

CONSULTANT REPORT

California Statewide Codes and Standards Program Impact Evaluation Report Phase Two, Volume One: Appliance Standards

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We wish to acknowledge the critical contribution of two groups of experts to the evaluation. The first group of four experts, knowledgeable about C&S adoption processes, served on an independent panel that determined attribution for each standard evaluated. The second group of industry experts estimated natural occurring market adoption (NOMAD) and engaged with their fellow experts to produce a consensus estimate for each standard.

Many other individuals answered our calls and e-mails as we searched for information on the product mix, market volumes, compliance, and other evaluation inputs. The evaluation results have been considerably strengthened by the help we received.

Finally, we appreciate the comments and questions from other groups and individuals that, while not closely involved in the process, still took an interest in this evaluation.

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Abstract

This report presents results from the impact evaluation of the California Statewide Codes and Standards Program (the Program) for program years 2013 through 2015. The evaluation was conducted for the California Public Utilities Commission (CPUC). PG&E, SDG&E, SCE, and SCG jointly implemented the Program, providing technical, cost, and market studies to support adoption of standards by the California Energy Commission (CEC) and the federal government. This volume one report covers the evaluation of energy, demand, and natural gas impacts from adoption of Title 20 and federal appliance standards in effect from 2013–2015.

The evaluation methodology followed the California protocol. First, the evaluation team estimated potential savings that would result if all new appliances met code. Next, the team adjusted for compliance to determine gross savings. The team followed this by determining net savings by adjusting—with the help of many industry experts—for naturally occurring market adoption of energy-efficient units. To determine the Program’s net savings, a panel of independent experts developed an attribution adjustment to account for the Program’s effect on standard adoption. Finally, the team allocated net savings to IOUs based on their share of California’s electricity and gas sales.

Keywords: impact evaluation, appliance standards, Title 20, federal appliance standards

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Executive Summary

Introduction

Energy efficiency standards set performance specifications that new appliances, equipment, and lighting must meet or exceed. Because they eliminate low-efficiency products from the market, these standards serve as an important component for reducing energy consumption.

Starting in the late 1990s, California's investor-owned utilities (IOUs) have taken a significant role in researching, proposing, and promoting efficiency standards through what has become the statewide utility Codes and Standards Program (the Program). Each IOU has a codes and standards (C&S) program. These individual programs provide a place within each utility for funding program activities and recording the C&S savings claimed in the IOU energy efficiency portfolios.

Scope

This third impact evaluation of the statewide C&S Program covers program years 2013, 2014, and 2015.¹ As in the 2010–2012 evaluation, California C&S (Title 20 and Title 24) and federal² regulations savings produced the savings claimed by the statewide C&S Program.

The statewide C&S Program is organized into five distinct subprograms: Building Codes Advocacy, Appliance Standards Advocacy, Compliance Improvement, Reach Codes, and Planning and Coordination. The Advocacy subprograms are resource³ programs; the other three are not.

Generally speaking, the evaluation scope includes two broad categories of efficiency regulations: appliance standards and building codes. The report is organized into volumes that correspond to these two categories. Volume One, this document, includes evaluation methods and findings for Title 20 and federal appliance standards. Volume Two includes descriptions of the evaluation and findings for Title 24 building codes.

Table ES-1⁴ presents IOU estimated savings from new Title 20 and federal appliance standards. The IOUs did not provide attribution values for federal standards; consequently, IOU estimates of net program savings or IOU share savings were unavailable for such instances. When standard categories include references to years prior to the evaluation period, this indicates that the standard was approved in that timeframe but did not take effect until the evaluation period. Negative gas values in the table indicate

¹ The first impact evaluation covered 2006–2008 and the second covered 2010–2012.

² Throughout this report standards are grouped together based on the year(s) that they became effective. For federal appliance standards, we identify the following groups: 2010–2012 federal standards (Fed 1-7), 2013 federal standards (Fed 8-17), and 2015 federal standards (Fed 18-26).

³ Resource programs have a measurable and verifiable impact on energy consumption where non-resource programs do not meet these requirements

⁴ New Title 20 and federal appliance standards refers to standards that the IOUs identified in their estimate of energy savings and that took effect in 2013, 2014, or 2015.

that reduced electric energy consumption for these appliances means that more gas heating will be required.

Table ES-1. IOU Estimate of Total Energy and Demand Savings for 2013-2015*

Total Savings for 2013–2015	GWh		MW		MMTherms***	
	Potential	IOU Share of Net Program**	Potential	IOU Share of Net Program	Potential	IOU Share of Net Program
2006–2009 T-20 Std 28b (TVs Tier 2)	1,072	197	119	22	-21	-5
2011 T-20 Stds 29-32 (Battery chargers)	1,303	372	220	63	-25	-10
2013 Federal Appliance Standards (Fed 8–17)	110		40		0	
2015 Federal Appliance Standards (Fed 18–26)	495		348		0	
Total	2,980		728		-46	

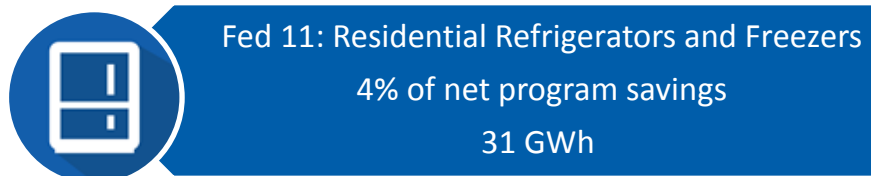
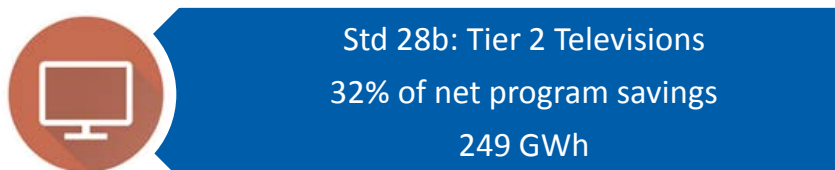
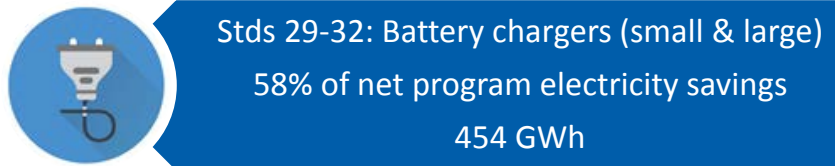
*Values may not sum exactly due to rounding.

**All report values are statewide unless otherwise noted. IOU Share of Net Program refers to attributable net program savings allocated to the IOUs’ service areas.

***MMTherms equals millions of therms.

Findings

The following illustrates newly evaluated appliance standards with the highest net program GWh savings in 2013–2015.



Followed by top gas saving standards (without interactive effects [IE]).



Fed 25: Residential Top Loading Clothes Washers
 37% of net program gas savings
 1.88 MTherms



Fed 19: Gas-fired Residential Water Heaters
 31% of net program gas savings
 1.54 MTherms

Electricity Savings

Table ES-2 summarizes electric energy savings (in GWh) from the new Title 20 standards for each IOU. The table's last row compares total evaluated savings to the IOU Estimate. As shown, evaluated net program savings accounted for 88% of the IOU Estimate.

**Table ES-2. Evaluated vs. IOU Estimate: IOU Share of 2013–2015 PY
 New Title 20 Electricity Savings (GWh)***

IOU	GWh	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
			Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E		31.6%	750	634	366	251	843	792	376	222
SCE		32.6%	774	654	377	259	870	817	388	229
SDG&E		7.4%	176	148	86	59	197	185	88	52
All IOUs		71.6%	1,699	1,437	829	569	1,911	1,794	853	503
Evaluated/IOU Estimated							112%	125%	103%	88%

*Values may not sum exactly due to rounding.

Table ES-3 summarizes electric energy savings (in GWh) from new federal standards for each IOU. The IOU estimate did not include net program values, so comparisons to evaluated net program savings were impossible. As shown, evaluated net savings accounted for 55% of the value included in the IOU Estimate.

**Table ES-3. Evaluated vs. IOU Estimate: IOU Share of 2013-2015 PY
New Federal Appliances Electricity Savings (GWh)***

GWh IOU	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	191	164	138	-	111	90	76	25
SCE	32.6%	197	169	142	-	114	93	78	25
SDG&E	7.4%	45	38	32	-	26	21	18	6
All IOUs	71.6%	433	371	312	-	251	204	171	56
Evaluated/IOU Estimated						58%	55%	55%	n/a

*Values may not sum exactly due to rounding.

Demand Reduction

Table ES-4 presents findings for new Title 20 standards demand savings in each IOU service territory. The last row compares evaluated savings to the IOU Estimate. Evaluated net program demand savings accounted for 46% of the IOU Estimate.

**Table ES-4. Evaluated vs. IOU Estimate: IOU Share of 2013-2015 PY
New Title 20 Demand Savings (MW)***

MW IOU	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	107.2	90.7	53.5	37.5	69.4	65.7	28.9	17.1
SCE	32.6%	110.6	93.5	55.2	38.6	71.6	67.7	29.8	17.6
SDG&E	7.4%	25.1	21.2	12.5	8.8	16.3	15.4	6.8	4.0
All IOUs	71.6%	242.8	205.4	121.3	84.9	157.3	148.8	65.4	38.6
Evaluated/IOU Estimated						65%	72%	54%	46%

*Values may not sum exactly due to rounding.

Table ES-5 presents findings in terms of demand savings from new federal standards in the IOU service territories. The IOU estimate did not include net program values, so comparisons to evaluated net program savings were impossible. Evaluated net demand savings accounted for 37% of the IOU Estimate.

**Table ES-5. Evaluated vs. IOU Estimate: IOU Share of 2013–2015 PY
New Federal Appliances Demand Savings (MW)***

MW IOU	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	122.7	104.8	74.4	-	40.1	35.5	27.5	7.3
SCE	32.6%	126.5	108.1	76.8	-	41.4	36.7	28.3	7.5
SDG&E	7.4%	28.7	24.5	17.4	-	9.4	8.3	6.4	1.7
All IOUs	71.6%	277.9	237.3	168.6	-	90.9	80.5	62.2	16.5
Evaluated/IOU Estimated						33%	34%	37%	n/a

*Values may not sum exactly due to rounding.

Gas Savings

Table ES-6 presents findings for gas savings from the new Title 20 standards when including IE.⁵ No direct savings resulted from the new Title 20 standards; so all gas impacts resulted from secondary IEs. As direct savings did not occur, the report does not include a table with IEs excluded (from Title 20 standard savings) as all values equaled zero.

With regard to gas savings attributed to the Southern California Gas company (SCG), California Public Utilities Commission (CPUC) policy is for savings to be determined excluding any interactive effects. As noted above, there are no gas savings from new Title 20 standards when IEs are excluded. For federal standards, the savings attributed to SCG are shown in Table ES-8 below in which IEs are excluded.

**Table ES-6. Evaluated vs. IOU Estimate: IOU Share of 2013-2015 PY
New Title 20 Gas Savings (MMTherms) Including Interactive Effects***

MMTherms IOU	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	(17)	(14)	(8)	(6)	(16)	(14)	(7)	(4)
SCG	58.4%	(27)	(23)	(13)	(9)	(25)	(23)	(12)	(7)
SDG&E	4.1%	(2)	(2)	(1)	(1)	(2)	(2)	(1)	(0)
All IOUs	99.0%	(45)	(38)	(22)	(15)	(42)	(39)	(20)	(12)
Evaluated/IOU Estimated						93%	102%	91%	77%

*Values may not sum exactly due to rounding.

⁵ The impact of each standard includes primary (direct) savings and secondary savings described as interactive effects (IEs). Specifically, IEs include negative gas savings due to increased heating when electric energy is saved indoors and positive electric IEs due to reduced cooling. IEs are discussed in Sections 3.1.2 and 4.1

In Table ES-7 and Table ES-8, we present our findings for gas savings from the new federal standards when IEs are included and excluded, respectively. Overall, we found much greater potential and gross gas savings than were expected by the IOUs. We also found positive net program savings in both cases after we adjusted for naturally occurring market adoption (NOMAD) and attribution.

Table ES-7. Evaluated vs. IOU Estimate: IOU Share of 2013-2015 PY New Federal Appliances Gas Savings Including Interactive Effects (MMTherms)*

MMTherms IOU	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	(0.1)	(0.1)	(0.2)	-	8.9	8.7	5.5	1.5
SCG	58.4%	(0.2)	(0.2)	(0.4)	-	14.3	13.9	8.8	2.4
SDG&E	4.1%	(0.0)	(0.0)	(0.0)	-	1.0	1.0	0.6	0.2
All IOUs	99.0%	(0.4)	(0.3)	(0.6)	-	24.3	23.6	14.9	4.0

*Values may not sum exactly due to rounding.

Table ES-8. Evaluated vs. IOU Estimate: IOU Share of 2013-2015 PY New Federal Appliances Gas Savings Excluding Interactive Effects (MMTherms)*

MMTherms IOU	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	0.9	0.8	0.6	-	10.0	9.7	6.4	1.8
SCG	58.4%	1.5	1.3	0.9	-	16.1	15.6	10.3	2.9
SDG&E	4.1%	0.1	0.1	0.1	-	1.1	1.1	0.7	0.2
All IOUs	99.0%	2.5	2.1	1.5	-	27.2	26.5	17.5	5.0

*Values may not sum exactly due to rounding.

Electricity Savings for Appliances Standards Overall

To provide some context for the C&S program’s overall impact, Table ES-9 presents the evaluated savings from all Title 20 and Federal appliance standards. These savings are also shown by IOU in the rows following the total. Similar cumulative views are provided for gas and demand in section 5.4.

Table ES-9. 2013-2015 Electricity Savings (GWh) for all Title 20 and Federal Appliance Standards*

Standards Group	Potential Energy Savings	Gross Energy Savings	Net Energy Savings	Program Net Energy Savings
2005 T-20	712	626	208	169
2005 T-20_2017_Updates	228	228	188	150
2006–2009 T-20	1,951	1,851	934	585
2006–2009 T-20 Std 28b (TVs Tier 2)	1,322	1,296	412	249
2006–2009 T-20_2017_Updates	1,947	1,674	1,520	1,200
2010–2012 Fed Appliance	133	78	36	15
2010–2012 Fed Appliance_2017_Updates	3,303	3,066	1,963	539
2011 T-20 (Battery chargers)	1,349	1,211	780	454
2013 Fed Appliance	175	159	134	55
2015 Fed Appliance	175	126	106	23
Total	11,295	10,315	6,281	3,439
PG&E	3,567	3,258	1,984	1,086
SCE	3,679	3,360	2,046	1,120
SDG&E	835	763	464	254
All Other	3,213	2,935	1,787	979

*Values may not sum exactly due to rounding.

Conclusions and Recommendations

Conclusion: Delivery of program savings estimates, CASE reports, and Code Change Theory Reports (CCTRs) has improved but there are still significant gaps in the documentation available to evaluators.⁶

Improvements include the following:

- Nearly all parameters (the exception was attribution values for federal standards) were provided at the start of the evaluation in the Integrated Standards Savings Model (ISSM)⁷ format.
- As requested, the evaluation team document market volume sources.
- CASE reports and CCTRs were delivered as planned and in a shorter time period than previous reports.
- Although no federal attribution values were provided, attribution documentation in support of federal standard adoption generally were complete and met previously identified requirements.



⁶ CASE: Codes and Standards Enhancement. CCTR: Code Change Theory Report.

⁷ The ISSM is a spreadsheet based tool that supports estimation and evaluation of savings from the statewide C&S program. To obtain the ISSM, please contact the CPUC or the evaluators.

Significant documentation gaps:

- **Product market volumes.** Specific source values used often could not be determined. Sources often proved several years old and did not reflect current market conditions.
- **Unit energy savings.** Values submitted in the IOU estimate did not match the CASE report, and no other documentation was provided. The absent documentation made it impossible to reconcile evaluation findings to the submitted estimate.



- **Standards developed after CASE reports were completed.** For example, the Small Battery Charger, Tier 2 (Standard 30): the CASE report did not identify this product category—USB chargers with greater than 20-Watt hour capacity, yet the CEC adopted it. The evaluation team did not receive documentation of the basis for unit energy savings, market volume, or savings potential.

Recommendations:

The statewide program administrators and CPUC should resolve data gap issues before starting the next impact evaluation.

The IOUs should update the Code Change Theory Reports or provide other supplementary documentation that reflects the adopted standard.



Conclusion: Compliance verification is becoming more challenging.

Issue aspects include the following:

- *Increasing complexity of regulations.* For example, Title 20 regulations on battery charger systems have led to the CEC listing some end-use devices and some battery charger components, but these listings do not include the entire battery charger system. Similar issues occur with regulations on swimming pool systems, which have changed from pump regulations to system regulations.
- *Product proliferation.* For products such as televisions and battery charger systems, the CEC listing process lags behind the rapidly changing set of products available in the market. To measure compliance, additional research must be conducted to determine compliance for the set of unlisted products.

Recommendation: The CPUC and evaluators should consider collaborating with the CEC to make efficient use of resources used to determine compliance.



Conclusion: Grouping of multiple product types/standards in a single CCTR tends to limit the evaluators' ability to assign attribution scores to each standard

The attribution team found insufficient information to calculate factor scores for some individual product types when supporting documentation grouped them with other products. In most instances, products were grouped in a similar manner to the rulemakings themselves. However, in federal standards there are often contributions and discussions based not on the rulemaking as a whole, but rather a specific appliance category or regulation. The extent to which equipment types and contributions to those equipment types can be separated affects the ability of the attribution team to provide a more nuanced and granular attribution score.

Examples include battery chargers, where a single Code Change Theory Report (CCTR) was provided for four standards. As noted, the CASE report included three categories, but did not include references to the Small Charger, Tier 2 USB, product category. Additionally, documentation combined water heaters, pool heaters, and direct-heating equipment.

Recommendation: Do not group dissimilar technologies together in a single CCTR.

Conclusion: Evaluating standards that target components (e.g., electric motors) proves challenging.

Particularly for small electric motors, concern exists that products manufactured overseas may contain noncompliant parts. Verifying compliance is impossible, short of tearing out the motor. Even if testing offered an option, it would remain challenging to identify whether a product contained a covered product as components specifications are rarely available. Trade associations such as the National Electrical Manufacturers Association (NEMA) may prove useful in obtaining market data on domestic small motor manufacturers, but these statistics would likely not represent a large fraction of foreign suppliers.

Recommendations:

Consider reevaluating these standards over time as more market studies are completed. Electric motor and small electric motor compliance also should be reevaluated after completion and application of the *Certification, Compliance, Labeling, and Enforcement for Electric Motors and Small Electric Motors Final Rule*.

1. Background on the Codes and Standards Program

1.1. Description of the California Statewide Program

Efficiency codes and standards (C&S) set minimum efficiency levels that new buildings and appliances must meet or exceed. As they eliminate low-efficiency products from the market, standards present an important policy for reducing energy consumption.

In the 1970s, states throughout the country began establishing regulatory frameworks for developing, adopting, and implementing efficiency standards. In 1974, the California State Legislature created the California Energy Commission (CEC), an agency with a regulatory role to adopt building and appliance efficiency standards. The California building standards are referred to as Title 24 standards, and the appliance standards are referred to as Title 20 standards, based on their respective locations in the California Administrative Code.⁸ Over the past 40 years, the federal government and individual states have continued developing and upgrading their efficiency standards.

Starting in the late 1990s, California utilities began playing a significant role in researching, proposing, and promoting efficiency standards through efforts that have become the statewide utility C&S Program. In recent years, the investor owned utilities (IOUs) have organized the statewide program into five distinct subprograms: Building Codes Advocacy, Appliance Standards Advocacy, Compliance Improvement, Reach Codes, and Planning and Coordination. The following section includes the program's overall mission, a brief description of each subprogram, and the program budget.

1.1.1. Program Description and Budget for the Codes and Standards Program

According to the Statewide C&S Program Implementation Plan,⁹ the program's mission is to save energy on behalf of ratepayers by influencing continuous improvements in energy efficiency regulations, improving compliance with existing C&S, and working with local governments to develop ordinances that exceed statewide minimum requirements.

Building Codes Advocacy Subprogram and Appliance Standards Advocacy Subprogram

These two subprograms conduct advocacy activities to improve building and appliance efficiency regulations. The California Energy Commission (CEC) serves as the principal audience for this, conducting periodic rulemakings—usually on a three-year cycle (for building regulations)—to update building and appliance energy efficiency regulations. In some cases, the program may seek to influence the state legislature and other state agencies, such as the California Air Resources Board—to influence policy regarding buildings and appliances.

⁸ In general, this report refers to standards adopted to regulate building energy efficiency as C&S that apply to appliances and equipment as standards.

⁹ Program Implementation Plans (PIPs) for the statewide program can be found with “Regulatory” documents for PY 2013–2015 on <http://eestats.cpuc.ca.gov/>

Subprogram activities include development of C&S Enhancement (CASE) studies, focused on energy efficiency improvements for promising design practices and technologies, and which will be presented to standards- and code-setting bodies. Advocacy includes affirmative expert testimony at public workshops and hearings, participation in stakeholder meetings, ongoing communications with industry representatives, and a variety of other support activities.

The program also strives to influence federal government and national energy policies that affect California by working with federal partners (e.g., the American Council for an Energy Efficient Economy or the Appliance Standards Awareness Project). The program also participates in U. S. Department of Energy (DOE) proceedings and legislative negotiations, which lead to federal regulations passed through to California (particularly, Title 20 appliance efficiency regulations are the same as federal regulations).

Compliance Improvement Subprogram

Following adoption, C&S supports compliance improvement with Title 24 building codes and Title 20 appliance standards. Compliance improvement activities complement the advocacy work by maximizing that verified savings from C&S realized and persist over time. The Compliance Improvement subprogram targets market actors throughout the entire compliance chain, providing education, outreach, and technical support and resources to improve compliance with building and appliance energy standards.

Reach Codes Subprogram

In addition to mandatory minimum-level codes, the C&S program advocates for the development and implementation of “reach codes” that exceed minimum state code requirements. Such codes have been adopted by many local jurisdictions, with subprogram support.

Planning and Coordination Subprogram

The new Planning and Coordination subprogram expands the C&S Program’s coordination role in the market adoption cycle for energy efficiency technologies and practices. As many measures offered through voluntary programs are subsequently adopted into the standards, this subprogram works to support portfolio planning, seeking to accelerating market acceptance and adoption of successful, cost-effective technologies or practices into code.

Program Budget

Table 1 shows C&S program and subprogram budgets for 2013 through 2015, including the total allocated for each utility. The five subprograms include two resource efforts: Advocacy and Reach Code. Historically, nearly all (i.e., over 99% in 2012) energy and demand savings from the C&S program have been associated with the Advocacy subprograms. The other subprograms (i.e., Compliance Improvement and Planning and Coordination) are non-resource programs.

The codes and standards program is unlike most resource programs in that the spending on advocacy efforts typically happens some years before a regulation becomes effective and able to produce energy savings. For example, the CASE report for the four battery charger standards—standards 29-32—was completed in October 2010 which means that planning for this study likely took place one or two years earlier. The standards that were adopted after completion of the CASE report became effective in 2013,

2014, and 2017. Rather than doing extensive review and analysis of advocacy efforts prior to the start of the evaluation period in 2013 in an effort to more accurately identify the resources used on specific standards, we simply report the program budget during the evaluation period.

Table 1. C&S Program Budgets for 2013-2015*

Program by Utility	PG&E	Edison	SDG&E	SoCalGas	Total
Building Codes Advocacy	\$8,448,762	\$5,160,765	\$813,357	\$627,248	\$15,050,132
Appliance Standards Advocacy	\$6,508,639	\$5,160,765	\$638,131	\$500,255	\$12,807,791
Compliance Improvement	\$3,593,615	\$3,444,109	\$979,210	\$750,335	\$8,767,268
Reach Codes	\$1,106,918	\$1,362,738	\$284,502	\$255,026	\$3,009,183
Planning and Coordination	\$2,460,777	\$2,610,952	\$450,226	\$383,956	\$5,905,911
Total Budget by Utility**	\$22,118,711	\$17,739,329	\$3,165,426	\$2,516,820	\$45,540,284

*Budget information obtained from PIPs can be found through the footnote in Section 1.1.1

**Values may not sum exactly due to rounding

1.1.2. Context for Program Impact Evaluation

In 2006, California adopted an evaluation protocol that included a methodology for evaluating C&S programs—fully implemented for the first time during the 2006–2008 program evaluation cycle. The original protocol and the methods developed in prior evaluations have become established a basis for evaluating and verifying program savings and can be used in the regulatory process, modified or supplemented thereafter as needed by the California Public Utilities Commission (CPUC) staff guidance.

The original protocol changed to eliminate a component called Naturally Occurring Standards Adoption. The impact evaluation report for PY 2006–2008¹⁰ documented the reasons for this. The evaluation team also supplemented the evaluation process by using the current, three-factor method to determine attribution in the course of the 2006–2008 evaluation. The team incorporated a very similar method into the federal attribution policy approach during the 2010-2012 evaluation.¹¹ Another notable part of the prior evaluations was developing the Integrated Standards Savings Model (ISSM), a flexible Microsoft Excel-based model for calculating energy and demand savings.

¹⁰ In general, this report refers to standards that are adopted to regulate building energy efficiency as codes and standards that apply to appliances and equipment as standards.

¹⁰ The Program Implementation Plans (PIPs) for the statewide program can be found with the “Regulatory” documents for PY 20.

¹¹ Gruending, Paula, Kenneth Keating, *Panel Studies: Utilities C&S Federal Advocacy – Policy Considerations for Calculating Net Attributable Savings*, 2015. This paper is available at the following link: <https://www.iepec.org/wp-content/uploads/2015/papers/002.pdf>

1.1.3. Scope for 2013-2015 Impact Evaluation: Appliance Standards

Table 2 summarizes the appliance standards within the evaluation scope that took effect in 2013 or later. We used the following codes to identify situations where a parameter is not evaluated:

- **PE:** The parameter was *previously evaluated* and we have no reason to re-evaluate it (e.g., NOMAD for Standard 28b).
- **n/a:** Evaluation is *not applicable* since the standard has not yet taken effect (e.g., Std 31) or the fuel is out of scope (e.g., Fed 22).

Table 2. Evaluation Scope for New Appliance Standards

Group	Standard	Description	C&S Start Year	2013-15 Potential Savings GWh*	2013-15 Potential Savings MMTherms*	Potential	Compliance	NOMAD	Attribution
2006-2009 Title 20	Std 28b	Televisions Tier 2	1/1/2013	1,073	(21)	✓	✓	PE	PE
2011 Title 20	Std 29	Small Battery Chargers – Tier 1	2/1/2013	1,179	(23)	✓	✓	PE	✓
	Std 30	Small Battery Chargers – Tier 2	1/1/2014	65	(1)	✓	✓	✓	✓
	Std 31	Small Battery Chargers – Tier 3	1/1/2017	-	-	n/a	n/a	PE	✓
	Std 32	Large Battery Chargers	1/1/2014	59	-	✓	✓	✓	✓
2013-2014 Fed Appliance	Fed 8	Commercial Clothes Washers	1/8/2013	1	0	✓	✓	✓	✓
	Fed 9	Residential Pool Heaters	4/16/2013	-	0	✓	✓	✓	✓
	Fed 10	Residential Direct Heating Equipment	4/16/2013	(0)	1	✓	✓	✓	✓
	Fed 11	Residential Refrigerators & Freezers	9/15/2014	41	(1)	✓	✓	✓	✓
	Fed 12	Residential Room AC	6/1/2014	14	-	✓	✓	✓	✓
	Fed 13	Fluorescent Ballasts	11/14/2014	51	(1)	✓	✓	✓	✓
	Fed 14	Small Comm. Package ACs	6/1/2013	0	-	✓	✓	✓	✓
	Fed 15	Large Comm. Package ACs	6/1/2014	0	-	✓	✓	✓	✓
	Fed 16	Computer Room ACs	10/29/2013	0	-	✓	✓	✓	✓
2015 Fed Appliance	Fed 17	Res. Dishwashers	5/30/2013	3	0	✓	✓	✓	✓
	Fed 18	Res. Clothes Dryers	1/1/2015	28	(1)	✓	✓	✓	✓
	Fed 19	Res. Gas-fired water heater	4/16/2015	-	0	✓	✓	✓	✓
	Fed 20	Res. Electric storage water heater	4/16/2015	77	-	✓	✓	✓	✓
	Fed 21	Res. Gas-fired instant. water heater	4/16/2015	(3)	1	✓	✓	✓	✓
	Fed 22	Res. Oil-fired storage water heater	4/16/2015	0	-	n/a	n/a	n/a	n/a
	Fed 23	Small Electric Motors	3/9/2015	164	-	✓	✓	✓	✓
	Fed 24	Res. Clothes Washers (Front Load)	3/7/2015	2	(0)	✓	✓	✓	✓
	Fed 25	Res. Clothes Washers (Top Load)	3/7/2015	44	(1)	✓	✓	✓	✓
	Fed 26	Res. Central AC, HPs	1/1/2015	183	-	✓	✓	✓	✓

*Potential savings in this table are based on IOU estimates.

The scope includes all of the Title 20 and federal appliance standards that were identified by the IOUs and that became effective during the evaluation period.

Regarding the previously evaluated parameters, we collected expert input for NOMAD for the battery charger standards (29, 30, and 32) because the effective dates were originally earlier than shown above. Even with the new dates, the NOMAD data were collected for Standards 29 and 30 several months after the standard became effective. Ideally, NOMAD data is collected shortly—less than one year—after a standard becomes effective. We assume that the experts are most knowledgeable about the market share of the newly regulated product at the time the standard was adopted or shortly after adoption. For this reason, we expect the estimate to be more accurate when NOMAD data are collected within the first year after adoption.

Similarly, we believe the best time to evaluate attribution is shortly after the standard has been adopted. In the case of the television standards 28a and 28b, these standards were adopted at the same time. Since standard 28a became effective at the beginning of 2011, we evaluated attribution for both parts of the adopted standard during the 2010-2012 impact evaluation.

In this report, we present evaluation results for four of the five Title 20 standards listed. Standard 31 was adopted along with the other 2011 Title 20 standards, but does not take effect until 2017. We evaluated attribution for this standard, but will not evaluate potential and compliance until after the standard’s effective date. So the report will include results for these Title 20 standards: 28b, 29, 30, and 32.

In addition to evaluating the new standards in the 2013-2015 program cycle, we also revisited a number of previously evaluated standards with a significant share of savings and where we have reason to believe the compliance rate and/or market size have since changed. These standards are shown in Table 3.

Table 3. Updated Standards

Standard Number	Description	Effective Date	Compliance	Market Size
Std 8	Residential pool pumps, high eff motor, Tier 1	1/1/2006		✓
Std 9	Residential pool pumps, 2-speed Motors, Tier 2	1/1/2008		✓
Fed 1	Electric motors 1–200 HP	12/19/2010		✓
Fed 6	Incandescent Reflector Lamps	7/14/2012	✓	✓
Fed 7	General service fluorescent lamps	7/14/2012		✓

1.2. IOU Estimate of Savings During 2013 to 2015

The IOUs provided an estimate of savings from the statewide C&S program in response to a data request from Commission staff. The IOU estimate includes the primary energy savings from each code or standard and secondary savings that are often described as interactive effects (IEs). Specifically, the IOU

estimate includes negative gas savings due to increased heating when electric energy is saved indoors and positive electric IEs due to reduced cooling¹². In this report, all of the values shown for the IOU estimate and evaluated savings include both primary energy savings and secondary IEs unless otherwise noted. Throughout this report, all savings values shown are statewide unless they are explicitly labelled as “IOU Share” or identified with a specific IOU. The IOU designation means that savings have been scaled to one utility’s service territory or the cumulative total for all four IOU service territories. Values labelled “IOU Share” in the tables are net program savings within the IOU service territories.

Throughout this report, we present the IOU estimate and the evaluation results based on the framework defined by the California Evaluation Protocols. We include a brief review of the evaluation protocol in Section 2.1 to define the terminology and methods used to describe and calculate savings from the program.

Table 4 summarizes the IOU estimate for savings from new standards during the years 2013, 2014, and 2015.

The IOU estimate of potential savings from the two groups of Federal Appliance standards is also included in Table 4. Since the IOUs did not provide attribution values for these standards, there is no IOU estimated value for the IOU Share of savings. We report the Title 20 and Federal standards separately in this report because we frequently compare IOU estimated savings to evaluated savings and meaningful comparisons are not possible for the two groups combined.

Table 4. IOU Estimate of Statewide Total Energy and Demand Savings for 2013-2015 Standards by Group

Total Savings for 2013-2015	GWh		MW		MMTherms	
	Potential	IOU Share Program Savings	Potential	IOU Share Program Savings	Potential	IOU Share Program Savings
2006-2009 T-20 Std 28b (TVs Tier 2)	1,072	197	119	22	-21	-5
2011 T-20 (Battery chargers)	1,303	372	220	63	-25	-10
2013 Federal Appliance standards	110	-	40	-	0	-
2015 Federal Appliance standards	495	-	348	-	0	-

1.2.1. New Title 20 Standards

Table 5, Table 6, and Table 7 present the IOU estimates of energy (GWh), demand (MW), and gas (MMtherms) savings from the new Title 20 standards. In Table 7, all gas savings shown are negative because they represent interactive effects of electric measures on the space heating end use and there are no direct positive gas savings from these Title 20 standards that offset the interactive effects.

¹² See Section 4.1 for the specific values used for electric and gas interactive effects.

Table 5. IOU Estimate of Energy Savings for New Title 20 Standards*

Electric Energy (GWh)		New Title 20				
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	IOU Share Program Savings
IOU Estimate	2013	719	608	381	258	185
	2014	821	694	401	276	198
	2015	836	707	377	261	187
	Total	2,375	2,009	1,158	796	569

*Values may not sum exactly due to rounding.

We note that the total potential savings of 2,375 GWh and the total IOU Share (of net program savings) of 569 GWh in Table 5 are also shown in Table 4. These values are the sum of savings from the Title 20 standards.

Table 6. IOU Estimate of Demand Savings for Title 20 Standards*

Demand (MW)		New Title 20				
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	IOU Share Program Savings
IOU Estimate	2013	101	86	55	38	27
	2014	118	100	59	41	30
	2015	120	102	56	39	28
	Total	339	287	170	119	85

*Values may not sum exactly due to rounding.

Table 7. IOU Estimate of Gas Savings for New Title 20 Standards*

Gas (MMtherms)		New Title 20				
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	IOU Share Program Savings
IOU Estimate	2013	(14)	(12)	(8)	(5)	(5)
	2014	(16)	(13)	(8)	(5)	(5)
	2015	(16)	(13)	(7)	(5)	(5)
	Total	(46)	(39)	(22)	(15)	(15)

*Values may not sum exactly due to rounding.

1.2.2. Federal Standards

Table 8, Table 9, and Table 10 present the IOU estimates of energy (GWh), demand (MW), and gas (MMtherms) savings from the new federal appliance standards. As noted above, the IOUs did not estimate attribution values for federal standards. Since attribution is the factor needed to calculate net program savings and the IOU share of net program savings, neither of these values are included in the tables in this section.

These estimates also include interactive effects, but for this group of standards, positive gas savings are roughly equal to the negative interactive effects as can be seen in Table 10¹³.

Table 8. IOU Estimate of Energy Savings for Federal Standards*

Electric Energy (GWh)		Federal Appliance				
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	IOU Share Program Savings
IOU Estimate	2013	1	1	0	n/a	n/a
	2014	21	19	17		
	2015	582	498	419		
	Total	604	518	436		

*Values may not sum exactly due to rounding.

Table 9. IOU Estimate of Demand Savings for Federal Standards*

Demand (MW)		Phase One Federal Appliance				
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	IOU Share Program Savings
IOU Estimate	2013	0	0	0	n/a	n/a
	2014	11	10	9		
	2015	377	322	226		
	Total	388	332	236		

*Values may not sum exactly due to rounding.

Table 10. IOU Estimate of Gas Savings for Federal Standards*

Gas (MMTherms)		Phase One Federal				
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	IOU Share Program Savings
IOU Estimate	2013	0	0	0	n/a	n/a
	2014	0	0	0		
	2015	(1)	(1)	(1)		
	Total	(0)	(0)	(1)		

*Values may not sum exactly due to rounding.

¹³ Since electric energy and demand IEs always add to electric energy (kWh or GWh) and demand (kW) savings, results generally include these factors. Gas IEs are unique since electric savings often increase gas usage (and reduce savings). For this reason, gas results are often reported with and without the application of IEs.

2. Overview of Evaluation Approach

2.1. Protocol

As described in Section 1.1.2 above, in each C&S program evaluation, the evaluation team applies the California Evaluation Protocols with documented modifications during the evaluation process.¹⁴ Figure 1 shows a flowchart of the evaluation process we used for the current evaluation (also used in the 2006-2008 and 2010-2012 program year evaluations).

Figure 1. C&S Advocacy Program Evaluation Protocol

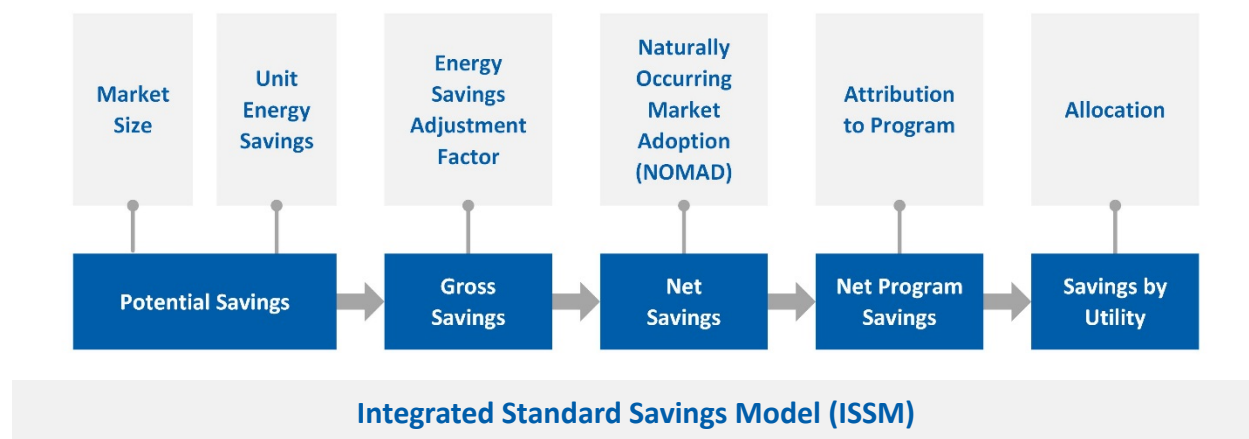


Figure 1 shows the major factors used to determine savings under the protocol. We based the potential energy savings attributable to the C&S program on the estimated unit energy savings and the number of those units (measures or appliances) entering the market each year. We applied the compliance adjustment to potential savings to derive gross energy savings. Net savings result from adjusting the gross savings by the NOMAD of measures or appliances meeting the code or standard that would have occurred in the absence of the code or standard. We determined the net program savings that are credited to the statewide C&S program by applying an attribution score. We then allocated to each utility these net savings attributable to the program, based on each utility's share of the statewide energy market (for electricity or gas).

With regard to the adjustment made to potential savings that determines gross savings, we have in the past used the word compliance or the phrase compliance adjustment factor (CAF) to describe this value for both appliance standards and building codes. We continue to use these terms to describe this value in our evaluation of appliance standards in Volume One and its associated appendices. In the context of building construction however, we have found that "compliance" has a range of meanings to various stakeholders in government and industry. For this reason, we use the term Energy Savings Adjustment Factor (ESAF) to describe this value in our evaluation of Title 24 building codes.

¹⁴ Hall, Nick, J. Roth, C. Best (TecMarket Works). *California Energy Efficiency Evaluation Protocols*. Prepared for the California Public Utilities Commission. 2006.

We implemented the analysis using the ISSM—developed by the evaluators specifically for the prior C&S program evaluations and modified for this evaluation—that incorporates all the input data from the evaluation, measurement, and verification (EM&V) activities. Modifications made for this evaluation are described in Section 2.3 below. To help ensure transparency, the evaluation team implemented the model in an Excel workbook. The IOUs use a similar model to calculate their estimate of C&S program savings.

2.2. Objectives

The primary objective of this evaluation is to verify the savings estimates for the advocacy subprograms of the statewide C&S program during the years 2013, 2014, and 2015.

In this evaluation, we prioritized activities based on the magnitude of savings associated with each code or standard and also on the uncertainty of the values used to compute savings. In short, we are focusing activities on C&S with large savings or significant uncertainty.

2.3. Report Structure

Generally speaking, the evaluation scope includes two broad categories of efficiency regulations: appliance standards and building codes. In the first Phase, we evaluated Title 20 and Federal Appliance standards that became effective in 2013 and 2014. The Phase Two report is organized into volumes that correspond to these two categories. Volume One, this document, includes evaluation methods and findings for Title 20 and federal appliance standards (including those evaluated in Phase One of the project). Volume Two includes descriptions of the evaluation and findings for Title 24 building codes. This two-volume approach was suggested by the CPUC staff and was agreed to by the project management team. The reasons for organizing the report into two volumes include:

- Differences in evaluation methods used and results reported for appliance standards and building codes. For appliance standards, each product category is evaluated independently. The primary difference in methods and reported results is the use of a whole-building approach to evaluate new construction. In this case, a group of standards are evaluated in terms of their collective effect on new building energy consumption.
- Document length and level of detail. In the 2010-2012 evaluation, the effort to keep the report to a manageable length of roughly 100 pages meant that much of the descriptive detail was included in the report appendices. The two volume approach allows much more of the evaluation to be documented in the report rather than in the appendices.

To avoid redundancy, some material is included in only one volume although it applies equally to evaluation of both appliance standards and building codes. These sections include:

- Descriptions of the Statewide Codes and Standards Program (Volume One)
- Overview of the evaluation approach (Volume One)
- Methodology descriptions for estimation of NOMAD and Attribution (Volume One)
- Uncertainty Analysis (Volume Two)

2.4. *Revisions to Integrated Standards and Savings Model*

The evaluation team made revisions to the functionality of the existing ISSM to accomplish the following:

- Eliminate the need for maintaining multiple versions
- Track and document input changes
- Allow for scenario analysis
- Enhance reporting capabilities
- Generate output for use in uncertainty analysis

The previous version included all models, inputs, and outputs in a single Excel workbook. Each new scenario required the user to change the inputs and save the ISSM file that included the new outputs. All comparative analysis had to be conducted externally.

The new version separates input files from the ISSM computation engine. The computation workbook also can save all outputs to a separate file.

The evaluation team designed the new ISSM to allow users to select from various input files via a new interface accessible from the dashboard. This interface prompts the user to navigate to a folder structure within the directory where the ISSM is stored. This folder structure can be used to manage input files for various scenarios (e.g., IOU estimates, evaluation scenarios or stages).

The new ISSM functionality copies data from selected input sheets into the model, and lists sheets chosen by the user on a new tab in the model. The folder name from which sheets are chosen is used to define a scenario, with which ISSM output is tagged. When the user elects to generate output, ISSM creates a file containing: the tab listing the input files, the complete “Standards” tab, and the “SummarybyStandard” tab. This file is saved in an Output folder in the same directory and tagged with a scenario and date stamp. (Note: Output generated from ISSM includes only values, not formulas ISSM.)

2.5. *Federal Preemption*

In some product categories, a federal regulation is adopted for a product type already regulated by the state of California. The federal regulation then becomes the law and supersedes state regulations. Once the federal government establishes an energy efficiency standard, no state may use a regulation that differs from the federal standard (i.e., the federal preemption).

Table 11 shows the standards, with potential savings in the evaluation period, pre-empted by federal regulations. Federal preemption does not directly affect the new standards shown in Table 2.

Adjustments, however, have been made to savings from previously evaluated lighting standards 11b, 26, and 27 due to preemption by federal EISA law. Impacts can be summarized as follows:

- Savings from standard 26 in 2012 did not continue in 2013 when pre-empted by EISA.
- Savings from standard 27 were included in 2013, but did not continue in 2014 when pre-empted by EISA.
- Savings from standard 11b—California’s earlier requirement that incandescent lamps reduce energy use by ~5%—decrease in 2012, 2013, and 2014 due to EISA preemption of specific lumen ranges.

The summaries included in Section 5.4 reflect preemption effects on previously evaluated standards.

Table 11. Pre-Empted Standards

Title 20 Standard		Pre-Empted By
Std 1	Commercial Refrigeration Equipment, Solid Door	Fed 3
Std 2	Commercial Refrigeration Equipment, Transparent Door	
Std 3	Commercial Ice Maker Equipment	
Std 5	Refrigerated Beverage Vending Machines	Fed 2
Std 11b	General-Service Incandescent Lamps, Tier 2	EISA
Std 12a	Pulse Start Metal Halide HID Luminaires, Tier 1 (Vertical Lamps)	
Std 12b	Pulse Start Metal Halide HID Luminaires, Tier 2 (All Other MH)	
Std 23	Metal Halide Fixtures/Luminaires	
Std 15	External Power Supplies, Tier 1	
Std 16	External Power Supplies, Tier 2	
Std 25	General-Purpose Lighting - 100 watt	
Std 26	General-Purpose Lighting - 75 watt	
Std 27	General-Purpose Lighting - 40 and 60 watt	
Std 22a	BR, ER, and R20 Incandescent Reflector Lamps: Residential	
Std 22b	BR, ER, and R20 Incandescent Reflector Lamps: Commercial	

2.6. California Standards Superseded by Later California Standards (Layering)

In the 2010–2012 impact evaluation report, the evaluation documented the impact of some new California standards superseding efficiency levels set by earlier California standards. In these cases, the IOU Estimate typically shows savings for each standard in each year. In this model, the first standard produces the first “layer” of savings and each later standard adds another layer of savings.

In the CPUC’s energy efficiency decision D. 10-04-029, the Commission determined that savings from earlier superseded standards ended when a new, more stringent standard took effect. According to Commission staff, however, portfolio savings targets for 2013–2015 were set assuming layering of superseded standards. Beginning in 2016, potential studies and IOU saving goals will be set with layered savings excluded.

The evaluation team found no instances where new standards evaluated were superseded by other California standards, nor did new standards supersede earlier standards. Layered savings, however, within the previously evaluated standards and savings in the 2013–2015 evaluation period changed depending on whether layered savings were included or excluded. Specifically, savings from standard 11b were lower in 2013 as Standard 27 superseded the 310–749 lumen range (corresponding to 40 and 60 watt lamps).

Table 12 presents superseded Title 20 standards. Savings tables in this report include these previously-evaluated standards, with layering included.

Table 12. Superseded California Standards

Earlier Standard		Later Superseding Standard(s)	
Std 11b	General Service Incandescent Lamps, Tier 2	Std 25	General Purpose Lighting, 100 watt
		Std 26	General Purpose Lighting, 75 watt
		Std 27	General Purpose Lighting, 40, 60 watt
Std 18a	Consumer Electronics: Televisions	Std 28a	Televisions, Tier 1

3. Methodology

This chapter provides brief descriptions of methods used to evaluate parameters that determined energy savings under the evaluation protocol; this report's appendices include additional detail on these methods.

3.1. Potential Savings

Potential savings refers to the maximum theoretical savings from a code or standard taking effect in the first full year, assuming every affected unit just meets the new code's or standard's requirements. The evaluation team calculated these savings by multiplying annual unit sales in California by unit energy or demand savings.

3.1.1. Methodology

The evaluation team used a two-step process for determining potential savings. First, the team identified the market impacted by each standard, and segmented that market based on the standard's requirements or on energy-use characteristics. For example, the commercial clothes washer standard (Fed 8) uses different energy-use requirements, based on whether the product is a top-loading or front-loading washer. Additional market research revealed the two main applications for commercial clothes washers are laundromats and multifamily dwellings. Therefore, the team not only needed to determine the number of commercial clothes washers sold in California each year; it had to assign market shares to each of the four categories (e.g., top-loading laundromat, front-loading laundromat, top-loading multifamily, and front-loading multifamily).

After the team characterized annual California sales for each market segment, it estimated unit energy savings for products in each market segment, basing unit energy savings on the following definitions:

- **Baseline:** If a previous standard exists, it serves as the baseline. If a previous standard does not exist, the team set the baseline as the market-segment-level average efficiency of products not compliant with the new standard.
- **Efficient:** The minimum efficiency level complying with the standard.

Although the evaluation team's analysis developed unit savings for multiple market segments, the team reported results at the standard level. ISSM is structured to use a single unit savings value and a single market volume to calculate potential for each standard. When the team combined multiple segments into values representing the standard's total impact, the team referred to values calculated for use in ISSM as standard levels. The team used market shares to develop weighted unit savings at the standard level, and then multiplied the unit savings by the market size to determine potential savings. The team also used fuel weights, where applicable—an approach pertinent to standards such as clothes washers and dishwashers (where water heating fuels can vary throughout California).

Finally, the team based demand savings on peak watt/kWh factors from the California Database for Energy Efficiency Resources (DEER) or IOU work papers.

3.1.2. Interactive Effects

As discussed, IEs are secondary energy impacts that may result from saving energy on a particular end use. For C&S, IEs are associated with savings in total electricity usage and with end uses within conditioned spaces. When reducing energy consumption for a particular end use, such as lighting, the evaluators identified two types of IEs: negative gas savings due to increased heating; and positive electric savings due to reduced cooling.

The evaluation team reviewed IE factors used in the IOU savings estimate for the Phase One appliance standards. In almost every case, the IOUs used IE values identified in the previous evaluation and applied these to the new standards. For this evaluation, the team checked basic assumptions about whether measures were located in a conditioned space or were outside, and whether indoor measures were located in residential or commercial spaces.

The team obtained updated interactive effect values from the most recent DEER¹⁵ and replaced older values with current ones.

3.1.3. Data Sources

As described in the evaluation plan, the evaluation team estimated the potential energy (GWh and MMtherms) and demand (MW) savings using a variety of sources, including the following:

- DEER
- IOU Interim Approved Work Papers for 2013 and 2014
- CASE reports (for Title 20 standards)
- Technical support documents published by the DOE (for Federal standards)
- Industry statistics published by product-manufacturing trade organizations
- Publicly available market characterization reports
- California evaluation reports or studies
- Data purchased from market research firms
- U.S. Census and U.S. Energy Information Administration data (used to scale national numbers to California-specific values)

After discussion with CPUC staff and advisors, the team agreed on the following guidelines to select data for use in the evaluation (if more than one source was available):

- Calculation of unit savings should use California-specific characteristics where available (e.g., number of cycles per year).
- DEER is preferable to all other sources, but not all products are available in DEER (e.g., room air conditioning is not a DEER measure).

¹⁵ DEER2014-Lighting-IE_and_Adjustment-Factor-Tables-17Feb2014.xlsx

The team checked all data sources used for reasonableness and applicability, documenting these in Appendix A.

3.2. Gross Savings/Compliance

For this evaluation, compliance consistent with the protocol must be an adjustment of potential savings to gross savings. The team continued to use the compliance definition used in the 2010–2012 evaluation:

$$(\text{number of units that meet or exceed the current standard})/(\text{total market volume})$$

To determine gross savings then, the team applied a compliance rate or compliance adjustment factor (CAF) to potential energy savings. For appliance standards, the report uses both of these interchangeable terms.

3.2.1. Methodology

For a state-regulated or federally-regulated product to be compliant with the California appliance efficiency regulations, its manufacturer must not only demonstrate that the product meets the performance requirements of the regulations, but also must certify the product’s performance with the CEC. The CEC maintains an online database of certified products at the model level.

Ideally, the team would determine the compliance rate for each standard based on the sales-weighted percentage of sampled products that the CEC database lists. This approach, however, does not always prove feasible for the following reasons:

- Product sales data at the model level are difficult or expensive to obtain.
- The product is often sold as a component of other products (e.g., battery charger systems).

Where feasible, the team estimated the listed compliance rate based on the market share of appliances listed in the CEC database.

Assuming that manufacturer product specifications are accurate, some products not listed in the CEC database may still meet the efficiency regulation requirements. For consistency across all standards in this evaluation, the team based the definition of compliance on the share of the market sampled that met the efficiency requirements, regardless of whether the CEC database listed the individual product.

Where data at the model level were available, the team weighted the compliance rate based on its market share (percentage of annual sales) using the equation below (which denotes the specific model by the subscript *i*):

$$\text{Compliance Rate} = \sum_i \begin{cases} 1 & \text{if model}_i \text{ is compliant} \\ 0 & \text{if model}_i \text{ is not compliant} \end{cases} \times [\text{market share}]_i$$

Where data at the model level were unavailable or too expensive to gather, the team estimated the compliance rate through reviewing online product listings or through interviews with industry experts, retailers, distributors, and manufacturers. The team scored the interviews based on the interviewee’s

market share, awareness of the standard and CEC database, and compliance of products sold/distributed/manufactured.

In summary, the evaluation team used the following three main methods, depending on data availability, to assess appliance compliance (listed in order of most preferable [and expensive] to least preferable):

- **Analysis of point-of-sale (POS) data:** The team purchased California specific sales data for appliances (e.g., TV and certain battery charger products) sold during the 2013 to 2015 period. This POS data included unit sales at the model level and covered approximately 75% of sales.¹⁶
- **Analysis of store website data:** The team selected physical retail stores (preferably across California) that also have websites. For each website, the team took a sample¹⁷ of models offered and assessed the compliance of those models. This first meant checking if the model was on the CEC list, and then checking if remaining models were ENERGY STAR certified.¹⁸ Finally, the team checked if product performance specifications met the standard requirements. Upon satisfying any of those criteria, the team counted the model as compliant.
- **Interviews with vendors or manufacturers:** For certain products that proved difficult to verify compliance using other methods (e.g., fluorescent ballasts), the team used information from interviews conducted with vendors or manufactures.

In some instances, the team used a combination of methods to ensure more robust results. For example, the compliance for fluorescent ballasts found in distributors' online catalogues could not be fully assessed using the ballast luminous efficiency (BLE) criterion, given BLE sets is a new industry-specific term, not yet listed in customer-facing product specification sheets.¹⁹ Instead, the team assessed compliance using the CEC list and conducted interviews with manufacturers to better understand the market.

Initially, the team considered conducting store visits to assess compliance, but rather conducted online research for the following reasons:

¹⁶ The data only include sales through vendors who have agreements in place with the market research firm. Sales through smaller stores are not captured through POS data.

¹⁷ For some online stores, we used a method referred to as web-harvesting to obtain data on all products that met a certain search criteria. The data include model number and other relevant product specifications that can be reviewed for compliance purposes.

¹⁸ The latest ENERGY STAR specifications are designed to be more stringent than federal standard requirements. For Title 20 appliances, we check that the ENERGY STAR specification meets or exceeds those required by the California standard.

¹⁹ Fluorescent ballasts must meet minimum power factor and BLE requirements in order to comply with the standard.

- Greater sample sizes could be achieved for the same budget and schedule.
- Shelf stock would only be available for smaller products (not large appliances such as refrigerators), and the team did not have data showing relationships between shelf stocks and unit sales.
- Product packaging or labels do not always provide manufacture dates, a potential advantage presented by store visits. Cadmus staff visited an electronics retail store to examine a handful of TVs, clothes washers and dryers, laptop computers, mobile phones/fitness trackers, dishwashers, and refrigerators.
- Typically, product manufacture dates could be found on stickers affixed to the store demo product (as shown in Figure 2). TVs and other large appliances (e.g., refrigerators, clothes washers) located this sticker on a difficult-to-reach area of the appliance (e.g., behind the TV [mounted on a wall or displayed high on a shelf], or on the inside of the refrigerator, dishwasher, or clothes dryer). Nearly every TV examined closely had a sticker with manufacture date. Computers and refrigerators sometimes had manufacture dates available, while dishwashers, clothes washers, mobile phones/fitness trackers, and clothes dryer labels did not provide manufacture dates.

Figure 2. Labels Showing Manufacture Dates



3.3. Net Savings/NOMAD

This section presents the methodology that the evaluation team used to estimate the NOMAD trend for each product or technology regulated by the Title 20 and federal appliance standards. As noted in Section 2.1’s evaluation protocol discussion, the NOMAD value was used to adjust gross standard savings, with the result being considered net standard savings. This did not account for program effects, which were determined through attribution analysis.

It is important to understand NOMAD’s meaning: NOMAD projects what the annual sales or installations of items meeting the standards would have been had standards not been adopted. It estimates energy-efficient product sales over time. Once a standard takes effect, the natural market no longer exists. The evaluation, however, required estimating the naturally occurring market trend—the counterfactual—to derive net savings for each standard.

3.3.1. Methodology Evaluation Approach

To determine the ISSM model coefficients necessary to calculate net energy savings for each Title 20 and federal standard, the evaluation team used a market adoption estimation approach in a Delphi panel framework, developed and applied in the two preceding C&S program evaluations.

The Delphi panel approach is a structured, interactive technique for obtaining expert group inputs, usually to develop forecasts. Each expert answers a questionnaire that provides a forecast and the expert’s rationale in two or more rounds. After each round, a facilitator provides the group with an anonymous summary of the experts’ forecasts and their supporting arguments for the forecasts. The experts can then revise their forecasts, again providing their supporting arguments. The process ends after a number of rounds and intends to reach consensus or stability.

The market adoption estimation approach uses a convenient, flexible, web-based data-collection application developed by Cadmus, which allows the experts to provide their inputs when convenient, view the anonymous responses of the other experts, and revise their inputs. The Cadmus Market Adoption Tool, as configured for this study, assumes market adoption over time can be characterized with an exponential diffusion curve (i.e., the S-shaped Bass curve). Market studies have widely used this to represent the market diffusion of technologies and products.

The evaluation team assembled expert panels for the Title 20 and federal appliance standards. Due to practical limits on time available to recruit experts and other real-world constraints, the team dedicated more evaluation resources to the standards with the greatest estimated energy savings, designating these as priority standards, as shown in Table 13.

Table 13. List of Priority Standards

	Description
Std 28b	Televisions Tier 2
Std 29	Small Battery Chargers—Tier 1
Std 30	Small Battery Chargers—Tier 2
Std 32	Large Battery Chargers
Fed 9	Residential Pool Heaters
Fed 10	Residential Direct Heating Equipment
Fed 11	Residential Refrigerators/Freezers
Fed 12	Residential Room Air Conditioners
Fed 13	Fluorescent Ballasts
Fed 14	Small Commercial Package Air Conditioners
Fed 15	Large Commercial Package Air Conditioners
Fed 16	Computer Room Air Conditioners
Fed 17	Residential Dishwashers

The evaluation team prioritized data collection for these standards by requiring input from a minimum of five expert panelists for each standard. The remaining standards also were evaluated by multiple experts, but the five-expert minimum threshold was not required.

3.3.2. Prior Program Adjustment

IOUs often implement resource acquisition programs for energy efficiency measures or efficient appliances, and these may be adopted as subsequent codes or standards requirements. Sometimes, such programs also can affect market adoption of product or measure over time. Consequently, the evaluation team, when soliciting expert opinions on market trends, regarded such influences as a part of the naturally occurring market.

While the team could have asked the expert panelists to estimate market trends in the programs' absence, previous evaluation work indicated doing so would introduce too much complexity and uncertainty to estimate market trends using this assumption. Therefore, the team instructed the expert panelists to estimate the natural market (in the standard's absence) based on the market they observed prior to the standard taking effect.

Including the market penetration effects of prior IOU programs in the NOMAD estimate raised an issue regarding how prior programs affected projections into the future of the naturally occurring market. Where programs significantly affected the market, it seems likely that natural market estimates would reflect these program effects. As NOMAD constituted a savings deduction, the upward shift in the adoption curve due to programs run in previous years meant that net savings would be underestimated.

To correct for the possible inappropriate deductions from prior IOU programs' effects, the team adjusted the NOMAD estimate when prior programs affected the market. As part of the data-collection process, team requested the IOUs provide data from their records regarding every program affecting the product volumes of appliances and measures regulated by the evaluated C&S.

In implementing this adjustment during the two earlier C&S impact evaluations, the team modeled the adjustment as a value greatest shortly after the programs were active and gradually reduced each year. The team used a 10% reduction of the initial value each year. Under this model, the adjustment reached zero after 10 years.

A prior program adjustment is included in the evaluated savings for Standard 28a, Televisions Tier 1. As discussed in Section 4.3, no adjustment is made for standard 28b, Televisions Tier 2.

3.4. *Net Program Savings/Attribution*

Attribution refers to the portion of energy savings that can be credited to the utilities' C&S program efforts for enabling or assisting adoption of each appliance or building standard. An attribution analysis results in an attribution score (a percentage between 0% and 100%) that represents a program's relative contribution to adoption of the standard.

In the 2013–2015 program cycle, the evaluation team calculated attribution for state and federal appliance standards, using the same evaluation approach as used for the 2006–2008 and 2010–2012 program cycles.²⁰

The process of determining attribution entailed the following steps:

1. The team collected data on stakeholder activities from a range of sources, including rulemaking dockets, Code Change Theory Reports (CCTR) (written by the IOUs), and stakeholder interviews.
2. A panel of independent C&S experts assessed the program’s contributions to adoption of each standard based on a careful and systematic review of the evidence and determination of an attribution score.

The team estimated the relative effort required to adopt a new code or standard in three factor areas, which the next subsection describes in greater detail. To calculate an overall attribution score, the team applied each estimate of relative effort as a weight to the factor score.

The following sections describe the team’s attribution model, data collection, and attribution analysis for state and federal C&S.

3.4.1. Methodology: The Attribution Model

The model sets forth specific criteria for evaluating the C&S program’s contributions to standards development and adoption. This applies to both federal and California rulemaking. The team conducted attribution analysis for 23 appliance and nine building standards, including the following:

- 2011 T20 Battery Chargers (four standards)
- 2013 Federal Appliance (10 standards)
- 2015 Federal Appliance (nine standards)
- 2013 T24 Nonresidential Alteration Building (nine standards)

The model focuses on three activity areas, representing the fundamental requirements that must be met for the CEC (for state standards), the DOE (for federal administrative rulemaking), or the U.S. Congress (for federal legislative rulemaking) to adopt a standard; the model describes these as factors, as discussed below.

Development of Compliance Determination Methods and Other Special Analytic Techniques

End users must be able to determine whether they comply with the standards. Similarly, code officials (for building standards) or manufacturers (for appliance standards) and regulators must have the tools and methods that allow them to verify compliance with the standards. In some cases, determining compliance entails using a reliable test method. In other cases, it involves using an analytical tool that

²⁰ The Cadmus Group. “The Proposed Cadmus Attribution Methodology (Revised).” March 9, 2009. This document can be found online at: <http://www.energydataweb.com/cpuc/search.aspx> Search the text for “attribution methodology (revised)” to access the document.

produces results that indicate whether compliance has been achieved. In addition, some standards require development of new analytic methods to estimate energy and demand savings.

Development of Code Language and Technical, Scientific, and Economic Information in Support of the Standard

The standard must be defined using careful technical language that spells out covered products, effective dates, and required efficiency levels. Significant scientific, engineering, and economic research must be completed before a standard can be adopted. Typically, this research concerns estimates of energy and peak demand savings and of measure cost-effectiveness.

Since implementation of the C&S program, much of this research and development at the state level has been summarized in CASE reports, funded by the utilities for C&S in which they played a significant role. At the federal level, research completed through CASE reports can be adapted for federal standards. The C&S Program, however, often conducts additional research or teams with other stakeholders that have conducted their own technical research to support the federal rulemaking process.

Demonstrating the Feasibility or Market Acceptance of Standard Adoption

Adopting a new standard implicitly requires compliance with a practicable and feasible standard. The standard's supporters must address stakeholder concerns and, through market research, demonstrate that stakeholders can comply with the standard.

Meeting this requirement requires satisfying three conditions:

- First, the market must be capable of supplying the products and services necessary to comply with the standard. If a product cannot be readily acquired through the marketplace, its technology must be well developed and its manufacturers capable of increasing supply before the standard takes effect.
- Second, the standard must not impose unreasonable and avoidable costs on end users, manufacturers, and other stakeholders.
- Third, the standard must not create significant negative externalities related to human health or the environment.

3.4.2. Data Collection Activities

The evaluation team based the determination of C&S Program's credits on a systematic and thorough review of available evidence about program activities. The team collected information from a variety of sources, including documents provided by the C&S program (e.g., CCTR, CASE reports.), public documents (e.g., transcripts, public comments), and stakeholder interviews. This following section describes these sources.

Review of Public and C&S Program Documents

The evaluation team collected information about C&S program and other stakeholder contributions to development and adoption of each standard, drawn from a large number of primary and secondary public sources, including CASE reports, Advanced Notice of Public Rulemaking announcements (federal

standards only), transcripts of CEC and DOE hearings and workshops, stakeholder letters, and comments to the CEC and DOE. The team also reviewed documents provided by the C&S program, including CCTRs and email logs, and then carefully read these sources, and extracted information about C&S program and other stakeholder activities, which could be entered into a spreadsheet for future reference in determining C&S Program credits.

Stakeholder Interviews

The evaluation team conducted interviews with key stakeholders to fill remaining gaps in its understanding of standards' development. Although each interview's focus varied, the team generally asked about the stakeholder's involvement in the rulemaking process, their impressions of the C&S Program's involvement, key issues that arose during the rulemaking, and the stakeholder's assessment of the C&S Program's contributions.

3.4.3. Estimation of Factor Scores

The following three principles guided determination of credit:

1. Attribution would be determined by disinterested third-party technical experts who did not have a stake in the amount of credit that was awarded.
2. Credit would be awarded on the basis of evidence about C&S Program activities obtained from written sources and interviews.
3. The scoring process would be transparent, documented, and repeatable.

To adhere to these three principles, the team convened a panel of independent C&S experts to determine the C&S Program's credit. This panel consisted of four experts: one representing the Midwest Energy Efficiency Alliance; one representing the Northwest Energy Efficiency Alliance; one representing the Institute of Market Transformation, and one independent consultant serving on the boards of several energy efficiency organizations. Three of the four panel members participated in the 2010–2012 program cycle attribution panel.

In December 2015, the panel convened in for a two-day session Cadmus' Portland office. At the meeting, the evaluation team explained the attribution model and the scoring protocol, and instructed the panelists about the kinds of evidence they should consider and about determination of the factor scores. The team informed the panelists that the Program's contribution to each factor would be judged relative to the contributions of other stakeholders (e.g., industry members, efficiency advocates, CEC, DOE). In addition, the team told the panelists that the effort required for determining a factor should not influence determination of the factor score.

The panel deliberations began with a presentation by Cadmus that explained the standard's development, including prescriptive or performance requirements, key stakeholders, and the development history. The team then presented evidence about C&S Program contributions within each factor area. The panel members discussed their thoughts regarding the three factors for each code or standard, and considered the inputs of all stakeholders (including the C&S Program). The discussion often included the members expressing an opinion on each factor score, asking the team questions

about the rulemaking activities, and discussing any issues or thoughts among themselves. After the discussion, the panel could mutually agree on factor scores, vote on the scores as individuals, or ask the team for more information and later reach agreement in light of the new information. If the panel could not agree on factor scores, the final score would be an average of the preferred factor scores of the members.

To ensure that the panel had the time necessary to fully evaluate the C&S presented, the evaluation team presented only 14 of the 23 standards to the panel, prioritizing these standards based on total savings. The panel presentation included standards with savings greater than 40 GWh, accounting for 97% of the estimated savings for all standards evaluated.

The team evaluated C&S with estimated savings of 40GWh or less. In sessions following the outline of the panel sessions, a team evaluator responsible for researching and summarizing the standard presented the standard development, stakeholders, history, and evidence to members of the attribution evaluation team. The team discussed the factors internally, expressed opinions on each factor score, and developed an attribution score.

3.4.4. Estimation of Factor Weights

The evaluation team internally developed factor weights for each code or standard for the program cycle. The team based the factor weights on an understanding of resource allocation across the factor areas for each code or standard. This assessment drew upon data collected through the team’s review of rulemaking documents and stakeholder interviews.

As a check against our factor weights, we asked the IOUs to provide their estimates of the factor weights for each standard. We distributed to the IOUs a survey similar to that used in the previous evaluations. For each state and federal code and standard, we asked, “What was the percentage allocation of total stakeholder resources across the factor areas in the development of the standard, where resources are defined in terms of budgets?” We also asked the IOUs to provide a brief explanation as to the reasoning behind their weights.

The team compared these weights to those provided by the IOUs. If the weights proved relatively close, the team used the weights developed internally. If large discrepancies arose between the team’s estimates and the IOUs’ (i.e., generally 10% or more), the team reviewed the justification provided by the IOUs, conducted additional research, and made adjustments to the weights, as necessary.

For example, if the team awarded a low weight to factor two, based on the assumption that data collection activity described in the CCTR required minimal resources, but the IOUs weighted factor two very highly, the team reviewed the IOUs’ explanation as well as supporting documentation. If the additional detail proved convincing, the team adjusted the weight upward.

3.4.5. Estimation of Attribution Scores

As a final step in the process, the evaluation team calculated the attribution score for each state or federal code or standard. This attribution score measured the C&S Program’s contribution to a

standard's adoption and multiplied net energy savings to determine the amount attributable to the C&S Program. The team calculated the attribution score by multiplying the factor weight and factor score for each factor within a standard, then summing those weighted scores.

4. Findings for Protocol Parameters

This chapter presents parameter value findings for each standard. The evaluation team made an exception regarding the parameters that determined overall potential: unit energy savings, market volumes, and total energy or demand. As these details of potential savings proved helpful in understanding the overall findings, this report includes them with the overall summary for each standard in the following chapter (not presenting them here to avoid redundancy).

The chapter begins with the team’s findings on the interactive components of potential savings, followed by presenting the evaluation results for compliance, NOMAD, and attribution.

4.1. Potential Savings/Interactive Effects

Table 14 presents IE values included in the IOU estimate and new values assigned for this evaluation. As previously noted, the IOU estimate used the same DEER-based values as the 2010–2012 impact evaluation. The team based the new values on the more recent 2014 DEER Lighting Measures Energy Impacts and HVAC Interactive Effects table.

Table 14. Summary of Interactive Effect Values

Standard	Description	Measure in Conditioned Space?	IE in IOU Estimate			IE Evaluated Values		
			kWh/kWh	kW/kW	Therms/kWh	kWh/kWh	kW/kW	Therms/kWh
Std 28b	Televisions Tier 2	Yes	1.050	1.320	-0.0207	1.070	1.297	-0.0130
Std 29	Small Battery Chargers – Tier 1	Yes	1.040	1.320	-0.0207	1.047	1.360	-0.0210
Std 30	Small Battery Chargers – Tier 2	Yes	1.040	1.320	-0.0207	1.047	1.360	-0.0210
Std 32	Large Battery Chargers	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 9	Residential Pool Heaters	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 10	Res. Direct Heating Equip.	Yes	1.000	1.000	-0.0177	1.000	1.000	0.0000
Fed 11	Res. Refrig./ Freezers	Yes	1.040	1.320	-0.0207	1.047	1.360	-0.0210
Fed 12	Residential Room Ac	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 13	Fluorescent Ballasts	Yes	1.100	1.2267	-0.0119	1.092	1.235	-0.0050
Fed 14	Small Comm. Package Acs	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 15	Large Comm. Package Acs	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 16	Computer Room Acs	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 17	Res. Dishwashers	Yes	1.040	1.320	-0.0207	1.047	1.360	-0.0210
Fed 18	Residential Clothes Dryers	Yes	1.040	1.320	-0.0207	1.040	1.320	-0.0207
Fed 19	Residential Gas-Fired Water Heater	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 20	Residential Electric Storage Water Heater	No	1.000	1.000	0.0000	1.000	1.000	0.0000

Standard	Description	Measure in Conditioned Space?	IE in IOU Estimate			IE Evaluated Values		
			kWh/kWh	kW/kW	Therms/kWh	kWh/kWh	kW/kW	Therms/kWh
Fed 21	Residential Gas-Fired Instantaneous Water Heater	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 23	Small Electric Motors	No	1.000	1.000	0.0000	1.000	1.000	0.0000
Fed 24	Residential Clothes Washers (Front Loading)	Yes	1.040	1.320	-0.0207	1.040	1.320	-0.0207
Fed 25	Residential Clothes Washers (Top Loading) Tier I	Yes	1.040	1.320	-0.0207	1.040	1.320	-0.0207
Fed 26	Residential Central AC, Heat Pumps And Furnaces	No	1.000	1.000	0.0000	1.000	1.000	0.0000

The team first identified whether or not the measures governed by each standard were generally located in conditioned spaces. Where measures were not in conditioned spaces, interactions did not occur with HVAC energy consumption. The team recorded the findings in the column labelled “Measures in Conditioned Space.” Shaded rows in the table indicated measures not found in conditioned spaces. Values shown for these standards served as the inputs used for the ISSM when interactive effects did not occur.

To obtain values for measures located in conditioned spaces, the evaluation team obtained the appropriate values for each IOU service territory, and weighted these according to each territory’s relative size to determine an appropriate statewide value. In addition, the team made the following assumptions for each standard to arrive at the final values:

- For Standard 28b, Televisions, Tier 2, the team assumed that half of the televisions would be in commercial space and the other half would be in residential spaces. The average of the statewide commercial and residential values provided the final value.
- The team used statewide residential values for the two small (consumer) battery charger standards (29 and 30), the residential refrigerator/freezer standard (Fed 11), and the residential dishwasher standard (Fed 17)
- The team used statewide commercial values for the fluorescent ballast standard (Fed 13)

The 2010–2012 evaluation used the same assumptions, and the final values only differed slightly from those based on the earlier DEER data.

4.2. Gross Savings/Compliance

Table 15 shows methods used and compliance rates by standard. Overall, compliance ranged from 35% to 100%, with an average of 90%.

Table 15. Summary of Compliance Methods and Findings

Group	Standard	Description	Compliance Method	IOU Compliance Estimate	2015 Evaluated Compliance Rate
2006–2009 Title 20	Std 28b	Televisions – Tier 2	POS	85%	99%
2011 Title 20	Std 29	Small Battery Chargers – Tier 1	POS	85%	90%
	Std 30	Small Battery Chargers – Tier 2	POS	85%	88%
	Std 32	Large Battery Chargers (≥ 2 kW rated input)	Websites/ Interviews	85%	78%
2010–2012 Federal Appliance	Fed 6	Incandescent Reflector Lamps	Self-survey (Longitudinal)	Previously Evaluated: 7%	65%
2013 Federal Appliance	Fed 8	Commercial Clothes Washers	Websites	89%	94%
	Fed 9	Residential Pool Heaters	Websites	89%	95%
	Fed 10	Residential Direct Heating Equipment	Websites	89%	95%
	Fed 11	Residential Refrigerators & Freezers	Websites	89%	95%
	Fed 12	Residential Room AC	Websites	89%	91%
	Fed 13	Fluorescent Ballasts	Websites/ Interviews	89%	80%
	Fed 14	Small Comm. Package ACs	Websites	89%	100%
	Fed 15	Large/Very Large Comm. Package ACs	Websites	89%	100%
	Fed 16	Computer Room ACs	Websites	89%	100%
	Fed 17	Residential Dishwashers	Websites	89%	99%
2015 Federal Appliance	Fed 18	Residential clothes dryers	Websites	85%	99%
	Fed 19	Residential gas-fired water heaters	Websites	85%	98%
	Fed 20	Residential electric storage water heaters	Websites	85%	88%
	Fed 21	Residential gas-fired instantaneous water heaters	Websites	85%	87%
	Fed 23	Small electric motors	Websites	85%	35%
	Fed 24	Residential clothes washers (front load)	Websites	85%	100%
	Fed 25	Residential clothes washers (top load)	Websites	85%	100%
	Fed 26	Residential central air conditioners, heat pumps	Websites	85%	98%

4.2.1. Limitations

The evaluation team encountered the following challenges to measuring compliance:

- Based on previous evaluation experience and a preliminary store visit, the team found the products' manufacture dates of products often were not available online or even on the physical products. As vendors are allowed to sell noncompliant stock, manufactured prior to the effective date, the team delayed compliance measurement for at least a year after the standard's effective date.
- Although the web-harvesting approach enables collection and analysis of a larger set of products from a particular website, this method is best suited for websites with a large diversity of products. As such, results from web-harvesting tend to rely on fewer retailers than manually taking a random sample of products from multiple retailers. Therefore, the results from the manual sampling approach is weighted more equally amongst retailers, while the web harvesting approach is weighted more heavily towards the store with the more diverse inventory.
- The CEC list sometimes provided the only compliance indicator. For products such as battery chargers or fluorescent ballasts, required product performance specifications often were not published; so the team could not tell if a product complied with the standard (short of the team conducting its own testing on the product).
- The CEC list may not be comprehensive. For example, the team found ENERGY STAR appliances not included in the CEC database.

4.3. Net Savings/NOMAD

Table 16 presents the evaluated NOMAD values and the values estimated by IOUs for 2013 through 2015. The evaluated values represent the results of the complete NOMAD estimation process, as described in the methodology section. Values range from 0% to -99%, averaging -38%.

4.3.1. Televisions, Tier 2 (Standard 28b)

As part of the 2010–2012 study, the evaluation team reviewed Title 20 standards for televisions, Tier 2 (Std 28b), and Small Battery Chargers Tier 1 (Std 29). The Standard 28b IOU estimate used the previously evaluated net NOMAD estimate for Standard 28a. These values include large prior program adjustments that lowered the net NOMAD values.

This report, however, does not include these adjustments in the evaluated net NOMAD estimate for Standard 28b. The adjustment made to net NOMAD for standard 28a (Tier 1) was based on programs operating prior to the 2011 effective date of Standard 28a. Ongoing savings from the Standard 28a continues to include this adjustment. Using the same program volume in adjusting Standard 28b (Tier 2) would adjust twice for the same units.

Although the IOU Business Consumer Electronics program continued to provide incentives for efficient televisions²¹ up to 2013's effective date for the Tier 2 standard, the Standard 28a adjustment already accounted for the Program's effect. Exclusion of the prior program adjustment caused the evaluated NOMAD estimate to differ from the IOU estimate for Standard 28b.

Table 16. Net NOMAD Adjustment Evaluated and IOU Estimate

Group	Standard	Description	IOU Estimated Net NOMAD Adjustment			Evaluated Net NOMAD Adjustment		
			2013	2014	2015	2013	2014	2015
2006-2009 Title 20	Std 28b	Televisions – Tier 2	-43%	-50%	-56%	-64%	-69%	-73%
2011 Title 20	Std 29	Small Battery Chargers – Tier 1	-32%	-36%	-40%	-32%	-36%	-40%
	Std 30	Small Battery Chargers – Tier 2	n/a	-36%	-40%	n/a	-37%	-41%
	Std 32	Large Battery Chargers (≥2kW rated input)	n/a	-38%	-40%	n/a	-13%	-15%
2013 Federal Appliance	Fed 8	Commercial Clothes Washers	-25%	-25%	-26%	-53%	-53%	-53%
	Fed 9	Residential Pool Heaters	-50%	-50%	-50%	-50%	-50%	-50%
	Fed 10	Residential Direct Heating Equipment	-41%	-41%	-41%	-49%	-51%	-53%
	Fed 11	Residential Refrigerators & Freezers	n/a	-12%	-14%	n/a	-27%	-29%
	Fed 12	Residential Room AC	n/a	-4%	-5%	n/a	-35%	-38%
	Fed 13	Fluorescent Ballasts	n/a	-9%	-10%	n/a	-25%	-27%
	Fed 14	Small Comm. Package ACs	-93%	-93%	-93%	-93%	-93%	-93%
	Fed 15	Large/Very Large Comm. Package ACs	n/a	-75%	-76%	n/a	-75%	-76%
	Fed 16	Computer Room ACs	-99%	-99%	-99%	-99%	-99%	-99%
	Fed 17	Residential Dishwashers	-65%	-66%	-67%	-52%	-56%	-60%
2015 Federal Appliance	Fed 18	Residential Clothes Dryers	n/a	n/a	-31%	n/a	n/a	-31%
	Fed 19	Residential Gas-fired Water Heater	n/a	n/a	-35%	n/a	n/a	-35%
	Fed 20	Residential Electric Storage Water Heater	n/a	n/a	-6%	n/a	n/a	-6%
	Fed 21	Residential Gas-fired Inst. Water Heater	n/a	n/a	0%	n/a	n/a	0%
	Fed 23	Small Electric Motors	n/a	n/a	-2%	n/a	n/a	-2%
	Fed 24	Residential Clothes Washers (Front Load)	n/a	n/a	0%	n/a	n/a	0%
	Fed 25	Residential Clothes Washers (Top Load)	n/a	n/a	0%	n/a	n/a	0%
Fed 26	Residential Central ACs and Heat Pumps	n/a	n/a	-36%	n/a	n/a	-36%	

4.4. Net Savings/Attribution

Table 17 reports factor scores, factor weights, and final attribution scores for each new Title 20 and federal appliance standard. Factor scores indicate the C&S Program's percentage contributions to the

²¹ KEMA. *Impact Evaluation Report Business and Consumer Electronics Program (WO34)*. April 15, 2013. Available online at <http://calmac.org/> and has the CALMAC Study ID: CPU0060.01

standards' development in each factor area. The final attribution score equals the weighted average of the factor scores. The scores ranged from 5% to 90%, with average 31%.

Table 17. Title 20 and Federal Appliance Standards – Attribution Scores

Appliance Standards: Title 20 and Federal		Factor Score			Weight			Final Attribution Score
		Compliance	Technical	Feasibility	Compliance	Technical	Feasibility	
Std 28b	Televisions, Tier 2	50%	65%	65%	30%	20%	50%	61%
Std 29	Small Battery Chargers – Tier 1	45%	50%	85%	25%	50%	25%	58%
Std 29	Small Battery Chargers – Tier 2	25%	50%	25%	45%	50%	85%	58%
Std 29	Small Battery Chargers – Tier 3	25%	50%	25%	45%	50%	85%	58%
Std 32	Large Battery Chargers (≥2kW)	90%	90%	90%	40%	40%	20%	90%
Fed 8	Commercial Clothes Washers	5%	15%	30%	5%	50%	45%	21%
Fed 9	Residential Pool Heaters	5%	5%	0%	35%	60%	5%	5%
Fed 10	Residential Direct Heating Equipment	5%	10%	0%	30%	65%	5%	8%
Fed 11	Residential Refrig. and Freezers	60%	30%	20%	30%	50%	20%	37%
Fed 12	Residential Room AC	40%	25%	15%	20%	40%	40%	24%
Fed 13	Fluorescent Ballasts	80%	65%	80%	30%	40%	30%	74%
Fed 14	Small Commercial Package ACs	10%	10%	10%	40%	30%	30%	10%
Fed 15	Large/Very Large Package ACs	10%	10%	10%	40%	30%	30%	10%
Fed 16	Computer Room ACs	10%	10%	10%	40%	30%	30%	10%
Fed 17	Residential Dishwashers	5%	5%	5%	50%	30%	20%	5%
Fed 18	Residential Clothes Dryers	50%	60%	10%	50%	30%	20%	45%
Fed 19	Residential Gas-fired water heaters	10%	50%	10%	15%	65%	20%	36%
Fed 20	Residential Electric storage water heaters	10%	50%	10%	15%	65%	20%	36%
Fed 21	Residential Gas-fired instant water heaters	10%	50%	10%	15%	65%	20%	36%
Fed 23	Small Electric Motors	0%	10%	10%	15%	50%	35%	9%
Fed 24	Residential Clothes Washers (Front Load)	20%	20%	70%	30%	50%	20%	30%
Fed 25	Residential Clothes Washers (Top Load)	20%	20%	70%	30%	50%	20%	30%
Fed 26	Res Central AC, Heat Pumps, and Furnaces	10%	25%	0%	40%	45%	15%	15%

The attribution panel determined each high-priority attribution score through developing a consensus, based on discussions of data collected by the attribution team. The panel discussed some standards as a group, as the rulemaking process may have covered multiple products in one rulemaking, such as heat pumps, central ACs and residential furnaces. The panel, however, also considered differences in standards when evidence emerged to support a different advocacy level for one standard over another (e.g., small versus large battery chargers).

While the panel did not create the weights, members discussed what they thought potential weights would be while deciding their scores. For example, as the standard for residential refrigeration and freezers was on its third update and had an established test procedure and that the difficulty of reaching consensus on a test method should affect the weighting.

Comparison to IOU Estimated Values. For appliance standards, IOUs only provided attribution values for Title 20 standards (and did not provide attribution for federal standards). Of the Title 20 standards evaluated, attribution for the television standards 28a and 28b was evaluated during the 2010–2012 evaluation as standard 28a became effective during that time period. Consequently, the IOU input includes an earlier evaluation finding of 61% attribution.

Standards 29 and 32, which regulate small and large battery chargers, respectively, were the only Title 20 standards that the evaluation examined in the current cycle. In both cases, the IOUs estimated 74% attribution, while the evaluators found 58% attribution for standard 29 and 90% attribution for standard 32.

5. Statewide Program Results

5.1. Program and Major Standard Group Findings

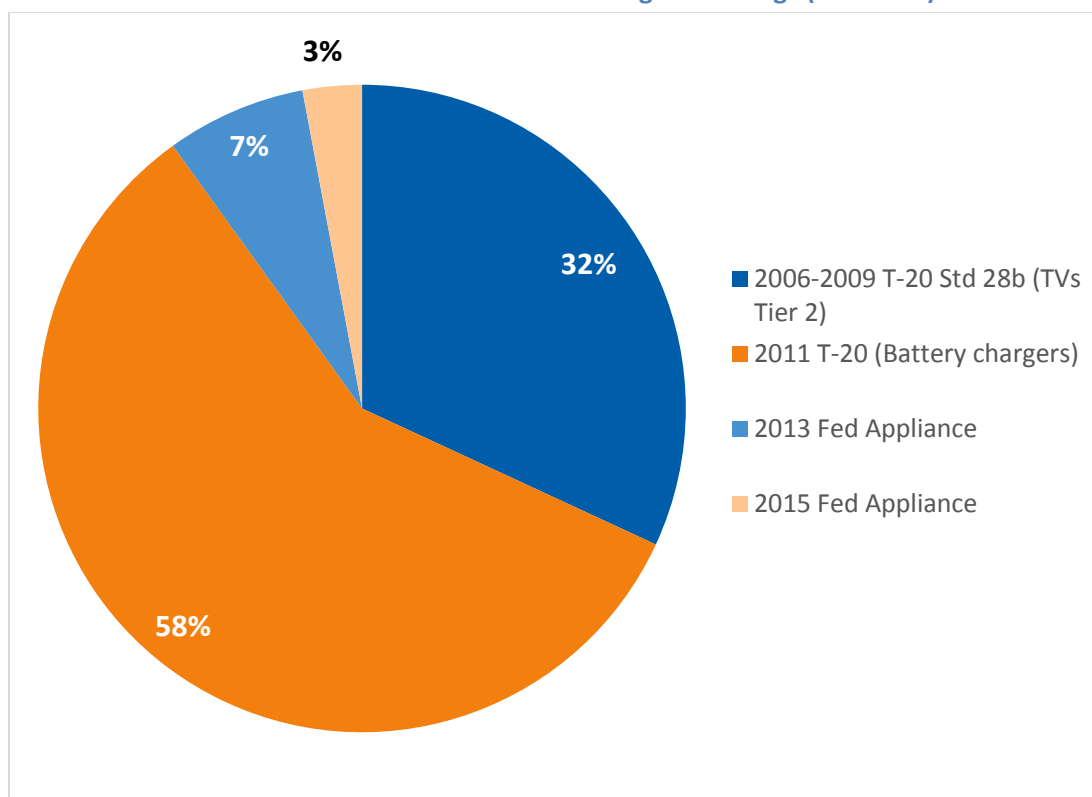
This section presents the evaluation's aggregate results.

As discussed, results can be reported on a statewide basis or in terms of savings allocated to the IOUs. For electric energy and demand, the IOUs represented about 72% of the statewide total, hence the savings total allocated to the IOUs also was about 72% of the statewide total. For gas savings, the IOUs represented 99% of the gas supplied; so statewide and IOU totals were practically the same. As the evaluation team has noted, all values were statewide, unless otherwise indicated. Due to potential confusion, the report indicates, in most cases, whether results were statewide or IOU-specific.

Note that the market size for each individual standard is adjusted for the effective date of the standard. For example, standard 29 is effective on 2/1/2013 and full-year market is adjusted to reflect that standard was in effect for 334 of 365 days of 2013.

As shown in Figure 3, the bulk of program net electricity savings can be attributed to Title 20 standards.

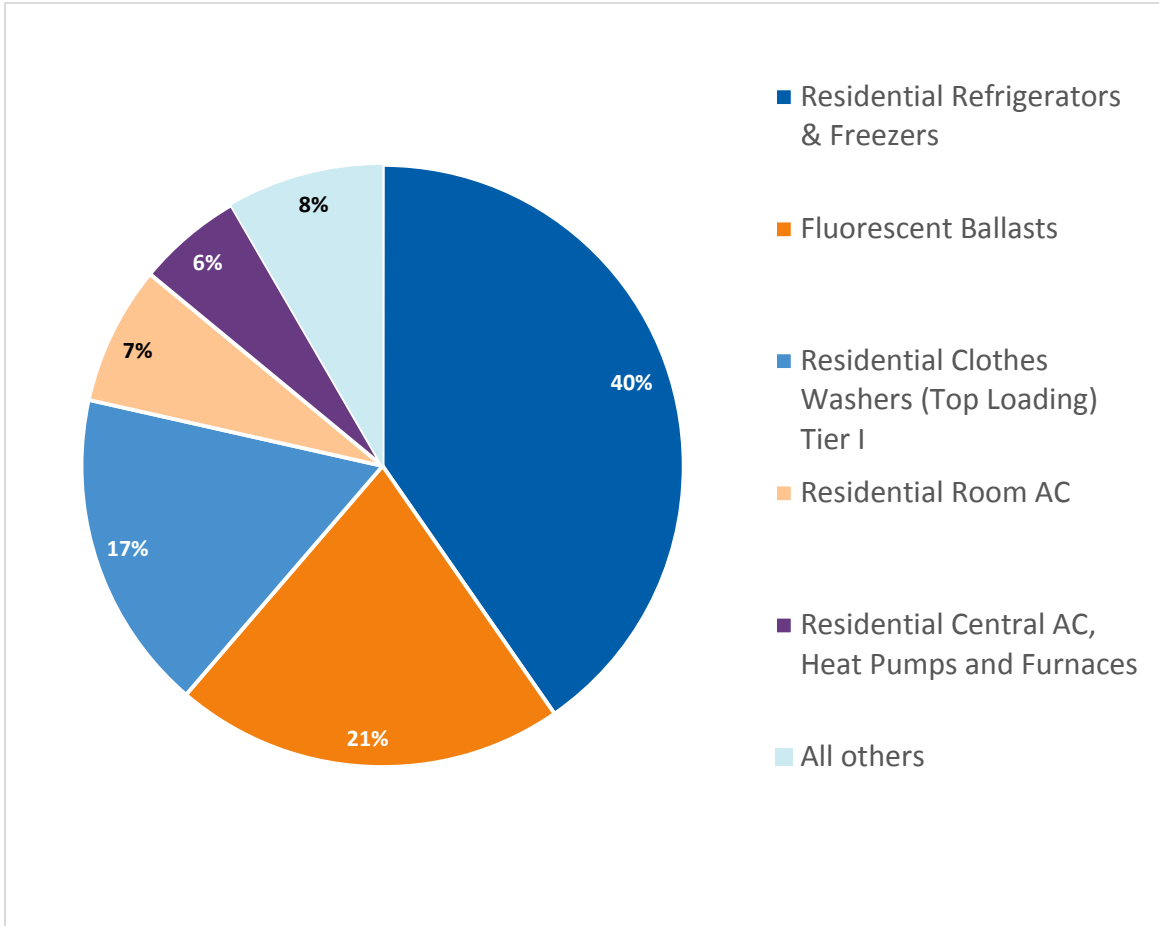
Figure 3. Distribution of 2013–2015 PY Statewide Net Program Savings (781 GWh) for New Standards



Most savings from the federal appliance standards (40% of the total shown) resulted from residential refrigerators/freezers, as shown in Figure 4. The federal residential dishwasher, gas-fired instantaneous water heater, and residential clothes washer standards (Fed 17, 21 & 24) had negative impacts on

electric energy and demand savings, given reduced gas usage served as the primary impact (shown later in Section 5.3.10).

Figure 4. Distribution of 2013–2015 PY Statewide Net Program Savings (44 GWh) for Federal Appliance Standards



The proportion of program net demand savings from new federal appliance standards was significantly larger than that from energy savings, with 30% of demand reduction attributable to the federal standards, as shown in Figure 5.

Figure 5. Distribution of 2013–2015 PY Statewide Net Program Demand Reduction (77 MW) for New Standards

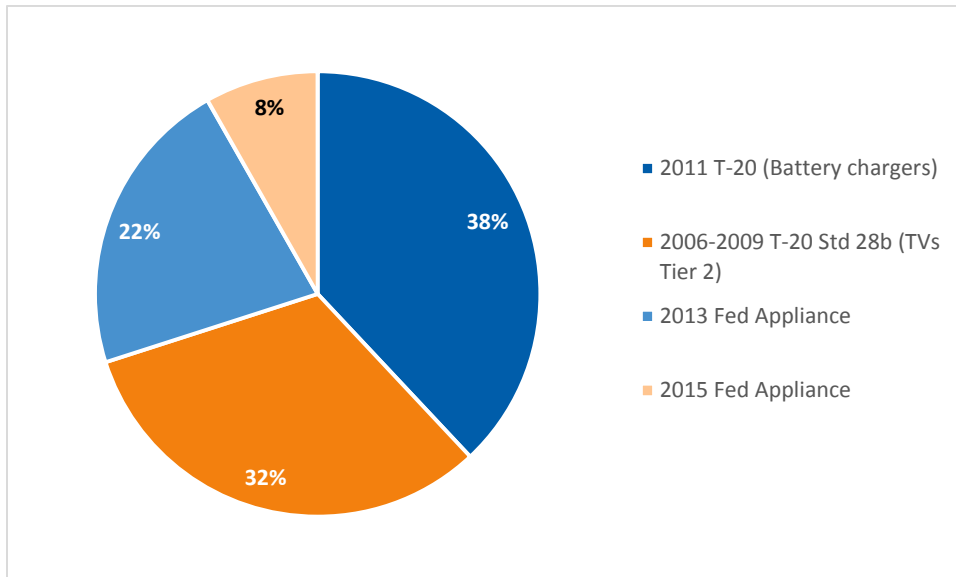


Figure 6 shows the distribution of demand reduction (by standard) for the new federal appliance standards

Figure 6. Distribution of 2013–2015 PY Statewide Net Program Demand Reduction (15 MW) for Federal Appliance Standards

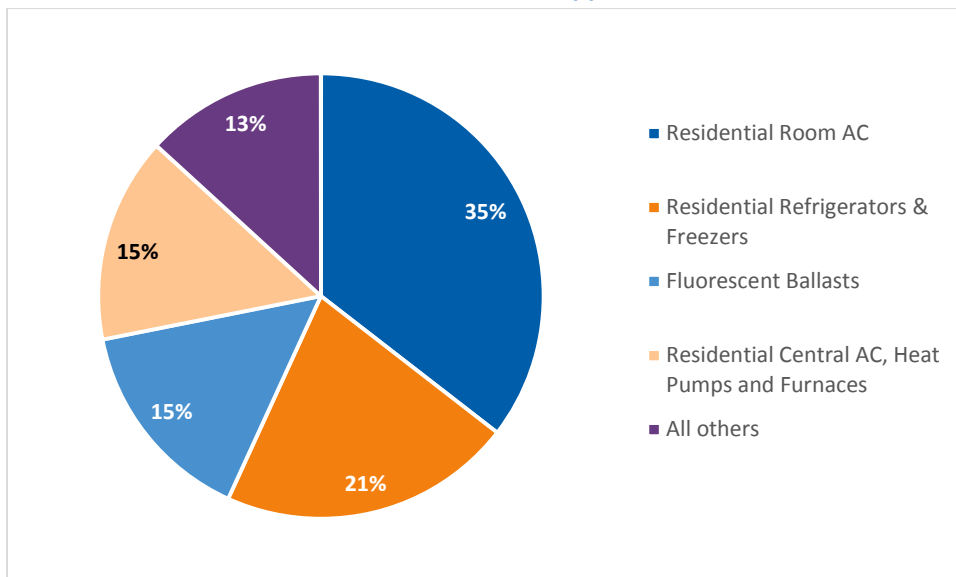


Table 18 through Table 30 show IOU saving estimates and evaluated savings for electricity, demand, and gas (by group and IOU share). The report presents Title 20 results and federal results separately due to the absence of IOU-estimated attribution values for federal standards.

Table 18. Evaluated vs. IOU Estimate: 2013–2015 PY Statewide Total Savings for New Title 20 (GWh)*

GWh	IOU Estimated Savings				Evaluated Savings			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2006-2009 T-20 Std 28b (TVs Tier 2)	1,072	907	456	276	1,322	1,296	412	249
2011 T-20 (Battery chargers)	1,303	1,102	703	520	1,349	1,211	780	454
2013-2015 Total	2,375	2,009	1,158	796	2,671	2,507	1,192	703
Evaluated/IOU Estimated					112%	125%	103%	88%

*Values may not sum exactly due to rounding.

Table 19. Evaluated vs. IOU Estimate: IOU Share of 2013–2015 PY New Title 20 Savings (GWh)*

GWh IOU	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	750	634	366	251	843	792	376	222
SCE	32.6%	774	654	377	259	870	817	388	229
SDG&E	7.4%	176	148	86	59	197	185	88	52
All IOUs	71.6%	1,699	1,437	829	569	1,911	1,794	853	503
Evaluated/IOU Estimated						112%	125%	103%	88%

*Values may not sum exactly due to rounding.

Table 20 and Table 21 summarize demand savings from Title 20 standards. The evaluation found less than half of the battery charger standard demand savings than that included in the IOU estimate.

Table 20. Evaluated vs. IOU Estimate: 2013–2015 PY Statewide Total Demand Reduction for New Title 20 (MW)*

MW	IOU Estimated Savings				Evaluated Savings			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2006-2009 T-20 Std 28b (TVs Tier 2)	119.0	100.6	50.6	30.6	131.1	128.6	40.8	24.7
2011 T-20 (Battery chargers)	220.4	186.4	119.0	88.0	88.8	79.4	50.5	29.3
2013-2015 Total	339.4	287.0	169.5	118.6	219.9	207.9	91.4	54.0
Evaluated/IOU Estimated					65%	72%	54%	46%

*Values may not sum exactly due to rounding.

Table 21. Evaluated vs. IOU Estimate: IOU Share of 2013-2015 PY New Title 20 Savings (MW)*

MW	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	107.2	90.7	53.5	37.5	69.4	65.7	28.9	17.1
SCE	32.6%	110.6	93.5	55.2	38.6	71.6	67.7	29.8	17.6
SDG&E	7.4%	25.1	21.2	12.5	8.8	16.3	15.4	6.8	4.0
All IOUs	71.6%	242.8	205.4	121.3	84.9	157.3	148.8	65.4	38.6
Evaluated/IOU Estimated						65%	72%	54%	46%

*Values may not sum exactly due to rounding.

Though Title 20 standards do not produce gas savings directly, they have negative impacts on total gas savings due to interactive effects, as shown in Table 22 and Table 23.

Regarding gas savings attributed to SCG, the CPUC’s policy required determined savings to exclude interactive effects. As discussed, Title 20 standards do not produce gas savings when excluding IEs. For federal standards, Table 30 shows savings attributed to SCG (with IEs excluded).

Table 22. Evaluated vs. IOU Estimate: 2013–2015 PY Statewide Total Gas Savings for New Title 20 Including Interactive Effects (MMTherms)*

MMTherms	IOU Estimated Savings				Evaluated Savings			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2006-2009 T-20 Std 28b (TVs Tier 2)	(21)	(18)	(9)	(5)	(16)	(16)	(5)	(3)
2011 T-20 (Battery chargers)	(25)	(21)	(13)	(10)	(27)	(24)	(15)	(9)
2013-2015 Total	(46)	(39)	(22)	(15)	(43)	(40)	(20)	(12)
Evaluated/IOU Estimated					93%	102%	91%	77%

*Values may not sum exactly due to rounding.

Table 23. Evaluated vs. IOU Estimate: IOU Share of 2013–2015 PY New Title 20 Gas Savings Including Interactive Effects (MMTherms)*

MMTherms	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	(17)	(14)	(8)	(6)	(16)	(14)	(7)	(4)
SCG	58.4%	(27)	(23)	(13)	(9)	(25)	(23)	(12)	(7)
SDG&E	4.1%	(2)	(2)	(1)	(1)	(2)	(2)	(1)	(0)
All IOUs	99.0%	(45)	(38)	(22)	(15)	(42)	(39)	(20)	(12)
Evaluated/IOU Estimated						93%	102%	91%	77%

*Values may not sum exactly due to rounding.

Table 24 shows evaluated and IOU estimates for phase one federal appliance standards. The difference between the residential refrigerator and freezer standard (Fed 11) primarily drove the evaluated potential and the IOU estimate. Although the evaluation found lower unit energy savings (as shown in Table 45), it also found the market size an order of magnitude larger (1.3 million units vs. the IOU estimate of 0.2 million units). As noted above, the IOUs did not provide attribution values for federal standards. As a result, it was not possible to calculate net program savings for the IOU estimated savings. This is also the reason that no comparisons of evaluated net program savings to the IOU estimated savings are shown.

Table 24. Evaluated vs. IOU Estimate: 2013–2015 PY Statewide Total Savings for New Federal Appliances (GWh)*

GWh	IOU Estimated Savings				Evaluated Savings			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2013 Fed Appliance	110	97	86	-	175	159	134	55
2015 Fed Appliance	495	421	351	-	175	126	106	23
2013-2015 Total	604	518	436	-	351	285	240	78
Evaluated/IOU Estimated					58%	55%	55%	n/a

*Values may not sum exactly due to rounding.

Table 25. Evaluated vs. IOU Estimate: IOU Share of 2013-2015 PY New Federal Appliances (GWh)*

GWh	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	191	164	138	-	111	90	76	25
SCE	32.6%	197	169	142	-	114	93	78	25
SDG&E	7.4%	45	38	32	-	26	21	18	6
All IOUs	71.6%	433	371	312	-	251	204	171	56
Evaluated/IOU Estimated						58%	55%	55%	n/a

*Values may not sum exactly due to rounding.

Table 26. Evaluated vs. IOU Estimate: 2013-2015 PY Statewide Total Savings for New Federal Appliances (MW)*

MW	IOU Estimated Savings				Evaluated Savings			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2013 Fed Appliance	40.1	35.7	32.6	-	71.8	65.1	52.5	16.7
2015 Fed Appliance	348.3	296.0	203.0	-	55.2	47.5	34.4	6.3
2013-2015 Total	388.4	331.7	235.6	-	127.0	112.6	87.0	23.1
Evaluated/IOU Estimated					33%	34%	37%	n/a

*Values may not sum exactly due to rounding.

Table 27. Evaluated vs. IOU Estimate: IOU Share of 2013–2015 PY New Federal Appliances (MW)*

MW	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	122.7	104.8	74.4	-	40.1	35.5	27.5	7.3
SCE	32.6%	126.5	108.1	76.8	-	41.4	36.7	28.3	7.5
SDG&E	7.4%	28.7	24.5	17.4	-	9.4	8.3	6.4	1.7
All IOUs	71.6%	277.9	237.3	168.6	-	90.9	80.5	62.2	16.5
Evaluated/IOU Estimated						33%	34%	37%	n/a

*Values may not sum exactly due to rounding.

The federal appliance standards produced gas savings directly, but included negative adjustments to gas via interactive effects. Therefore, the report shows total gas impact with and without interactive effects. The Residential Dishwashers and Residential Direct Heating Equipment standards produced the bulk of direct gas savings, but, after adjusting for NOMAD and attribution, net program savings for these standards became insignificant, and total net program gas savings were negative.

Table 28. Evaluated vs. IOU Estimate: 2013–2015 PY Statewide Total Savings for New Federal Appliances (MMTherms), Including Interactive Effects*

MMTherms	IOU Estimated Savings				Evaluated Savings			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2013 Fed Appliance	(0.1)	(0.1)	(0.5)	-	8.4	8.2	1.7	(0.3)
2015 Fed Appliance	(0.3)	(0.2)	(0.2)	-	16.1	15.7	13.4	4.4
2013-2015 Total	(0.4)	(0.3)	(0.6)	-	24.5	23.9	15.0	4.1

*Values may not sum exactly due to rounding.

Table 29. Evaluated vs. IOU Estimate: IOU Share of 2013–2015 PY New Federal Appliances Including Interactive Effects (MMTherms)*

MMTherms	Percentage of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	(0.1)	(0.1)	(0.2)	-	8.9	8.7	5.5	1.5
SCG	58.4%	(0.2)	(0.2)	(0.4)	-	14.3	13.9	8.8	2.4
SDG&E	4.1%	(0.0)	(0.0)	(0.0)	-	1.0	1.0	0.6	0.2
All IOUs	99.0%	(0.4)	(0.3)	(0.6)	-	24.3	23.6	14.9	4.0

*Values may not sum exactly due to rounding.

**Table 30. Evaluated vs. IOU Estimate: IOU Share of 2013–2015 PY
New Federal Appliances Excluding Interactive Effects (MMTherms)***

MMTherms IOU	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	0.9	0.8	0.6	-	10.0	9.7	6.4	1.8
SCG	58.4%	1.5	1.3	0.9	-	16.1	15.6	10.3	2.9
SDG&E	4.1%	0.1	0.1	0.1	-	1.1	1.1	0.7	0.2
All IOUs	99.0%	2.5	2.1	1.5	-	27.2	26.5	17.5	5.0

*Values may not sum exactly due to rounding.

5.2. Findings for Title 20 Appliance Standards

5.2.1. Standard 28b, Televisions Tier 2, Effective January 1, 2013

As shown in Table 31 and Table 32, the evaluation team found higher potential energy savings for Tier 2 televisions than those estimated by the IOUs, with results driven by higher unit energy savings and a larger market size. The team also found a higher compliance rate than estimated by the IOUs. Evaluated net and program savings, however, were lower as the evaluation team excluded the prior program adjustment to NOMAD, as discussed in Section 4.3.

Table 31. Evaluated vs. IOU Estimated Unit Savings for Standard 28b Televisions Tier 2

Televisions - Tier 2	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	102.0	0.0090	0.0000	1.050	1.320	0.000
Evaluated	110.0	0.0090	0.0000	1.070	1.297	-0.013

Table 32. Evaluated vs. IOU Estimated Market Size and Savings for Standard 28b Televisions Tier 2*

Televisions Tier 2	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
+IOU Estimate	2013	3,338,000	357.5	85%	302.3	-43%	172.2	61%	104.2	11.6	(2.1)
	2014	3,338,000	357.5	85%	302.3	-50%	150.7	61%	91.2	10.1	(1.8)
	2015	3,338,000	357.5	85%	302.3	-56%	132.7	61%	80.3	8.9	(1.6)
	Total		1,072.5		907.0		455.7		275.7	30.6	(5.4)
Evaluated	2013	3,744,138	440.7	97%	428.3	-64%	156.2	61%	94.5	9.37	(1.15)
	2014	3,744,138	440.7	99%	434.1	-69%	136.3	61%	82.5	8.18	(1.00)
	2015	3,744,138	440.7	99%	434.1	-73%	119.4	61%	72.2	7.16	(0.88)
	Total		1,322.1		1,296.5		411.8		249.2	24.7	(3.0)

*Values may not sum exactly due to rounding.

5.2.2. Standard 29, Small Battery Chargers—Tier 1, Effective 2/1/2013

This standard covers consumer battery charger systems, excluding non-USB chargers or USB chargers under 20 watt-hours.

To estimate market size, the evaluation team used sales data purchased from NPD Group for certain products or data available in the Technical Support Document²² (TSD) issued by DOE,²³ depending on the product category. If sources examined could not prove data for certain product categories, the team used values provided in the CASE report.

To assess energy and demand savings, the team evaluated the reasonableness of assumptions (e.g., baseline and compliant wattages, duty cycle) used in the CASE report and made adjustments to values that the team found unreasonable or erroneous. The team also examined the CASE report calculations for annual energy consumption (AEC), but could not reproduce baseline and compliant AEC values for certain product categories. This report’s appendices provide further details regarding these adjustments. While the team found unit energy savings almost twice that estimated by the IOUs, the results also indicated a significantly smaller market size, as shown in Table 34. The team found compliance findings 5% higher than those estimated by the IOUs. Conversely, the unit demand reduction was almost half of that estimated by the IOUs—a finding amplified by the smaller evaluated market size (shown in Table 34).

²² For evaluating some Title 20 standards, the team used U.S. Department of Energy (DOE) Technical Support Documents (TSDs) as they provided, at no cost, high-quality research on markets or products.

²³ <http://www.regulations.gov/contentStreamer?documentId=EERE-2008-BT-STD-0005-0230&attachmentNumber=1&disposition=attachment&contentType=pdf>

Table 33. Evaluated vs. IOU Estimated Unit Savings for Standard 29 Small Battery Chargers—Tier 1

Small Battery Chargers – Tier 1 (consumer with no USB charger or USB charger <20 watt-hours)	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	5.00	0.0007	0.000	1.040	1.320	0.000
Evaluated	9.90	0.0004	0.000	1.047	1.360	-0.021

Table 34. Evaluated vs. IOU Estimated Market Size and Savings for Std. 29 Small Battery Chargers—T1*

Small Battery Chargers Tier 1	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2013	69,466,624	361.4	85%	305.7	-32%	208.4	74%	154.2	26.4	(3.1)
	2014	77,636,054	404.0	85%	341.6	-36%	218.8	74%	161.9	27.7	(3.2)
	2015	79,463,721	413.5	85%	349.7	-40%	211.0	74%	156.1	26.7	(3.1)
	Total		1,178.9		996.9		638.2		472.3	80.7	(9.4)
Evaluated	2013	40,049,717	415.1	90%	373.6	-32%	254.8	58%	146.5	7.5	(2.9)
	2014	43,766,906	453.7	90%	408.3	-36%	261.5	58%	150.4	7.7	(3.0)
	2015	43,766,906	453.7	90%	408.3	-40%	246.4	58%	141.7	7.2	(2.8)
	Total		1,322.4		1,190.2		762.6		438.5	22.4	(8.8)

*Values may not sum exactly due to rounding.

5.2.3. Standard 30, Small Battery Chargers—Tier 2 (Effective January 1, 2014)

Standard 30 covers USB chargers with a capacity of 20 watt-hours or more, which the evaluation team could attribute to a single consumer product class: media tablets. As shown in Table 35 and Table 36, the team found no savings resulted from this standard due to the lack of documentation regarding a baseline efficiency level. The team found an 88% compliance rate for this standard.

Table 35. Evaluated vs. IOU Estimated Unit Savings for Standard 30 Small Battery Chargers—Tier 2

Small Battery Chargers Tier 2	Unit Savings		
	Electricity (kWh)	Demand (kW)	Gas (Therms)
IOU Estimate	10.50	0.0014	0.00
Evaluated	0.00	0.0000	0.00

Table 36. IOU Estimated Market Size and Savings for Standard 30 Small Battery Chargers—Tier 2*

Small Battery Chargers Tier 2	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2013	0	0.0	n/a	0.0	n/a	0.0	n/a	0.0	0.0	0.0
	2014	2,760,000	30.1	85%	25.5	-36%	16.3	74%	12.1	2.1	(0.2)
	2015	3,174,000	34.7	85%	29.3	-40%	17.7	74%	13.1	2.2	(0.3)

*Values may not sum exactly due to rounding.

Note: Standard 31, Small Battery Chargers—Tier 3 (Effective 1/1/2017) did not produce savings during the 2013–2015 evaluation period.

5.2.4. Standard 32, Large Battery Chargers (Effective January 1, 2014)

Standard 32 covers large battery charger systems, defined as having a rated input power above 2kW (e.g., lift trucks).²⁴ As shown in Table 37 and Table 38, the evaluation team found smaller unit energy savings and slightly smaller unit sales compared to those estimated by the IOUs (the appendices provide additional details). Overall, the team found program net savings similar to those from the IOU estimate with a smaller NOMAD adjustment and higher attribution.

Table 37. Evaluated vs. IOU Estimated Unit Energy Savings for Standard 32 Large Battery Chargers

Large Battery Chargers	Unit Savings		
	Electricity (kWh)	Demand (kW)	Gas (Therms)
IOU Estimate	3,323	0.4481	0.00
Evaluated	1,782	0.0800	0.00

Table 38. Evaluated vs. IOU Estimated Market Size and Savings for Standard 32 Large Battery Chargers*

Large Battery Chargers	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2014	8,757	29.1	85%	24.6	-38%	15.2	74%	11.3	1.5	0.0
	2015	9,020	30.0	85%	25.3	-40%	15.3	74%	11.3	1.5	0.0
	Total		59.1		50.0		30.5		22.6	3.0	0.0
Evaluated	2014	7,334	13.1	78%	10.2	-13%	8.9	90%	8.0	0.4	-
	2015	7,334	13.1	78%	10.2	-15%	8.6	90%	7.8	0.3	-
	Total		26.1		20.4		17.5		15.8	0.7	-

*Values may not sum exactly due to rounding.

²⁴ This standard exempts electric vehicles.

5.3. Findings for Federal Appliance Standards

5.3.1. Federal 8, Commercial Clothes Washers (Effective January 8, 2013)

The Code of Federal Regulations defines a commercial clothes washer as a soft-mounted, front-loading (capacity 3.5 ft³ or smaller) or top-loading (capacity 4.0 ft³ or smaller) clothes washer, designed for applications such as multifamily housing common areas or coin laundries. As shown in Table 39 and Table 40 the evaluation team found smaller unit electricity savings, larger gas savings, and significantly larger unit sales compared to those estimated by the IOUs (see the appendices for further details).

Table 39. Evaluated vs. IOU Estimated Unit Energy Savings for Federal 8 Commercial Clothes Washers

Commercial Clothes Washers	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	126.0	0.0200	18.00	1.000	1.000	0.000
Evaluated	90.0	0.0120	20.00	1.092	1.235	-0.005

Table 40. Evaluated vs. IOU Estimated Market Size and Savings for Federal 8 Commercial Clothes Washers*

Commercial Clothes Washers	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2013	3,415	0.43	89%	0.38	-25%	0.29	0%	-	-	0.43
	2014	3,540	0.45	89%	0.40	-25%	0.30	0%	-	-	0.45
	2015	3,543	0.45	89%	0.40	-26%	0.29	0%	-	-	0.45
	Total		1.32		1.18		0.88		-	-	1.32
Evaluated	2013	39,997	3.93	94%	3.70	-53%	1.73	21%	0.37	0.055	3.93
	2014	40,779	4.01	94%	3.77	-53%	1.76	21%	0.37	0.056	4.01
	2015	40,779	4.01	94%	3.77	-53%	1.76	21%	0.37	0.056	4.01
	Total		11.95		11.23		5.24		1.11	0.168	11.95

*Values may not sum exactly due to rounding.

5.3.2. Federal 9, Residential Pool Heaters (Effective April 16, 2013)

Electric savings were neither claimed nor found for this measure, and, as shown in Table 41, evaluated per-unit gas savings were similar to the IOU estimate.

Table 41. Evaluated vs. IOU Estimated Unit Savings for Federal 9 Residential Pool Heaters

Residential Pool Heaters	Unit Savings		
	Electricity (kWh)	Demand (kW)	Gas (Therms)
IOU Estimate	0	0	16
Evaluated	0	0	18

As shown in Table 42, the team found a larger market size than the IOUs estimated, along with a high compliance rate. A larger NOMAD adjustment and higher attribution, however, resulted in negligible total program net gas savings.

Table 42. Evaluated vs. IOU Estimated Market Size and Savings for Federal 9 Residential Pool Heaters*

Residential Pool Heaters	Year	Units	MMtherms							GWh	MW
			Potential Gas Savings	CAF	Gross Gas Savings	NOMAD Adjust.	Net Gas Savings	Attrib.	Program Net Gas Savings	Program Net Energy Savings	Program Net Demand Savings
IOU Estimate	2013	1,589	0.03	89%	0.02	-50%	0.01	-	-	-	-
	2014	2,782	0.04	89%	0.04	-50%	0.02	-	-	-	-
	2015	2,800	0.04	89%	0.04	-50%	0.02	-	-	-	-
	Total		0.11		0.10		0.05		-	-	-
Evaluated	2013	11,572	0.21	95%	0.20	-50%	0.10	5%	0.00	-	-
	2014	16,246	0.29	95%	0.28	-50%	0.14	5%	0.01	-	-
	2015	16,246	0.29	95%	0.28	-50%	0.14	5%	0.01	-	-
	Total		0.79		0.75		0.38		0.02	-	-

*Values may not sum exactly due to rounding.

5.3.3. Federal 10, Residential Direct Heating Equipment (Effective April 16, 2013)

Electric savings were neither claimed nor found, and, as shown in Table 43, evaluated per-unit gas savings were somewhat smaller than the IOU estimate.

Table 43. Evaluated vs. IOU Estimated Unit Savings for Federal 10 Res. Direct Heating Equipment

Residential Direct Heating Equipment	Unit Savings		
	Electricity (kWh)	Demand (kW)	Gas (Therms)
IOU Estimate	-13	0	19
Evaluated	0	0	13

As shown in Table 44, the team found a larger market size than the IOUs estimated, along with a high compliance rate. The NOMAD and attribution adjustments, however, resulted in small total program net gas savings.

Table 44. Evaluated vs. IOU Estimated Market Size and Savings for Federal 10 Residential Direct Heating Equipment*

Residential Direct Heating Equipment	Year	Units	MMtherms						Attrib.	Program Net Standards Gas Savings	GWh Program Net Standards Energy Savings	MW Program Net Standards Demand Savings
			Potential Standards Gas Savings	CAF	Gross Standards Gas Savings	NOMAD Adjust.	Net Standards Gas Savings					
IOU Estimate	2013	9,700	0.18	89%	0.16	-41%	0.09	-	-	-	-	
	2014	13,426	0.25	89%	0.22	-41%	0.13	-	-	-		
	2015	13,491	0.25	89%	0.22	-42%	0.13	-	-	-		
	Total		0.68		0.61		0.35		-	-	-	
Evaluated	2013	43,174	0.56	95%	0.53	-58%	0.22	8%	0.02	-	-	
	2014	60,610	0.79	95%	0.75	-58%	0.31	8%	0.02	-	-	
	2015	60,610	0.79	95%	0.75	-58%	0.31	8%	0.02	-	-	
	Total		2.14		2.03		0.84		0.07			

*Values may not sum exactly due to rounding.

5.3.4. Federal 11, Residential Refrigerators and Freezers (Effective September 15, 2014)

As shown in Table 45 and Table 46, the evaluation team found unit energy savings and demand reduction significantly lower than estimates by the IOUs. The team, however, also found a much larger market size,²⁵ leading to higher potential, gross, and net savings.

The team estimated 37% attribution for this standard, but the IOUs did not provide attribution estimates for the federal appliance standards.

Table 45. Evaluated vs. IOU Estimated Unit Savings for Federal 11 Residential Refrigerators and Freezers

Residential Refrigerators & Freezers	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	149.0	0.0200	0.00	1.040	1.320	0.000
Evaluated	58.0	0.0070	0.00	1.047	1.360	-0.021

²⁵ The evaluated market size was based on 2014 AHAM (Association of Home Appliance Manufacturers) distributor sales for California.

Table 46. Evaluated vs. IOU Estimated Market Size and Savings for Federal 11 Residential Refrigerators and Freezers*

Residential Refrigerators & Freezers	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2014	59,636	9.2	89%	8.2	-12%	7.2	-	-	-	-
	2015	206,213	32.0	89%	28.4	-14%	24.5	-	-	-	-
	Total		41.2		36.7		31.7		-	-	-
Evaluated	2014	393,136	23.9	95%	22.7	-12%	19.9	37%	7.3	1.2	(0.1)
	2015	1,328,654	80.7	95%	76.6	-15%	65.1	37%	24.1	3.8	(0.5)
	Total		104.6		99.3		84.9		31.4	4.9	(0.6)

*Values may not sum exactly due to rounding.

5.3.5. Federal 12, Residential Room Air Conditioners, Effective June 1, 2014

As shown in Table 47 and Table 48, the evaluation team found similar energy and demand unit savings to the IOU estimates, but identified a larger market size that at least doubled potential, gross, and net savings.²⁶

The team’s estimated 24% attribution for this standard, but the IOUs did not provide attribution estimates for the federal appliance standards.

Table 47. Evaluated vs. IOU Estimated Unit Savings for Federal 12 Residential Room Air Conditioners

Residential Room AC	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	71.0	0.1160	0.00	1.000	1.000	0.000
Evaluated	73.0	0.1030	0.00	1.000	1.000	0.000

²⁶ The evaluated market size was based on 2014 AHAM distributor sales for California.

Table 48. Evaluated vs. IOU Estimated Market Size and Savings for Federal 12 Residential Room Air Conditioners*

Residential Room AC	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2014	71,150	5.05	89%	4.50	-4%	4.30	0%	-	-	-
	2015	121,637	8.64	89%	7.69	-5%	7.32	0%	-	-	-
	Total		13.69		12.18		11.62		-	-	-
Evaluated	2014	170,260	12.43	91%	11.31	-19%	9.18	24%	2.20	3.11	-
	2015	290,397	21.20	91%	19.29	-22%	15.02	24%	3.60	5.09	-
	Total		33.63		30.60		24.20		5.81	8.19	-

*Values may not sum exactly due to rounding.

5.3.6. Federal 13, Fluorescent Ballasts (Effective November 14, 2014)

As shown in Table 49 and Table 50, the evaluation team found smaller energy and demand unit savings than did the IOU estimates, but the results also indicated a larger market size, leading to an overall finding of evaluated savings at 60-80% of the IOU estimated potential, gross, and net savings.

The fluorescent ballast standard (Fed 13) led to a changed method for calculating fluorescent ballasts' efficiency. DOE developed a new metric, BLE, which replaced the commonly used ballast efficacy factor (BEF), which served as the primary metric in calculating and comparing efficiency. DOE produced the new metric as BEF relies on a ballast's full system and installed linear fluorescent lamps, and therefore cannot be used to calculate just the ballast's efficiency; BLE can be used for this purpose.

Although BLE provides a better metric for assessing fluorescent ballast energy savings, a baseline did not exist for this measure, making it difficult to calculate per-unit fluorescent ballast savings using BLE (i.e., a comparison cannot be made to a previous standard). Consequently, the team determined that using data from DOE's TSD and final ruling to assess potential energy savings provided the best approach, and the team used these data to determine a baseline and energy saving level for new ballasts to meet for sales in the United States (after the standard took effect). The team multiplied savings by the market share to determine weighted average unit savings. The appendices detail the steps involved in this process as well as the data sources used.

The team's estimated 74% attribution for this standard—a high rate for a federal standard. The IOUs did not provide attribution estimates for the federal appliance standards. For compliance and feasibility, the team's findings were based on factor scores of 80%.

Table 49. Evaluated vs. IOU Estimated Unit Savings for Federal 13 Fluorescent Ballasts

Fluorescent Ballasts	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	23.0	0.0040	0.00	1.100	1.227	0.000
Evaluated	15.3	0.0029	0.00	1.092	1.235	-0.005

Table 50. Evaluated vs. IOU Estimated Market Size and Savings for Federal 13 Fluorescent Ballasts*

Fluorescent Ballasts	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2014	223,752	5.7	89%	5.0	-9%	4.6	-	-	-	-
	2015	1,795,746	45.4	89%	40.4	-10%	36.3	-	-	-	-
	Total		51.1		45.5		40.8		-	-	-
Evaluated	2014	309,726	4.4	80%	3.5	-25%	2.6	74%	2.0	0.4	(0.01)
	2015	2,355,210	33.4	80%	26.7	-27%	19.4	74%	14.4	3.1	(0.07)
	Total		37.7		30.2		22.1		16.3	3.5	(0.07)

*Values may not sum exactly due to rounding.

5.3.7. Federal 14, Small Commercial Package ACs, Effective June 1, 2013

As shown in Table 51, the evaluation team found significantly smaller energy and demand savings than estimated by the IOUs. As shown in Table 52, however, this standard realized a market size so small that savings were negligible in either case.

Table 51. Evaluated vs. IOU Estimated Unit Savings for Federal 14 Small Commercial Package ACs

Small Commercial Package Air-Conditioners ≥65 and <135 kBtu/h	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	345.2	0.1791	0.00	1.000	1.000	0.000
Evaluated	23.0	0.0060	0.00	1.000	1.000	0.000

**Table 52. Evaluated vs. IOU Estimated Market Size and Savings
for Federal 14 Small Commercial Package ACs***

Small Commercial Package Air-Conditioners ≥65 and <135 kBtu/h	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2013	1	0.0	89%	0.0	-93%	0.0	-	-	-	-
	2014	2	0.0	89%	0.0	-93%	0.0	-	-	-	-
	2015	2	0.0	89%	0.0	-93%	0.0	-	-	-	-
	Total		0.0		0.0		0.0		-	-	-
Evaluated	2013	9	0.0	100%	0.0	-93%	0.0	10%	0.0	0.00	-
	2014	16	0.0	100%	0.0	-93%	0.0	10%	0.0	0.00	-
	2015	16	0.0	100%	0.0	-93%	0.0	10%	0.0	0.00	-
	Total		0.0		0.0		0.0		0.0	0.0	-

*Values may not sum exactly due to rounding.

5.3.8. Federal 15, Large Commercial Package ACs (Effective June 1, 2014)

As shown in Table 53, the evaluation team found significantly smaller energy and demand savings than estimated by the IOUs. As shown in Table 54, however, this standard realized a market size so small that savings were negligible in either case.

Table 53. Evaluated vs. IOU Estimated Unit Savings for Federal 15 Large Commercial Package ACs

Large and Very Large Commercial Package Air-Conditioners ≥135 kBtu/h	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	3225.4	1.6736	0.00	1.000	1.000	0.000
Evaluated	688.0	0.2730	0.00	1.000	1.000	0.000

Table 54. Evaluated vs. IOU Estimated Market Size and Savings for Federal 15 Large Commercial Package ACs*

Large and Very Large Commercial Package Air-Conditioners ≥135 kBtu/h	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2013	0	-	n/a	-	n/a	-	-	-	-	-
	2014	12	0.0	89%	0.0	-75%	0.0	-	-	-	-
	2015	20	0.1	89%	0.1	-76%	0.0	-	-	-	-
	Total		0.1		0.1		0.0		-	-	-
Evaluated	2013	0	-	n/a	-	n/a	-	n/a	-	-	-
	2014	97	0.1	100%	0.1	-75%	0.0	10%	0.0	0.00	-
	2015	166	0.1	100%	0.1	-76%	0.0	10%	0.0	0.00	-
	Total		0.2		0.2		0.0		0.0	0.0	-

*Values may not sum exactly due to rounding.

5.3.9. Federal 16, Computer Room ACs (Effective October 29, 2013)

As shown in Table 55 and Table 56, the evaluation team found similar unit energy savings, but lower demand reduction than provided by the IOU estimates. The team found a larger—but still very small—market size, resulting in negligible potential savings. While the team compliance at 100%, based on input from experts on the team, 99% of the market would have adopted this efficiency level in the standard’s absence.

The team estimated this standard’s attribution at 10%, and the IOUs did not provide attribution estimates for the federal appliance standards.

Table 55. Evaluated vs. IOU Estimated Unit Savings for Federal 16 Computer Room ACs

Computer Room Acs ≥65,000 Btu/h and < 760,000 Btu/h	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity	Demand	Gas			
	(kWh)	(kW)	(Therms)			
IOU Estimate	77.0	0.0399	0.00	1.000	1.000	0.000
Evaluated	76.0	0.0090	0.00	1.000	1.000	0.000

Table 56. Evaluated vs. IOU Estimated Market Size and Savings for Federal 16 Computer Room ACs*

Computer Room ACs >=65,000 Btu/h and < 760,000 Btu/h	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2013	40	0.0	89%	0.0	-99%	0.0	-	-	-	-
	2014	234	0.0	89%	0.0	-99%	0.0	-	-	-	-
	2015	240	0.0	89%	0.0	-99%	0.0	-	-	-	-
	Total		0.0		0.0		0.0		-	-	-
Evaluated	2013	477	0.0	100%	0.0	-99%	0.0	10%	0.0	0.0	0.0
	2014	2,723	0.2	100%	0.2	-99%	0.0	10%	0.0	0.0	0.0
	2015	2,723	0.2	100%	0.2	-99%	0.0	10%	0.0	0.0	0.0
	Total		0.5		0.5		0.0		0.0	0.0	0.0

*Values may not sum exactly due to rounding.

5.3.10. Federal 17, Residential Dishwashers, Effective May 30, 2013

As shown in Table 57 and Table 58, the evaluation team found positive gas and negative electric and demand savings for this standard. The electric consumption under the new standard is slightly higher than the old standard mostly due to a specific allowance of 14.5 kWh/year for standby mode.

Water heating fuel shares drove this result: the 2009 Residential Appliance Saturation Survey indicated the majority of PG&E and SCE/SoCalGas customers used gas water heating. The team found a significantly larger market size than that estimated by the IOUs, resulting in relatively significant negative potential and gross electric savings.

The team estimated this standard’s attribution at 5%; the IOUs did not provide attribution estimates for the federal appliance standards.

Table 57. Evaluated vs. IOU Estimated Unit Savings for Federal 17 Residential Dishwashers

Residential Dishwashers	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	8.7	0.0014	1.06	1.040	1.320	0.000
Evaluated	-6.2	-0.0007	2.50	1.047	1.360	-0.021

Table 58. Evaluated vs. IOU Estimated Market Size and Savings for Federal 17 Residential Dishwashers*

Residential Dishwashers	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2013	64,139	0.58	89%	0.52	-65%	0.18	0%	-	-	-
	2014	107,185	0.97	89%	0.86	-66%	0.29	0%	-	-	-
	2015	111,179	1.01	89%	0.90	-67%	0.29	0%	-	-	-
	Total		2.56		2.28		0.77		-	-	-
Evaluated	2013	466,199	(3.03)	99%	(3.00)	-78%	(0.67)	5%	(0.03)	(0.005)	0.014
	2014	787,790	(5.11)	99%	(5.06)	-78%	(1.14)	5%	(0.06)	(0.008)	0.023
	2015	787,790	(5.11)	99%	(5.06)	-78%	(1.14)	5%	(0.06)	(0.008)	0.023
	Total		(13.25)		(13.12)		(2.95)		(0.15)	(0.022)	0.060

*Values may not sum exactly due to rounding.

5.3.11. Federal 18, Residential Clothes Dryers, Effective January 1, 2015

The evaluation team found fewer unit electricity savings for this standard, but greater gas savings, as shown in Table 59 and Table 60.

Table 59. Evaluated vs. IOU Estimated Unit Savings for Federal 18, Residential Clothes Dryers

Residential Clothes Dryers	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	28.9	0.0044	0.02	1.040	1.320	0.000
Evaluated	10.3	0.0013	0.35	1.040	1.320	-0.021

Table 60. Evaluated vs. IOU Estimated Market Size and Savings for Federal 18, Residential Clothes Dryers

Residential Clothes Dryers	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2015	940,304	28.26	85%	24.02	-31%	16.48	0%	-	-	-
Evaluated	2015	720,291	7.72	99%	7.64	-31%	5.24	45%	2.36	0.378	0.030

5.3.12. Federal 19, Residential Gas-fired Water Heater, Effective April 16, 2015

The evaluation team found significantly greater potential gas savings for this standard than did the IOU estimates, due to larger per-unit savings and units, as shown in Table 61 and Table 62.

Table 61. Evaluated vs. IOU Estimated Unit Savings for Federal 19, Residential Gas-fired Water Heater

Residential Gas-Fired Water Heater	Unit Savings		
	Electricity (kWh)	Demand (kW)	Gas (Therms)
IOU Estimate	0	0.0000	0.80
Evaluated	0	0.0000	9.00

Table 62. Evaluated vs. IOU Estimated Market Size and Savings for Federal 19, Residential Gas-fired Water Heater

Residential Gas-Fired Water Heater	Year	Units	MMtherms							GWh	MW
			Potential Gas Savings	CAF	Gross Gas Savings	NOMAD Adjustment	Net Gas Savings	Attrib.	Program Net Gas Savings	Program Net Energy Savings	Program Net Demand Savings
IOU Estimate	2015	401,684	0.32	85%	0.27	-35%	0.18	0%	0	0	0
Evaluated	2015	742,294	6.68	98%	6.55	-35%	4.28	36%	1.54	-	-

5.3.13. Federal 20, Residential Electric Storage Water Heater, Effective April 16, 2015

The evaluation team found the same unit energy savings for Federal 20 (shown in Table 63), but found a smaller market size than the IOUs estimated (shown in Table 64).

Table 63. Evaluated vs. IOU Estimated Unit Savings for Federal 20, Residential Electric Storage Water Heater

Residential Electric storage water heater	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	173.0	0.0230	0.00	1.000	1.000	0.000
Evaluated	173.0	0.0170	0.00	1.000	1.000	0.000

Table 64. Evaluated vs. IOU Estimated Market Size and Savings for Federal 20, Residential Electric Storage Water Heater

Residential Electric Storage Water Heater	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2015	444,799	77.0	85%	65.41	-6%	61	0%	0.000	0.0000	0
Evaluated	2015	62,420	10.8	88%	9.5	-6%	8.9	36%	3.2	0.3	-

5.3.14. Federal 21, Residential Gas-fired Instantaneous Water Heater, Effective April 16, 2015

The evaluation team found significantly larger gas unit savings (shown in Table 65), but a much smaller market size (shown in Table 66). With regard to the negative electric savings, DOE notes in its TSD that tankless (“instantaneous”) gas-fired units at 0.78 EF and above use more electricity than less-efficient units.

Table 65. Evaluated vs. IOU Estimated Unit Savings for Federal 21, Residential Gas-fired Instantaneous Water Heater

Residential Gas-fired instantaneous water heater	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	-29.1	-0.0039	5.80	1.000	1.000	0.000
Evaluated	-29.0	-0.0030	58.00	1.000	1.000	0.000

Table 66. Evaluated vs. IOU Estimated Market Size and Savings for Federal 21, Residential Gas-fired Instantaneous Water Heater

Residential Gas-Fired Instantaneous Water Heater	Year	Units	MMtherms							GWh	MW
			Potential Gas Savings	CAF	Gross Gas Savings	NOMAD Adjustment	Net Gas Savings	Attrib.	Program Net Gas Savings	Program Net Energy Savings	Program Net Demand Savings
IOU Estimate	2015	108,150	0.63	85%	0.53	0%	0.53	0%	0	0	0
Evaluated	2015	39,068	2.27	87%	1.97	0%	1.97	36%	0.71	(0.35)	(0.04)

5.3.15. Federal 23, Small Electric Motors, Effective March 9, 2015

The evaluation team found smaller potential energy savings for this standard than those claimed by the IOUs (shown in Table 67 and Table 68), along with the lowest compliance for all standards evaluated in this cycle.

Table 67. Evaluated vs. IOU Estimated Unit Savings for Federal 23, Small Electric Motors

Small Electric Motors	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	380.0	0.0594	0.00	1.000	1.000	0.000
Evaluated	266.0	0.0400	0.00	1.000	1.000	0.000

Table 68. Evaluated vs. IOU Estimated Market Size and Savings for Federal 23 Small Electric Motors

Small Electric Motors	Year	Units*	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2015	430,754	163.7	85%	139.13	-2%	136	0%	0.000	0.0000	0
Evaluated	2015	278,161	74.0	35%	25.9	-2%	25.4	9%	2.16	0.3	-

* Units are not annual values, but adjusted based on the standard's effective date.

5.3.16. Federal 24, Residential Clothes Washers (Front Load), Effective March 7, 2015

The evaluation team found higher unit gas savings and a slightly smaller market size than did the IOUs (shown in Table 69 and Table 70). Higher machine electric consumption for front-loading units and the expected mix of gas water heating drove the finding of negative electric impact for this standard.

Table 69. Evaluated vs. IOU Estimated Unit Savings for Federal 24, Residential Clothes Washers (Front Load)

Residential Clothes Washers (Front Loading)	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	4.5	0.0007	0.0288	1.040	1.320	0.000
Evaluated	-16.0	-0.0020	4.3000	1.040	1.320	-0.021

Table 70. Evaluated vs. IOU Estimated Market Size and Savings for Federal 24, Residential Clothes Washers (Front Load)

Residential Clothes Washers (Front Loading)	Year	Units	MMtherms							GWh	MW
			Potential Gas Savings	CAF	Gross Gas Savings	NOMAD Adjustment	Net Gas Savings	Attrib.	Program Net Gas Savings	Program Net Energy Savings	Program Net Demand Savings
IOU Estimate	2015	490,691	(0.031)	85%	(0.027)	0%	(0.027)	0%	2.29	0	0
Evaluated	2015	363,739	1.684		1.684		1.684		0.505	(1.816)	(0.288)

5.3.17. Federal 25, Residential Clothes Washers (Top Load), Effective March 7, 2015

The evaluation team found lower electricity savings, but also higher gas unit savings and a larger market size (shown in Table 71 and Table 72).

Table 71. Evaluated vs. IOU Estimated Unit Savings for Federal 25, Residential Clothes Washers (Top Load)

Residential Clothes Washers (Top Loading) Tier I	Unit Savings			Interactive Energy Savings Factor (kWh/kWh)	Interactive Demand Savings Factor (kW/kW)	Interactive Gas Savings Adjustment Factor (Therms/GWh)
	Electricity (kWh)	Demand (kW)	Gas (Therms)			
IOU Estimate	96.9	0.0148	0.5357	1.040	1.320	0.000
Evaluated	70.0	0.0091	10.2000	1.040	1.320	-0.021

Table 72. Evaluated vs. IOU Estimated Market Size and Savings for Federal 25, Residential Clothes Washers (Top Load)

Residential Clothes Washers (Top Loading) Tier I	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2015	435,141	43.86	85%	37.28	0%	37.28	0%	0.000	0.0000	0
Evaluated	2015	613,776	44.68	100%	44.68	0%	44.68	30%	13.40	2.21	1.61

5.3.18. Federal 26, Residential Central Air Conditioners and Heat Pumps (Effective January 1, 2015)

As shown in Table 73 and Table 74, the evaluation team found significantly smaller unit energy savings and a smaller market size for this standard than did the IOUs.

Table 73. Evaluated vs. IOU Estimated Unit Savings for Federal 26, Residential Central Air Conditioners and Heat Pumps

Residential Central AC, Heat Pumps and Furnaces	Unit Savings		
	Electricity (kWh)	Demand (kW)	Gas (Therms)
IOU Estimate	213	0.3475	0.00
Evaluated	108	0.0840	0.00

Table 74. Evaluated vs. IOU Estimated Market Size and Savings for Federal 26, Residential Central Air Conditioners and Heat Pumps

Residential Central AC, Heat Pumps and Furnaces	Year	Units	GWh							MW	MMtherms
			Potential Energy Savings	CAF	Gross Energy Savings	NOMAD Adjustment	Net Energy Savings	Attrib.	Program Net Energy Savings	Program Net Demand Savings	Program Net Gas Savings
IOU Estimate	2015	858,942	183.0	85%	155.58	-36%	100	0%	0.000	0.0000	0
Evaluated	2015	422,382	45.4	99%	45.0	-36%	28.9	15%	4.41	3.4	-

5.4. Findings for All Appliance Standards Evaluated to Date

This section includes savings from all previously evaluated appliance standards along with new standards for the years 2013–2015. Savings reported in this section include IEs.

The stream of savings from each code or standard may change each year for a variety of reasons, including the following:

- Increase in the estimated NOMAD value, which reduces net savings.
- Reduction of the prior program adjustment, which increases the magnitude of the net NOMAD value
- Federal preemption of a California Title 20 standard (detailed in Section 2.5).
- Updates to market volumes where more recent data were available. For example, the team obtained market data for televisions and used the new market size of 3.7 million units for both TV standards: 28a and 28b.
- Changes in compliance rates. For example, the team used new shelf-survey data to update the compliance rates for Fed 6, Incandescent Reflector Lamps.
- The reevaluated the market size for these standards, with Table 75 showing the previous and updated values.

Table 75. Standards Updated Market Size

Standard Number	Description	Effective Date	2013–2015 Annual Units	Previous Annual Units
Std 8	Residential pool pumps, high-efficiency motor, Tier 1	1/1/2006	314,221	142,700
Std 9	Residential pool pumps, 2-speed Motors, Tier 2	1/1/2008		
Fed 1	Electric motors 1–200 HP	12/19/2010	324,000	254,280
Fed 6	Incandescent Reflector Lamps	07/14/2012	Units: 7,239,740 Compliance: 65%	Units: 7,239,740 Compliance: 7%
Fed 7	General service fluorescent lamps	7/14/2012	24,126,000	9,212,320

Table 76 shows the changes to previously evaluated standards. Standards in grey changed due to preemption by federal standards.

Table 76. Updates to Previously Evaluated Standards* 2013-2015 Total Savings

GWh	Previously Evaluated Savings				Updated Savings				
	Standard	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
Std 8	103	103	86	68	228	228	188	150	
Std 9	1,010	868	789	623	1,947	1,674	1,520	1,200	
Std 12a	389	389	162	121	-	-	-	-	
Std 12b	160	160	68	51	-	-	-	-	
Std 15	325	325	122	71	-	-	-	-	
Std 16	59	58	36	21	-	-	-	-	
Std 23	133	126	96	70	-	-	-	-	
Fed 1	439	399	375	195	559	509	478	249	
Fed 6	165	11	11	3	165	107	102	28	
Fed 7	985	936	528	100	2,580	2,451	1,383	263	
Total	3,767	3,376	2,274	1,323	5,478	4,968	3,671	1,889	
Change					145%	147%	161%	143%	

*Values may not sum exactly due to rounding.

5.4.1. Evaluated Savings for all Title 20 and Federal Appliance Standards

Table 77, Table 78, Table 79, and Table 80 present the three-year total savings from all previously evaluated appliance standards and the standards in the Phase One scope. This enables the team to calculate overall totals for electricity, demand, and gas.

Once again, gas savings change substantially when IEs are included or excluded. When IEs are included as shown in Table 79, total IEs (due to large electricity savings) are greater than direct gas savings: the overall result is that more gas is needed or as shown, savings are negative.

When IEs are excluded, direct gas savings become visible as shown in Table 80.

These totals include savings from California standards superseded by later Title 20 standards. The savings from such supersede standards are sometimes referred to as layered savings. The 2010–2012 evaluation report includes additional discussion and analysis of layered savings. In general, all values in this report include layered savings.

Table 77. 2013–2015 Electricity Savings for Evaluated Appliance Standards (GWh)*

Standards Group	Potential Energy Savings	Gross Energy Savings	Net Energy Savings	Program Net Energy Savings
2005 T-20	712	626	208	169
2005 T-20_2017_Updates	228	228	188	150
2006–2009 T-20	1,951	1,851	934	585
2006–2009 T-20 Std 28b (TVs Tier 2)	1,322	1,296	412	249
2006–2009 T-20_2017_Updates	1,947	1,674	1,520	1,200
2010–2012 Fed Appliance	133	78	36	15
2010–2012 Fed Appliance_2017_Updates	3,303	3,066	1,963	539
2011 T-20 (Battery chargers)	1,349	1,211	780	454
2013 Fed Appliance	175	159	134	55
2015 Fed Appliance	175	126	106	23
Total	11,295	10,315	6,281	3,439
PG&E	3,567	3,258	1,984	1,086
SCE	3,679	3,360	2,046	1,120
SDG&E	835	763	464	254
All Other	3,213	2,935	1,787	979

*Values may not sum exactly due to rounding.

Table 78. 2013–2015 Demand Savings for Evaluated Appliance Standards (MW)*

Standards Group	Potential Demand Savings	Gross Demand Savings	Net Demand Savings	Program Net Demand Savings
2005 T-20	104	91	29	24
2005 T-20_2017_Updates	44	44	36	29
2006–2009 T-20	252	237	132	83
2006–2009 T-20 Std 28b (TVs Tier 2)	131	129	41	25
2006–2009 T-20_2017_Updates	141	122	110	87
2010–2012 Fed Appliance	21	13	6	3
2010–2012 Fed Appliance_2017_Updates	827	770	471	113
2011 T-20 (Battery chargers)	89	79	51	29
2013 Fed Appliance	72	65	53	17
2015 Fed Appliance	55	47	34	6
Total	1,736	1,597	962	415
PG&E	548	504	304	131
SCE	566	520	313	135
SDG&E	128	118	71	31
All Other	494	454	274	118

*Values may not sum exactly due to rounding.

Table 79. 2013–2015 Gas Savings for Evaluated Appliance Standards Including Interactive Effects (MMtherms)*

Standards Group	Potential Gas Savings	Gross Gas Savings	Net Gas Savings	Program Net Gas Savings
2005 T-20	(1)	(0)	4	3
2005 T-20_2017_Updates	0	0	0	0
2006–2009 T-20	(23)	(22)	(11)	(7)
2006–2009 T-20 Std 28b (TVs Tier 2)	(16)	(16)	(5)	(3)
2006–2009 T-20_2017_Updates	0	0	0	0
2010–2012 Fed Appliance	(1)	(0)	0	(0)
2010–2012 Fed Appliance_2017_Updates	(11)	(10)	(6)	(1)
2011 T-20 (Battery chargers)	(27)	(24)	(15)	(9)
2013 Fed Appliance	8	8	2	(0)
2015 Fed Appliance	16	16	13	4
Total	(55)	(48)	(18)	(13)
PG&E	(17)	(15)	(6)	(4)
SCE	(18)	(16)	(6)	(4)
SCG	0	0	0	0
SDG&E	(4)	(4)	(1)	(1)
All Other	(16)	(14)	(5)	(4)

*Values may not sum exactly due to rounding.

Table 80. 2013–2015 Gas Savings for Evaluated Appliance Standards Excluding Interactive Effects (MMtherms)*

Standards Group	Potential Gas Savings	Gross Gas Savings	Net Gas Savings	Program Net Gas Savings
2005 T-20	7.4	7.4	5.3	3.9
2005 T-20_2017_Updates	0.0	0.0	0.0	0.0
2006–2009 T-20	0.0	0.0	0.0	0.0
2006–2009 T-20 Std 28b (TVs Tier 2)	0.0	0.0	0.0	0.0
2006–2009 T-20_2017_Updates	0.0	0.0	0.0	0.0
2010–2012 Fed Appliance	1.2	1.1	0.8	0.2
2010–2012 Fed Appliance_2017_Updates	0.0	0.0	0.0	0.0
2011 T-20 (Battery chargers)	0.0	0.0	0.0	0.0
2013 Fed Appliance	10.5	10.1	3.4	0.4
2015 Fed Appliance	17.0	16.6	14.3	4.7
Total	36.1	35.3	23.8	9.2
PG&E	13.2	12.9	8.7	3.3
SCE	0.0	0.0	0.0	0.0
SCG	21.1	20.6	13.9	5.3
SDG&E	1.5	1.5	1.0	0.4
All Other	0.4	0.3	0.2	0.1

*Values may not sum exactly due to rounding.

6. Conclusions and Recommendations

This chapter summarizes the evaluation team’s conclusions and recommendations regarding the evaluation process. In the 2010–2012 evaluation, the team concluded that program saving estimates were not initially documented well in the IOU savings estimates and CCTRs.

The team recognized that the statewide C&S program differed from resource-acquisition programs in that it did not use participant databases that define program savings for evaluators. Rather, evaluators generally depended on resource programs to provide documentation of estimated savings. For the C&S program, however, the evaluation team had to spend considerable effort in collecting information that ordinarily would be provided by the program, such as the following:

- **Product market volumes.** For the majority of C&S, market data from approximately the time of the CEC approval process supported the IOU Estimate. Many product mix and annual volume values derived from CASE reports, usually dated between 2004 and 2008. Their sources were necessarily somewhat older.
- **Delays in the availability of CASE reports and CCTRs.** The IOUs took 16 months to deliver all CCTRs. As the CCTRs proved critical to determining attribution, the contents and availability of these documents directly affected the evaluation.

Conclusion: Delivery of program savings estimates, CASE reports, and CCTRs improved, but significant gaps remain in the documentation available to evaluators.

Improvements include the following:

- Nearly all parameters (except for attribution values of federal standards) were provided at the start of the evaluation in the ISSM format.
- Market volume sources were documented, as requested.
- CASE reports and CCTRs were delivered as planned and in a shorter time period than previously.
- Although no federal attribution values were provided, attribution documentation to support federal standard adoption generally was complete and met the requirements previously identified.

Significant documentation gaps:

- **Product market volumes:**
 - Although the sources were documented by name, the team often could not find specific source values used.
 - As in the past, sources often were several years old and did not represent current market conditions.
- **Unit energy savings.** Submitted estimate values did not match the CASE report, and no other documentation was provided. Absent documentation made it impossible to reconcile evaluation findings to the submitted estimate.

- **Standards were developed after completing CASE reports.** For example, the Small Battery Charger, Tier 2 (Standard 30) product category (i.e., USB chargers with greater than 20-Watt hour capacity) was not identified in the CASE report, yet the CEC adopted it. The team did not receive documentation on the basis for unit energy savings, market volumes, or savings potentials.

Recommendations:

Statewide program administrators and the CPUC should resolve data gap issues before starting the next impact evaluation.

The IOUs should update the Code Change Theory Reports or provide other supplementary documentation that reflects the adopted standard.

Conclusion: Verifying compliance has become more challenging.

This issue includes the following factors:

- **Increasing complexity of regulations and data needs to assess compliance.** For example, Title 20 regulations on battery charger systems used the maximum 24-hour charge and maintenance energy as the performance parameter. This information, however, this information was not readily available in the product literature; and only testing provided a way to determine compliance for products not listed on the CEC list. Similar issues occurred with regulations on swimming pool systems, which changed from pump motor requirements to specific control settings.
- **Product proliferation.** For products such as televisions and battery charger systems, the CEC listing process lagged behind the rapidly changing products available on the market. Measuring compliance requires additional research to determine compliance for unlisted products.

Recommendation: The CPUC and evaluators should consider collaborating with the CEC to efficiently use resources for determining compliance.

Conclusion: Grouping multiple product types/standards in a single CCTR tends to limit the evaluators' ability to assign attribution scores to each standard

The attribution team found insufficient information to calculate factor scores for some individual product types when supporting documentation grouped them with other products. In most instances, products were grouped in a similar manner to the rulemakings themselves. However, in federal standards there are often contributions and discussions based not on the rulemaking as a whole, but rather a specific appliance category or regulation. The extent to which equipment types and contributions to those equipment types can be separated affects the ability of the attribution team to provide a more nuanced and granular attribution score.

Examples include the following:

- A single CCTR was provided for battery chargers, which had four standards. As discussed, the CASE report included three categories, but it did not include references to the Small Charger, Tier 2—USB product category.

- Combined documentation for water heaters, pool heaters, and direct-heating equipment.

Recommendation: Do not group unlike technologies together in a single CCTR.

Conclusion: Evaluating standards that target components (e.g., electric motors) proves challenging.

Particularly for small electric motors, concern exists that products manufactured overseas may contain noncompliant parts. Verifying compliance is impossible, short of tearing out the motor. Even if testing offered an option, it would remain challenging to identify whether a product contained a covered product as components specifications are rarely available. Trade associations such as the National Electrical Manufacturers Association (NEMA) may prove useful in obtaining market data on domestic small motor manufacturers, but these statistics would likely not represent a large fraction of foreign suppliers.

Recommendations:

Consider reevaluating these standards over time as more market studies are completed.

Electric motor and small electric motor compliance also should be reevaluated after completion and application of the *Certification, Compliance, Labeling, and Enforcement for Electric Motors and Small Electric Motors Final Rule*.