%
BCTC	2,000	2,923	12,077	11,153	14.2%	20.8%	1.1%	0.4%
AVA	178	728	2,675	2,125	6.2%	25.5%	1.9%	-0.2%
BPA	880	2,770	10,376	8,486	7.8%	24.6%	0.5%	-1.3%
CHPD	26	199	717	544	3.5%	26.8%	1.6%	-0.9%
DOPD	47	105	415	357	10.2%	22.7%	1.3%	-0.1%
GCPD	127	254	846	719	13.0%	26.1%	1.9%	0.4%
IPC	338	696	4,788	4,429	6.6%	13.6%	3.2%	2.5%
NWMT	142	259	1,820	1,703	7.3%	13.2%	0.6%	0.0%
PACW	346	1,048	4,238	3,536	7.5%	22.9%	1.0%	-0.6%
PGE	650	1,201	4,159	3,608	13.5%	25.0%	1.3%	0.0%
PSE	943	1,292	5,303	4,954	15.1%	20.7%	0.9%	0.3%
SCL	225	533	1,898	1,589	10.6%	25.1%	0.3%	-1.3%
TPWR	114	265	1,035	884	9.9%	23.1%	0.4%	-1.0%
WAUW	5	14	147	138	3.3%	9.4%	2.2%	1.6%
APS	1,178	2,111	9,473	8,540	11.1%	19.8%	2.7%	1.8%
CFE	0	0	3,353	3,353	0.0%	0.0%	4.0%	4.0%
EPE	203	275	2,191	2,119	8.5%	11.5%	2.8%	2.5%
NEVP	402	1,186	6,659	5,874	5.7%	16.8%	0.9%	-0.2%
PACE	616	2,512	11,015	9,119	5.3%	21.6%	3.0%	1.3%
PNM	267	357	2,905	2,815	8.4%	11.2%	0.9%	0.6%
PSCO	1,278	2,069	7,821	7,030	14.0%	22.7%	0.3%	-0.7%
SPP	224	416	2,102	1,909	9.6%	17.9%	0.8%	-0.1%
SRP	999	1,911	7,373	6,461	11.9%	22.8%	1.1%	-0.1%
TEP	477	758	3,096	2,814	13.3%	21.2%	0.0%	-0.8%
WACM	206	998	4,605	3,813	4.3%	20.8%	2.2%	0.4%
WALC	74	339	1,585	1,320	4.5%	20.5%	1.0%	-0.7%
WECC	**24,874**	**43,592**	**191,678**	**172,960**	**11.5%**	**20.1%**	**1.3%**	**0.3%**

Alberta

Summary Tables

As explained further below, the Common Case Load Forecast for Alberta is identical to the load forecast that AESO submitted to WECC's Load and Resources Subcommittee.

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
AESO	110,704	1,107	22,141	89,670	-19%
Provincial Total	**110,704**	**1,107**	**22,141**	**89,670**	**-19%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
AESO	15,437	154	3,572	12,019	-22%
Provincial Total	**15,437**	**154**	**3,572**	**12,019**	**-22%**

Table 3. Comparison of Reference Case and High DSM Case (2021 Cumulative Savings)

Balancing Authority	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
AESO	1%	1%	20%	23%
Provincial Total	**1%**	**1%**	**20%**	**23%**

Notes: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

High DSM Savings Projection

We develop High DSM savings projections for AESO on a sector-by-sector basis. To do so, it is necessary to first disaggregate AESO's LRS load forecast for 2020 into individual sectors (see Table 4). This allocation is based on the sector-level load forecasts from AESO's published load forecast, *Future Demand and Energy Outlook (2009 – 2029)*.

Table 4. Projected 2021 Energy Sales to Alberta Internal Load

Sector	% of Total[1]	GWh[2]
Residential	11%	12,177
Commercial	18%	19,927
Farm	2%	2,214
Oil Sands	19%	21,034
Industrial (excl. Oil Sands)	50%	55,352
Total	100%	110,704

[1] Source: AESO Future Demand and Energy Outlook (2009 – 2029), Table 4-1
[2] GWh values for each sector are calculated by multiplying the corresponding percentage and the total LRS forecast for AESO in 2021 (110,704 GWh).

To estimate the economic potential for the AESO balancing authority, the DSM working group relied on the recent energy efficiency potential study conducted by the Canadian Manufacturers and Exporters (CME) for Alberta's industrial and manufacturing sector (CME, 2010), as well as a number of other recent energy efficiency potential studies conducted for utilities/states in the surrounding region. The economic potential estimates produced by these studies is summarized in Table 5, disaggregated by sector and expressed in terms of the baseline sales for that sector. In general, the baseline sales projections in each study represent projected electricity consumption in the absence of future programs and policies to support energy efficiency, but typically do account for some amount of "naturally occurring" conservation in response to stock turnover and market prices.

Table 5. Electric Energy Efficiency Economic Potential by Sector (% of Baseline Electricity Sales)

Utility/Region	Study	Target Year	Residential	Commercial	Industrial	Irrigation
Alberta	CME (2010)	2020	n/a	n/a	19%	n/a
Public Service Colorado	KEMA (2010)	2020	28%	24%	12%	n/a
Western Montana	NPCC (2009)	2020	31%	16%	13%	9%
NorthWestern Energy	Nexant (2009)	2029	18%	12%	18%	n/a
Rocky Mountain Power	Quantec (2007)	2027	17%	14%	8%	11%
BC Hydro	Marbek (2007)	2020	23%	28%	32%	n/a
Tri-State (CO & WY)	Nexant (2010)	2020	19%	18%	16%	10%
Median Value			21%	17%	15%	10%

We apply the potential study results to AESO on a sector-by-sector basis. For the residential, commercial, and irrigation/farm sectors, we apply the median values among the set of studies in Table 4 (21%, 17%, and 10% of baseline electricity sales, respectively). For the industrial sector, we separately estimate the economic potential for the oil sands sub-sector and for the remaining portion of Alberta's industrial sector. The CME potential study scope does not include the oil sands sub-sector; thus, we apply the electric potential results from that study (19% of baseline sales in 2020) to estimate the economic potential for the *non-oil sands* sub-sectors of Alberta's industrial load. That estimate is largely consistent with the industrial sector economic potential estimates from the other studies listed in Table 5. For the oil sands sub-sector, we estimate economic potential by examining potential study results for the petroleum refining sub-sector, among those studies that present sub-sector level results (see Table 6). We assume that the economic potential for Alberta's oil sands sub-sector, as a percentage of baseline sales, is equal to the median value from these studies (24% of baseline electricity sales).

Table 6. Economic Potential Estimates for Petroleum Refining Sub-Sector

Utility/Region	Study	Target Year	% of Baseline Electricity Sales
Public Service Colorado	KEMA (2010)	2020	28%
Rocky Mountain Power	Quantec (2007)	2027	11%
NorthWestern Energy	Nexant (2009)	2029	21%
BC Hydro	Marbek (2007)	2020	28%
Median Value			24%

We estimate the total 2021 economic potential in AESO by applying the potential percentage values, as estimated above, to the projected sectoral load in 2021, as shown in Table 7. This calculation yields a total estimated economic potential for AESO of 22,141 GWh in 2021.

Table 7. Estimated Electric Energy Efficiency Economic Potential for AESO in 2021 (GWh)

Sector	Baseline Load (GWh)	Economic Potential (% of Baseline)	Economic Potential (GWh)
Residential	12,177	21%	2,557
Commercial	19,927	17%	3,388
Farm	2,214	10%	221
Oil Sands	21,034	24%	5,048
Industrial (excl. Oil Sands)	55,352	19%	10,517
Total	110,704	20%	22,141

The final step in the High DSM scenario analysis is to estimate the peak demand savings associated with the energy efficiency potential estimate presented in Table 7. To do so, we first calculate the sectoral peak-to-energy savings ratios from those potential studies that present peak and energy savings by sector (see Table 8). We then apply the median peak-to-energy savings ratio for each sector to the previously estimated energy savings potential (see Table 9). This calculation yields an estimated peak demand savings of 3,572 MW in 2020.

Table 8. Sectoral Peak-to-Energy Savings Ratios Derived from Economic Potential Studies

Utility/Region	Study	Residential	Commercial	Irrigation	Industrial	Petroleum
Public Service Colorado	KEMA (2010)	0.29	0.20	n/a	0.14	0.12
BC Hydro	Marbek (2007)	0.26	0.14	n/a	0.12	n/a
Tri-State (CO & WY)	Nexant (2010)	0.17	0.21	0.23	0.20	n/a
Median Value		0.20	0.26	0.14	0.23	0.12

Table 9. Peak Demand Savings Associated with AESO Energy Efficiency Economic Potential (2021)

Sector	GWh	MW/GWh	Peak MW
Residential	2,557	0.26	665
Commercial	3,388	0.2	678
Farm	221	0.23	51
Oil Sands	5,048	0.14	707
Industrial (excl. Oil Sands)	10,517	0.14	1,472
Total	22,141	0.17	3,572

Arizona

Summary Tables

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
APS	41,444	6,919	11,022	37,341	-10%
SRP	35,283	4,235	10,011	29,506	-16%
TEP	14,857	2,649	4,221	13,286	-11%
WALC	6,239	222	1,577	4,884	-22%
State Total	**97,823**	**14,025**	**26,831**	**85,017**	**-13%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
APS	9,473	1,178	2,111	8,540	-10%
SRP	7,373	999	1,911	6,461	-12%
TEP	3,096	477	758	2,814	-9%
WALC	1,310	61	303	1,068	-18%
State Total	**21,252**	**2,715**	**5,083**	**18,884**	**-11%**

Table 3. Comparison of Common Case and High DSM Case (2021 Cumulative Savings)

Balancing Authority (In-State Portion)	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
APS	14%	11%	23%	20%
SRP	11%	12%	25%	23%
TEP	15%	13%	24%	21%
WALC	3%	4%	24%	22%
State Total	**13%**	**11%**	**24%**	**21%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

High DSM Case Savings Projection

To estimate the economic potential for the balancing authorities in Arizona, the DSM working group relied on the 2010 energy efficiency potential study conducted for Salt River Project (Cadmus, 2010), and extrapolated the results of that study to the rest of the state.[22] Table 4 summarizes the technical and economic potential estimates from the SRP study, net of naturally occurring energy efficiency savings, for the year 2020. For the purpose of the TEPPC High DSM Case, we assume that the economic potential for SRP in 2021 is equal to the study's estimated potential for the year 2020.

Table 4. SRP Energy Efficiency Potential Estimates (2020)

Sector	2020 Baseline Sales (GWh)[1]	Net Technical Potential		Net Economic Potential	
		GWh	% of Baseline	GWh	% of Baseline
Residential	14,882	5,438	37%	5,015	34%
Commercial	10,268	3,562	35%	3,370	33%
Industrial	6,420	747	12%	677	11%
Total	31,571	9,747	31%	9,063	29%

Source: Cadmus (2010), Table 13

[1] Note that the 2020 baseline sales projection in the energy efficiency potential study, which is based on end-use level forecasting model, is significantly lower than the 2020 load forecast that SRP submitted to WECC in early 2010 (40,382 GWh, or 41,160 GWh with embedded energy efficiency savings "added back in"). In principle, had the baseline forecast used in the potential study been calibrated to the WECC forecast, the resulting energy efficiency potential estimate would likely be higher in absolute terms.

The potential estimates presented in the SRP study represent savings at the customer meter. For the purpose of developing the High DSM load forecast, the savings must be scaled up to the bus-bar to account for avoided T&D losses (see Table 5).

Table 5. Estimated Economic Potential at the Generator Bus-Bar

Sector	Marginal T&D Losses[1]	Net Economic Potential	
		Customer Meter	Bus-Bar
Residential	10%	5,015	5,572
Commercial	9%	3,370	3,703
Industrial	8%	677	736
Total	n/a	9,063	10,011

[1] Marginal T&D loss factors are the relevant metric for estimating avoided T&D losses from DSM, and are higher than average T&D loss factors because resistive losses increase exponentially with load.

The SRP potential study provided estimates of energy savings, but not peak demand savings. We therefore estimate the peak demand savings associated with SRP's economic potential

[22] An energy efficiency potential study was conducted for Arizona Public Service in 2007 (ICF, 2007). However, that study provides potential estimates only for the year 2006. Applying those results to estimate the economic potential for APS in 2020 would arguably entail a more tenuous set of assumptions than extrapolating the results of the SRP potential study. Therefore, the DSM working group opted to rely solely on the results of the SRP study.

energy efficiency estimate by applying a stipulated peak-to-energy savings ratio for each sector, based on the median value across other potential studies conducted for utilities in the Southwest (see Table 6). As shown in Table 7, applying these sectoral peak-to-energy savings ratios to SRP yields an estimated economic potential peak demand savings of 1,911 MW.

Table 6. Peak-to-Energy Savings Ratios from a Sample of Energy Efficiency Potential Studies

Utility/Region	Study	Residential	Commercial	Industrial
Public Service Colorado	KEMA (2010)	0.29	0.20	0.14
Public Service New Mexico	Itron (2006)	0.21	0.18	0.10
Tri-State (NM)	Nexant (2010)	0.17	0.19	0.21
Arizona Public Service	ICF (2007)	0.18	0.21	n/a
Median Value		0.19	0.20	0.14

Table 7. Estimated Peak Demand Savings Economic Potential

Sector	Net Economic Potential		
	GWh	MW/GWh	MW
Residential	5,572	0.19	1078
Commercial	3,703	0.20	728
Industrial	736	0.14	105
Total	10,011	0.19	1,911

Finally, we extrapolate the SRP potential study results to the other balancing authorities in Arizona, on a sector-by-sector basis, in proportion to the 2008 retail sales in each balancing authority (see Table 8). While we recognize that this is a simplistic approach, and ignores potential differences in demographics, climate, and end-use characteristics, we also believe that it is a reasonable approximation given the data and resources available.

Table 8. Extrapolation of Net Economic Potential to Other Arizona Balancing Authorities

Balancing Authority (In-State Portion)	Residential	Commercial	Industrial	Total
Retail Sales[1]				
SRP	12,775	11,245	3,379	27,399
APS	13,673	13,265	3,166	30,104
TEP	4,689	2,927	5,563	13,179
WALC	1,652	2,321	424	4,397
Net Economic Potential in 2021 (GWh)				
SRP	5,572	3,703	736	10,011
APS	5,964	4,368	690	11,022
TEP	2,045	964	1,212	4,221
WALC	721	764	92	1,577
Net Economic Potential in 2021 (MW)				
SRP	1,078	728	105	1,911
APS	1,154	859	98	2,111
TEP	396	190	172	758
WALC	139	150	13	303

[1] Data Source: EIA-861 retail sales data for 2008.

British Columbia

Summary Tables

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
BCTC	66,892	11,076	17,931	60,037	-10%
Provincial Total	**66,892**	**11,076**	**17,931**	**60,037**	**-10%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
BCTC	12,077	2,000	2,923	11,153	-8%
Provincial Total	**12,077**	**2,000**	**2,923**	**11,153**	**-8%**

Table 3. Comparison of Reference Case and High DSM Case (2021 Cumulative Savings)

Balancing Authority (In-State Portion)	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
BCTC	14%	14%	23%	21%
Provincial Total	**14%**	**14%**	**23%**	**21%**

Notes: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

High DSM Scenario Savings Projection

For the BCTC balancing authority, we estimate the economic potential based on the results of BC Hydro's 2007 Conservation Potential Review. That study estimates the economic potential for five "Analysis Areas": (1) Energy Efficiency and Peak Load Technologies and O&M, (2) Customer Supplied Renewable Energies, (3) Behavior, (4) Lifestyle, and (5) Fuel Switching. For consistency with the potential studies used in other states, we focus exclusively on the results from Analysis Area 1. Furthermore, that Analysis Area includes both energy efficiency measures as well as demand response, but for the purpose of the present analysis, we focus only on the impact of energy efficiency measures.

Table 6 excerpts the relevant potential estimates from the 2007 Conservation Potential Review, for Fiscal Year 2021 (year ending March 31, 2021), which we use as a proxy for calendar year 2021 (the horizon year in the TEPPC study). Note that the peak demand values refer to the peak-hour demand reduction.

Table 6. BC Hydro Economic Potential for Energy Efficiency Measures (FY2021)

	Residential	Commercial	Industrial	Total
GWh	4,820	5,019	8,064	17,903
MW	1,238	715	962	2,915

Source: Residential Sector report, Exhibits E3 and 7.11; Commercial Sector report, Exhibits E3 and 7.16; Industrial Sector report, Exhibits E3 and 7.13.

Notes: All values represent savings at the customer-meter. The baseline in the CPR accounts for naturally occurring conservation; thus, the economic potential estimates represent savings "net of naturally-occurring conservation."

Several adjustments to these estimates were performed in order to develop a High DSM savings estimate for the BCTC balancing authority.

- First, BC Hydro represents about 95% of the load within the BCTC balancing authority. We extrapolate the economic potential estimate for BC Hydro to the entire balancing authority in proportion to retail sales.
- Second, the 2007 Conservation Potential Review was performed in 2007, and thus the economic potential for FY2021 estimated in that study includes some savings that were since acquired in 2008-2010. We estimate that savings achieved in 2008-2010 reduce the economic potential in FY2021 by 2,169 GWh and 349 MW.[23]
- Third, because the potential estimates represent savings at the customer-meter, we gross up these estimates (after the preceding adjustments) to the bus-bar, assuming 7% T&D losses.

These adjustments are shown in Table 7; the High DSM case savings projection for BCTC is equal to Adjusted Potential at the bus-bar.

Table 7. Adjustments to the Economic Potential Estimate to Calculate the High DSM Saving Projection

	BC Hydro Economic Potential (2008-2020)	BCTC Economic Potential (2008-2020)	Reduction to Account for 2008-2010 Savings	BCTC Adjusted Potential (customer-meter)	BCTC Adjusted Potential (bus-bar)
GWh	17,903	18,845	-2,169	16,676	17,931
MW	2,915	3,068	-349	2,719	2,923

[23] Specifically, the estimate assumes annual incremental savings from ratepayer funded programs (BC Hydro and Fortis) of 519 GWh in 2008 and 825 GWh in both 2009 and 2010, and annual incremental savings from appliance standards equal to zero GWh in 2008 and 41 GWh in both 2009 and 2010. The estimates for energy savings in 2008 and 2009 were provided by Katherine Muncaster of the BC Ministry of Energy, Mines & Petroleum. We assume savings in 2010 was equal to the 2009 achievement, and we estimate peak demand savings in 2008-2010 based on the same peak-to-energy savings ratio as the potential estimate (0.161 MW/GWh).

California

We first describe the approach taken to develop these estimates for the CAISO balancing authority, and then describe the approach for the other California balancing authorities.

Summary Tables

Table 1. High DSM Load Forecasts for 2020: Annual Electricity Consumption (GWh)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
CISO	249,856	39,884	44,288	245,452	-2%
IID	4,260	412	804	3,868	-9%
LDWP	30,789	3,535	5,403	28,920	-6%
SMUD	17,975	2,251	3,467	16,758	-7%
TIDC	2,829	279	507	2,602	-8%
State Total	**305,709**	**46,361**	**54,470**	**297,601**	**-3%**

Table 2. High DSM Load Forecasts for 2020: Annual Peak Demand (MW)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
CISO	49,324	11,469	14,388	46,405	-6%
IID	1,176	92	180	1,088	-7%
LDWP	8,044	750	1,146	7,648	-5%
SMUD	4,357	401	617	4,140	-5%
TIDC	667	65	119	614	-8%
State Total	**63,568**	**12,777**	**16,450**	**59,895**	**-6%**

Table 3. Comparison of Reference Case and High DSM Case (2020 Cumulative Savings)

Balancing Authority (In-State Portion)	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
CISO	14%	19%	15%	24%
IID	9%	7%	17%	14%
LDWP	10%	9%	16%	13%
SMUD	11%	8%	17%	13%
TIDC	9%	9%	16%	16%
State Total	**13%**	**17%**	**15%**	**22%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

High DSM Savings Projection and Load Forecast: *CAISO Balancing Authority*

The High DSM savings projection for the CAISO balancing authority is based on the "High Goals" scenario from the California Energy Commission's 2010 report, *Incremental Impacts of Energy Efficiency Policy Initiatives Relative to the 2009 Integrated Energy Policy Report Adopted Demand Forecast*, plus additional savings associated with decay replacement. These targets are intended to be a proxy for the economic potential, and are almost identical to the economic potential estimate contained in Itron's 2008 Goals Update report for the CPUC.

Table 4 identifies the total savings associated with the High DSM case for the three investor-owned utilities (IOUs), and also identifies the portion of savings that is *incremental* to the Energy Commission's December 2009 demand forecast (and that is therefore also incremental to the forecast that CAISO submitted to WECC, which is based directly on the Energy Commission's December 2009 demand forecast).

Table 4. IOU High DSM Case Savings (Cumulative Savings in 2021 at the Customer Meter)

	Total Committed & Uncommitted		Incremental Uncommitted	
	GWh	MW	GWh	MW
High Goals Scenario[1]	33,720	11,187	16,085	7,548
Decay Replacement[2]	1,959	405	1,959	405
Total	35,679	11,591	18,044	7,953

[1] Source: CEC 2010, *Incremental Impacts of Energy Efficiency Policy Initiatives Relative to the 2009 Integrated Energy Policy Report Adopted Demand Forecast*, Attachment A, Tables 4-11, 4-12, 4-13, and 4-14. Values in the source document have been linearly extrapolated to 2021.

[2] Source: CEC 2010, *Incremental Impacts of Energy Efficiency Policy Initiatives Relative to the 2009 Integrated Energy Policy Report Adopted Demand Forecast*, Table 12. Values in the source document have been linearly extrapolated to 2021.

The values in Table 4 apply only to the IOU-portion of CAISO, and represent savings at the customer meter. For the TEPPC High DSM Case, these projections must be grossed up to include T&D losses and extrapolated to the remainder of the CAISO balancing authority, as shown in Table 5. Based on these assumptions and calculations, the projected cumulative savings over 2011-2021 is equal to 44,288 GWh and 14,388 MW.

Table 5. High DSM Case Savings for CAISO (Cumulative Savings in 2021, Bus-Bar)

	Total Committed & Uncommitted		Incremental Uncommitted	
	GWh	MW	GWh	MW
IOUs[1]	39,193	12,733	19,821	8,736
POUs in CAISO[2]	5,095	1,655	2,576	1,136
Total	44,288	14,388	22,398	9,871

[1] These numbers have been grossed up from the IOU totals in Table 4, based on an assumed T&D loss factor of 9%, which is roughly the average value used by the CPUC in its projection of energy efficiency savings for the LTPP. See http://www.cpuc.ca.gov/NR/rdonlyres/C382EBDD-7E00-4D2F-863B-7380EDBF843C/0/TechnicalAttachmentSpreadsheetv5.xls

[2] A High DSM savings projection was extrapolated to the POUs in CAISO in proportion to their net energy for load, as projected in the Energy Commission's December 2009, *California Energy Demand 2010-2020 Adopted Forecast*, Form 1.5a.

High DSM Savings Projections and Load Forecasts: *Other California Balancing Authorities*

The High DSM savings projection for the other California balancing authorities is estimated by extrapolating the High DSM potential estimate for the IOUs' annual energy savings, in proportion to each balancing authority's net energy for load. However, rather than also extrapolating peak demand saving in this manner, the peak demand savings for each non-CAISO balancing authority was calculated based on the peak-to-energy savings ratio implied by the Common Case savings assumption for the same balancing authority. This approach was taken in order to maintain greater consistency with the underlying load shapes inherent in each balancing authority's Common Case forecast, and because the peak-to-energy savings ratio implied by the CEC's analysis for the IOUs is unusually high. The results of these calculations are shown in Table 6.

Table 6. Extrapolation of IOU High DSM Savings to Non-CAISO Balancing Authorities

Balancing Authority	Utility/ Utilities	Net Energy for Load (2020 GWh)[1]	High DSM Savings (2011-2021 Cumulative)		
			GWh	MW/GWh	MW
CAISO	IOUs	235,286	39,193	0.32	12,733
	POUs	30,584	5,095	0.32	1,655
IID	IID	4,828	804	0.22	180
LADWP	LADWP, Burbank, Glendale	32,437	5,403	0.21	1,146
SMUD	SMUD, Redding, Roseville, Shasta, Modesto	20,816	3,467	0.18	617
TID	TID, Merced	3,041	507	0.23	119

[1] Source: 2009 IEPR Demand Forecast, Form 1.5a

Colorado

Summary Tables

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
PSCO	46,552	6,826	8,542	44,836	-4%
WACM	20,003	713	4,928	15,788	-21%
State Total	**66,555**	**7,538**	**13,470**	**60,623**	**-9%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
PSCO	7,821	1,278	2,069	7,030	-10%
WACM	3,088	138	1,009	2,217	-28%
State Total	**10,909**	**1,416**	**3,078**	**9,247**	**-15%**

Table 3. Comparison of Reference Case and High DSM Case (2021 Cumulative Savings)

Balancing Authority (In-State Portion)	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
PSCO	13%	14%	16%	23%
WACM	3%	4%	24%	31%
State Total	**10%**	**11%**	**18%**	**25%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

PSCO Balancing Authority

The High DSM assumptions for the PSCO balancing authority are based on the March 2010 energy efficiency market potential study for PSCo, the utility (KEMA, 2010). The results of that study are summarized below in Table 4, which presents cumulative savings over the 2010-2020 period. The table presents all types of potential estimate that were reported in the study: technical potential, economic potential, net economic potential (which excludes naturally occurring energy efficiency), and three estimates of achievable potential under varying incentive levels (expressed as a percentage of incremental measure cost).

Table 4: Results of PSCo Energy Efficiency Market Potential Study (Cumulative Savings for 2010-2020)*

Cumulative Savings	Technical	Economic	**Net Economic**	Achievable		
				100% Incentives	75% Incentives	50% Incentives
Energy Savings						
GWh	8,938	7,563	**6,420**	4,892	2,806	1,802
% Base 2020 Retail Sales	27%	23%	20%	15%	9%	6%
Peak Demand Savings						
MW	2,161	1,730	**1,572**	1,198	538	328
% Base 2020 Peak Demand	33%	26%	24%	18%	8%	5%

Source: KEMA (2010), Table 1-1 and Figures 1-1, 1-2, 5-4, and 5-5
* Excludes savings from emerging technologies and behavioral measures

For the purpose of the High DSM scenario, *we assume that the full economic potential is achieved* in the PSCO balancing authority region. However, we also assume that naturally occurring energy efficiency improvements are captured within the LRS load forecast (the load forecast provided by the balancing authority to WECC) and the Common Case load forecast. Thus, for our purposes, we focus on the Net Economic Potential. Furthermore, we assume that the net economic potential estimate for the 2010-2020 period is a reasonable proxy for the 2011-2021 forecast period (i.e., that we can shift the EE potential period forward by one year).

Developing a High DSM load forecast for the PSCO balancing authority involves two additional steps:

1) Adding avoided T&D losses to the net economic potential estimate for the utility, PSCo
2) Extrapolating from the PSCo service territory to the entire PSCO balancing authority

<u>Adding Avoided T&D Losses to the PSCo Potential Estimate</u>

The potential estimates presented in the PSCo study represent savings at the customer meter. For the purpose of developing a High DSM load forecast, the savings must be scaled up to the bus-bar to account for avoided T&D losses. We scale up the net economic potential estimate by an assumed marginal T&D loss factor of 9.5%, which was derived from data presented in PSCo's load forecast update to its 2007 IRP.[24] The results of this adjustment are shown in Table 5.

[24] PSCo's updated load forecast for its 2007 IRP presents total T&D losses (Table 2.7-6) and retail sales (Table 2.7-3), from which we calculated average loss factors for the utility's retail load (residential and C&I customers). See: http://www.xcelenergy.com/SiteCollectionDocuments/docs/CRPLoadForecast.pdf. We assume that marginal T&D loss factors are equal to 1.4 times the average T&D loss factor, based on preliminary analysis conducted by Jim Lazar and shared with members of the DSM working group. Marginal loss factors are the relevant metric for estimating avoided T&D losses from DSM and are higher than average loss factors, because resistive losses increase exponentially with load.

Table 5. PSCo Net Economic Potential Savings Including Avoided T&D Losses[1]

	Res.	Comm.	Ind.	Total
GWh	2,639	3,888	567	7,094
MW	821	829	86	1,737

[1] The KEMA potential study presents the sectoral split for the gross economic potential, but not for the net economic potential; we apply the sectoral distribution for gross economic potential to estimate the net economic potential for each sector, and scale these numbers to the bus-bar level to include avoided T&D losses.

<u>Extrapolating the PSCo Potential Study Results to the Entire PSCO balancing authority</u>

The PSCO balancing authority consists of PSCo, Black Hills (Colorado service territory), and a number of municipal utilities and rural electric cooperatives (the largest of which are Intermountain and Holy Cross). We extrapolate the PSCo potential study results to the entire PSCO balancing authority by simply scaling up the energy and peak demand savings potential for each sector (residential, commercial, and industrial) based on the ratio of the total balancing authority retail sales to PSCo's retail sales for that sector. While we recognize that this is a simplistic approach, and ignores potential differences in demographics, climate, and end-use characteristics, we also believe that it is a reasonable approximation given the data and resources available. This extrapolation is presented below in Table 6, which shows the net economic potential and retail sales by sector, for both PSCo and the entire PSCO balancing authority. This extrapolation yields an estimated net economic potential for the PSCO balancing authority equal to 8,542 GWh and 2,069 MW by 2021.

Table 6. Extrapolation of Net Economic Potential to PSCO Balancing Authority

	Residential	Commercial	Industrial	Total
<u>2008 Retail Sales</u>[1]				
PSCo utility	8,905	13,044	6,273	28,271
PSCO balancing authority	11,667	14,927	7,035	33,678
<u>Net Economic Potential in 2021 (GWh)</u>				
PSCo utility	2,639	3,888	567	7,094
Total PSCO balancing authority[2]	3,457	4,449	636	**8,542**
<u>Net Economic Potential in 2021 (MW)</u>				
PSCo utility	821	829	86	1,737
Total PSCO balancing authority[2]	1,076	949	97	**2,069**

[1] Data Source: EIA-861 retail sales data for 2008.
[2] Calculated by multiplying the PSCo net economic potential for each sector by the ratio of PSCo utility retail sales to PSCO balancing authority retail sales for that sector.

WACM Balancing Authority (Colorado Portion only)

The High DSM scenario savings estimate for the WACM balancing authority is based on the results of two recent energy efficiency studies conducted for utilities in the region: the 2009 study for Colorado Springs Utilities (Summit Blue Consulting, 2009); and the 2010 study for Tri-State Generation and Transmission Cooperative (Nexant, 2010). The results of those studies, for the year 2020, are presented below in Tables 7 and 8. For the purpose of the TEPPC High DSM Case, we assume that the same values are applicable to the year 2021.

Note that the potential study for Colorado Springs does not explicitly indicate whether or how the analysis accounts for naturally occurring savings. Based on the study's description of the methodology used to develop baseline end-use saturation levels, it appears that the potential estimates reported in the study represent gross savings. In contrast, the Tri-State study is explicit that naturally occurring savings are incorporated into its baseline projection of end-use saturations, and therefore the potential estimates represent net savings.

Table 7. Colorado Springs Utilities Energy Efficiency Potential Study Results (2020)

	Gross Technical	Gross Economic	Achievable (mid-case) [1]
GWh	2,291	1,758	348
MW[2]	530	367	80
% 2008 Retail Sales	50%	38%	8%

1 The CSU potential study estimated the achievable potential under three different incentive scenarios. The mid-case corresponds to incentives that cover 50% of incremental measure cost. The study does not present the low and high case results in tabular form, and therefore the results for those scenarios are not included in this table.

2 The Colorado Springs potential study does not report the potential peak demand savings (Technical or Economic) from energy efficiency measures alone; it only reports the combined peak demand savings from both energy efficiency and demand response. We estimate peak demand reductions from energy efficiency by applying the ratio of peak-to-energy savings implied by the technical and economic potential estimates in the PSCo potential study.

Table 8. Tri-State Energy Efficiency Potential Study Results for Colorado (2010-2020)

	Net Technical	Net Economic	Max. Achievable[1]
GWh	2,582	1,820	1,084
MW	568	345	205
% of 2008 retail sales	31%	22%	13%

Source: Calculated from detailed savings tables in Nexant (2010), Appendix A

1 Max. Achievable scenario assumes incentives cover 100% of incremental measure cost. The study also estimated achievable potential under three other incentive levels.

As in the case of the PSCO balancing authority, for the purpose of the High DSM scenario we assume that the full economic potential is achieved in the Colorado portion of the WACM balancing authority region. Developing a High DSM load forecast for the balancing authority involves four additional steps:

1) De-rating the economic potential estimate for Colorado Springs to account for naturally-occurring savings
2) Adding avoided T&D losses to the potential estimates from both studies
3) Extrapolating the potential study results to the entire Colorado portion of the WACM balancing authority

<u>De-rating the Colorado Springs Economic Potential to Account for Naturally Occurring Savings</u>

As indicated above, we assume that the economic potential estimates reported in the Colorado Springs potential study represent gross savings, and we therefore de-rate those estimates according to an assumed net-to-gross (NTG) ratio. The study disaggregates the potential estimates into two sectors, Residential and Commercial/Industrial. We estimate the NTG for each sector based on the NTG ratios implied by the PSCo potential study (i.e., the ratio of net economic potential to gross economic potential for each sector). This calculation and the results are shown in Table 9.

Table 9. Estimated Net Economic Potential for Colorado Springs

	Gross Economic Potential			NTG ratio*		Net Economic Potential		
	Res	C/I	Total	Res	C/I	Res	C/I	Total
GWh	302	1455	1758	85%	85%	257	1235	1492
MW	88	279	367	91%	91%	80	254	334

* The NTG ratio is equal to the ratio of the Net Economic Potential and Economic Potential estimates from PSCo's potential study. These ratios were calculated for the Res. and C/I sectors individually, though the calculated values for the two sectors are identical.

Adding Avoided T&D Losses to the Potential Estimates

The potential estimates presented in the Colorado Springs and Tri-State studies represent savings at the customer meter. As in the case of the foregoing analysis for PSCO, these potential estimates must be scaled up to the bus-bar to account for avoided T&D losses, based on an estimated marginal T&D loss factor (5.9% for Colorado Springs and 7.7% for Tri-State).[25] The results of this adjustment are shown below in Table 10.

Table 10. Colorado Springs and Tri-State Net Economic Potential Savings Including Avoided T&D Losses

<table>
<tr><th>Utility</th><th>Energy or Peak Demand Savings</th><th>Res.</th><th>Com.</th><th>Ind.</th><th>Irrig.</th><th>Total</th></tr>
<tr><td rowspan="2">Colorado Springs</td><td>GWh</td><td>301</td><td colspan="3">1,450</td><td>1,752</td></tr>
<tr><td>MW</td><td>85</td><td colspan="3">270</td><td>355</td></tr>
<tr><td rowspan="2">Tri-State</td><td>GWh</td><td>844</td><td>350</td><td>694</td><td>84</td><td>1,972</td></tr>
<tr><td>MW</td><td>144</td><td>74</td><td>139</td><td>17</td><td>373</td></tr>
</table>

Extrapolating the Study Results to the Entire Colorado Portion of WACM

The Colorado portion of the WACM balancing authority consists of numerous municipal utilities (the largest being Colorado Springs and Fort Collins) and numerous rural electrical cooperatives. Tri-State G&T serves most of the state's cooperatives within WACM, as well as several small municipal utilities.

For the purpose of extrapolating the potential study results to the Colorado portion of WACM, we divide the WACM utilities into two groups: Group 1 consists of Colorado Springs and Fort Collins (the two largest utilities, representing about 30% of the load in the Colorado portion of WACM) and Group 2 consists of all other utilities. We extrapolate the Colorado Springs

[25] Colorado Springs potential study cites an average T&D loss factor of 4.2%, and Tri-State's potential study cites an averge T&D loss factor of 5.5%. Marginal T&D loss factors are assumed to be equal to 1.4 times the average T&D loss factor.

potential study results to Group 1 and the Tri-State study to Group 2. The logic behind this division is that we assume that the relevant characteristics of Fort Collins are more similar to Colorado Springs than to Tri-State, while the relevant characteristics of the other utilities are more similar to Tri-State.

To extrapolate each potential study to the applicable group of utilities, we follow a similar procedure as with the PSCO balancing authority. Namely, we scale up the adjusted potential study results for each sector, in proportion to 2008 retail sales for that sector. The extrapolations for Groups 1 and 2, respectively, are presented below in Tables 11 and 12. Table 13 combines these results to present the total estimated net economic potential for the Colorado portion of WACM, equal to 4,928 GWh and 1,076 MW in 2021. All results represent savings at the bus bar and are net of naturally occurring savings.

Table 11. Estimated Net Economic Potential for WACM Group 1

	Res.	C&I	Total
2008 Retail Sales[1]			
Colorado Springs	1,409	3,167	4,576
WACM-Colorado Group 1	1,882	4,124	6,006
Net Economic Potential in 2021 (GWh)			
Colorado Springs	273	1,313	1,585
WACM-Colorado Group 1	364	1,709	2,074
Net Economic Potential in 2021 (MW)			
Colorado Springs	85	270	355
WACM-Colorado Group 1	113	351	465

[1] Data Source: EIA-861 retail sales data for 2008.

Table 12. Estimated Net Economic Potential for WACM Group 2

	Res.	Com.	Ind./Irr.	Total
2008 Retail Sales[1]				
Tri-State (Colorado)	3,101	1,913	3,505	8,519
WACM-Colorado Group 2	4,172	3,099	5,188	12,459
Net Economic Potential in 2021 (GWh)				
Tri-State (Colorado)	844	350	779	1,972
WACM-Colorado Group 2	1,135	566	1,153	2,854
Net Economic Potential in 2021 (MW)				
Tri-State (Colorado)	144	74	156	373
WACM-Colorado Group 2	194	119	231	544

[1] Data Source: EIA-861 retail sales data for 2008.

Table 13. Estimated Net Economic Potential for the Colorado Portion of WACM

	Group 1	Group 2	Total
GWh	2,074	2,854	4,928
MW	465	544	1,009

New Mexico

Summary Tables

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
PNM	16,887	1,419	1,899	16,407	-3%
EPE	10,679	914	1,239	10,354	-3%
WALC	1,310	47	132	1,225	-6%
State Total	**28,876**	**2,379**	**3,271**	**27,985**	**-3%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
PNM	2,905	267	357	2,815	-3%
EPE	2,191	203	275	2,119	-3%
WALC	275	13	36	252	-9%
State Total	**5,372**	**482**	**668**	**5,186**	**-3%**

Table 3. Comparison of Reference Case and High DSM Case (2020 Cumulative Savings)

Balancing Authority	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
PNM	8%	8%	10%	11%
EPE	8%	8%	11%	11%
WALC	3%	4%	10%	13%
State Total	**8%**	**8%**	**10%**	**11%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

High DSM Scenario Savings Projection

The High DSM savings projections for the New Mexico balancing authorities are based on the 2011 energy efficiency potential study conducted for the state (GEP, 2011). Table 4 presents the statewide economic potential estimates for each sector, in the year 2021, which includes the portion of New Mexico outside of WECC. The table also identifies the economic potential for each sector as a percentage of the sectoral baseline load forecast. The baseline load forecast represents the hypothetical load with no new energy efficiency programs or updates to federal standards beyond what was in place as of the date that the potential study was conducted.

Table 4. New Mexico Statewide Economic Potential (2021)

	Residential	Commercial	Industrial	Total
Baseline Load Forecast (GWh)	7,032	7,607	8,265	22,904
Economic Potential (% of Baseline Load)	12.6%	10.7%	6.8%	9.9%
Economic Potential (GWh)	886	814	562	2,262

Source: GEP (2011), Tables H-2, H-3, and H-4.

The High DSM Case savings projection for each New Mexico balancing authority was derived by applying percentages in Table 4 to the hypothetical "no-future-EE" load forecast for each balancing authority. The hypothetical "no-future3-EE" forecasts for each balancing authority are equal to the Common Case load forecast plus the corresponding Common Case energy efficiency savings projection, and were disaggregated by sector based on historical EIA retail sales data for each utility in the balancing authority. These calculations and the resulting potential estimate for each of the three New Mexico balancing authorities are shown in Tables 5 – 7 (see notes to tables for further details).

Table 5. PNM Balancing Authority Economic Potential Estimate (2021)

	Residential	Commercial	Industrial	Total
Baseline Load Forecast (% of Total)[1]	34%	41%	25%	100%
Baseline Load Forecast (GWh)[2]	6,232	7,517	4,557	18,306
Economic Potential (% of Baseline Load)[3]	12.6%	10.7%	6.8%	10.4%
Economic Potential (GWh)[4]	785	804	310	1,899

1 These percentages are derived from 2008 EIA sector-level retail sales data for each utility in the balancing authority.

2 The total baseline load forecast for the balancing authority was calculated as the sum of the 2021 Common Case load forecast plus the Common Case energy efficiency savings projection, and is represents the hypothetical load forecast with no future energy efficiency programs or new federal standards. Note that the PNM balancing authority includes the portion of Navopache Electric's service territory in Arizona; for simplicity, we include that load within these tabulations, rather than developing a separate High DSM forecast for only that small amount of balancing authority load in Arizona.

3 The sector-level economic potential percentages for PNM are assumed to be the same as the corresponding statewide percentages shown in Table 4.

4 The sector-level economic potential in GWh was calculated by multiplying the economic potential percentages for each sector by the corresponding baseline load forecast.

Table 6. EPE Balancing Authority Economic Potential Estimate (2021)

	Residential	Commercial	Industrial	Total
Baseline Load Forecast (% of Total)	32%	53%	16%	100%
Baseline Load Forecast (GWh)	3,673	6,103	1,817	11,593
Economic Potential (% of Baseline Load)	12.6%	10.7%	6.8%	10.7%
Economic Potential (GWh)	463	653	124	1,239

1 These percentages are derived from 2008 EIA sector-level retail sales data for each utility in the balancing authority.
2 The total baseline load forecast for the balancing authority was calculated as the sum of the 2021 Common Case load forecast plus the Common Case energy efficiency savings projection, and is represents the hypothetical load forecast with no future energy efficiency programs or new federal standards. Note that the EPE balancing authority includes the portion of El Paso Electric's service territory in Texas; for simplicity, we include that load within these tabulations, rather than developing a separate High DSM forecast for only the small amount of WECC load in Texas.
3 The sector-level economic potential percentages for EPE are assumed to be the same as the corresponding statewide percentages shown in Table 4.
4 The sector-level economic potential in GWh was calculated by multiplying the economic potential percentages for each sector by the corresponding baseline load forecast.

Table 7. WALC-New Mexico Balancing Authority Economic Potential Estimate (2021)

	Residential	Commercial	Industrial	Total
Baseline Load Forecast (% of Total)	20%	46%	35%	100%
Baseline Load Forecast (GWh)	265	620	471	1,357
Economic Potential (% of Baseline Load)	12.6%	10.7%	6.8%	9.7%
Economic Potential (GWh)	33	66	32	132

1 These percentages are derived from 2008 EIA sector-level retail sales data for each utility in the balancing authority.
2 The total baseline load forecast for the balancing authority was calculated as the sum of the 2021 Common Case load forecast plus the Common Case energy efficiency savings projection, and is represents the hypothetical load forecast with no future energy efficiency programs or new federal standards. Note that the tabulation here includes only the portion of WALC within New Mexico; the High DSM savings assumptions for the Arizona portion of WALC are included in the High DSM write-up for Arizona.
3 The sector-level economic potential percentages for WALC are assumed to be the same as the corresponding statewide percentages shown in Table 4.
4 The sector-level economic potential in GWh was calculated by multiplying the economic potential percentages for each sector by the corresponding baseline load forecast.

Tables 5-7 include the High DSM Case annual energy savings for each balancing authority. The corresponding peak demand savings were calculated by applying the peak-to-energy savings ratio from the Common Case for each balancing authority, as shown in Table 8.

Table 8. High DSM Case Peak Demand Savings Projection (2021)

Balancing Authority	Common Case Savings			High DSM Savings	
	GWh	MW	MW/GWh	GWh	MW
PNM	1,419	267	0.19	1,899	357
EPE	914	203	0.22	1,239	275
WALC	47	13	0.28	132	36
Total	2,379	482	0.20	3,271	668

Nevada

Summary Tables

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
NEVP	26,665	1,659	6,509	21,815	-18%
SPP	12,694	795	2,297	11,191	-12%
State Total	**39,359**	**2,454**	**8,806**	**33,007**	**-16%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
NEVP	6,659	402	1,186	5,874	-12%
SPP	2,102	224	416	1,909	-9%
State Total	**8,761**	**626**	**1,603**	**7,784**	**-11%**

Table 3. Comparison of Reference Case and High DSM Case (2020 Cumulative Savings)

Balancing Authority (In-State Portion)	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
NEVP	6%	6%	23%	17%
SPP	6%	10%	17%	18%
State Total	**6%**	**7%**	**21%**	**17%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

High DSM Scenario Savings Projection

There have not been any recent energy efficiency potential studies for Nevada utilities that include an estimate of the economic potential. The SPSC DSM Work Group therefore developed an estimate of economic potential for Nevada, by extrapolating the results of two recent economic potential studies for other utilities in the desert southwest: the 2010 potential study for Salt River Project (Cadmus, 2010) and the 2007 potential study for Rocky Mountain

Power (Quantec, 2007).[26] Table 4 summarizes the economic potential estimates from these two studies.

Table 4. Economic Potential Estimates (GWh)

Market Sector	**Salt River Project (2020)**	**Rocky Mountain Power (Utah service territory, 2027)**
Residential	5,015	1,997
Commercial	3,370	2,365
Industrial	677	885
Total	9,063	5,247

Sources: Cadmus (2010), Table 13; *Quantec (2007), Tables 53, 55, and 57.*

We extrapolate the SRP and RMP potential study results to the two balancing authorities in Nevada, on a sector-by-sector basis, in proportion to the 2008 retail sales in each balancing authority (see Table 5). Specifically, for each sector, we calculate the economic potential as a percentage of 2008 retail sales for both SRP and RMP, then compute the average of the two percentages, and multiply the resulting average to the sectoral retail sales for each Nevada balancing authority to estimate the economic potential for that sector. While we recognize that this is a simplistic approach, and ignores potential differences in demographics, climate, and end-use characteristics, we also believe that it is a reasonable approximation given the data and resources available.

[26] A different potential study for Rocky Mountain Power was issued more recently (Cadmus, 2011), but that study does not include an estimate of economic potential, and therefore is not used for the purpose of this extrapolation. In addition, several other energy efficiency potential studies for southwestern utilities have been issued within the past five years, but, for various reasons, none are suitable for extrapolation to Nevada.

Table 5. Extrapolation of Economic Potential to Nevada Balancing Authorities

	Residential	Commercial	Industrial	Total
2008 Retail Sales (Bundled + Delivery)[1]				
SRP	12,775	11,245	3,379	27,399
PacifiCorp (Utah)	6,561	7,934	8,126	22,621
NEVP	9,600	6,010	8,842	24,452
SPP	2,262	3,086	3,795	9,143
Net Economic Potential in 2021 (% of 2008 retail sales)				
SRP	39%	30%	20%	33%
PacifiCorp (Utah)	30%	30%	11%	23%
NEVP	35%	30%	15%	27%
SPP	35%	30%	15%	25%
Net Economic Potential in 2021 (GWh)				
SRP	5,015	3,370	677	9,063
PacifiCorp (Utah)	1,997	2,365	885	5,247
NEVP	3,345	1,796	1,367	6,509
SPP	788	922	587	2,297

[1] Data Source: EIA-861 retail sales data for 2008.

The SRP and RMP potential studies provide estimates of annual energy savings, but not peak demand savings. We therefore estimate the peak demand savings associated with achieving the economic potential by applying a stipulated peak-to-energy savings ratio for each sector, based on the median value across other potential studies conducted for utilities in the Southwest (see Table 6). The resulting estimates of peak demand savings for the two Nevada balancing authorities are shown in Table 7.

Table 6. Peak-to-Energy Savings Ratios from a Sample of Energy Efficiency Potential Studies

Utility/Region	Study	Residential	Commercial	Industrial
Public Service Colorado	KEMA (2010)	0.29	0.20	0.14
Public Service New Mexico	Itron (2006)	0.21	0.18	0.10
Tri-State (NM)	Nexant (2010)	0.17	0.19	0.21
Arizona Public Service	ICF (2007)	0.18	0.21	n/a
Median Value		0.19	0.20	0.14

Table 7. Estimated Peak Demand Savings Economic Potential

	Residential	Commercial	Industrial	Total
Assumed Peak-to-Energy Savings Ratio (MW/GWh)	0.19	0.20	0.14	n/a
NEVP	636	359	191	1,186
SPP	150	184	82	416

Pacific Northwest States

This section explains how the High DSM Case efficiency savings projections were developed for each state, and then how the state-level savings were allocated to the balancing authorities in the PNW.

Summary Tables - Results by State

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

State	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
ID	30,713	3,040	6,431	27,323	-11%
MT	44,197	4,786	9,641	39,342	-11%
OR	56,589	7,362	13,514	50,437	-11%
WA	70,625	8,860	16,885	62,600	-11%
PNW Region Total	**202,124**	**24,048**	**46,470**	**179,702**	**-11%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

State	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
ID	6,878	475	1,243	6,109	-11%
MT	8,200	676	1,968	6,908	-16%
OR	10,586	1,181	2,889	8,879	-16%
WA	13,413	1,719	3,412	11,720	-13%
PNW Region Total	**39,077**	**4,051**	**9,512**	**33,615**	**-14%**

Table 3. Comparison of Reference Case and High DSM Case (2021 Cumulative Savings)

State	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
ID	9%	6%	19%	17%
MT	10%	8%	20%	22%
OR	12%	10%	21%	25%
WA	11%	11%	21%	23%
PNW Region Total	**11%**	**9%**	**21%**	**22%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by the sum of High DSM savings and High DSM load forecast)

High DSM Savings Projections by State

In order to implement economic potential criterion for the Pacific Northwest states, the DSM working group relied on the conservation potential assessment conducted by the Northwest Power and Conservation Council (NPCC) for its 6th Power Plan. At the request of the DSM working group for last year's High DSM Case, NPCC staff provided an estimate of the "total economic potential" in 2020, for the NPCC planning area as a whole. This estimate is greater than the 2020 conservation target presented in the 6th Plan for two primary reasons:

- The conservation targets in the 6th Plan assume that only 85% of the technical potential is "achievable," whereas the total economic potential does not include this constraint.
- The conservation targets in the 6th Plan are based on assumptions about how fast conservation savings can be acquired, given certain practical limitations of energy efficiency programs. The total economic potential does not impose these constraints.

For the High DSM Case, we rely on the total economic potential rather than the conservation targets in the 6th Plan, in order to maintain consistency between the PNW and other states, where the High DSM savings estimates are based on acquiring the full economic potential without any non-economic "achievability" constraints. For this year's High DSM Case, we use the same potential estimate as provided last year, which applied to the period 2010-2020. Thus, in effect, we assume that the potential estimate can be "shifted" one year forward (i.e., that the additional potential gained by going out one year further into the future is more or less offset by the actual conservation achievements in 2010). Throughout the remainder of this document, references to potential estimates for year 2020 should therefore be understood to apply to the year 2021 for the purpose of this year's High DSM Case.

The analysis provided by NPCC staff indicates that, in 2020, the total economic potential for the NPCC planning area (Idaho, Oregon, Washington, and Western Montana) is equal to 5,000 aMW. In comparison, the 2020 conservation potential target in the 6th Plan is 3,225 aMW. We estimate the total economic potential for each state in the Pacific Northwest by scaling up the corresponding 6th Plan conservation target, based on the ratio of the total economic potential and the conservation target for the region (i.e., 5,000 aMW divided by 3,255 aMW = 1.55 scaling factor), as shown in Table 4. Note that the conservation numbers for Montana are statewide, and were calculated by extrapolating the NPCC conservation potential estimates for Western Montana to the entire state; thus the total 6th plan conservation target for the region shown in Table 4 slightly exceeds the value reported in the 6th plan (which is limited to Western Montana).

Table 4. Total Economic Potential for PNW States

State	6th Plan Conservation Target (2020) [1]			Total Economic Potential (2020)		
	aMW	GWh	Peak MW	aMW	GWh	Peak MW
ID	473	4,148	948	734	6,431	1,470
MT	116	1,013	224	179	1,571	347
OR	995	8,716	1,870	1,543	13,514	2,899
WA	1,837	16,096	3,246	2,849	24,954	5,033
Total	3,422	29,973	6,288	5,305	46,470	9,749

[1] The state-level conservation targets were provided to the DSM working group by NPCC staff in the course of developing the High DSM Case for the 2010 TEPPC Study Program.

The state-level High DSM load forecasts were then allocated to individual balancing authorities, in proportion to retail sales, as shown in Table 5. There are two minor items to note related to this extrapolation. First, Table 5 includes an estimate of the economic potential for the California-portion of PACW, which was derived simply by extrapolating the estimated economic potential for the Oregon portion of PACW; thus, the total economic potential energy savings (GWh) shown in Table 5 is slightly greater than the corresponding total shown in Table 4. Second, in the course of modeling last year's High DSM Case, it was determined that, in the case of the IPC balancing authority, allocating state-level *peak demand* savings based simply on retail sales yielded an overly compressed load shape. Therefore, the peak demand savings for IPC was, instead, calculated from the energy savings, based on an assumed peak-to-energy savings ratio of 0.17 MW/GWh. This is the peak-to-energy savings ratio implied by the Common Case savings assumptions for IPC, and is significantly lower than the peak-to-energy savings ratio implied by the 6th Plan conservation target for Idaho (0.23 MW/GWh). As a result of this adjustment to the NPCC economic potential estimate, the total peak demand savings shown in Table 5 is slightly lower than the corresponding value shown in Table 4.

Based on the economic potential estimates in Table 5, the High DSM load forecasts are shown for each balancing authority in Tables 6 and 7, for energy and peak load, respectively. Note that for balancing authorities spanning multiple states, the DSM Work Group will "roll-up" the numbers across states into a single load forecast for the balancing authority (including portions of the PACE balancing authority that are outside of the PNW and therefore excluded from these tables).

Table 5. Allocation of State-Level Economic Potential Estimates to Balancing Authorities

Balancing Authority (PNW portion)	State	Balancing Authority Percent of StateLoad[1]	Full Economic Potential (2020)		
			aMW	GWh	MW
AVA	ID	18%	133	1,164	266
	WA	9%	261	2,289	462
BPA	ID	8%	60	526	120
	MT	21%	38	333	74
	OR	30%	469	4,108	881
	WA	34%	959	8,403	1,695
CHPD	WA	4%	113	987	199
DOPD	WA	2%	59	520	105
GCPD	WA	5%	144	1,258	254
IPC[3]	ID	60%	441	3,866	657
	OR	2%	26	231	39
NWMT	MT	75%	134	1,173	259
PACE	ID	14%	100	875	200
PACW	OR	26%	408	3,575	767
	WA	5%	129	1,130	228
	CA[2]	n/a	28	245	53
PGE	OR	41%	639	5,600	1,201
PSE	WA	26%	731	6,407	1,292
SCL	WA	11%	302	2,644	533
TPWR	WA	5%	150	1,316	265
WAUW	MT	4%	7	65	14
PNW Total			5,333	46,716	9,565

[1] The distribution of each state's load across balancing authorities is based on the load forecast data provided to WECC by individual balancing authorities.

[2] To estimate the economic potential in the California portion of PACW, we multiplied the potential results for the Oregon portion of PACW by the ratio of the PACW load in California and Oregon (0.07). That ratio was derived from the load forecast data provided in PacifiCorp's March 2010 IRP.

[3] The peak demand savings (MW) for IPC was calculated from the energy savings, based on an assumed peak-to-energy savings ratio of 0.17 MW/GWh, rather than by allocating state-level peak demand savings estimates in proportion to retail sales.

Table 6. Balancing Authority High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority (PNW portion)	State	A	B	C	D = A - (C - B)	E = D/A - 1
		Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
		(GWh)	(GWh)	(GWh)	(GWh)	(%)
AVA	ID	5,388	570	1,164	4,794	-11%
	WA	9,077	960	2,289	7,748	-15%
BPA	ID	2,343	285	526	2,103	-10%
	WA	3,016	367	333	3,049	1%
	OR	15,983	1,945	4,108	13,821	-14%
	MT	32,108	3,907	8,403	27,612	-14%
CHPD	WA	4,037	135	987	3,185	-21%
DOPD	WA	1,931	117	520	1,528	-21%
GCPD	WA	5,103	314	1,258	4,160	-18%
IPC	ID	18,570	1,924	3,866	16,629	-10%
	OR	969	100	231	839	-13%
NWMT	MT	11,268	851	1,173	10,946	-3%
PACE	ID	4,411	261	875	3,797	-14%
PACW	OR	16,570	1,501	3,575	14,496	-13%
	WA	5,016	454	1,130	4,340	-13%
	CA	1,163	105	245	1,023	-12%
PGE	OR	23,067	3,816	5,600	21,283	-8%
PSE	WA	26,340	4,667	6,407	24,600	-7%
SCL	WA	10,662	1,258	2,644	9,275	-13%
TPWR	WA	5,443	588	1,316	4,715	-13%
WAUW	MT	821	28	65	784	-4%
Total		**203,287**	**24,154**	**46,716**	**180,725**	**-11%**

Table 7. Balancing Authority High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority (PNW portion)	State	A Common Case Load Forecast (MW)	B Common Case Efficiency Savings (MW)	C High DSM Efficiency Savings (MW)	D = A - (C - B) High DSM Load Forecast (MW)	E = D/A - 1 Percent Change from Common Case Load Forecast (%)
AVA	ID	997	66	266	797	-20%
	WA	1,679	112	462	1,329	-21%
BPA	ID	455	39	120	373	-18%
	WA	585	50	74	561	-4%
	OR	3,103	263	881	2,485	-20%
	MT	6,233	529	1,695	5,067	-19%
CHPD	WA	717	26	199	544	-24%
DOPD	WA	415	47	105	357	-14%
GCPD	WA	846	127	254	719	-15%
IPC	ID	4,550	321	657	4,214	-7%
	OR	238	17	39	215	-9%
NWMT	MT	1,820	142	259	1,703	-6%
PACE	ID	876	49	200	725	-17%
PACW	OR	3,087	252	767	2,572	-17%
	WA	935	76	228	783	-16%
	CA	217	18	53	182	-16%
PGE	OR	4,159	650	1,201	3,608	-13%
PSE	WA	5,303	943	1,292	4,954	-7%
SCL	WA	1,898	225	533	1,589	-16%
TPWR	WA	1,035	114	265	884	-15%
WAUW	MT	147	5	14	138	-6%
Total		**39,293**	**4,069**	**9,565**	**33,797**	**-14%**

Utah

Summary Tables

Table 1. High DSM Load Forecasts for 2020: Annual Electricity Consumption (GWh)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
PACE	37,482	2,217	6,412	33,287	-11%
State Total	**37,482**	**2,217**	**6,412**	**33,287**	**-11%**

Table 2. High DSM Load Forecasts for 2020: Annual Peak Demand (MW)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = D/A - 1
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
PACE	7,441	416	2,030	5,827	-22%
State Total	**7,441**	**416**	**2,030**	**5,827**	**-22%**

Table 3. Comparison of Reference Case and High DSM Case (2020 Cumulative Savings)

Balancing Authority (In-State Portion)	Reference Case Savings (% of Load Forecast w/o EE)		High DSM Case Savings (% of Load Forecast w/o EE)	
	GWh	MW	GWh	MW
PACE	6%	5%	16%	26%
State Total	**6%**	**5%**	**16%**	**26%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

High DSM Savings Projection

The High DSM savings projection for the PACE balancing authority is based, in part, on PacifiCorp's 2011 energy efficiency potential study (Cadmus, 2011). Table 4 presents the *technical potential* estimate from that study, for the Utah portion of PacifiCorp's service territory, in the year 2030.

Table 4. Technical Potential Estimate for 2030 (PacifiCorp Utah Service Territory)

Market Sector	**aMW**	**GWh**	**MW[1]**
Residential	429	3,758	1,190
Commercial	304	2,663	843
Industrial	158	1,384	438
Irrigation	3	25	8
Street Lighting	4	32	10
Total	897	7,861	2,489

Source: Cadmus (2011), Tables 63, 65, 67, 69, and 70

[1] The study provides peak demand savings potential for the Utah service territory as a whole, but not for each individual market segment within the service territory. The peak demand savings shown in this table were estimated by applying the peak-to-energy savings ratio implied by the peak and energy savings estimates for the entire service territory (2489 MW / 7861 GWh = 0.32 MW/GWh) to each market sector.

In order to use the potential estimates in Table 4 for developing a High DSM savings projection for the entire Utah portion of the PACE balancing authority, three additional steps are required:

1) Estimate the technical potential for the year 2021
2) Estimate economic potential based on the technical potential estimate
3) Extrapolate the results to the entire Utah portion of the PACE balancing authority

Estimating Technical Potential for the Year 2021

The SPSC DSM Work Group is initially developing High DSM Case savings projections and load forecasts for the year 2021. The technical potential estimate in the Cadmus study, however, is based on the year 2030. Those results must therefore be adjusted to account for the fact that technical potential increases over time. To inform this adjustment, Table 5 segments the technical potential for each market sector into "discretionary" and "lost opportunity" measures.

Table 5. PacifiCorp Technical Potential Estimate: Discretionary vs. Lost Opportunity Measures

Sector	**Discretionary**	**Lost Opportunity**
Residential	38%	62%
Commercial	72%	28%
Industrial	100%	0%
Irrigation	100%	0%
Street Lighting	100%	0%
Total	64%	36%

[1] *Source: Calculated from Cadmus (2011), Tables 54.*

To estimate the available technical potential for 2021, we assume that all discretionary measures are available immediately, but that the lost opportunity potential for each market sector increases linearly with time. Based on this assumption, Table 6 presents the estimated technical potential for the PacifiCorp's Utah service territory in 2021. Given the relative contribution of discretionary and lost opportunity measures, the estimated technical potential in 2021 (721 aMW) is equal to approximately 80% of the technical potential in 2030 (879 aMW).

Table 6. Technical Potential Estimate for 2021 (PacifiCorp Utah Service Territory)

Market Sector	**aMW**	**GWh**	**MW**
Residential	295	2,584	818
Commercial	261	2,289	725
Industrial	158	1,384	438
Irrigation	3	25	8
Street Lighting	4	32	10
Total	721	6,314	1,999

Estimating Economic Potential Based on the Technical Potential Estimate

The 2011 PacifiCorp potential study provides estimates of technical potential and achievable technical potential; it does not, however, provide an estimate of economic potential. Therefore, we also rely on PacifiCorp's 2007 energy efficiency potential study (Quantec, 2007), which provides estimates of both technical and economic potential. In that study, the economic potential for the Utah portion of PacifiCorp's service territory is equal to 80% of the corresponding technical potential. We apply the same percentage to the updated technical potential estimate in Table 6, in order to estimate the economic potential for the Utah portion of PacifiCorp's service territory, as shown in Table 7.

Table 7. Updated Economic Potential Estimates for PacifiCorp Utah Service Territory in 2021

Market Sector	**aMW**	**GWh**	**MW**
Residential	235	2,061	653
Commercial	208	1,826	578
Industrial	126	1,104	350
Irrigation	2	20	6
Street Lighting	3	25	8
Total	575	5,036	1,595

Extrapolating the Results to the Entire Utah Portion of the PACE Balancing Authority

The Utah portion of the PACE balancing authority includes PacifiCorp, as well as numerous municipal utilities and cooperatives. We extrapolate the PacifiCorp potential study results for each sector (residential, commercial, and industrial) to the entire Utah portion of PACE by simply scaling up the energy and peak demand savings potential based on the ratio of the total balancing authority retail sales to PacifiCorp's retail sales, for that sector. While we recognize that this is a simplistic approach, and ignores potential differences in demographics, climate, and end-use characteristics, we also believe that it is a reasonable approximation given the data and resources available. This extrapolation, presented below in Table 8, yields an estimated 2021 economic potential for the entire Utah portion of PACE equal to 6,412 GWh and 2,030 MW.

Table 8. Extrapolation of Economic Potential to Utah Portion of PACE

	Res.	**Com.**	**Ind.**	**Total**
Retail Sales[1]				
PacifiCorp (Utah)	6,561	7,934	8,126	22,621
PACE (Utah)	8,786	10,286	9,086	28,159
Net Economic Potential in 2021 (GWh)				
PacifiCorp (Utah)	2,061	1,826	1,149	5,036
PACE (Utah)	2,760	2,367	1,284	6,412
Net Economic Potential in 2021 (MW)				
PacifiCorp (Utah)	653	578	364	1,595
PACE (Utah)	874	750	407	2,030

[1] Data Source: EIA-861 retail sales data for 2008.

Wyoming

Summary Tables

Table 1. High DSM Load Forecasts for 2021: Annual Electricity Consumption (GWh)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(GWh)	(GWh)	(GWh)	(GWh)	(%)
PACE	13,594	804	1,939	12,459	-8%
WACM	9,827	350	1,539	8,638	-12%
State Total	**23,421**	**1,154**	**3,478**	**21,098**	**-10%**

Table 2. High DSM Load Forecasts for 2021: Annual Peak Demand (MW)

Balancing Authority (In-State Portion)	A	B	C	D = A - (C - B)	E = (D/A - 1)
	Common Case Load Forecast	Common Case Efficiency Savings	High DSM Efficiency Savings	High DSM Load Forecast	Percent Change from Common Case Load Forecast
	(MW)	(MW)	(MW)	(MW)	(%)
PACE	2,699	151	282	2,568	-5%
WACM	1,517	68	301	1,284	-15%
State Total	**4,216**	**219**	**583**	**3,851**	**-9%**

Table 3. Comparison of Reference Case and High DSM Case (2020 Cumulative Savings)

Balancing Authority (In-State Portion)	Common Case Savings (% of No-EE Load Forecast)		High DSM Case Savings (% of No-EE Load Forecast)	
	GWh	MW	GWh	MW
PACE	6%	5%	13%	10%
WACM	3%	4%	15%	19%
State Total	**5%**	**5%**	**14%**	**13%**

Note: The percentages in this table were calculated by dividing the savings projection by the sum of the savings projection and the post-savings load forecast (e.g., High DSM savings divided by High DSM savings plus High DSM load forecast)

PACE Balancing Authority

The High DSM savings projection for the PACE balancing authority is based, in part, on PacifiCorp's 2011 energy efficiency potential study (Cadmus, 2011). Table 4 presents the *technical potential* estimate from that study, for the Wyoming portion of PacifiCorp's service territory, in the year 2030.

Table 4. Technical Potential Estimate for 2030 (PacifiCorp Wyoming Service Territory)

Market Sector	aMW	GWh	MW[1]
Residential	47	412	60
Commercial	53	464	68
Industrial	158	1,384	201
Irrigation	0	3	0
Street Lighting	1	5	1
Total	259	2,269	330

Source: Cadmus (2011), Tables 63, 65, 67, 69, and 70

[1] The study provides peak demand savings potential for the Wyoming service territory as a whole, but not for each individual market segment within the service territory. The peak demand savings shown in this table were estimated by applying the peak-to-energy savings ratio implied by the peak and energy savings estimates for the entire service territory (330 MW / 2269 GWh = 0.15 MW/GWh) to each market sector.

In order to use the potential estimates in Table 4 for developing a High DSM savings projection for the entire Wyoming portion of the PACE balancing authority, three additional steps are required:

4) Estimate the technical potential for the year 2021
5) Estimate economic potential based on the technical potential estimate
6) Extrapolate the results to the entire Wyoming portion of the PACE balancing authority

<u>Estimating Technical Potential for the Year 2021</u>

The SPSC DSM Work Group is initially developing High DSM Case savings projections and load forecasts for the year 2021. The technical potential estimate in the Cadmus study, however, is based on the year 2030. Those results must therefore be adjusted to account for the fact that technical potential increases over time. To inform this adjustment, Table 5 segments the technical potential for each market sector into "discretionary" and "lost opportunity" measures.

Table 5. PacifiCorp Technical Potential Estimate: Discretionary vs. Lost Opportunity Measures

Sector	Discretionary	Lost Opportunity
Residential	38%	62%
Commercial	72%	28%
Industrial	100%	0%
Irrigation	100%	0%
Street Lighting	100%	0%
Total	64%	36%

[1] *Source: Calculated from Cadmus (2011), Table 54.*

To estimate the available technical potential for 2021, we assume that all discretionary measures are available immediately, but that the lost opportunity potential for each market sector increases linearly with time. Based on this assumption, Table 6 presents the estimated technical potential for the PacifiCorp's Wyoming service territory in 2021. Given the relative contribution of discretionary and lost opportunity measures, the estimated technical potential in 2021 (237 aMW) is equal to approximately 91% of the technical potential in 2030 (259 aMW).

Table 6. Technical Potential Estimate for 2021 (PacifiCorp Wyoming Service Territory)

Market Sector	**aMW**	**GWh**	**MW**
Residential	32	283	41
Commercial	46	399	58
Industrial	158	1,384	201
Irrigation	0	3	0
Street Lighting	1	5	1
Total	237	2,074	302

Estimating Economic Potential Based on the Technical Potential Estimate

The SPSC DSM Work Group determined that the savings projections for the High DSM Case are to be based on achieving the full *economic potential* throughout the WECC. The 2011 PacifiCorp potential study provides estimates of technical potential and achievable technical potential; it does not, however, provide an estimate of economic potential. Therefore, we also rely on PacifiCorp's 2007 energy efficiency potential study (Quantec, 2007), which provides estimates of both technical and economic potential. In that study, the economic potential for the Wyoming portion of PacifiCorp's service territory is equal to 89% of the corresponding technical potential. We apply the same percentage to the updated technical potential estimate in Table 6, in order to estimate an updated economic potential for the Wyoming portion of PacifiCorp's service territory, as shown in Table 7.

Table 7. Updated Economic Potential Estimates for PacifiCorp Wyoming Service Territory in 2021

Market Sector	**aMW**	**GWh**	**MW**
Residential	29	253	37
Commercial	41	356	52
Industrial	141	1,235	180
Irrigation	0	2	0
Street Lighting	1	5	1
Total	211	1,851	269

Extrapolating the Results to the Entire Wyoming Portion of the PACE Balancing Authority

The Wyoming portion of the PACE balancing authority consists primarily of PacifiCorp's load, but also includes several small utilities and cooperatives. We extrapolate the PacifiCorp potential study results for each sector (residential, commercial, and industrial) to the entire Wyoming portion of PACE by simply scaling up the energy and peak demand savings potential based on the ratio of the total balancing authority retail sales to PacifiCorp's retail sales, for that sector. While we recognize that this is a simplistic approach, and ignores potential differences in demographics, climate, and end-use characteristics, we also believe that it is a reasonable approximation given the data and resources available. This extrapolation, presented below in

Table 8, yields an estimated economic potential for the entire Wyoming portion of PACE equal to 1,939 GWh and 282 MW.

Table 8. Extrapolation of Economic Potential to Wyoming Portion of PACE

	Res.	**Com.**	**Ind.**	**Total**
Retail Sales[1]				
PacifiCorp (Wyoming)	1,083	1,519	6,734	9,335
PACE (Wyoming)	1,254	1,691	6,775	9,720
Net Economic Potential in 2021 (GWh)				
PacifiCorp (Wyoming)	253	356	1,242	1,851
PACE (Wyoming)	293	397	1,250	1,939
Net Economic Potential in 2021 (MW)				
PacifiCorp (Wyoming)	37	52	181	269
PACE (Wyoming)	43	58	182	282

[1] Data Source: EIA-861 retail sales data for 2008.

WACM Balancing Authority

The High DSM scenario savings estimate for the WACM balancing authority is based on the 2010 energy efficiency potential study for Tri-State Generation and Transmission Cooperative (Nexant, 2010). The potential estimates from that study, for the Wyoming portion of Tri-State's service territory in the year 2020, are presented below in Table 9.

Table 9. Tri-State Energy Efficiency Potential (Wyoming Service Territory, 2020)

	Technical	Economic	Max. Achievable[1]
GWh	402	308	179
MW	83	62	36
% of baseline retail sales	20%	15%	9%

Source: Calculated from detailed savings tables in Nexant (2010), Appendix A
Notes: The potential study indicates that the baseline projection accounts for naturally occurring savings, thus the potential estimates are net of naturally occurring savings.
[1] Max. Achievable scenario assumes incentives cover 100% of incremental measure cost. The study also estimated achievable potential under three other incentive levels.

For the purpose of the High DSM scenario we assume that the full economic potential is achieved in the Wyoming portion of the WACM balancing authority region. Developing a High DSM load forecast for the balancing authority involves three additional steps:

4) Adding avoided T&D losses to the economic potential estimate
5) Extrapolating the potential study results to the entire Wyoming portion of the WACM balancing authority

Adding Avoided T&D Losses to the Potential Estimates

The potential estimates presented in the Tri-State study represent savings at the customer meter. The economic potential estimate must therefore be scaled up to the bus-bar to account for avoided T&D losses, based on an estimated marginal T&D loss factor (7.7%).[27] The results of this adjustment are shown below in Table 10.

Table 10. Tri-State Economic Potential (Wyoming, 2020) Including Avoided T&D Losses

	Res.	Com.	Ind.	Irrig.	Total
GWh	83	14	224	12	334
MW	14	3	45	5	67

Extrapolating the Study Results to the Entire Wyoming Portion of WACM

The Wyoming portion of the WACM balancing authority consists of numerous utilities (the largest being Powder River, Cheyenne, High Plains, and Lower Valley). Tri-State G&T serves about one quarter of the total load within the Wyoming portion of WACM.

To extrapolate the Tri-State potential study, we follow a similar procedure as with the PACE balancing authority. Namely, we scale up the potential study results for each sector, in proportion to 2008 retail sales for that sector. This extrapolation is presented below in Table 11, which indicates that the total economic potential in the Wyoming portion of WACM is estimated to be 1,539 GWh and 301 MW in 2020. These values represent savings at the bus bar and are net of naturally occurring savings.

Table 11. Estimated Economic Potential for Wyoming Portion of WACM

	Res.	Com.	Ind. & Irr.	Total
2008 Retail Sales				
Tri-State (WY)	387	56	1,210	1,653
WACM (WY)	1,465	2,721	2,785	6,970
Net Economic Potential in 2020 (GWh)				
Tri-State (WY)	83	14	237	334
WACM (WY)	314	681	545	1,539
Net Economic Potential in 2020 (MW)				
Tri-State (WY)	14	3	50	67
WACM (WY)	53	132	116	301

[1] Data Source: EIA-861 retail sales data for 2008.

[27] Tri-State's potential study cites an average T&D loss factor of 5.5%. We assume that marginal T&D loss factors are equal to 1.4 times the average T&D loss factor, based on preliminary analysis conducted by Jim Lazar and shared with members of the DSM working group. Marginal loss factors are the relevant metric for estimating avoided T&D losses from DSM and are higher than average loss factors, because resistive losses increase exponentially with load.

Appendix C. SPSC 20-Year High DSM Case: Additional Methodological Details, Assumptions, and Analysis

This appendix contains further details on the assumptions, methods, and data sources to develop the SPSC 20-year High DSM Case load forecasts, along with details on the resulting load forecasts themselves. This information is intended to supplement the overview provided within Chapter 4 of the main body of the report

C.1 Weather and economic data and analyses for the SAE Base Case Forecast

Historical weather data of the National Weather Service's Automated Surface Observation System (ASOS), from 100 stations selected to cover the WECC region and covering the period 1991-2011, were obtained from the commercial vendor DTN. The raw data were daily average temperatures by station. These data were processed in a series of steps for use in the SAE econometric model estimation. First, daily and monthly degree days by station were calculated. Second, these statistics were calculated for "zones" defined by mapping the ASOS station geography to WECC BAs. Next, in a preliminary analysis, spline approximations were computed relating daily energy and peak demand to average temperatures in terms of heating and cooling degree days. These results were used to calculate the *XCool* and *XHeat* indices in the SAE regression model.

For economic and demographic variables, both historical data (from 1998) and 10- and 20-year forecasts were obtained from Moody's, Inc., including households, population, household income, employment, and gross state products manufacturing gross products (for states in WECC). These purchased data were in monthly form at the state and province level, and were processed for use in the SAE econometric analysis. The following indices were created: For the residential models, numbers-of-households, household sizes, and household income; for the commercial models, population, non-manufacturing employment, and gross manufacturing produce (value of output).

C.2. End-Use Categories and Efficiency Units

As discussed within the main body of the report, the end-use structure of the SAE model mirrors the end-use categories in EIA's National Energy Modeling System (NEMS). The stock efficiency for each end-use is therefore defined in the same units as in NEMS, as summarized in Table C - 1.

Table C - 1. End-Use Categories and Stock Efficiency Units in the SAE Load Forecasting Model

Sector	End-Use Category	Abbreviation	Stock Efficiency Unit
Residential	Electric furnaces	EFurn	Energy factor
	Heat-pump heating	HPHeat	HSPF
	Ground-source heat pump heating	GHPHeat	COP
	Secondary heating	SecHt	kWh/year
	Central air conditioning	CAC	SEER
	Heat pump cooling	HPCool	SEER
	Ground-source heat pump cooling	GHPCool	EER
	Room air conditioning	RAC	EER
	Electric water heating	EWHeat	Energy factor
	Electric cooking	ECook	kWh/year
	Refrigerators	Ref1	kWh/year
	Secondary refrigerators	Ref2	kWh/year
	Dishwashers	Dish	kWh/year
	Freezers	Frz	kWh/year
	Clothes washers	CWash	kWh/cycle
	Electric dryers	EDry	Energy factor
	TVs (a)	TV	kWh/yr
	Furnace fans	FurnFan	kWh/year
	Lighting	Light	kWh/household/year
	Miscellaneous (b)	Misc	kWh/household/year
Commercial	Heating	Heat	btu-out/btu-in (c)
	Cooling	Cool	btu-out/btu-in (c)
	Ventilation	Vent	1000 cfm-hours output/ 1000 btu input
	Water heating	EWHeat	btu-out/btu-in (c)
	Cooking	Cooking	btu-out/btu-in (c)
	Refrigeration	Refrig	btu-out/btu-in (c)
	Outdoor Lighting	OLight	lumens per watt
	Indoor Lighting	ILight	lumens per watt
	Office equipment	Office	n/a (d)
	Miscellaneous	Misc	n/a (d)

(a) Composite of televisions and set-top boxes

(b) Composite of ceiling fans, coffee makers, DVD players, unspecified electric devices, electric printers, home audio systems, personal computers, rechargeable electronics, spas, security systems, and video games

(c) For commercial heating, cooling, water heating, cooking, and refrigeration, the unit of efficiency is described as follows in the NEMS Commercial Module documentation: "[Energy] service demand is defined as Btus out (amount of delivered energy). Equipment efficiency or equipment Coefficient of Performance (COP) of the technologies that meet required service demands, together with the distribution of that equipment and the levels of service demanded, determines the fuel consumption, or Btu input. Efficiency is defined as the ratio of Btus out to Btus in for a closed system, which is a system that does not draw from external sources for Btu transference. The COP is a more appropriate measure of…performance where the system is more open, as in the case of a heat pump…The terms efficiency and COP are used interchangeably [in the documentation] when referring to the ratio of delivered to consumed energy" (USEIA 2011).

(d) For the Commercial "Office" and "Miscellaneous" categories, the SAE framework does not define an efficiency metric or index for these categories; instead, levels of efficiency, and their changes, are incorporated from exogenous assumptions that affect electricity demand for these end-uses in the NEMS model.

C.3. Data Sources for End-Use Assumptions in the SAE Base Case

When constructing the SAE Base Case load forecasts, EIA's *Annual Energy Outlook* 2012 Reference Case was the default data source for residential and commercial average stock efficiencies and saturation, covering both the historical model estimation period (1998-2010) and the forecast period (2011-2032). The EIA data, however, are specified at the census region level, which for the western U.S. includes the Pacific Region (CA, OR, WA) and the Mountain Region (all other U.S. states within WECC). This coarse level of geographical granularity is less than ideal, as both stock efficiency levels and saturation can vary substantially within a given census region (especially saturations for heating and cooling end-uses).

Where possible, more localized data sources were used as either a substitute or complement to the EIA-NEMS data, as described below. In some cases, alternate time series data sources were available that could be substituted for the EIA data in whole. In other cases, however, the alternate data were available only for a single "base year", which was then used as a benchmark to calibrate the corresponding EIA trajectory.

Stock Efficiency Data Sources (Table C - 2): For residential end uses, alternate time series data for a sub-set of end uses were available from the Northwest Power and Conservation Council (NPCC) and the National Research Council Canada (NRC) and were used for Northwestern and Canadian BAs, respectively. For a number of other regions, base-year benchmark data were available to calibrate the EIA trajectories. This included data from the California Energy Commission (CEC),[28] and base-year data from recent energy efficiency potential studies by Public Service of New Mexico (PNM) and PacifiCorp (PAC). For commercial stock efficiency, EIA data was used for all BAs, but base-year benchmark data from the CEC, PAC, and NRC were used for the corresponding regions to calibrate the EIA trajectories.

Saturation Data Sources (Table C - 3): NPCC and NRC data were again used in place of EIA data for the Northwestern and Canadian BAs, respectively. Alternate time series saturation data from the CEC's Residential Appliance Saturation Survey was used for California BAs, and time series data on residential heating shares for Arizona was available from the U.S. Census and was used for Arizona BAs. In addition, base-year benchmark were available for a number of other regions to calibrate the EIA saturation trajectories. This included data from the CEC's Commercial End Use Saturation Survey, central air conditioning share data by state from a Federal Energy Regulatory Commission (FERC) study, and base-year saturation data from PNM and PAC efficiency potential studies.

[28]Note that the present section pertains to the SAE Base Case; however, the SAE Reference Case relied on stock efficiency projections that reflect achievement of the state's energy efficiency goals, based on a potential study conducted for the California Public Utilities Commission.

Table C - 2. Data Sources for Stock Efficiency Trajectories and Base-Year Benchmarks

Sector	End Use	California	Southwest (excl. NM and PACE)	New Mexico	PACE	Pacific Northwest	Canadian Provinces
Residential	**EFurn**	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	HPHeat	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	GHPHeat	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	SecHt	EIA	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	CAC	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	EIA	NRC
	HPCool	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	GHPCool	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	RAC	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	EIA	NRC
	EWHeat	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	ECook	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	Ref1	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	Ref2	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	Frz	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	Dish	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	CWash	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	EDry	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	EIA
	TV	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	FurnFan	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	Light	EIA (CEC)	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	Misc	EIA	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
Commercial	**Heat**	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	Cool	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	Vent	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	EWHeat	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	Cooking	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	Refrig	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	OLight	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	ILight	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	Office	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)
	Misc	EIA (CEC)	EIA	EIA	EIA (PAC)	EIA	EIA (NRC)

* Note: Data sources within parentheses refer to benchmark values available for a single base year, which were used to calibrate the EIA census-region trajectory.

Table C - 3. Data Sources for Residential Saturation Trajectories and Base-Year Benchmarks

Sector	End Use	California	Arizona	Colorado	Nevada	New Mexico	PACE	Pacific Northwest	Canadian Provinces
Residential	**EFurn**	CEC	Census	EIA (Census)	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	HPHeat	CEC	Census	EIA (Census)	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	GHPHeat	CEC	Census	EIA (Census)	EIA	EIA	EIA (PAC)	EIA	NRC
	SecHt	EIA	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	CAC	CEC	EIA (FERC)	EIA (FERC)	EIA (FERC)	EIA (PNM)	EIA (PAC)	NPCC	NRC
	HPCool	CEC	EIA (FERC)	EIA (FERC)	EIA (FERC)	EIA	EIA (PAC)	NPCC	NRC
	GHPCool	CEC	EIA (FERC)	EIA (FERC)	EIA (FERC)	EIA (PNM)	EIA (PAC)	EIA	NRC
	RAC	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	EWHeat	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	ECook	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	Ref1	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	Ref2	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	Frz	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	Dish	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	CWash	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	EDry	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	NPCC	NRC
	TV	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	FurnFan	CEC	EIA	EIA	EIA	EIA (PNM)	EIA (PAC)	EIA	EIA
	Light	CEC	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	EIA
	Misc	CEC	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	EIA
Commercial	**Heat**	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	NPCC	NRC
	Cool	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	NRC
	Vent	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	NRC
	EWHeat	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	NPCC	NRC
	Cooking	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	NRC
	Refrig	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	NPCC	NRC
	OLight	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	NRC
	ILight	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	NPCC	NRC
	Office	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	NRC
	Misc	EIA (CEC)	EIA	EIA	EIA	EIA	EIA (PAC)	EIA	NRC

* Note: Data sources within parentheses refer to benchmark values available for a single base year, which were used to calibrate the EIA census-region trajectory.

C.4. EE Adjustments for SAE Reference Case

The SAE load forecasting framework was used to develop an initial set of "SAE Base Case" forecasts using the end-use efficiency and saturation assumptions described in the previous section. Because those end-use efficiency projections are not necessarily consistent with current set of energy efficiency policies and program plans, the initial SAE Base Case forecasts for many balancing authorities were adjusted in order to bring them in line with the expected impacts of current energy efficiency policies and program plans; the resulting set of adjusted forecasts are termed the "SAE Reference Case." The general process used to develop and apply these EE adjustments is described within Section 4.3.1. Within this appendix, we provide further details on the specific assumptions employed for each BA and the resulting EE adjustment for the SAE Reference Case (if any).

Table C - 4 summarizes the underlying EE policy and program assumptions for the SAE Reference Case. Based on these assumptions, EE adjustments were applied to the SAE Base Case forecasts for eleven BAs: APS, AVA, BPA, EPE, IPC, PACE, PGE, PSC, PSE, SRP, TEP. Table C - 5 summarizes the resulting EE adjustments for those eleven BAs. For all other BAs, the SAE Base Case forecasts were deemed to adequately reflect the expected impact of current EE policies and program plans over the 20-year study period, and therefore no adjustment to the SAE Base Case forecasts was applied.

As described previously within Section 4.3.1, the determination of whether or not apply an EE adjustment, and the size of any EE adjustment applied, was based on a comparison of the projected savings from current EE policies and program plans to an extrapolation of historical EE program savings trends. Those comparisons are depicted graphically in Figure C - 1 through Figure C - 17 below, for each BA for which the requisite data were available. In each of those figures, the left-hand graphic depicts historical incremental annual energy savings, based on EIA Form-861 data and any other sources available, along with projected incremental annual energy savings resulting from current EE policies and program plans, based on the assumptions outlined in Table C - 4. The right-hand graphic in each figure compares the extrapolated historical savings (based on a simple linear extrapolation) to the projected savings from current policies and program plans, in terms of cumulative savings from programs implemented in the year 2000 onward.

Table C - 4. Policy and Program Assumptions Used for EE Adjustments in the SAE Reference Case

Balancing Authority	Policy and Program Assumptions
AESO	No long-term EE policies or plans
APS	Planned cumulative savings through 2021 are based data submitted by APS to WECC, and reflect full compliance with Arizona's Energy Efficiency Rule. It is assume that these values are net of measure decay, given that the EE Rule is specified in terms of cumulative savings. From 2022 onward, absent specific policy requirements, it is assumed that APS will simply maintain cumulative savings equal to 20% of its annual load, per the requirements of the Energy Efficiency Rule, which is roughly equivalent to the assumption that the annual growth in cumulative savings reverts back to its historical trend.
AVA	Planned cumulative savings through 2032 are based on the projection of utility program savings in Avista's 2011 IRP, net of measure decay.
BCTC	Insufficient historical EE savings data exist to perform the adjustment

BPA	Planned cumulative savings through 2032 are based on the portion of NPCC's 6th plan conservation targets allocated to the BPA BA load.
CFE	No long-term EE policies or plans
CISO	Planned EE impacts are addressed directly through SAE end-use efficiency forecasts
CHPD	Small BA; no EE adjustment analysis warranted
DOPD	Small BA; no EE adjustment analysis warranted
EPE	Planned cumulative savings through 2021 are based data submitted by EPE to WECC, and reflect full compliance with New Mexico's and Texas' energy efficiency resource standards. From 2022 onward, it is assumed that growth in cumulative savings reverts back to its historical trend, absent specific policy or planning targets
GCPD	Small BA; no EE adjustment analysis warranted
IID	Small BA; no EE adjustment analysis warranted
IPC	Planned cumulative savings through 2032 are based on the projection of utility program savings in Idaho Power's 2011 IRP, net of measure decay.
LDWP	Planned cumulative savings represent only a negligible acceleration over a continuation of historical trends
NEVP	Planned savings through 2021 correspond roughly to continuation of historical trend
NWMT	Small BA; no EE adjustment analysis warranted
PACE	Planned cumulative savings through 2021 are based data submitted by PacifiCorp to WECC, and reflect achievement of the EE savings targets in PacifiCorp's 2011 IRP. From 2022 onward, growth in cumulative savings is assumed to revert back to its historical trend, given the lack of any specific policy or planning targets over that time period.
PACW	Based on PacifiCorp's 2011 IRP planning assumptions, there is no acceleration in EE savings over the forecast period relative to the historical trend.
PGE	Planned cumulative savings through 2021 are based data submitted by PGE to WECC, and reflect achievement of EE savings targets planned by the Energy Trust of Oregon. From 2022 onward, growth in cumulative savings is assumed to revert back to its historical trend, given the lack of any specific policy or planning targets over that time period.
PNM	Based on PNM's 2011 IRP, planned savings accelerate rapidly over the next decade, but program activities in the following decade are expected to largely cease, with much of the cumulative savings achieved over the 2011-2021 period decaying away by 2032. As a result, the planned cumulative savings in 2032 differ negligibly from what would occur under an extrapolation of historical cumulative savings trends.
PSC	Planned cumulative savings through 2021 are based on data submitted by PSCO to WECC, and should be interpreted as net of decay. From 2022-2032, cumulative savings are assumed to grow at historical rate, given lack of policy or programmatic targets.
PSE	Planned cumulative savings through 2032 are based on the projection of cumulative utility program savings from PSE's 2011 IRP, which is assumed to be net of measure decay.
SCL	Based on SCL's 2010 IRP, planned savings accelerate somewhat over the next decade, but planned program activity in the following decade tapers off dramatically, with much of the cumulative savings achieved over the 2011-2021 period decaying away by 2032. As a result, the planned cumulative savings in 2032 differ negligibly from what would occur under an extrapolation of historical cumulative savings trends.
SMUD	The acceleration of planned savings relative to the historical trend is negligible
SPP	Planned savings through 2021 correspond roughly to continuation of historical trend
SRP	Planned cumulative savings through 2021 are based on achievement of SRP's "Sustainable Porfolio Plan" EE savings target, and account for the rapid measure decay associated with the M-Power program (1-year measure life). From 2022-2032, growth in cumulative savings is assumed to revert back to the historical rate of growth, given the lack of program or policy targets over that period.
TEP	Planned cumulative savings through 2021 are based data submitted by TEP to WECC, and reflect full compliance with Arizona's Energy Efficiency Rule. It is assume that these values are net of measure decay, given that the EE Rule is specified in terms of cumulative savings. From 2022

	onward, absent specific policy requirements, it is assumed that TEP will simply maintain cumulative savings equal to 20% of its annual load, per the requirements of the Energy Efficiency Rule, which is roughly equivalent to the assumption that the annual growth in cumulative savings reverts back to its historical trend.
TIDC	Small BA; no EE adjustment analysis warranted
TPWR	Small BA; no EE adjustment analysis warranted
WACM	No long-term EE policies or plans for most of the utility load within the BA (served by Tri-State)
WALC	No long-term EE policies or plans
WAUW	No long-term EE policies or plans

Table C - 5. Summary of EE Adjustments for the SAE Reference Case

Balancing Authority	Annual Energy (2032)			Annual Peak (2032)		
	SAE Base Case Forecast (GWh)	Adjustment for SAE Reference Case (GWh)	Adjustment for SAE Reference Case (%)	SAE Base Case Forecast (MW)	Adjustment for SAE Reference Case (MW)	Adjustment for SAE Reference Case (%)
APS	56,031	-4,391	-7.8%	12,612	-525	-4.2%
AVA	17,064	-828	-4.9%	3,044	-110	-3.6%
BPA	72,509	-2,126	-2.9%	11,532	-190	-1.6%
EPE	11,949	-490	-4.1%	2,675	-68	-2.6%
IPC	18,154	-788	-4.3%	4,003	-103	-2.6%
PACE	61,415	-1,502	-2.4%	10,853	-195	-1.8%
PGE	27,424	-1,723	-6.3%	4,685	-240	-5.1%
PSC	57,234	-3,040	-5.3%	10,560	-286	-2.7%
PSE	30,430	-1,023	-3.4%	5,352	-136	-2.5%
SRP	48,380	-2,216	-4.6%	10,531	-286	-2.7%
TEP	17,201	-2,145	-12.5%	3,545	-305	-8.6%

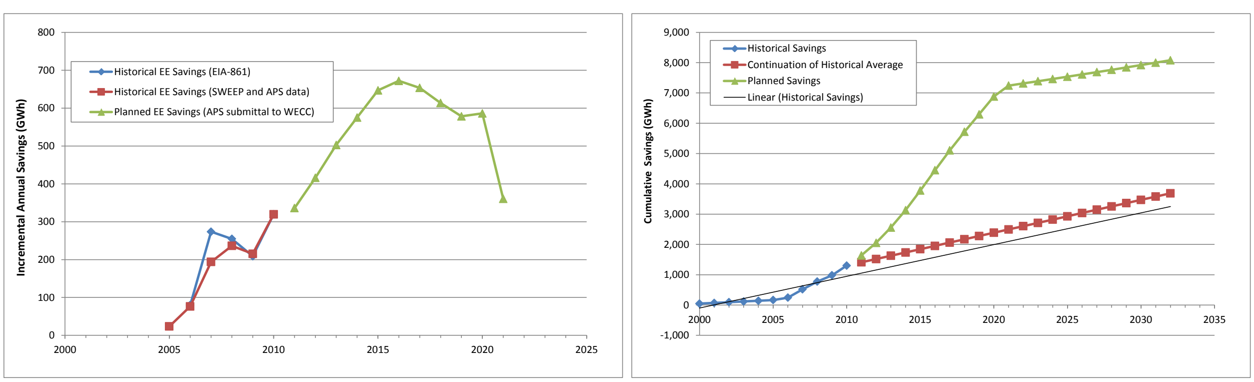

Figure C - 1. Projected EE Program Savings vs. Extrapolation of Historical Trends (APS)

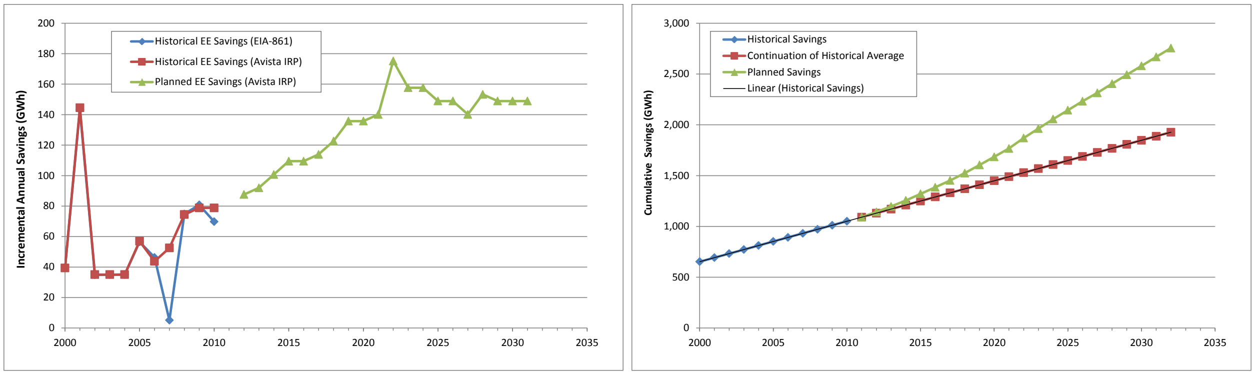

Figure C - 2. Projected EE Program Savings vs. Extrapolation of Historical Trends (AVA)

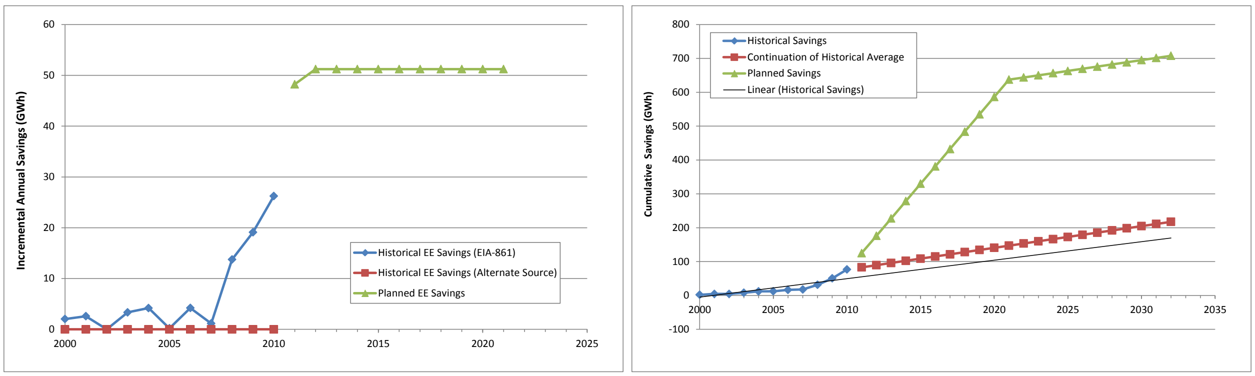

Figure C - 3. Projected EE Program Savings vs. Extrapolation of Historical Trends (EPE)

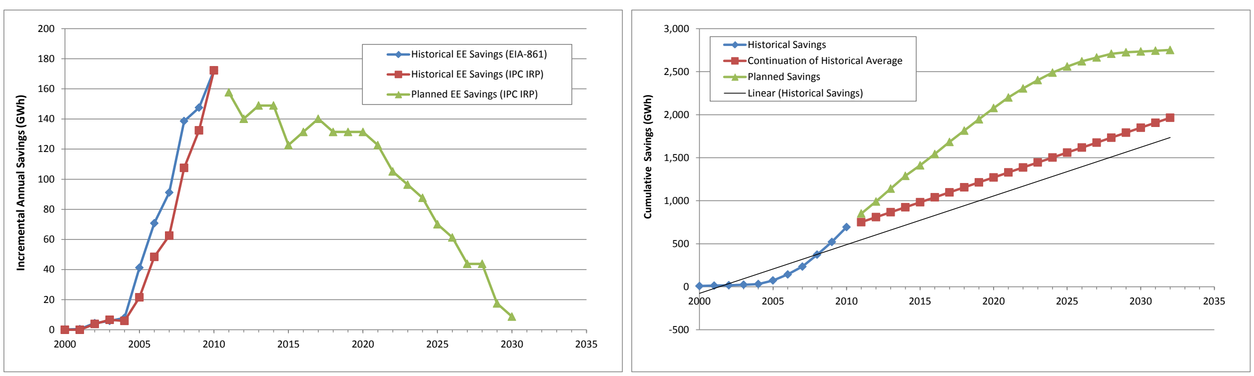

Figure C - 4. Projected EE Program Savings vs. Extrapolation of Historical Trends (IPC)

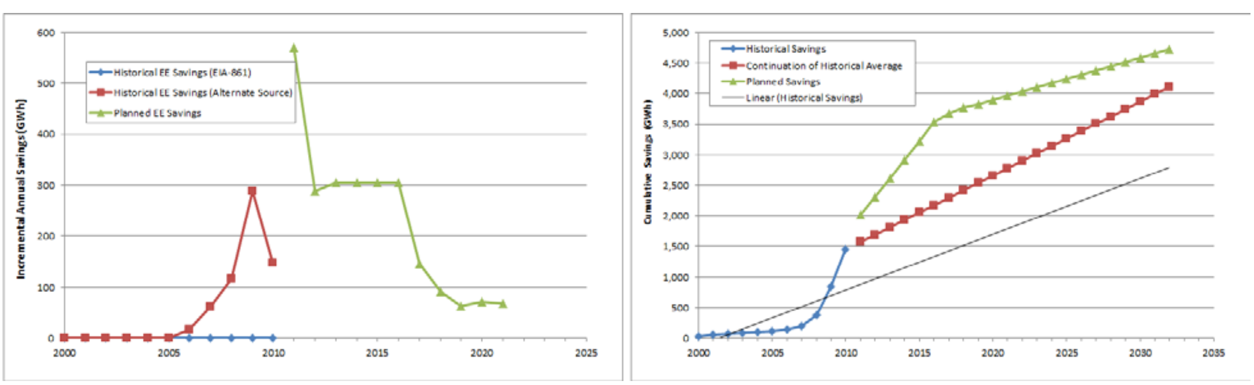

Figure C - 5. Projected EE Program Savings vs. Extrapolation of Historical Trends (LADWP)

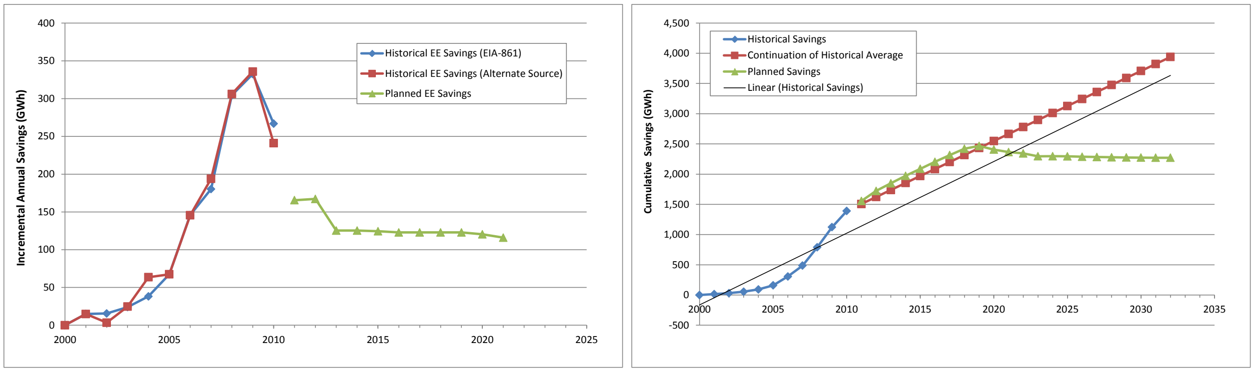

Figure C - 6. Projected EE Program Savings vs. Extrapolation of Historical Trends (NEVP)

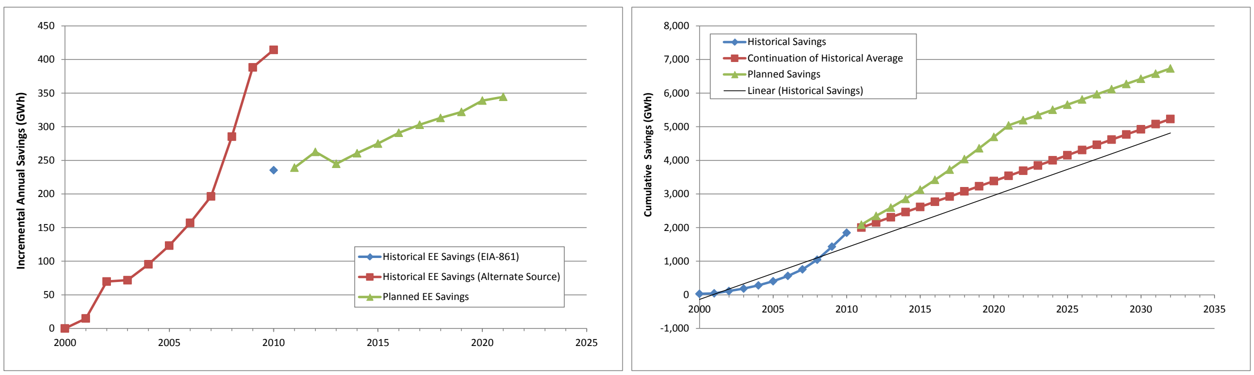

Figure C - 7. Projected EE Program Savings vs. Extrapolation of Historical Trends (PACE)

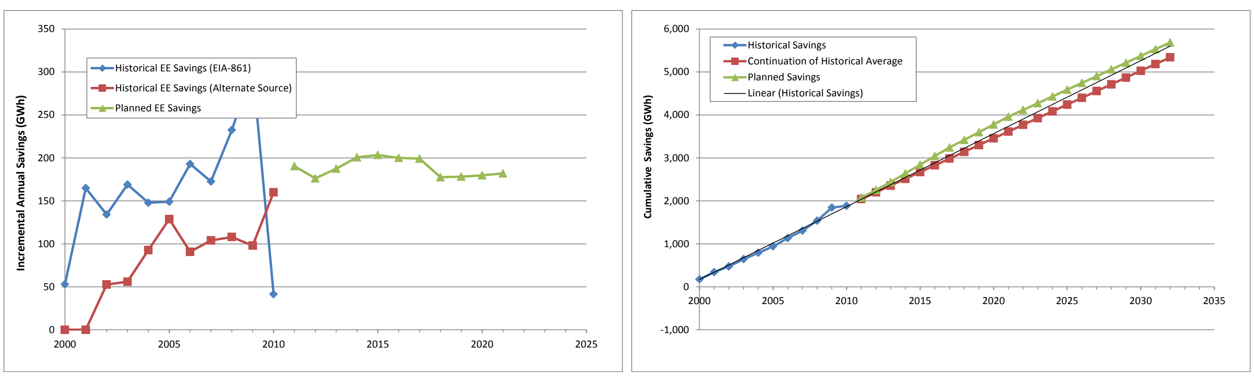

Figure C - 8. Projected EE Program Savings vs. Extrapolation of Historical Trends (PACW)

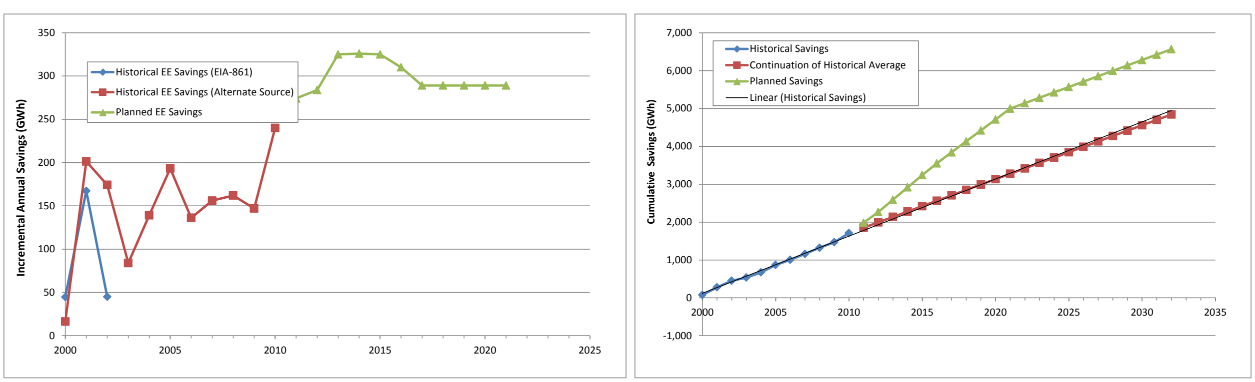

Figure C - 9. Projected EE Program Savings vs. Extrapolation of Historical Trends (PGE)

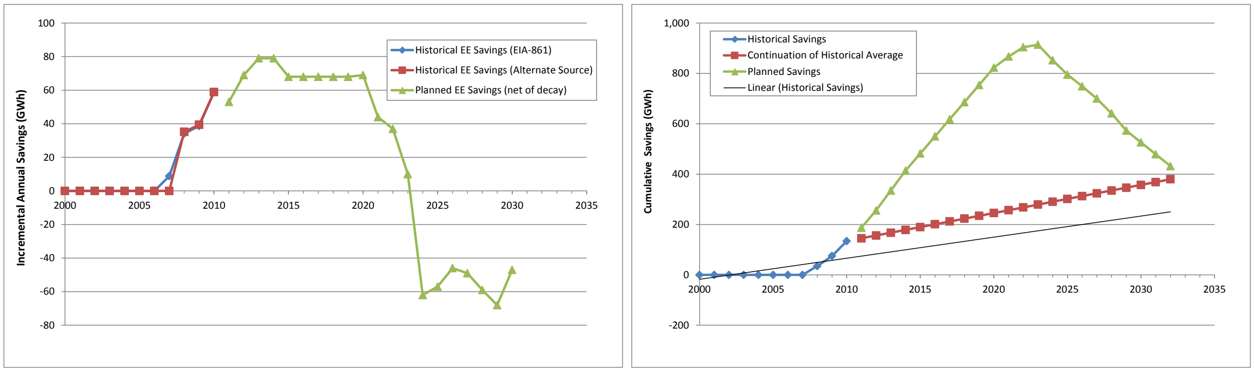

Figure C - 10. Projected EE Program Savings vs. Extrapolation of Historical Trends (PNM)

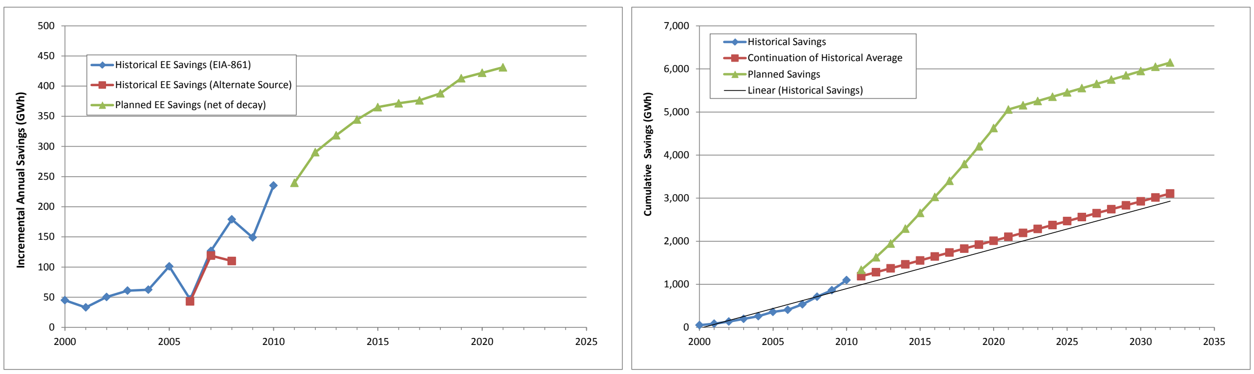

Figure C - 11. Projected EE Program Savings vs. Extrapolation of Historical Trends (PSCO)

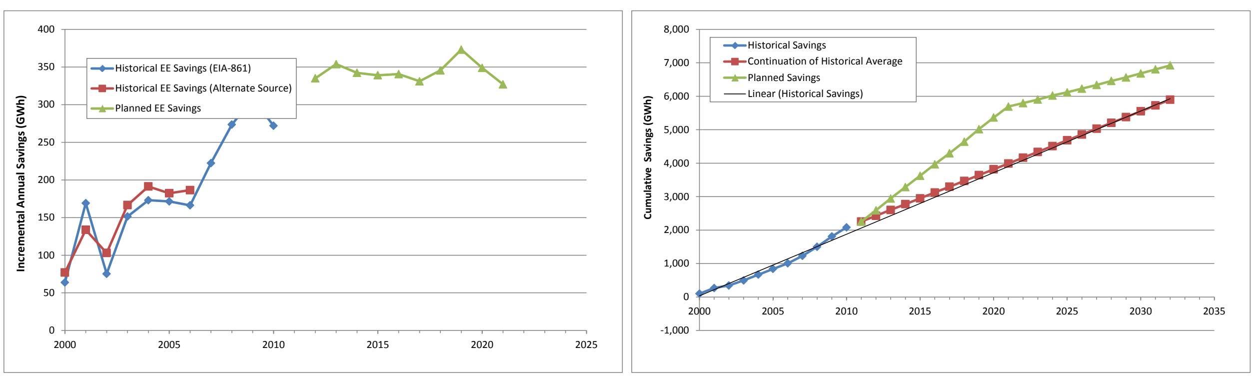

Figure C - 12. Projected EE Program Savings vs. Extrapolation of Historical Trends (PSE)

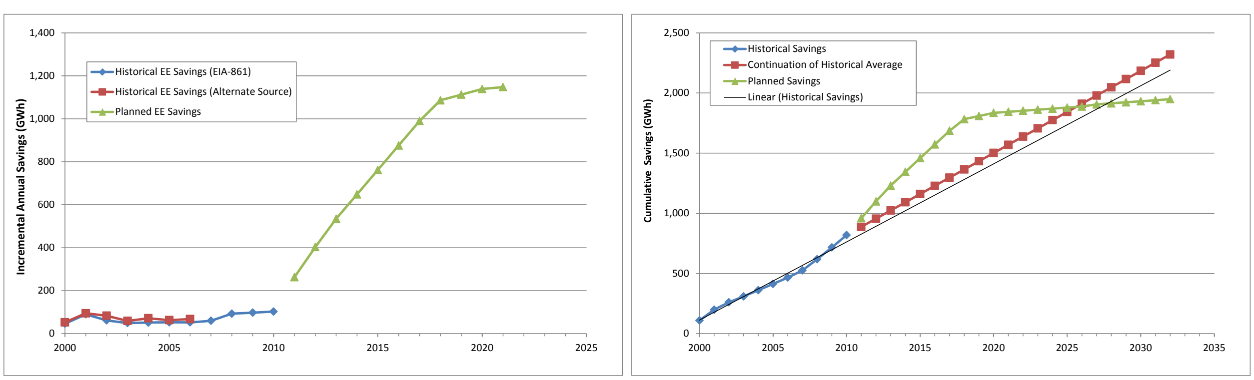

Figure C - 13. Projected EE Program Savings vs. Extrapolation of Historical Trends (SCL)

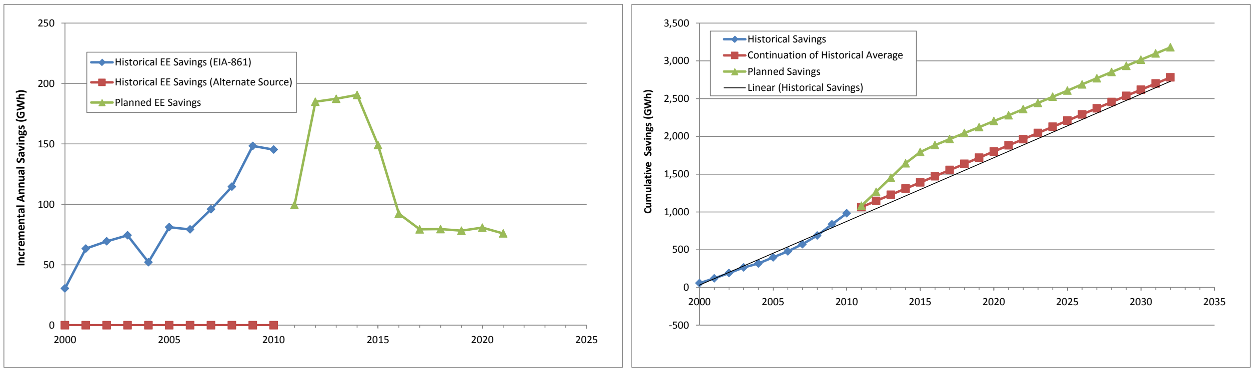

Figure C - 14. Projected EE Program Savings vs. Extrapolation of Historical Trends (SMUD)

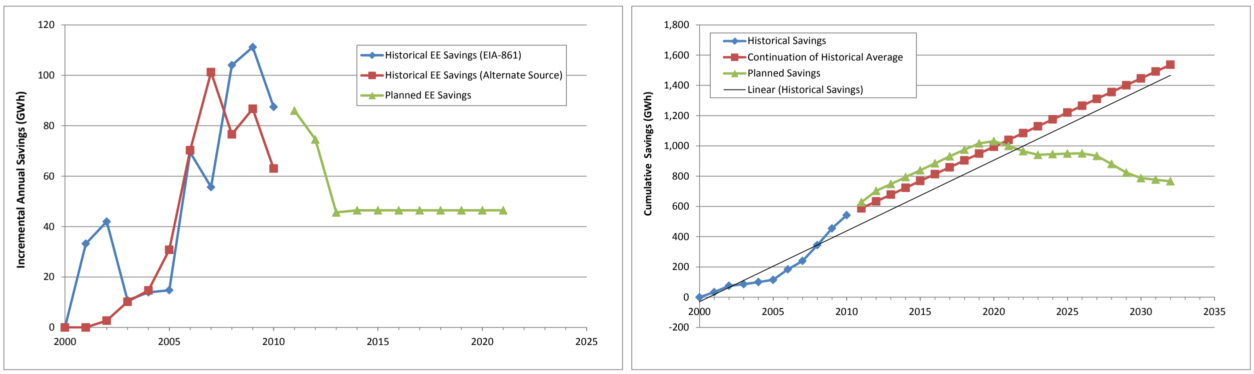

Figure C - 15. Projected EE Program Savings vs. Extrapolation of Historical Trends (SPP)

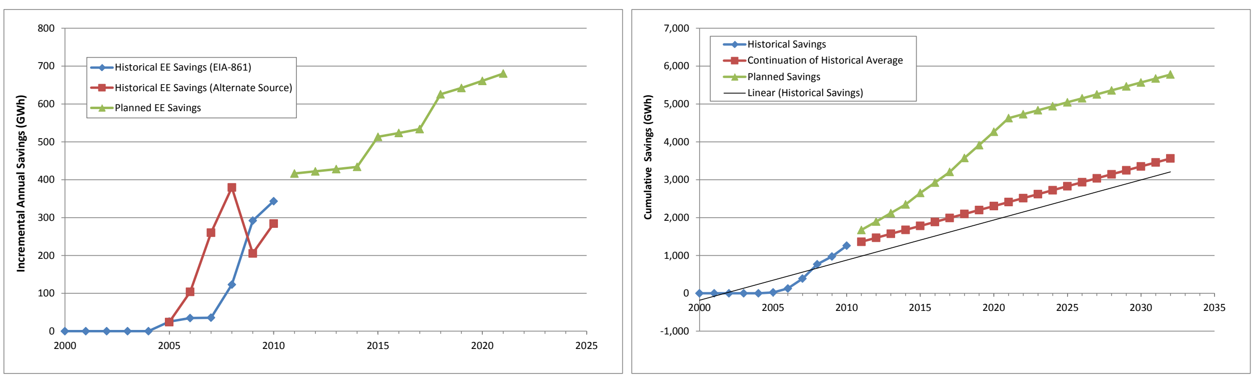

Figure C - 16. Projected EE Program Savings vs. Extrapolation of Historical Trends (SRP)

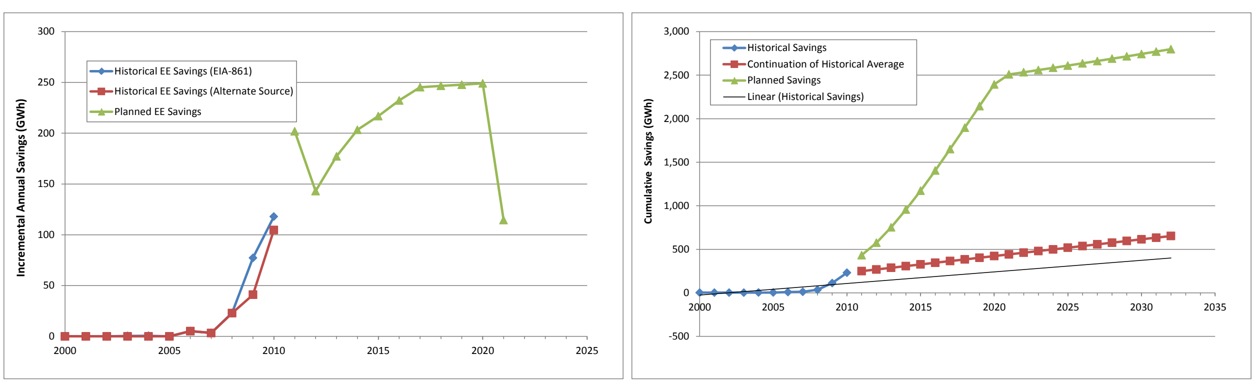

Figure C - 17. Projected EE Program Savings vs. Extrapolation of Historical Trends (TEP)

C.5. SAE Reference Case Load Forecasts

The SAE Reference Case load forecasts are summarized graphically in Section 4.3.2. Here within the technical appendix, we provide additional numeric details. In particular, Table C - 6 presents the SAE Reference Case load forecasts for the year 2032, in terms of energy and non-coincident peak demand, as well as the compound annual growth rates over the 2010-2032 period, as plotted within Figure 21. Table C - 7 displays 2032 energy and peak demand by sector and region, as shown earlier in Figure 23. Table C - 8 shows 2032 residential energy and peak demand by end use and region, and Table C - 9 shows the corresponding information for the commercial sector; the data from these two tables are aggregated within Figure 24 in the main body of the report.

Table C - 6. SAE Reference Case Load Forecast by WECC Load Zone (2032)

Load Zone	Annual Energy		Non-Coincident Annual Peak Demand	
	GWh	CAGR (2010-2032)	MW	CAGR (2010-2032)
AESO	129,624	2.7%	18,010	2.6%
APS	52,668	2.4%	11,988	2.4%
AVA	16,137	1.3%	2,865	1.3%
BCTC	73,858	1.1%	13,132	0.9%
BPA	64,781	1.0%	12,494	1.1%
CFE	18,361	2.5%	3,327	2.0%
CHPD	5,076	2.2%	820	1.4%
DOPD	2,184	2.2%	449	1.0%
EPE	11,361	1.6%	2,294	1.6%
FAR_EAST	3,741	2.7%	704	2.3%
GCPD	6,673	2.3%	1,065	2.0%
IID	5,991	2.4%	1,366	1.4%
LDWP	34,868	0.9%	7,466	0.4%
MAGIC_VLY	4,642	-0.3%	1,025	0.0%
NEVP	37,334	1.9%	9,337	2.0%
NWMT	12,617	0.8%	2,056	0.9%
PACE_ID	4,830	1.3%	628	-0.8%
PACE_UT	39,165	0.9%	8,237	1.6%
PACE_WY	15,983	1.9%	2,080	2.0%
PACW	27,811	1.4%	5,429	1.7%
PGE_BAY	49,869	0.4%	10,398	0.9%
PGE_VLY	80,873	1.6%	14,426	0.5%
PGN	25,858	1.1%	5,046	1.5%
PNM	21,344	1.6%	3,650	1.5%
PSC	53,267	1.1%	9,564	1.0%
PSE	29,561	0.9%	5,187	0.3%
SCE	133,054	1.1%	26,262	0.5%
SCL	11,915	0.8%	1,994	0.4%
SDGE	27,579	1.2%	5,567	0.7%
SMUD	20,737	0.8%	4,834	0.4%
SPP	14,631	1.2%	2,594	1.4%
SRP	46,477	1.9%	10,326	2.1%
TEP	16,093	0.5%	3,465	0.5%
TIDC	3,236	1.3%	767	1.2%
TPWR	5,299	0.4%	996	0.0%
TREAS_VLY	11,448	0.9%	2,423	1.4%
WACM	29,680	1.1%	4,836	1.3%

WALC	8,190	0.9%	1,627	0.6%
WAUW	692	0.4%	120	0.1%
WECC Total	**1,157,509**	**1.4%**	**218,854**	**1.2%**

Table C - 7. SAE Reference Case Load Forecast by Customer Sector and Region (2032)

Customer Sector	Annual Energy (GWh)				Contribution to Regional Peak (MW)*			
	WECC	NW	CA	SW	WECC	NW	CA	SW
Residential	420,594	156,075	138,580	125,939	84,455	30,551	31,374	31,188
Commercial	479,580	156,594	168,895	154,092	87,688	23,692	31,714	29,372
Industrial	257,335	124,077	48,734	84,523	36,666	17,362	7,126	12,581
Total	1,157,509	436,746	356,208	364,554	208,809	71,604	70,214	73,140

* For each customer sector, the monthly peak demand is shown for the peak month in the region (i.e., in December for BAs in the NW and in July for all other regions and for WECC as a whole)

Table C - 8. SAE Reference Case Load – 2032 residential energy and peak demand by end-use and region

End Use	Annual Energy (GWh)				Contribution to Regional Peak (MW)*			
	WECC*	NW	CA	SW	WECC	NW	CA	SW
Electric furnace	21,768	16,874	1,201	3,692	0	6,451	0	0
Heat pump heating	6,806	4,692	523	1,591	0	1,762	0	0
Ground-source heat pump heating	215	87	25	103	0	39	0	0
Secondary heating	3,118	2,097	533	488	0	778	0	0
Central air	35,049	3,905	11,811	19,333	31,699	0	12,978	13,397
Heat pump cooling	7,733	1,027	398	6,308	5,731	0	405	4,108
Ground-source heat pump cooling	398	36	25	337	294	0	25	226
Room air	2,646	480	638	1,528	2,345	0	668	1,009
Electric water heating	37,280	22,125	2,429	12,726	4,153	4,123	280	1,491
Electric cooking	14,170	4,034	5,325	4,811	1,807	1,530	695	609
Refrigerator	35,626	8,399	19,489	7,739	5,519	1,113	3,014	1,248
Secondary refrigerator	7,055	2,075	3,367	1,613	1,084	276	519	259
Freezer	10,122	2,921	4,270	2,931	1,854	403	768	556
Dishwasher	10,052	3,774	3,149	3,128	1,411	435	448	456
Clothes washer	2,392	896	735	761	408	146	124	135
Electric dryer	19,020	5,598	7,357	6,065	4,252	928	1,626	1,422
TV	30,481	12,994	7,702	9,784	4,487	2,194	1,147	1,499
Furnace fan	9,083	4,848	772	3,463	0	1,731	0	0
Lighting	50,590	25,592	12,126	12,873	2,941	3,502	709	794
Miscellaneous	116,990	33,622	56,704	26,665	16,292	5,117	7,968	3,831

* For each customer sector, the monthly peak demand is shown for the peak month in the region (i.e., in December for BAs in the NW and in July for all other regions and for WECC as a whole)

Table C - 9. SAE Reference Case – 2032 commercial energy and peak demand by end-use and region

End Use	Annual Energy (GWh)				Contribution to Regional Peak (MW)*			
	WECC	NW	CA	SW	WECC	NW	CA	SW
Heating	4,404	3,584	331	488	0	1,284	0	0
Cooling	27,799	2,811	10,037	14,951	12,357	0	5,492	4,550
Ventilation	61,270	21,794	19,044	20,432	10,174	3,038	3,155	3,552
Electric water heating	6,240	2,372	1,382	2,487	1,178	488	260	485
Electric cooking	6,002	692	4,866	444	1,326	143	1,078	102

Refrigeration	42,073	11,695	20,654	9,724	6,614	1,706	3,257	1,600
Outside lighting	18,532	4,348	9,762	4,422	201	531	105	50
Interior lighting	115,539	36,889	40,166	38,484	21,636	5,740	7,515	7,531
Office equipment	30,143	8,899	15,245	5,999	4,695	1,241	2,402	980
Miscellaneous	167,578	63,508	47,409	56,660	29,323	9,503	8,450	10,384

* For each customer sector, the monthly peak demand is shown for the peak month in the region (i.e., in December for BAs in the NW and in July for all other regions and for WECC as a whole)

C.6. Data Sources and Assumptions for Average Stock Efficiencies in the High DSM Case

As discussed in Section 4.4, the 20-Year High DSM study case focuses on a single year (2032, the end of the planning horizon), stipulates average stock efficiencies for each end-use in that year, and then adjusts the SAE Base Case load forecast for each end-use based on the efficiency improvements relative to the average stock efficiencies used for the SAE Base Case forecasts. The average stock efficiencies stipulated for the High DSM case are intended to represent the most efficient equipment *presently* commercially available.

To develop stock efficiency assumptions for the High DSM Case, we relied primarily upon studies conducted for the EIA by Navigant Consulting on present and future end-use technology characteristics (Navigant, 2007; Navigant, 2008; Navigant & SAIC, 2011a; Navigant & SAIC, 2011b). For most residential and commercial end-uses, these studies identify the present-day (e.g., year 2010) commercially-available high efficiency option, and these are the default values used to define average stock efficiency levels for the High DSM case.[29]

Some of the end uses included within the SAE model, however, have not been included in recent Navigant analyses. In a number of other cases, the Navigant 2010 high efficiency option is lower than the projected 2032 stock efficiency in the base case. And in several cases, the SAE definitions of categories – i.e., the technologies within them – differ from their counterparts in NEMS. In these instances, where possible we used Navigant's projected high efficiency option for a future year (rather than for 2010). In other cases, however, it was necessary to develop the High DSM case stock efficiency assumption from other sources, including LBNL's recent "MaxTech" report and technical support documents from the U. S. DOE appliance standards program (Desroches & Garbesi, 2011).

We describe below the specific data sources used for each end-use category, along with any additional assumptions or steps required in order to apply those data sources to the SAE model.

<u>Residential End-Uses</u>

Electric furnaces and secondary heating: Electric furnaces are assumed in EIA-NEMS to operate at 100% efficiency (i.e., presently and in all forecast years); this end use was not studied by Navigant, and no other source was identified for a higher efficiency scenario. It was therefore

[29] Current high-efficiency levels on the market are steadily increasing for a number of end uses, and at any given time, estimates as to what this level is for a given end use may vary. Thus, we are not interpreting the Navigant estimates as being definitive. Rather, they are reasonably comprehensive and in addition were constructed in such a way as to conform with the structure of the NEMS model, upon which the SAE framework is based. Both these aspects motivated the use of the Navigant studies as our primary source.

posited that by 2032 these furnaces would be converted to electric heat pumps, and the Navigant 2010 Typical HSPF of 8 was used as the 2032 high efficiency option. (For BAs in Washington and Oregon, stock efficiencies in the Itron SAE model are based on data provided by the Northwest Power and Conservation Council (NPCC), for which the units are specified in terms of "thermal efficiency"; we interpreted these efficiencies as equivalent to COP and applied the above procedure with values converted appropriately.) For secondary heating, it was assumed that the percentage energy savings relative to the Base Case was the same as for electric furnaces.

Electric heat-pump heating: For BAs in the NPCC, the SAE 2032 Base Case efficiency exceeded the Navigant 2010 high efficiency level of 10.7 HSPF. We determined that there is a currently-available Energy Star unit of 14 HSPF (4.10 COP), and used this as the 2032 target in all BA. This level, and a reported Energy Star currently available unit equivalent to 4.10 COP was used.

Ground-source heat-pump heating, central air conditioning, heat-pump cooling, ground-source heat-pump cooling, and room air conditioning: The Navigant 2010 high efficiency values were used for all BAs.

Electric water-heating: The Navigant 2010 high efficiency was used for BAs in the NPCC. For all other BAs, this 2010 high was exceeded by the SAE 2032 Base Case efficiency. For these, we applied the NPCC 2032 percentage energy savings for this end use from either Oregon/Washington (to California, Alberta, and British Columbia) or Idaho/Montana (all others). The result is an average stock efficiency greater than 1.00, the energy factor upper bound for standard units; we can interpret this as reflecting a switch by some fraction of households to heat pump models, which have energy factors of 2.00 or above.

Electric cooking: This end-use was not analyzed by Navigant. For NPCC BAs, in which the stock efficiency units are specified as an energy factor, we used the proposed but not-adopted "max tech" energy factor of 0.77 reported in USDOE (2009b). For all others exclusive of New Mexico, stock efficiencies are specified as a UEC (kWh/year), and we used the technical assumptions in USDOE (2009a) to impute a SAE 2032 Base case efficiency of 0.72, and computed the implied reduction in UEC associated with an increase in stock efficiency to a 0.77 energy factor. For New Mexico, where the reference case UEC was calibrated to state-specific data, we applied the same percentage energy savings (or UEC reduction) as in Arizona and its neighboring states.

Refrigerators, second refrigerators, and freezers: For refrigerators – which are refrigerator-freezers in EIA-NEMS (either top-mount or side-mount) – the Navigant 2010 high efficiency level is 285 kWh/year for a representative unit; this is a forty-percent UEC reduction from the 2010 typical unit. Stand-alone freezers were not analyzed by Navigant, but EIA-NEMS assumes a 2010 high efficiency UEC that is also forty-percent below the 2010 typical unit, corresponding to an Energy Star model (Comstock 2012). Secondary refrigerators are not an end-use in EIA-NEMS; in the reference case forecast, this end-use was assumed to have a UEC of ninety percent that of primary refrigerators in all forecast years. The assumed stock efficiencies for refrigerators, secondary refrigerators, and freezers in the High DSM Case varied by region. For

NPCC BAs, efficiency units are a form of energy factor (cubic feet / kWh/ day). For all three end uses, we computed the efficiency increase corresponding to a forty-percent decrease in unit energy consumption applied to the stock average represented by SAE 2011 Base Case efficiency, and used this as the 2032 High DSM benchmark. For all other BAs except those in New Mexico, we used the Navigant 2010 high efficiency UEC for the 2032 High DSM benchmark (285 kWh/yr) for refrigerators. For secondary refrigerators, the UEC for the 2032 High DSM case is equal to ninety percent of the UEC for primary refrigerators (i.e., 256.5 kWh/year), applying the same relationship as in the SAE Reference Case. For freezers, the 2032 high efficiency level corresponds to a UEC forty percent below that of SAE Base Case 2011 value, the same assumption about current high efficiency freezers as in AEO-NEMS. Finally for New Mexico BAs, for all three of these end uses, we applied the High DSM percentage energy savings calculated for Arizona and neighboring states.

Dishwashers: For all BAs except those in New Mexico, the Navigant 2010 high efficiency was used as the High DSM 2032 benchmark. For New Mexico, the percentage energy savings calculated for Arizona and neighboring states was used.

Clothes washers and electric dryers:
Clothes washers: For NPCC BAs, the Navigant 2010 high efficiency was used. For others excepting New Mexico, a high-efficiency-level machine energy kWh/cycle reported in the Technical Support documentation for the US DOE appliance standard was used. For New Mexico, because a difference of efficiency units complicated the use of the Navigant estimate, the percentage energy savings calculated for Arizona and neighboring states was used.

Dryers: For all BAs except New Mexico, the Navigant 2020 high efficiency estimate was used. (For these BAs, the Navigant 2010 high was exceeded by the SAE Base Case efficiency.) For New Mexico, the percentage energy savings calculated for Arizona and neighboring states was used.

TVs: This end use was not analyzed by Navigant. Instead, detailed information on stock efficiencies and saturations in the *AEO 2012* Reference Case were obtained from EIA, and combined with estimates of energy used by current "best on market" technologies in the LBNL MaxTech report to calculate a high efficiency benchmark (UEC) for 2032; these calculations were performed for Census regions 8 and 9 separately, and applied to BAs in each accordingly. For New Mexico, the percentage energy savings calculated for Arizona and neighboring states was used.

Furnace fans: For all BAs, we used an estimate of 6% energy savings potential from improved efficiency reported by Franco et al. (2008) as a proxy for a current best-available (Franco et. Al, 2008).

Lighting: This end use was analyzed by Navigant. However, the Navigant estimates specify efficiency levels in the standard units of lumens per Watt, whereas the SAE model represents lighting efficiency as a UEC in units of kWh/year/household, so that estimates of high-efficiency options must be adapted. As in the case of TVs, we obtained detailed information on stock efficiencies and saturations in the *AEO 2012* Reference Case from EIA. To construct the 2032

High DSM benchmark, we assumed that saturations (i.e., total bulb counts) and utilizations were the same as in this Reference Case but that all bulbs were replaced by a CFL, and computed the resulting implied UEC. Here again, these calculations were performed for Census regions 8 and 9 separately, and applied to BAs in each accordingly.

Miscellaneous end uses: This category comprises a set of end uses not analyzed by Navigant. Several of these were studied in the LBNL MaxTech report. For these, we combined the latter's current best-on-market energy use estimates with EIA information on *AEO 2012* stock efficiencies and saturations, and constructed new miscellaneous UECs (kWh/year/household) – again for Census regions 8 and 9 separately – incorporating the reductions in the modified end-uses.

<u>Commercial End-Uses</u>

In contrast to the NEMS residential module, in the commercial module each end-use is represented by a set of technologies, and the commercial module computes, and reports as outputs, aggregate or composite average efficiencies across the set for each end-use. At the same time, however, the model does generate internal files containing efficiencies for all technologies that contribute, in the model solution, to meeting the service demand for that end-use – this applies to all seven end-use categories in the model. Thus, for example, in the *AEO* reference case, electric boilers, electric resistance heaters, rooftop air-source heat-pumps, and ground-source heat-pumps, all play a role in meeting heating demand, and the corresponding efficiencies of all four are reported for each year of the projection, as well as the overall, average heating efficiency.

The SAE model uses these "whole end-use" efficiency metrics; as with the residential sector, the analysis adjusts those computed by NEMS using intra-WECC information, and these are part of the SAE reference forecast. By accessing the model's internal data, however, we are able to disaggregate the efficiency information for each end-use, and to use this greater detail to define our High DSM targets. In particular, the Navigant studies cited above also dealt with commercial-sector end-use technologies, and also included in most information on 2010 high-efficiency units. We were therefore able to use the Navigant information to define our 2032 High DSM targets.

For all the commercial end-uses except "Office" and "Miscellaneous," the Navigant 2010 high efficiency estimates were used to define the 2032 High DSM benchmarks. The "Office" and "Miscellaneous" categories are composites of different end-uses. The SAE framework does not define an efficiency metric or index for these categories; instead, levels of efficiency, and their changes, are incorporated from exogenous assumptions that affect electricity demand for these end-uses in the NEMS model. The "Office" comprises electronic equipment including computers, monitors, and servers, among others. The preliminary energy savings estimate reported in the tables was derived by applying potential estimates for computers, desktop monitors, and servers reported in Navigant (2009). The "Miscellaneous" category comprises end uses including transformers, X-ray equipment, elevators, and municipal water services. The preliminary energy savings estimate reported in the tables was derived by applying current "best on market" energy use levels reported in the LBNL MaxTech report for dry and liquid transformers, elevators, and escalators. It should be noted that the largest fraction of energy use in this category – on the order of one-half the total – is for water services, particularly pumping.

Industrial Sector Efficiency Assumptions

In contrast to the Residential and Commercial Modules, the NEMS Industrial Module is built on an econometric rather than technology framework, and does not contain end-use detail. This carries over to the SAE model. Thus, a much simpler approach was taken to developing industrial 2032 High DSM targets. We drew upon the results of several recent industrial potential studies that focused on utility service territories within WECC. Table C - 10 summarizes the key information, in particular, estimates of cumulative energy savings in the studies' final forecast years for technical, economic, and achievable potential cases. It was judged that the low-to-moderate achievable potentials generally reflected the amount of DSM-induced savings already embedded in the SAE Base Case, so that the difference between those potentials and the corresponding technical potentials within each study area was an appropriate approximate magnitude for a 2032 High DSM savings target. As indicated in the table, this delta ranges from roughly 3% to more than 15% across the studies. Absent further information, a uniform 10% savings was applied for all BAs. In other words, for each BA, the High DSM Case was derived by assuming a 10% reduction in industrial energy consumption from the SAE Base Case forecast in 2032.

Table C - 10. Industrial Sector Energy Efficiency Potential Study Results

Client	**Analyst**	**Year of study**	**Forecast horizon**	**Annual Energy Savings in Horizon Year as Percentage of Baseline Usage**		
				Technical	**Economic**	**Achievable**
Idaho Power	Nexant	2009	2028	11.57%	10.66%	Low: 1.73% Moderate: 2.63% Aggressive: 2.83% Maximum: 3.03%
New Mexico	Global Energy Partners	2011	2025	18.70%	15.10%	Low: 5.00% High: 11.5%
Pacific Power	Cadmus	2011	2030	19.30%	N/A	15.79%
Rocky Mountain	Cadmus	2011	2030	11.51%	N/A	8.77%
PSCo - Colorado	Kema	2010	2020	12.40%	11.70%	50% incentive: 3.55% 75% incentive: 5.50% 100% incentive: 7.22%
Tri-State	Nexant	2010	2025	23.00%	21.00%	Low: 7.6% Moderate: 9.5% Aggressive: 11.9% Maximum: 14.9%

C.7 Calculating Efficiency Gains in the High DSM Case

As described within Section 4.4.1, the second critical step in deriving the High DSM forecasts, after defining the stock efficiency assumptions for the High DSM Case, is to calculate – for each individual residential and commercial end-use – the percentage energy savings associated with moving from the average stock efficiency in the SAE Base Case for the year 2032 to the assumed average stock efficiency in 2032 for the High DSM Case. Here we further describe the mechanics of that step. The results of these calculations, expressed in terms of the percentage reduction in annual energy consumption relative to the SAE Base Case, are tabulated in Table C - 11 and Table C - 12, for residential and commercial end-uses respectively. Within those tables, the results are grouped into combinations of states and/or load zones with identical end-use assumptions.

<u>Residential Sector End-Uses</u>

In both NEMS and the SAE model, residential-sector efficiency is described for some end-uses in terms of technical units – such as COP or SEER – and for others in terms of UECs, either kWh per year or kWh per household per year. The 2032 high-efficiency benchmarks were used to calculate percentage improvements in these efficiency indices for year 2032. For each WECC BA/LSE we can write the year 2032 reference case consumption as

$$Load_{Ref\ 2032} = \sum_i Enduse_{i\ Ref\ 2032}\ , \qquad (1)$$

where both sides of the equation are in GWh. For end-uses with efficiency in technical units, the High DSM consumption was calculated as

$$Enduse_{i\ HighDSM\ 2032} = \frac{1}{1+\%\Delta Eff} \cdot Enduse_{i\ Ref\ 2032}, \qquad (2)$$

where $\%\Delta Eff$ is the percentage improvement in efficiency for the given end-use. For end-uses with efficiency in UEC terms, the High DSM consumption was calculated as

$$Enduse_{i\ HighDSM\ 2032} = \left(1-\%\Delta UEC\right) \cdot Enduse_{i\ Ref\ 2032}, \qquad (3)$$

where $\%\Delta UEC$ is the percentage reduction in the UEC for the given end-use. Combining both types, the total residential High DSM consumption for the given BA is then

$$Load_{HighDSM\ 2032} = \sum_i Enduse_{i\ HighDSM\ 2032}. \qquad (4)$$

<u>Commercial Sector End-Uses</u>

Although both are based on engineering-economic principles, the structure of the NEMS commercial module (sub-model) differs in certain details from that of the residential, which is in turn reflected in the representation of end-use efficiency. (Further details on the contents of this sub-section are provided in the Appendix.) While the commercial module also uses technology input data including efficiencies in terms of technical units or UECs, these are converted within the model (for most end-uses) into the metric of btu-out/btu-in for the energy service demands computed by the model for a given scenario, and the module's end-use efficiency outputs are reported in terms of this metric. Furthermore, while as described above efficiency levels for most end-uses in the residential sector are represented by technical units or UECs of "representative" technologies, by contrast, in the commercial module the average efficiency for each end-use is a composite across different technology types providing the energy service within that end-use.

These differences are reflected in the calculations of end-use-level commercial High DSM savings. In the commercial module the electricity consumption within each end-use – indexed by *i* - is the sum of consumption provided by the corresponding set of end-use technologies, indexed by *tech* (in the following formulae we suppress the time index for simplicity):

$$Enduse_i = \sum_{tech} Enduse_{i,tech}. \tag{5}$$

For each technology type, we used the "2010 high efficiency" level reported by Navigant (or a proxy), $Eff_{i,tech,high}$, and defined a consumption share-weighted high-efficiency level for 2032 as

$$Eff_{i,high} = \sum_{tech} \frac{Eff_{i,tech,high} \cdot Enduse_{i,tech}}{Enduse_i}. \tag{6}$$

The calculation of commercial 2032 High DSM energy savings was then similar to that for residential sector represented in equation (5), above, but used this high-efficiency composite.

Tables 3 and 4 display the High DSM 2032 energy savings percentages for the residential and commercial sectors, respectively, by end-use and by "load groups" – sub-sets of BAs for which the savings factors are equal. For the residential sector, these percentages are those referred to above as $\%\Delta UEC$ for end-uses with efficiency measured by *UEC*. For residential end-uses with efficiency measured by technical units, the savings percentages are given by $\%\Delta Eff / (1+\%\Delta Eff)$; commercial sector percentages are also given by the latter expression, where $\%\Delta Eff$ is the percentage improvement from the baseline efficiency to "$Eff_{i,high}$" (per equation 7).

For both sectors, the pattern of equal savings percentages within what we are calling "load groups" arises for several reasons. First, in the SAE Base Case, 2032 efficiency levels are based upon those of U. S. Census Regions 8 and 9 in the EIA *AEO 2012* Reference Case. For most BAs, the changes to these levels resulting from the SAE econometric analysis using localized data are small – or there are no changes – and are the same within certain subsets geographically adjacent BAs, as reflected in the tables.

A second reason, pertaining to the residential sector, is that efficiency data for BAs in Washington, Oregon, Idaho, and Montana that was used in the SAE analysis was for several end-uses based upon different units than those in NEMS, and assumptions necessary for accommodating these units in the High DSM analysis resulted in some systematic differences (between BAs in these states, and those elsewhere).

A third reason arises in the end-uses for which information to set the High DSM 2032 efficiency levels was not available from the Navigant studies noted previously and had to be assembled from other sources, and applied through additional calculations to determine the 2032 high-efficiency benchmarks. In these cases, the High DSM percentage energy savings are either the same for all BAs – as is the case for residential furnace fans and the commercial "Office" category – or the same among all BAs within each of the Census Regions, as is the case for residential lighting and both the residential and the commercial miscellaneous categories.

Table C - 11. High DSM Case Energy Savings in 2032 Relative to SAE Base Case (Residential)

End-Use Category	States or Load Zone							
	AZ, CO, NV, PACE UT-WY	ID, MT, PACE ID	NM	CA	WA, OR	BPA	PACW	AB, BC
Electric furnace	57.4%	57.4%	57.4%	57.4%	59.7%	59.4%	59.4%	57.4%
Heat pump heating	42.5%	7.9%	42.5%	42.4%	6.8%	6.9%	8.2%	42.4%
Ground-source heat pump heating	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%
Secondary heating	57.4%	57.4%	57.4%	57.4%	59.7%	59.5%	59.5%	57.4%
Central air	37.9%	38.9%	37.9%	38.1%	38.9%	38.9%	38.8%	45.6%
Heat pump cooling	35.7%	35.7%	35.9%	35.9%	35.7%	35.7%	35.7%	35.7%
Ground-source heat pump cooling	36.9%	36.9%	36.9%	36.9%	36.9%	36.9%	36.9%	36.9%
Room air	11.4%	11.5%	11.4%	11.5%	11.5%	11.5%	11.5%	8.8%
Electric water heating	4.7%	4.7%	4.7%	4.6%	4.6%	4.7%	4.7%	4.6%
Electric cooking	6.0%	5.5%	6.0%	6.9%	4.9%	4.9%	4.9%	6.9%
Refrigerator	47.0%	27.0%	47.0%	46.8%	26.7%	26.7%	26.7%	46.8%
Secondary refrigerator	47.0%	27.0%	47.0%	46.8%	26.7%	26.7%	26.7%	46.8%
Freezer	27.6%	36.4%	27.6%	28.1%	36.2%	36.3%	36.2%	28.1%
Dishwasher	38.1%	36.0%	38.1%	38.1%	35.3%	35.4%	35.6%	38.1%
Clothes washer	24.8%	48.4%	24.8%	24.8%	47.8%	47.8%	47.8%	24.8%
Electric dryer	5.6%	13.7%	5.6%	4.0%	13.8%	13.8%	12.8%	4.0%
TV	53.4%	53.6%	53.4%	55.7%	55.7%	55.5%	55.7%	55.7%
Furnace fan	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Lighting	51.4%	51.4%	51.4%	52.3%	52.3%	52.2%	52.3%	51.4%
Miscellaneous	9.8%	9.8%	9.8%	11.7%	11.7%	11.5%	11.7%	11.7%

Table C - 12. High DSM Case Energy Savings in 2032 Relative to SAE Base Case (Commercial)

End-Use Category	States or Load Zone					
	AZ, ID, MT, NM, NV, PACE ID-UT-WY	CO, UT, WY	CA	OR, WA, AB, BC	BPA	PACW
Heating	34.9%	31.9%	35.0%	31.5%	31.9%	31.9%
Cooling	27.5%	34.5%	19.9%	26.4%	26.6%	25.8%
Ventilation	63.7%	64.2%	57.6%	63.4%	63.4%	62.8%

Electric water heating	19.2%	25.9%	34.1%	34.7%	33.4%	34.6%
Electric cooking	1.8%	1.8%	3.0%	1.8%	1.8%	1.9%
Refrigeration	45.5%	45.5%	59.8%	47.2%	47.0%	48.5%
Outside lighting	21.5%	21.9%	28.1%	23.4%	23.2%	23.9%
Interior lighting	21.5%	21.9%	18.4%	23.4%	23.2%	22.9%
Office	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%
Miscellaneous	13.0%	13.0%	11.2%	11.2%	11.3%	11.2%

C.8 High DSM Case Incremental Energy Savings

Section 4.5 compares the SAE High DSM Case load forecasts to the SAE Reference Case forecasts, illustrating the incremental savings associated with the stock efficiency assumptions in the High DSM Case relative to what is expected to occur under the current set of energy efficiency policies and program plans that form the basis for the SAE Reference Case. Here we provide additional details on this comparison.

To begin, Table C - 13 and Table C - 14 present the reduction in annual energy consumption in 2032, relative to the SAE Reference Case, for each individual residential and commercial end-use across WECC as a whole. Table C - 15 aggregates those data into the 10 end-use categories introduced earlier in Section 4.3.2, showing the distribution in total WECC-wide annual energy savings across those end-use categories. As shown, the percentage energy savings ranges from 10% for the Commercial Miscellaneous set of end-uses to a 56% reduction in annual energy consumption for Commercial Refrigeration. These values in these three tables reflect the net effect of various end-use efficiency levels and saturation levels specified for each load zone.

Table C - 16 presents the distribution in residential and commercial sector savings across the 10 end-use categories, for each of the three major geographic regions and for WECC as a whole. These are the same data that are plotted within Figure 27 of the main body of the report, and the values are calculated from the information contained in Table C - 13 and Table C - 14. The table illustrates, for example, that Commercial HVAC end-uses represent the largest source of energy savings in the High DSM Case for WECC as a whole (20% of the total savings across all residential and commercial end-uses).

Finally, Table C - 17 presents the reduction in annual energy and peak demand in 2032, relative the SAE Reference Case, for each load zone. These are the same data that are plotted within Figure 25 of the main body of the report and reflect both the saturation of the various end-uses and stock efficiency levels specific to each individual load zone.

Table C - 13. WECC-Wide Annual Energy Savings Relative to SAE Reference Case (Residential)

End Use	Reduction in 2032 Annual Energy Consumption (GWh)	Reduction in 2032 Annual Energy Consumption (%)
Electric furnace	12,564	57.0%
Heat pump heating	1,851	28.0%
Ground-source heat pump heating	43	21.5%
Secondary heating	1,817	57.6%
Central air	10,144	28.9%
Heat pump cooling	2,389	31.2%
Ground-source heat pump cooling	127	33.1%

Room air	5	0.2%
Electric water heating	160	0.4%
Electric cooking	747	5.3%
Refrigerator	16,363	45.9%
Secondary refrigerator	3,162	44.9%
Freezer	3,136	30.6%
Dishwasher	3,610	35.8%
Clothes washer	670	27.8%
Electric dryer	2,708	14.2%
TV	16,104	52.8%
Furnace fan	282	3.2%
Lighting	23,913	46.8%
Miscellaneous	11,398	9.8%

Table C - 14. WECC-Wide Annual Energy Savings Relative to SAE Reference Case (Commercial)

End Use	Reduction in 2032 Annual Energy Consumption (GWh)	Reduction in 2032 Annual Energy Consumption (%)
Heating	1,429	32.44%
Cooling	5,994	21.56%
Ventilation	35,555	57.59%
Electric water heating	1,620	26.07%
Electric cooking	212	3.53%
Refrigeration	23,755	56.37%
Outside lighting	4,919	26.36%
Interior lighting	20,230	17.41%
Office	7,075	23.52%
Miscellaneous	16,525	9.93%

Table C - 15. High DSM Case Incremental Savings Relative to SAE Reference Case, by Residential and Commercial End-Use Group

End-Use Group	Reduction in Annual Energy Use Relative to the SAE Reference Case
Residential Appliances	31%
Residential Cooling	28%
Residential Lighting	47%
Residential Miscellaneous & TV	19%
Residential Space & Water Heating	21%
Commercial HVAC	45%
Commercial Lighting	19%
Commercial Miscellaneous	10%
Commercial Office	23%
Commercial Refrigeration	56%

Table C - 16. Distribution of High DSM Residential & Commercial Annual Energy Savings by End-Use Category and Region

End-Use Group	WECC	California	Northwest	Southwest
Residential Appliances	13%	22%	8%	9%
Residential Cooling	6%	2%	2%	14%
Residential Lighting	10%	6%	15%	9%
Residential Miscellaneous & TV	12%	14%	12%	9%
Residential Space & Water Heating	7%	1%	15%	5%
Commercial HVAC	20%	15%	19%	26%

Commercial Lighting	11%	11%	11%	12%
Commercial Miscellaneous	7%	7%	7%	8%
Commercial Office	3%	5%	2%	2%
Commercial Refrigeration	10%	18%	6%	6%
Total Residential & Commercial Savings	**100%**	**100%**	**100%**	**100%**

Table C - 17. High DSM Case Incremental Savings Relative to SAE Reference Case, by Load Zone

Load Zone	Percentage Reduction in Annual Energy	Percentage Reduction in Non-Coincident Peak Demand
AESO	22%	22%
APS	19%	21%
AVA	19%	21%
BCTC	23%	24%
BPA	20%	25%
CFE	0%	0%
CHPD	23%	26%
DOPD	26%	28%
EPE	22%	22%
FAR_EAST	19%	22%
GCPD	16%	15%
IID	24%	20%
LDWP	25%	23%
MAGIC_VLY	19%	22%
NEVP	24%	29%
NWMT	22%	23%
PACE_ID	22%	23%
PACE_UT	22%	24%
PACE_WY	18%	20%
PACW	26%	26%
PGE_BAY	24%	22%
PGE_VLY	24%	22%
PGN	19%	22%
PNM	25%	26%
PSC	18%	16%
PSE	22%	25%
SCE	25%	22%
SCL	24%	24%
SDGE	23%	21%
SMUD	19%	17%
SPP	21%	23%
SRP	21%	23%
TEP	11%	18%
TIDC	20%	17%
TPWR	19%	20%
TREAS_VLY	19%	22%
WACM	17%	19%
WALC	26%	26%
WAUW	29%	24%
WECC	22%	22%

C.9 SPSC High DSM Case Load Forecasts

The SPSC High DSM Case load forecasts are summarized graphically in Section 4.6 in terms of the compound annual growth rates for each load zone. Here we provide additional numeric details. Specifically, Table C - 18 and Table C - 19 present the SPSC High DSM Case annual energy and non-coincident peak demand forecasts for each load zone, respectively. The tables present the forecasted load in 2032, along with the corresponding percentage reduction from the WECC Reference Case. In addition, the tables compare the CAGRs for the WECC Reference Case and SPSC High DSM Case (the latter of which is presented graphically in Figure 28 and Figure 29 within the main body of the report).

Table C - 18. SPSC High DSM Case Annual Energy (2032)

Load Zone	SPSC High DSM Case Non-Coincident Peak Demand (MW)	Reduction from WECC Reference Case (%)	CAGRs (2010-2032)	
			WECC Reference Case	SPSC High DSM Case
AESO	130,702	-22.3%	4.0%	2.8%
APS	45,348	-19.0%	2.7%	1.8%
AVA	13,787	-19.2%	1.5%	0.5%
BCTC	56,395	-23.5%	1.1%	-0.2%
BPA	44,410	-20.4%	0.3%	-0.7%
CFE	19,834	0.0%	2.9%	2.9%
CHPD	3,851	-23.1%	2.1%	0.9%
DOPD	2,017	-25.8%	3.3%	1.9%
EPE	11,041	-21.8%	2.6%	1.4%
FAR_EAST	3,427	-18.8%	3.3%	2.3%
GCPD	5,316	-16.1%	2.0%	1.2%
IID	3,888	-23.9%	1.6%	0.4%
LDWP	25,811	-25.1%	0.9%	-0.4%
MAGIC_VLY	4,549	-18.8%	0.5%	-0.4%
NEVP	22,214	-24.3%	0.8%	-0.5%
NWMT	9,493	-22.0%	0.7%	-0.5%
PACE_ID	4,102	-22.3%	1.7%	0.5%
PACE_UT	34,026	-22.4%	1.4%	0.2%
PACE_WY	14,444	-18.2%	2.4%	1.5%
PACW	18,546	-25.8%	0.9%	-0.5%
PGE_BAY	36,231	-23.6%	0.2%	-1.1%
PGE_VLY	54,324	-23.6%	1.0%	-0.3%
PGN	21,658	-18.8%	1.3%	0.3%
PNM	14,508	-24.8%	1.2%	-0.1%
PSC	42,925	-17.9%	1.0%	0.1%
PSE	22,063	-21.8%	0.6%	-0.5%
SCE	89,956	-24.9%	0.6%	-0.7%
SCL	8,775	-23.8%	0.7%	-0.5%
SDGE	20,161	-23.0%	1.0%	-0.2%
SMUD	14,789	-19.0%	0.3%	-0.7%
SPP	11,255	-20.5%	1.0%	0.0%
SRP	32,774	-20.9%	1.4%	0.3%
TEP	13,815	-11.2%	0.4%	-0.2%
TIDC	2,616	-19.8%	1.3%	0.3%
TPWR	4,928	-18.6%	1.0%	0.1%
TREAS_VLY	10,754	-18.8%	1.6%	0.7%

WACM	31,621	-17.0%	2.2%	1.4%
WALC	6,220	-26.1%	1.0%	-0.4%
WAUW	783	-28.8%	2.5%	1.0%
WECC Total	**913,356**	**-21.5%**	**1.4%**	**0.3%**

Table C - 19. SPSC High DSM Case Non-Coincident Peak Demand (2032)

Load Zone	SPSC High DSM Case Non-Coincident Peak Demand (MW)	Reduction from WECC Reference Case (%)	CAGRs (2010-2032)	
			WECC Reference Case	SPSC High DSM Case
AESO	17,608	22.1%	3.7%	2.5%
APS	10,057	21.1%	2.7%	1.6%
AVA	2,522	21.1%	1.8%	0.7%
BCTC	9,762	24.2%	0.8%	-0.4%
BPA	7,478	24.6%	0.0%	-1.2%
CFE	4,541	0.0%	3.4%	3.4%
CHPD	532	26.5%	0.8%	-0.6%
DOPD	309	28.3%	0.8%	-0.7%
EPE	2,017	22.1%	2.2%	1.0%
FAR_EAST	809	21.7%	4.1%	3.0%
GCPD	871	14.9%	1.8%	1.1%
IID	1,023	20.4%	1.1%	0.1%
LDWP	6,322	23.4%	0.9%	-0.3%
MAGIC_VLY	1,275	21.8%	2.1%	1.0%
NEVP	4,823	28.9%	0.5%	-1.0%
NWMT	1,471	23.0%	0.5%	-0.7%
PACE_ID	721	23.1%	1.0%	-0.2%
PACE_UT	8,720	23.1%	3.1%	1.9%
PACE_WY	1,828	23.1%	2.6%	1.4%
PACW	3,402	26.2%	0.9%	-0.5%
PGE_BAY	6,802	21.8%	0.0%	-1.1%
PGE_VLY	9,296	21.8%	-0.3%	-1.4%
PGN	3,645	22.0%	1.2%	0.0%
PNM	2,287	25.6%	0.7%	-0.6%
PSC	6,881	16.3%	0.3%	-0.5%
PSE	4,255	25.1%	0.8%	-0.6%
SCE	16,512	22.1%	-0.4%	-1.6%
SCL	1,449	23.9%	0.1%	-1.1%
SDGE	3,702	21.3%	0.0%	-1.1%
SMUD	2,767	17.0%	-1.3%	-2.1%
SPP	1,739	22.7%	0.7%	-0.5%
SRP	6,466	23.2%	1.2%	0.0%
TEP	2,446	17.7%	-0.2%	-1.1%
TIDC	577	17.1%	0.7%	-0.1%
TPWR	819	20.4%	0.2%	-0.9%
TREAS_VLY	2,934	21.7%	3.5%	2.3%
WACM	4,740	18.8%	2.2%	1.2%
WALC	1,216	25.6%	0.6%	-0.7%
WAUW	132	24.2%	1.9%	0.6%
WECC Total	**164,759**	**21.9%**	**1.0%**	**-0.1%**