CONSULTANT REPORT

Statewide Codes and Standards Program Impact Evaluation Report

For Program Years 2010-2012

Prepared for: California Public Utilities Commission

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DNV GL

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Many other individuals answered our calls and emails as we searched for information on product mix, market volumes, code compliance, and other evaluation inputs. Among this group, the 200 building owners and managers that hosted code compliance site visits warrant a special mention. The evaluation results are considerably strengthened by the help we received.

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LIST OF ACRONYMS AND ABBREVIATIONS

A/C (AC)	Air Conditioning
ACCA	Air Conditioning Contractors of America
ACM	Alternative Calculation Method
ACP	Air Care Plus
ADM	ADM Associates
AEC	Architectural Energy Cooperation
AERS	Automated Energy Review for Schools
AHP	Analytic Hierarchy Process
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BEA	Building Efficiency Analysis
Bldg	Building
C&I	Commercial and Industrial
C&S	Codes and Standards
CAF	Compliance Adjustment Factor
CASE	Codes and Standards Enhancement Initiative
CATI	Computer Assisted Telephone Interviewing
CBEE	California Board of Energy Efficiency
CCTR	Code Change Theory Report
CEC	California Energy Commission
CEP	Compliance Enhancement Program
CFL	Compact Fluorescent Lamp
CF1-R	Title 24 Residential Compliance Form
CfR	Composite for Remainder
CG	Contract Group
CHEERS	California Home Energy Efficiency Rating Services
CIEE	California Institute for Energy Efficiency
CMFNH	California Multifamily New Homes Program
CMMHP	Comprehensive Manufactured-Mobile Home Program
CPUC	California Public Utilities Commission
CRCA	Computerized Refrigerant Charge and Airflow
CTZ	Climate Thermal Zone
CV	Coefficient of Variation
CZ	Climate Zone
DEER	Database for Energy Efficiency Resources
DfC	Designed for Comfort
DHW	Domestic Hot Water
DMQC	Data Management and Quality Control
DOE	United States Department of Energy
DRET	Demand Response Emerging Technologies
DSA	Division of the State Architect
ECM	Energy Conservation Measure
ED	Energy Division
EE	Energy Efficiency

EEGA	Energy Efficiency Groupware Application
EM&V	Evaluation, Measurement, and Verification
EER	Energy Efficiency Rating
EUL	Economic Useful Life
FLA	Full Load Amps
GWh	Gigawatt Hours
HERS	Home Energy Rating System
HIM	High Impact Measure
HMG	Heschong-Mahone Group, acquired by TRC in 2013
HUD	Housing & Urban Development
HVAC	Heating, Ventilation and Air Conditioning
ICF	ICF International
IDEEA	Innovative Designs for Energy Efficiency Applications
InDEE	Innovative Design for Energy Efficiency
IOU	Investor-Owned Utility
IPMVP	International Performance Measurement and Verification Protocol
ISSM	Integrated Standards Savings Model
ITD	Installed To Date
kBtu	Thousand Btu
kW	Kilowatt
kWh	Kilowatt Hour
LADWP	Los Angeles Department of Water & Power
LBNL	Lawrence Berkeley National Laboratory
LEED	Leadership in Energy and Environmental Design
LGP	Local Government Programs
LPD	Lighting Power Density
M&V	Measurement and Verification
MECT	Master Evaluation Contractor Team
MF	Multifamily
MHRA	Manufactured Housing Research Alliance
Mil	Million
MS	Microsoft
Mtherms	Million therms; also MTherms
N	Sample Size
NAC	Normalized Annual Consumption
NC	New Construction
NCCS	New Construction/ Codes and Standards
NOMAD	Naturally Occurring Market Adoption
NOSAD	Normally Occurring Standards Adoption
NP	Non Participant
NRNC	Non Residential New Construction
NTG	Net to Gross
NTGR	Net to Gross Ratio
NTP	Notice to Proceed
P	Participant
PG&E	Pacific Gas & Electric
PIER	Public Interest Energy Research
PTAC	Packaged Terminal Air Conditioner
PY	Program Year

Q2	Second Quarter
Q3	Third Quarter
Q4	Fourth Quarter
QA	Quality Assurance
QC	Quality Control
QII	Quality Insulation Installation
RCA	Refrigerant Charge and Airflow
Res	Residential
RFP	Request for Proposal
RH	Relative Humidity
RLA	Rated Load Amps
RMSE	Root Mean Square Error
RNC	Residential New Construction
ROB	Replace on Burnout
RP	Relative Precision
SAS	Statistical Analysis Software
SBD	Savings By Design
SCE	Southern California Edison
SCG	Southern California Gas
SCP	Sustainable Communities Program
SDG&E	San Diego Gas & Electric
SDGE	San Diego Gas & Electric
SEER	Seasonal Energy Efficiency Rating
SES	Savings Estimate Spreadsheet
SF	Single Family
Sf	Square Foot
SFA	Single Family Attached
SHGC	Solar Heat Gain Coefficient
SoCalGas	Southern California Gas
SOW	Statement of Work
Sqft	Square Foot
T20	Title 20 Appliance Efficiency Standards
T24	Title 24 Building Energy Efficiency Standards
TBD	To Be Determined
TDV	Time-Dependent Valuation
TRC	TRC Companies, acquired HMG in 2013
TXV	Thermostatic Expansion Valve
UES	Unit Energy Savings
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
VSP	Verification Service Providers
W/ SF	Watts per Square Foot
WH	Water Heater

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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 2010 through 2012. The evaluation was conducted for the California Public Utilities Commission (CPUC). The Program implemented jointly by PG&E, SDG&E, SCE, and SCG provides technical, cost, and market studies that support the adoption of standards by the California Energy Commission (CEC) and the federal government. The evaluation covered energy, demand, and natural gas impacts during the period 2010 through 2012 from the adoption of Title 20 appliance standards, Title 24 building codes, and federal appliance standards.

The evaluation methodology followed the California protocol. First, we estimated potential savings that would result if all new buildings and appliances met code. There were large reductions in Title 24 potential due to the slowdown in both residential and nonresidential buildings construction. Next, we adjusted for compliance to determine gross savings. For nonresidential buildings, compliance was based on field verification and modeling while compliance for residential construction relied on findings from the prior evaluation. A mix of primary and secondary sources was used to determine compliance for appliance standards. We then determined net savings by adjusting—with the help of 73 industry experts—for naturally occurring market adoption (NOMAD) of energy-efficient units. To determine net Program savings an attribution adjustment was made by a panel of independent but knowledgeable experts to account for the Program's effect on adoption of each standard. Finally, net savings were allocated to IOUs based on their share of California electricity and gas sales.

The evaluation found statewide realization rates relative to the IOU Estimated savings of 98% (2,203 Gwh), 94% (374 MW), and 62% (20.4 million therms with interactive effects neglected), respectively, for cumulative electricity, demand, and natural gas savings over the three-year period. Electric savings were near to the IOU Estimate as a result of many offsetting adjustments. Findings for individual standards varied widely from the original estimates.

Keywords: impact evaluation, codes and standards

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EXECUTIVE SUMMARY

Introduction

Energy-efficiency standards set minimum efficiency levels that new appliances and buildings must meet or exceed. Because they eliminate low-efficiency products from the market (at least in theory), these standards are an important component of 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 (C&S) Program. Each IOU has a C&S program. These individual programs provide a place within each utility for funding the program activities and recording the C&S savings claimed in the IOU energy-efficiency portfolios. Until 2005, the statewide C&S Program was a non-resource, information-only program. Starting in 2006, the California Public Utilities Commission (CPUC or Commission) authorized the IOUs[1] to count C&S savings toward energy-efficiency goals.

Scope

The C&S Program comprises several subprograms, but the IOUs expected that over 99.5% of C&S Program energy savings would be produced by the Building Codes and Appliance Standards advocacy subprograms. For this reason, we dedicated most of the evaluation resources to these two subprograms, and this report summarizes the evaluation findings and conclusions related to these two subprograms.

Before the current evaluation period, all of the savings claimed by the statewide C&S Program were produced by California codes and standards (Title 20 and Title 24). In the current evaluation cycle of Program Years (PY) 2010-2012, the statewide C&S Program included claims for savings produced by federal regulations.

As shown in Table ES-1, the IOUs' documentation of the statewide program identifies approximately 84 codes and standards for which they claim savings credit since the inception of the program. The estimated savings of each code or standard is measured from the effective date, i.e., when savings due to the code or standard actually begin to occur. Because of this lag, the 2006-2009 evaluation cycle measured the impact of IOU activity prior to 2006.[2] The current evaluation determined savings during the 2010-2012 period. The 2005 Title 20 and 2005 Title 24 groups represent continuing savings and are accounted for in the final results, but we generally did not re-evaluate parameters such as annual market volume for appliances or specific construction segments from prior evaluations. The emphasis in this evaluation was on those codes and standards that were adopted due to IOU effort after 2006, and that became effective before the end of 2012.

[1] This authorization was included in CPUC Decision D.05-09-043.

[2] The initial impact evaluation addressed program years 2006 through 2008, but the assessment was extended through the transition year 2009.

Table ES-1. C&S Groups and Evaluation Scope

IOU C&S Group	Number and Type of Codes and Standards*	Evaluation Scope
2005 Title 20	22 appliance standards	2006-2008 PY Evaluation
2006-2009 Title 20	11 appliance standards	2010-2012 PY Evaluation
Federal	7 appliance standards	2010-2012 PY Evaluation
2005 Title 24	19 building codes	2006-2008 PY Evaluation
2008 Title 24	22 building codes	2010-2012 PY Evaluation

* The "Number and Type of Codes and Standards" in the table is used to give an overview of the evaluation scope. Please note that this list includes cases where one code or standard regulates several appliance categories or building characteristics.

The aim of the C&S impact evaluation is to evaluate all parameters that adjust the potential savings of codes and standards to determine the net savings allocated to the IOUs .[3] All of the Title 20 and Federal appliance standards adopted since 2006 were evaluated in full. For the Title 24 codes however, evaluation of the compliance adjustment factor and compliance rate is expensive and time consuming, due to resources required for field audits and energy modeling. For this reason, the size of the building market segments and the level of construction activity were considerations in this evaluation design. The impact evaluation of the 2006-2008 program years concentrated on Title 24 compliance of residential buildings. Nonresidential construction represented 69% of the statewide total construction value (in 2010 and 2011). For these reasons, we focused primary research on compliance with the Title 24 building codes of nonresidential construction in this evaluation.

Findings

Finding: Overall evaluated savings for each IOU

Table ES-2 summarizes electric energy savings (in GWh) for each IOU for PY 2010-2102. In the last row of this table, we provide a comparison of the total evaluated savings to the IOU Estimate. As shown, evaluated net program savings were found to be 98% of the value included in the IOU Estimate.

In cases where electricity savings occur within the building envelope, positive interactive effects (savings due to reduced air conditioner use) have been included in the evaluated electric energy (GWh) and demand (MW) savings. The overall impact of interactive effects is shown in Appendix K.

Additional discussion of the energy (GWh and Mtherms) and demand (MW) results is included in sections 6.1.2, 6.1.4, and 6.1.5.

[3] Potential energy savings is the estimated unit energy savings times the number of units (measures or appliances) entering the market each year. Gross energy savings is the potential energy savings adjusted by the compliance adjustment factor (CAF). Net savings result from adjusting the gross savings by the naturally occurring market adoption (NOMAD) of measures or appliances meeting the code or standard that would have occurred in the absence of the code or standard. Net savings are then attributed to the program and finally allocated to each IOU.

Table ES-2. Evaluated vs. IOU Estimate:
IOU Share of 2010-2012 PY Statewide Total Savings (GWh)

GWh	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
IOU		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	2,616	2,196	1,525	992	2,286	2,885	1,981	972
SCE	32.6%	2,698	2,265	1,573	1,024	2,358	2,976	2,044	1,003
SDG&E	7.4%	612	514	357	232	535	675	464	228
All IOUs	71.6%	5,926	4,976	3,454	2,248	5,180	6,536	4,489	2,203
Evaluated / IOU Estimated						87%	131%	130%	98%

Table ES-3 presents our findings in terms of demand savings in the IOU service territories. The last row provides a comparison of the evaluated savings to the IOU Estimate. We observe that evaluated net program demand savings were found to be 94% of the IOU Estimate.

Table ES-3. Evaluated vs. IOU Estimate:
IOU Share of 2010-2012 PY Statewide Total Savings (MW)

MW	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
IOU		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	476	400	285	176	403	552	375	165
SCE	32.6%	491	412	294	181	415	569	387	170
SDG&E	7.4%	111	94	67	41	94	129	88	39
All IOUs	71.6%	1,079	906	645	398	912	1,250	850	374
Evaluated / IOU Estimated						85%	138%	132%	94%

Table ES-4 presents our findings in terms of gas energy savings (in MTherms) in the IOU service territories. The SCG line is shaded since this table includes interactive effects and CPUC policy is to exclude interactive effects from SCG savings estimates. No percentage comparison of the evaluated savings to the IOU Estimate is provided since the negative values make these percentages less meaningful. Many of these values are negative due to the interaction between electricity savings and gas heating. As a result of the large electric savings shown above we expect that additional (gas) heating will be required. The overall impact of interactive effects is shown in Appendix K.

Table ES-4. Evaluated vs. IOU Estimate:
IOU Share of 2010-2012 PY Statewide Total Savings (Mtherms)

Mtherms	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
IOU		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	(2.52)	(0.31)	2.06	1.77	(9.15)	(10.34)	(3.84)	(0.34)
SCG	58.4%	(4.03)	(0.49)	3.30	2.83	(14.66)	(16.56)	(6.16)	(0.55)
SDG&E	4.1%	(0.29)	(0.03)	0.23	0.20	(1.04)	(1.18)	(0.44)	(0.04)
All IOUs	99.0%	(6.84)	(0.83)	5.59	4.81	(24.85)	(28.07)	(10.44)	(0.93)

Table ES-5 presents gas savings when interactive effects are not considered. As noted above, this is the correct approach to reporting savings for SCG (the lines for the other utilities are shaded since the appropriate values—with interactive effects—are shown in Table ES-4).

Table ES-5. Evaluated vs. IOU Estimate (Excluding Interactive Effects): 2010-2012 PY Statewide Total Savings for Title 20, Federal, and Title 24 (Mtherms)

Mtherms	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
IOU		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	24.02	21.23	17.03	12.22	14.19	13.23	10.06	7.52
SCG	58.4%	38.46	34.00	27.27	19.56	22.72	21.19	16.11	12.04
SDG&E	4.1%	2.73	2.41	1.94	1.39	1.61	1.50	1.14	0.85
All IOUs	99.0%	65.20	57.64	46.23	33.17	38.53	35.92	27.32	20.41
Evaluated / IOU Estimated						59%	62%	59%	62%

In general, the total net program savings estimated by the IOUs as a result of their program activities is very close to what our independent evaluation measured. This does not mean, however, that the evaluated results were close to the IOU Estimates for most of the individual codes and standards. A closer examination shows very divergent results for individual codes and standards. By chance, the differences were offsetting and the evaluated net program savings were close to the IOU Estimate.

For planning processes where potential or gross savings may be of interest, we note that there are larger differences between the evaluation findings and the IOU Estimate in gross savings. For example, evaluated potential savings are 13-15% lower than the IOU Estimate while evaluated gross savings are 31-38% higher than the IOU values.

Findings: Title 24 Compliance

Measurement of compliance for high impact Title 24 building codes was a high priority for this evaluation. Cadmus' research produced compliance values used in the evaluation for four building codes or code categories: nonresidential new construction, interior lighting alteration projects, envelope insulation projects, and cool roof projects. For all other categories, the evaluation relied on the IOU Estimate in the savings calculation.

Title 24 compliance rate is a measurement of the measures or number of measures installed in buildings that meet building code requirements. This measurement can be achieved in two ways: prescriptively or based on performance. The prescriptive method will assign a *yes/no* value for a measure as installed. This method allows for a maximum of 1.0 for full compliance. Alternatively, compliance can be based on performance of a measure or suite of measures in terms of energy consumption. This method measures the total consumption of a building if it was to just meet the code in comparison to what it consumes as built. Compliance exceeds 1.0 in cases where the as built measures consume less energy than if the building had just met code.

For nonresidential new construction and interior lighting alteration projects, simulation models provided energy consumption values that we used to calculate the Title 24 compliance rates shown in Table ES-5. A compliance rate of over 100% indicates that the as-built energy consumption is better than required under the 2008 Title 24 code.

Table ES-5. Performance-Based Compliance Rates

Category	Type	Energy Consumption		Compliance Rate
		2008 Code	As-Built	
Nonresidential New Construction (90 sites)	kWh	22,847,342	19,886,535	115%
	kW	6,838	5,865	117%
	Therms	193,601	191,551	101%
Lighting Alterations (68 sites)	kWh	14,213,347	13,168,667	108%
	kW	4,627	4,322	107%

We present the compliance rates for envelope insulation projects and cool roof projects in Table ES-6. These rates are based on our prescriptive analysis of audited sites.

Table ES-6. Prescriptive Compliance Rates

Category	kWh	kW	Therms
B17 Envelope Insulation (Re-Roof) (18 Sites)	83%	83%	83%
B31 Cool Roof Expansion (Re-Roof) (11 Sites)	82%	82%	82%

Cadmus used compliance adjustment factors (CAFs) to calculate gross savings from potential savings. Table ES-7 shows the results of our CAF sampling error analysis. Due to both the larger sample size and a more representative sample design, the new construction CAF 90% confidence interval fell within ±10% relative precision for electric energy and demand savings. The CAF for alterations was less precise, with 90% confidence interval between 26% and 47%.

Table ES-7. Confidence and Precision Results for Title 24 Compliance

Nonresidential New Construction			
Statistic (n=90)	kWh	kW	Therms
Relative Precision (90% confidence)	6%	5%	14%
Lighting Alterations			
Statistic (n=68)	kWh	kW	Therms
Relative Precision (90% confidence)	26%	41%	47%

Overall, our analysis allows us to say (with 90% confidence) that compliance is much better than 100%--that is, the energy consumption of buildings and lighting alteration projects as built is lower than it would be if these construction projects just met code. Additionally, the data indicate that energy savings from both new construction and alterations exceed the IOU Estimate.

The overall sample design for the field research included five distinct climate regions[4] and selection of jurisdictions using a proportional-to-size method within each region. Based on statistical testing, we found the new construction sample to be representative of the overall

[4] Based on analysis of the California Energy Commission's 16 climate zones.

population for new construction. For both alterations and new construction, results were post-weighted to ensure representativeness. This allows us to apply the evaluation results to statewide construction activity. The smaller number and particular geographic distribution of the lighting alteration sites were the reason for poorer precision around estimates for this category.

Although a detailed analysis of building performance was beyond the scope of this evaluation, the site data did provide useful insights: lighting systems were responsible for 80% of all energy savings, followed by HVAC efficiency measures (15%), and cool roofs (5%). The building envelope stood out as a major building component that in the total for all sites was just below 2008 code requirements.

Recommendations

Throughout the evaluation, the IOUs provided essential support through the documentation provided in response to the CPUC data requests and also through meetings with the CPUC and the evaluation team. While we were able to complete our impact evaluation of the Title 20, Title 24, and Federal codes and standards, we also identify several areas where specific actions could mitigate issues encountered, improve forecast accuracy, and support future evaluations. We recognize that some recommendations require additional resources, but this may be warranted by the magnitude of C&S savings.

Conclusion: Program saving estimates are not initially well-documented in the IOU savings estimate and CCTRs

The statewide C&S program differs from resource-acquisition programs in that there are no participant databases that define program savings for evaluators. Generally, the statewide program activity is focused on the development and adoption of new codes and standards. We also note that significant IOU resources are spent in support of compliance improvement.

Evaluators generally depend on resource programs to provide documentation of estimated savings. For the C&S program however, it was necessary for the evaluation team to spend considerable effort to collect information that would ordinarily be provided by the program. Examples of such information include:

- Product market volumes. For the majority of the codes and standards, market data from around the time of the CEC approval process was used to support the IOU Estimate. Many of the product mix and annual volume values are taken from the CASE reports which are usually dated between 2004 and 2008. Their sources are necessarily somewhat older.
- Potential Title 24 savings from new construction. The IOU Estimate included 377 GWh per year of savings (based on a 2006 estimate of construction) while the evaluators found 112 GWh (based on actual data for 2010-2012). Nearly all of the change was due to the adjustment for construction volume.
- Delays in the availability of CASE reports and CCTRs[5]. It took sixteen months for the IOUs to deliver all of the CCTRs. Since the CCTRs are critical to the determination of attribution, the contents and availability of these documents had a direct impact on the evaluation.

Data requests are a normal part of any evaluation, but the limited initial documention of the program by the utilities required 14 formal data requests to improve documentation of the initial IOU savings estimate.

[5] The advocacy subprograms create two documents that capture key information for evaluators: Codes and Standards Enhancement (CASE) reports and Code Change Theory Reports (CCTRs) These documents summarize much of the work done by the advocacy subprograms.

Recommendation: Dedicate additional resources to documentation of program savings and the program's role in code development and adoption through the CCTRs

The IOUs should consider providing greater support to documentation of program savings in at least these two areas: market volume estimates and development of CCTRs.

Since a relatively small number of standards produce nearly all of the expected savings, the IOUs could improve their forecast by tracking the product markets for the standards with the greatest savings. For these standards in particular, out-of-date information should be replaced with data about the market during the program years being evaluated.

In addition, improved documentation of IOU efforts at the federal level would be helpful to the evaluators' attribution research.

Commission staff should continue to develop C&S-specific reporting guidelines and processes for the IOUs to follow. A clearly-defined process for reporting at defined intervals would enable the CPUC to provide more timely feedback to the IOUs on their documentation of expected savings from codes and standards.

Conclusion: Commission staff and the evaluators have developed additional methods in several areas over the course of the two C&S impact evaluations.

The evaluation protocol provides an essential framework for the evaluation process. During the two impact evaluations, the evaluation team and Commission staff defined methods in several areas that were not completely defined in the protocol. Examples include:

- Development of a general attribution method for the PY 2006-2008 evaluation and a method for federal attribution for the current evaluation.
- Definition of a method to adjust natural market adoption for IOU resource programs that may affect the market prior to code adoption.
- Application of Title 24 compliance findings based on performance (energy consumption).

In these cases and several others, methods were defined to address areas that are not directly addressed in the evaluation protocol.

Recommendation: Consider development of a summary document that describes areas where evaluation methods have been developed

Documentation of evaluation methods would be helpful to identify which areas have required the most additional development and what analytic areas might be the focus of future modifications or updates to the existing protocol.

1 Background on the Codes and Standards Program

1.1 Description of the California Statewide Program

Energy-efficiency standards set minimum efficiency levels that new appliances and buildings must meet or exceed. Because they eliminate low-efficiency products from the market (at least in theory), these standards are an important component of reducing energy consumption.

In the 1970s, states began establishing regulatory frameworks for developing, adopting, and implementing efficiency standards. In California, the California Energy Commission (CEC) was created, 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. To be consistent with conventional terminology, this report refers to the Title 24 standards as "building codes," and the regulations affecting appliances and equipment as "standards."

The federal government, individual states, and independent code-setting entities have continued developing and upgrading their efficiency codes and standards over the past 40 years.

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 (C&S) Program. Each IOU has a C&S program. These individual programs provide a place within each utility for funding the program activities and recording the C&S savings claimed in the IOU energy-efficiency portfolios. Until 2005, the statewide C&S Program was a non-resource, information-only program. Starting in 2006, the California Public Utilities Commission (CPUC or Commission) authorized the IOUs[6] to count savings toward energy-efficiency goals.

1.2 Subprograms and Scope

During the 2010-2012 program cycle, the IOUs implemented the statewide C&S Program through the four subprograms listed in Table 1. This table also provides the IOU budgets for each subprogram for the years 2010, 2011, and 2012. We observe that the Building Codes and Appliance Standards advocacy subprograms represent about 79% of the statewide C&S Program budget.

[6] This authorization was included in CPUC Decision D.05-09-043.

Table 1. 2010-2012 Budget by Subprogram and IOU

C&S Subprogram	PG&E	SCE	SCG	SDG&E	2010-2012 Total	Annual Average
Building Codes Title 24 Advocacy	$8,415,444	$3,516,880	$822,537	$1,174,293	$13,929,154	$4,643,051
Appliance Standards Title 20 / Federal Advocacy	$7,324,803	$1,145,868	$250,000	$300,000	$9,020,671	$3,006,890
Compliance Enhancement Program (CEP)	$1,237,298	$1,326,999	$629,999	$630,000	$3,824,296	$1,274,765
Reach Codes	$1,383,790	$776,971	$99,999	$99,999	$2,360,759	$786,920
Total	$18,361,335	$6,766,718	$1,802,535	$2,204,292	$29,134,880	$9,711,627

As shown in Table 2, the IOUs expected that nearly all—more than 99%—of C&S Program energy savings would be produced by the Building Codes and Appliance Standards advocacy subprograms. For this reason, we dedicated most of the evaluation resources to these two subprograms, and this report summarizes the evaluation findings and conclusions related to these two subprograms.

Cadmus has prepared separate evaluation reports to describe the evaluation findings and conclusions for the Compliance Enhancement Program (CEP) subprogram and the Reach Codes subprogram.[7]

The work to advocate for adoption of codes or standards takes place before the date of adoption. Effective dates usually follow adoption by at least one year, providing time for the industry to adapt to the code requirements. For appliances, the effective date means that any product manufactured after that date must comply with the new standard. As a result, it usually takes some months for the old, less-efficient inventory to clear from the market. The impact of each code or standard is measured from the effective date, i.e., when savings due to the code or standard actually begin to occur. Because of this lag, the 2006-2009 evaluation cycle measured the impact of IOU activity prior to 2006.[8] The current evaluation measures savings during the 2010-2012 period that were based on IOU effort after 2006, and it only includes savings from codes and standards that became effective before the end of 2012.

The advocacy subprograms create two documents that capture key information for evaluators. One of these is the Codes and Standards Enhancement (CASE) report. CASE reports are research briefs that summarize much of the work done by the advocacy subprograms to allow the CEC to consider adoption of proposed codes and standards. CASE reports are usually

[7] Lee, Allen and Filerman, Suzanne. *Compliance Enhancement Subprogram 2010-2012 Pilot Process Evaluation.* October 2013. CPUC (CALMAC.org #CPU0070.01) and

Lee, Allen and Filerman, Suzanne. *Reach Code Subprogram 2010-2012 Process and Pilot Impact Evaluations.* October 2013. CPUC (CALMAC.org #CPU0070.02)

[8] The initial impact evaluation addressed program years 2006 through 2008, but the assessment was extended through the transition year 2009.

prepared by consultants funded by the program. These documents typically include technical analysis, market analysis, and product lifecycle cost-effectiveness analysis. A CASE report was prepared for each of the Title 20 standards and for most of the Title 24 codes. The IOUs generally do not prepare CASE reports for the Title 24 "Composite for Remainder" codes or the federal appliance standards. The other key documents are Code Change Theory Reports (CCTRs). CCTRs document the details of the advocacy process, including decisions regarding development of CASE reports, outreach to key stakeholders, and the role of the C&S program in code development and adoption. Together, CASE reports and CCTRs summarize most of the key inputs needed to conduct the evaluation under the C&S protocol. The IOUs prepare CCTRs for every code and standard for which they estimate program savings.

Before the current evaluation period, all of the savings claimed by the statewide C&S Program were produced by California codes and standards (Title 20 and Title 24). In the current evaluation cycle of PY 2010-2012, the statewide C&S Program has included claims for savings produced by federal regulations. In some cases, a federal standard supersedes an existing California standard and, in others, a federal standard applies to a product not previously regulated in California.

Table 2. Subprograms, Energy Savings, and Report Scope

Subprogram	Resource Program	Share of IOU Estimated Savings	Report Scope
Building Codes Title 24 Advocacy	Yes	Over 99.5%	Statewide C&S Program Impact Evaluation Report (also referred to as the 2010-2012 PY Evaluation)
Appliance Standards Title 20 and Federal Advocacy	Yes		
Compliance Enhancement Program (CEP)	No	N/A	CEP Evaluation Report focused on the CEP process evaluation
Reach Codes	Yes	Less than 0.5%	Reach Code Evaluation Report focused on the reach code process and (limited) impact evaluation

The size of the building market segments and the level of construction activity were considerations in the evaluation design. For the years 2010 and 2011 (for which actual construction data were available when the evaluation plan was developed), nonresidential construction represented 69% of the statewide total construction value. For this reason, we decided to conduct primary research on compliance with the Title 24 building codes of nonresidential construction. The impact evaluation of the 2006-2008 program years concentrated on Title 24 compliance of residential buildings. For these reasons, evaluation of the nonresidential segment is a high priority in the current evaluation.

1.3 C&S Grouping and Evaluation Scope

The IOUs' documentation of the statewide program identifies approximately 84 codes and standards for which they claim some savings credit since inception of the program. The number varies depending on the period considered and how multi-tier standards are counted. To organize this list, the IOUs have identified groups of codes and standards based on when advocacy was done, the code or standard effective date, and the type of regulation—Title 20

(appliance standards), Title 24 (building energy codes), or federal (appliance standards). Table 3 lists the eight groups identified by the IOUs, along with the number of codes or standards in each and the evaluation scope.

In general, we used the effective date of a code or standard to determine whether to include it in the scope of this evaluation. If the effective date was between January 1, 2009, and December 31, 2012, we included the code or standard in the scope. The only exceptions are the four standards in the 2006 Title 20 group (listed below), all of which took effect in 2008. Because these standards were adopted after the start of the prior study, they were not evaluated at that time. Instead, we included these standards in the scope of this study.

Because codes and standards that take effect after December 2012 are not included in this evaluation, the 2011 Title 20 group (of three battery charger standards) is out of the current scope. At the start of the evaluation, the first of these standards was to take effect in 2012. When the effective date was changed to 2013, this standard no longer fit within the scope of this study.

The 2005 Title 20 and 2005 Title 24 groups represent continuing savings and will be accounted for in the final results, but we will not re-evaluate protocol parameters. Some of these standards have been superseded by more stringent specifications. This topic is discussed in Sections 2.2.2 and 6.1.3 below. Additional analysis detail is provided in Appendix A.

For simplicity, this report will refer to the 2006, 2008, and 2009 Title 20 standards as the 2006-2009 Title 20 standards that are within the scope of this evaluation.

Table 3. C&S Groups and Evaluation Scope

IOU C&S Group	Number and Type of Codes and Standards*	Evaluation Scope
2005 Title 20	22 appliance standards	2006-2008 PY Evaluation
2006 Title 20	4 appliance standards	2010-2012 PY Evaluation
2008 Title 20	5 appliance standards	
2009 Title 20	2 appliance standards	
2011 Title 20	3 appliance standards	Not evaluated since these are not effective until 2013 or later
Federal	7 appliance standards	2010-2012 PY Evaluation
2005 Title 24	19 building codes	2006-2008 PY Evaluation
2008 Title 24	22 building codes	2010-2012 PY Evaluation

* The "Number and Type of Codes and Standards" in the table is used to give an overview of the evaluation scope. Please note that this list includes cases where one code or standard regulates several appliance categories or building characteristics.

The full list of appliance standards in each of the Title 20 groups is shown in Table 4. The Federal appliance standards are also included in this table as a separate group.

Regarding the inclusion of Standard 9 and Standard 11b in the 2006 group, all of the standards (1 through 21, inclusive) resulted from IOU advocacy prior to 2006. However, during the 2006-2008 PY evaluation, the evaluation team and Commission staff decided not to evaluate Standard 9 and Standard 11b, in part because those standards did not become effective until after the start of 2006 and including them in the scope of the 2006-2008 PY evaluation was impossible. For this reason, we have included both standards in the 2006 group of standards.

Table 4. Groups for Title 20 and Federal Appliance Standards

Group	Reference	Effective	Appliance Standard
2005 Title 20	Std 1	1-Jan-2006	Commercial Refrigeration Equipment, Solid Door
	Std 2	1-Jan-2007	Commercial Refrigeration Equipment, Transparent Door
	Std 3	1-Jan-2008	Commercial Ice Maker Equipment
	Std 4	1-Jan-2006	Walk-In Refrigerators / Freezers
	Std 5	1-Jan-2006	Refrigerated Beverage Vending Machines
	Std 6	1-Oct-2006	Large Packaged Commercial Air Conditioners, Tier 1
	Std 7	1-Jan-2010	Large Packaged Commercial Air Conditioners, Tier 2
	Std 8	1-Jan-2006	Residential Pool Pumps, High Eff Motor, Tier 1
	Std 10	1-Jan-2006	Portable Electric Spas
	Std 11a	1-Jan-2006	General Service Incandescent Lamps, Tier 1
	Std 12a	1-Jan-2006	Pulse Start Metal Halide HID Luminaires, Tier 1 (Vertical)
	Std 12b	1-Jan-2008	Pulse Start Metal Halide HID Luminaires, Tier 2
	Std 13	1-Jan-2008	Modular Furniture Task Lighting Fixtures
	Std 14	1-Jan-2006	Hot Food Holding Cabinets
	Std 15	1-Jan-2007	External Power Supplies, Tier 1
	Std 16	1-Jul-2008	External Power Supplies, Tier 2
	Std 17	1-Jan-2007	Consumer Electronics - Audio Players
	Std 18a	1-Jan-2006	Consumer Electronics - Televisions
	Std 18b	1-Jan-2006	Consumer Electronics - DVDs
	Std 19	1-Jan-2006	Water Dispensers
	Std 20	1-Jan-2006	Unit Heaters and Duct Furnaces
	Std 21	1-Jan-2006	Commercial Dishwasher Pre-Rinse Spray Valves
2006 Title 20	Std 9	1-Jan-2008	Residential Pool Pumps, 2-Speed Motors, Tier 2
	Std 11b	1-Jan-2008	General Service Incandescent Lamps, Tier 2
	Std 22a	1-Jan-2008	BR, ER and R20 Incandescent Reflector Lamps: Residential
	Std 22b	1-Jan-2008	BR, ER and R20 Incandescent Reflector Lamps: Commercial
2008 Title 20	Std 23	1-Jan-2010	Metal Halide Fixtures
	Std 24	1-Jan-2010	Portable Lighting Fixtures
	Std 25	1-Jan-2011	General Purpose Lighting – 100 watt
	Std 26	1-Jan-2012	General Purpose Lighting – 75 watt
	Std 27*	1-Jan-2013	General Purpose Lighting – 60 and 40 watt
2009 Title 20	Std 28a	1-Jan-2011	Televisions, Tier 1
	Std 28b*	1-Jan-2013	Televisions, Tier 2

Group	Reference	Effective	Appliance Standard
2011 Title 20	Std 29*	1-Feb-2013	Battery Charger – Consumer, Tier 1
	Std 31*	1-Jan-2014	Battery Charger – Large, Tier 1
	Std 32*	1-Jan-2014	Battery Charger – Large, Tier 2 incremental
Federal	Fed 1	1-Dec-2010	Electric Motors 1-200HP
	Fed 2	31-Aug-2011	Refrigerated Beverage Vending Machines
	Fed 3	1-Jan-2012	Commercial Refrigeration
	Fed 4	1-Mar-2012	ASHRAE Products (Commercial Boilers)
	Fed 5	1-Apr-2012	Residential Electric & Gas Ranges
	Fed 6	14-Jul-2012	Incandescent Reflector Lamps
	Fed 7	14-Jul-2012	General Service Fluorescent Lamps

* Not evaluated since effective date is outside of the current evaluation period

The full list of building codes in each of the Title 24 groups (2005 Title 24 and 2008 Title 24) is shown in Table 5. The codes referred to as "Composite for Remainder" or "CfR" are those for which the IOUs did not prepare CASE reports for submission to the CEC to support code adoption. The IOUs claimed savings for these codes, but the proportion of savings they claimed typically reflected the fact that they had a smaller role in their adoption than those for which they prepared CASE reports.

Table 5. Groups for Title 24 Building Codes

Group	Reference	Effective	Building Code
2005 Title 24	Std B1	1-Jan-2006	Time-Dependent Valuation, Residential
	Std B2	1-Jan-2006	Time-Dependent Valuation, Nonresidential
	Std B3	1-Jan-2006	Residential Hardwired lighting
	Std B4	1-Jan-2006	Duct Improvement
	Std B5	1-Jan-2006	Window Replacement
	Std B6	1-Jan-2006	Lighting Controls Under Skylights
	Std B7	1-Jan-2006	Ducts in Existing Commercial Buildings
	Std B8	1-Jan-2006	Cool Roofs
	Std B9	1-Jan-2006	Relocatable Classrooms
	Std B10	1-Jan-2006	Bi-Level Lighting Control Credits
	Std B11	1-Jan-2006	Duct Testing/Sealing in New Commercial Buildings
	Std B12	1-Jan-2006	Cooling Tower Applications
	Std B13	1-Jan-2006	Multifamily Water Heating
	Std B14a	1-Jan-2006	Composite for Remainder (CfR) - Residential
	Std B14b	1-Jan-2006	CfR - Nonresidential
	Std B15a	1-Jan-2006	Whole Building - Residential New Construction (Electric)
	Std B15b	1-Jan-2006	Whole Building - Nonresidential New Construction (Electric)
	Std B16a	1-Jan-2006	Whole Building - Residential New Construction (Gas)
	Std B16b	1-Jan-2006	Whole Building - Nonresidential New Construction (Gas)
2008 Title 24	Std B17	1-Oct-2010	Envelope Insulation
	Std B18	1-Oct-2010	Overall Envelope Trade-off
	Std B19	1-Oct-2010	Skylighting
	Std B20	1-Oct-2010	Sidelighting
	Std B21	1-Oct-2010	Tailored Indoor Lighting
	Std B22a	1-Oct-2010	TDV Lighting Controls
	Std B22b	1-Oct-2010	Demand Response Indoor Lighting
	Std B23	1-Oct-2010	Outdoor Lighting
	Std B24	1-Oct-2010	Outdoor Signs
	Std B26	1-Oct-2010	Refrigerated Warehouses
	Std B27	1-Oct-2010	DDC to Zone
	Std B28	1-Jul-2010	Residential Swimming Pool
	Std B29	1-Oct-2010	Site-Built Fenestration
	Std B30	1-Jul-2010	Residential Fenestration
	Std B31	1-Oct-2010	Cool Roof Expansion
	Std B32	1-Sep-2010	Multifamily Water Heating Control
	Std B33a	1-Sep-2010	CfR Interior Lighting Complete Building Method
	Std B33b	1-Sep-2010	CfR Interior Lighting Area Category Method
	Std B33c	1-Sep-2010	CfR Interior Lighting Egress Control
	Std B33d	1-Sep-2010	CfR HVAC Efficiency
	Std B33e	1-Sep-2010	CfR Residential Cool Roofs
	Std B33f	1-Sep-2010	CfR Residential Fan Watt Limit

1.4 IOU Estimate of Energy Savings During 2010 to 2012

The IOUs provided an estimate of savings from the statewide C&S Program in response to a data request from Commission staff. The project management team, consisting of Commission staff, DNV GL, and Cadmus, reviewed the initial estimate and identified several areas in which the savings calculations were inconsistent with the guidance provided by Commission staff. The evaluation team made adjustments in each of these areas to produce an estimate that was consistent with the guidance provided.

The IOU Estimate includes the primary energy savings from each code or standard and secondary savings that are often described as an Interactive Effects (IEs). Specifically, the IOU Estimate includes negative gas savings due to increased heating when electric energy is saved indoors. The IOUs did not include any positive electric IEs due to reduced cooling. 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. We discuss IEs in more detail in Section 3.1.3.

Additional details on the original IOU Estimate and the specific adjustments made to produce the values shown below are provided in Appendix B.

Table 6 through Table 14 below summarize the IOU Estimate (after adjustments) for potential, gross, net, and net program savings—statewide—in terms of electric energy (GWh), electric demand (MW), and gas energy (MTherms)[9],[10]. These terms have specific definitions in the C&S evaluation protocol. The protocol and these definitions are discussed in Section 2.1.

Table 6. IOU Estimate of Electric Energy Savings for Title 20 Standards

Electric Energy (GWh)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	597	549	299	219	693	491	462	345
	2011	592	547	275	202	1,476	1,153	887	659
	2012	554	524	245	180	1,236	993	678	505
	Total	1,743	1,620	820	601	3,405	2,637	2,026	1,510

[9] The IOU Estimate for savings from Reach Codes is not included here because those savings were evaluated separately. Estimated gross savings for the Reach Codes subprogram for 2010-2012 are 9.4 GWh, 0 MW, and 0.5 MTherms. Results of the pilot impact evaluation of the Reach Codes subprogram can be found at CALMAC.org #CPU0070.02.

[10] Net savings refers to statewide savings adjusted for natural market adoption, and net program savings refers to savings attributed to the IOU program. See Section 2.1 for more information.

Table 7. IOU Estimate of Demand Savings for Title 20 Standards

Electric Demand (MW)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	85.4	78.8	45.2	33.5	99.4	73.3	68.8	51.8
	2011	84.7	78.6	41.6	30.8	167.1	130.6	103.9	77.7
	2012	79.7	75.5	37.1	27.5	138.0	111.3	80.1	60.2
	Total	249.8	233.0	123.8	91.8	404.5	315.2	252.7	189.7

Table 8. IOU Estimate of Gas Savings for Title 20 Standards

Gas Energy (MTherms)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	-3.5	-3.2	-0.9	-0.6	-9.7	-6.4	-6.0	-4.4
	2011	-3.5	-3.1	-0.6	-0.4	-20.6	-15.6	-12.3	-9.1
	2012	-3.1	-2.9	-0.3	-0.2	-16.6	-12.9	-9.1	-6.7
	Total	-10.2	-9.2	-1.8	-1.1	-46.8	-34.8	-27.3	-20.2

Table 9. IOU Estimate of Electric Energy Savings for Federal Standards

Electric Energy (GWh)		Federal Appliance			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	5	5	5	2
	2011	66	62	56	28
	2012	539	512	448	224
	Total	610	580	508	254

Table 10. IOU Estimate of Demand Savings for Federal Standards

Electric Demand (MW)		Federal Appliance			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	0.7	0.7	0.6	0.3
	2011	9.0	8.5	7.6	3.8
	2012	91.5	86.9	77.1	38.6
	Total	101.2	96.1	85.4	42.7

Table 11. IOU Estimate of Gas Savings for Federal Standards

Gas Energy (MTherms)		Federal Appliance			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	0.0	0.0	0.0	0.0
	2011	0.0	0.0	0.0	0.0
	2012	-6.6	-6.3	-5.6	-2.8
	Total	-6.6	-6.3	-5.6	-2.8

Table 12. IOU Estimate of Electric Energy Savings for Title 24 Building Codes

Electric Energy (GWh)		2005 Title 24				2008 Title 24			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	312	266	184	98	221	184	140	72
	2011	312	266	170	93	683	568	418	216
	2012	312	266	155	89	683	568	406	210
	Total	936	797	509	280	1,588	1,320	965	498

Table 13. IOU Estimate of Demand Savings for Title 24 Building Codes

Electric Demand (MW)		2005 Title 24				2008 Title 24			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	90.1	73.5	50.4	25.3	73.5	61.1	48.3	26.3
	2011	90.1	73.5	46.5	24.1	204.4	170.0	127.8	67.8
	2012	90.1	73.5	42.7	22.9	204.4	170.0	124.0	65.8
	Total	270.2	220.5	139.5	72.3	482.4	401.1	300.1	159.9

Table 14. IOU Estimate of Gas Savings for Title 24 Building Codes

Gas Energy (MTherms)		2005 Title 24				2008 Title 24			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	4.3	4.4	3.8	2.8	6.4	5.3	4.5	3.2
	2011	4.3	4.4	3.7	2.8	18.7	15.6	12.5	8.9
	2012	4.3	4.4	3.7	2.7	18.7	15.6	12.2	8.6
	Total	12.9	13.1	11.2	8.3	43.8	36.4	29.1	20.7

2 Overview of Evaluation Approach

2.1 Protocol

For the prior C&S Program evaluation, the evaluation team started with the California Evaluation Protocols[11] and then modified them, as appropriate, during the evaluation process[12]. The evaluation process used in the 2010-2012 PY cycle is shown in Figure 1.

Figure 1. C&S Advocacy Program Evaluation Protocol

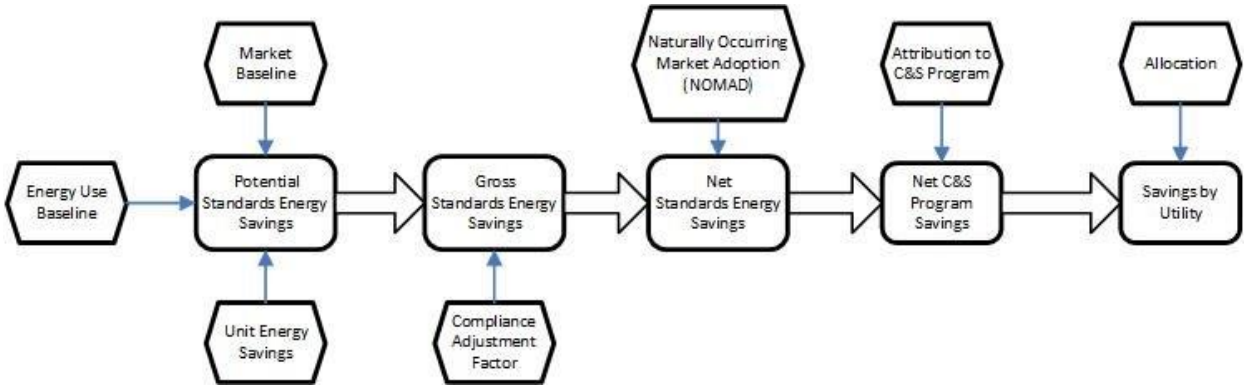


Figure 1 shows the major factors used to determine savings under the protocol. We based the *potential energy savings* attributable to the C&S Program on the estimated unit energy savings and the number of those units (measures or appliances) entering the market each year. We adjusted these potential savings by the compliance adjustment factor (CAF) to derive *gross energy savings*. *Net savings* result from adjusting the gross savings by the naturally occurring market adoption (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).

We implemented the analysis using the Integrated Standards Savings Model (ISSM)—developed by the evaluators specifically for the prior C&S Program evaluation and modified for this evaluation—that incorporates all the input data from the EM&V activities. To help ensure transparency, the model is implemented in an Excel spreadsheet. The IOUs use a similar model to calculate their estimate of C&S Program savings.

[11] Hall, Nick, Johna Roth, Carmen Best. (TecMarket Works). 2006. *California Energy Efficiency Evaluation Protocols*. California Public Utilities Commission.

[12] The main modification was the elimination of the adjustment for Normally Occurring Standards Adoption (NOSAD). This decision was discussed in a memo (Lee, Allen; Stewart, Jim. 2008. *Cadmus' NOSAD Review and Recommendations.* California Public Utilities Commission.) and in the evaluation report (Lee, Allen. 2010. *Codes & Standards (C&S) Programs Impact Evaluation for Program Years 2006-2008.* California Public Utilities Commission.)

2.2 Objectives

The primary objective of this evaluation is to determine the energy and demand savings during 2010, 2011, and 2012 that can be attributed to the IOUs' C&S Program activities. Savings continue to accrue for codes and standards evaluated in the last cycle[13] as new buildings and appliances enter the market each year. Since then, new codes and standards have been adopted and gone into effect that were influenced by C&S Program advocacy occurring since the beginning of 2006 and before 2010[14].

As noted, the scope of the 2010-2012 PY evaluation encompasses all codes and standards in the 2006-2009 Title 20 group, the 2008 Title 24 group, and the federal standards group. As shown in Table 3, the standards in the 2005 groups were evaluated in the 2006-2008 PY evaluation.

Due to resource constraints, this study investigated certain parameters in the evaluation protocol in more detail than others. This is especially the case for compliance adjustments for building codes. For Title 24, the prior evaluation produced detailed results for residential new construction, but the analysis was not as complete for nonresidential construction or for additions and alterations, both residential and nonresidential. In addition, during the planning stages of this evaluation, construction data showed that nonresidential construction represented about 69% of the total statewide construction value. Accordingly, this evaluation focused on the Title 24 code that targeted nonresidential new construction and addition and alteration projects.

A secondary objective of this evaluation was to provide specific feedback on the evaluation protocol itself and to make recommendations for its further refinement. The evaluators typically identify some areas in which the protocol can be improved or expanded in the course of the evaluation. For example, two areas in which work that has been performed in this evaluation could be incorporated into the evaluation protocol are treatment of savings relative to measure life and treatment of savings from federal standards.

The chapters below describe the major tasks completed in the evaluation. We have kept these descriptions brief and high-level to keep the report to an appropriate overall length. The appendices to this report provide more detailed information about the C&S Program evaluation tasks and process.

The list of standards to be evaluated in accordance with the evaluation plan is shown in Table 15 and Table 16. These tables show with check marks which analyses were conducted for each Title 20 standard, federal standard, and Title 24 code as part of this evaluation: potential savings, gross savings (CAF), net savings (NOMAD), and net program savings (attribution). In a few cases where we did not evaluate a standard, reasons—such as an effective date that fell after the 2010-2012 cycle—are provided in the table. In some cases, the evaluation team was able to collect market data prior to those effective dates, and we expect that they will inform a future impact evaluation. These standards are indicated with a "P."

[13] Savings continue for new products covered by a specific code or standard unless it is pre-empted by federal regulations or superseded by a subsequent California C&S.

[14] All C&S for which the IOUs provided savings estimates were adopted before 2010.

Table 15. Title 20 and Federal Standards Considered for the 2010-2012 Program Evaluation

REF	Name	Effective Date	Potential	Compliance	NOMAD	Attribution
Std 4	Walk-In Refrigerators / Freezers*	1/2006	-	✓	-	-
Std 9	Resid. Pool Pumps, 2-Speed Motors, Tier 2	1/2008	✓	✓	-	-
Std 11b	General Svc. Incandescent Lamps, Tier 2	1/2008	✓	✓	-	-
Std 12a	Pulse Start Metal Halide HID, Tier 1	1/2006	Not evaluated. Standard does not apply to products made after 1/2009			
Std 22a	Residential Incandescent Reflector Lamps	1/2008	✓	✓	✓	✓
Std 22b	Commercial Incandescent Reflector Lamps	1/2008	✓	✓	✓	✓
Std 23	Metal Halide Fixtures	1/2010	✓	✓	✓	✓
Std 24	Portable Lighting Fixtures	1/2010	✓	✓	✓	✓
Std 25	General-Purpose Lighting – 100 W	1/2011	✓	✓	✓	✓
Std 26	General-Purpose Lighting – 75 W	1/2012	✓	✓	✓	✓
Std 27	General-Purpose Lighting – 60 and 40 W	1/2013**	P	P	✓	✓
Std 28a	Televisions, Tier 1	1/2011	✓	✓	✓	✓
Std 28b	Televisions, Tier 2	1/2013**	P	P	✓	✓
Std 29	Battery Charger – Consumer Tier 1	2/2013**	Not evaluated: Effective Date out of scope. Market data documented.			
Std 31	Battery Charger – Large, Tier 1	1/2014**				
Std 32	Battery Charger – Large, Tier 2	1/2014**				
Fed 1	Electric Motors 1-200 HP	12/2010	✓	✓	✓	✓
Fed 2	Refrig.Beverage Vending (Std 5 in 06-08)	8/1/2011	-	-	-	✓
Fed 3	Commercial Refrig. (Std 1, 2, 3 in 06-08)	1/1/2012	-	-	✓	✓
Fed 4	Commercial Boilers	3/2012	Not evaluated: Relatively small savings			
Fed 5	Residential Gas Ranges	4/2012	✓	✓	✓	✓
Fed 6	Incandescent Reflector Lamps	7/2012	✓	✓	✓	✓
Fed 7	General-Service Fluorescent Lamps	7/2012	✓	✓	✓	✓

P = Pre-Effective-Date Measurement Provided. Unless otherwise noted, potential savings are based on prior standard requirements and compliance is based on the available market data.

* Although standard 4 is in the 2005 Title 20 group and Cadmus evaluated walk-in refrigerators and freezers in the 2006-2008 PY evaluation, we re-evaluated the CAF due to the small sample size in the previous evaluation.

** This standard was not in effect during the 2010-2012 program cycle

As shown in Table 16, Cadmus evaluated potential savings for all of the 2008 Title 24 codes. At a minimum, the evaluators adjusted potential savings for the actual level of construction activity.

Table 16. Title 24 Building Codes Considered for the 2010-2012 Program Evaluation

REF	Name	Adjusted Effective Date*	Potential	Compliance	NOMAD	Attribution
Std B17	Envelope Insulation	1-Oct-2010	✓	✓	✓	✓
Std B18	Overall Envelope Trade-off	1-Oct-2010	✓	✓	-	✓
Std B19	Skylighting	1-Oct-2010	✓	✓	✓	✓
Std B20	Sidelighting	1-Oct-2010	✓	✓	✓	✓
Std B21	Tailored Indoor Lighting	1-Oct-2010	✓	✓	✓	✓
Std B22a	TDV Lighting Controls	1-Oct-2010	✓	-	-	✓
Std B22b	Demand Response Indoor Lighting	1-Oct-2010	✓	✓	✓	-
Std B23	Outdoor Lighting	1-Oct-2010	✓	-	✓	✓
Std B24	Outdoor Signs	1-Oct-2010	✓	-	✓	✓
Std B26	Refrigerated Warehouses	1-Oct-2010	✓	-	-	✓
Std B27	DDC to Zone	1-Oct-2010	✓	✓	✓	✓
Std B28	Residential Swimming Pool	1-Jul-2010	✓	-	✓	✓
Std B29	Site Built Fenestration	1-Oct-2010	✓	-	✓	✓
Std B30	Residential Fenestration	1-Jul-2010	✓	-	✓	✓
Std B31	Cool Roof Expansion	1-Oct-2010	✓	✓	✓	✓
Std B32	MF Water Heating Control	1-Sep-2010	✓	✓	✓	✓
Std B33a	CfR IL Complete Building Method	1-Sep-2010	✓	✓	-	✓
Std B33b	CfR IL Area Category Method	1-Sep-2010	✓	✓	-	✓
Std B33c	CfR IL Egress Control	1-Sep-2010	✓	✓	-	✓
Std B33d	CfR HVAC Efficiency	1-Sep-2010	✓	✓	-	✓
Std B33e	CfR Res Cool Roofs	1-Sep-2010	✓	-	-	✓
Std B33f	CfR Res Central Fan WL	1-Sep-2010	✓	-	-	✓

* All 2008 Title 24 codes became effective on 1/1/2010. Adjusted Effective Date here reflects the assumed lag between the legal requirement and the completion of construction that produces savings. The assumed lags are 6 months for residential, 8 months for the B33 CfR codes, and 9 months for the nonresidential codes.

To conduct a rigorous evaluation of Title 24 compliance, evaluators must conduct site visits to a sufficiently large sample of buildings to document construction characteristics. Since the cost of site visits and building compliance analysis is relatively high, the evaluation concentrated compliance evaluation on the following areas for nonresidential buildings: new construction, lighting alteration projects, and roof replacement projects. We used the results of this work to determine compliance for all of the codes indicated in Table 16. In cases where compliance was not evaluated, we used the IOU Estimate in the overall savings calculation.

As shown in the table, Cadmus collected data on naturally occurring market adoption (NOMAD) for all but a few of the codes. We did not collect primary data to estimate NOMAD for Std B18 and Std B22a, since the IOU Estimate of savings was very small. We used the IOU Estimate for NOMAD for the refrigerated warehouse standard (Std B26) when we were unable to recruit experts to participate. Cadmus did not collect data on the Composite for Remainder (CfR) codes, since this category had not been broken out into defined components when we conducted the NOMAD data collection.

2.2.1 Federal Pre-Emption

In some product categories, a federal regulation is adopted for a product type that was already regulated by the state of California. In these cases, the federal regulation becomes the law and supersedes the state regulation. Once the federal government establishes an energy-efficiency standard, no state may have a regulation different from the federal standard. This is referred to as federal pre-emption.

The standards with potential savings in the evaluation period that are pre-empted by federal regulations are shown in Table 17.

Table 17. 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 25	General-Purpose Lighting - 100 watt	
Std 26	General-Purpose Lighting - 75 watt	
Std 22a	BR, ER and R20 Incandescent Reflector Lamps: Residential	Fed 6
Std 22b	BR, ER and R20 Incandescent Reflector Lamps: Commercial	

For evaluation purposes, a state standard only has potential to produce savings until the date upon which a federal standard pre-empts it. This occurred in the case of Title 20 Standard 6, which set an efficiency requirement for large packaged air conditioners. Standard 6 was found to produce potential savings of about 13.5 GWh per year from 2006 through 2009. When the federal regulation took effect in 2010, there were no further potential savings from Standard 6.

The IOUs have participated in the federal standard-setting process for several years, including cases where a federal standard pre-empts an existing state standard. Prior to the current cycle, a methodology to evaluate federal standards had not been developed due to time and resource constraints. This was one of the reasons that savings from federal standards were not included in the scope of the 2006-2008 PY evaluation.

The evaluation team developed methods to evaluate C&S Program savings from federal standards as part of the 2010-2012 PY study. To determine potential, gross, and net savings, the evaluators used the same methods for federal standards as are used for state standards. Commission staff directed the development of a model for federal attribution, which was presented at a workshop for stakeholders, to determine the portion of net savings that can be credited to the statewide C&S Program. This model is similar to the attribution model used for California codes and standards. Since the IOUs are aware of these developments, they have included savings from federal standards in their 2010-2012 estimates.

The effect that federal pre-emption has on potential savings from California codes and standards is shown with other evaluation results in Chapter 4. Note that potential savings for standards that have been pre-empted has been moved from the Title 20 standards to the federal standards, to make the IOU Estimate more directly comparable to the evaluated savings. This and other adjustments to the IOU Estimate are described in Appendix A.

2.2.2 California Standards Superseded by Later California Standards (Layering)

The evaluation had another unique situation to resolve when some of the new California standards superseded 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 D. 10-04-029, the CPUC determined that savings from earlier superseded standards end when a new, more stringent standard takes effect.[15] However, according to Commission staff, portfolio savings targets were set assuming layering of superseded standards. In order to be consistent with how the targets were set up, for the current project, Commission staff directed the evaluators to determine evaluated savings in two scenarios.[16]

- Scenario One: Layered savings are included. Evaluation results reported in this report include layered savings unless otherwise noted.
- Scenario Two: Layered savings are excluded. Only incremental savings from the most recent standard are included. Scenario Two results are provided briefly in section 6.1.3 and in more detail in Appendix A.

To implement these scenarios, Commission staff and evaluators reviewed all of the codes and standards being evaluated. To qualify as an instance of layering, the Commission staff required that standards be adopted separately (not at the same time, as happens when one standard includes two tiers that take effect at different times). Another qualification is that the superseding code or standard must regulate the same feature(s) of a product. Table 18 shows the two standards that we found had been superseded by later standards.

Table 18. 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 18a	Consumer Electronics: Televisions	Std 28a	Televisions, Tier 1

[15] 'The baseline for gross savings should be the previous standard or the prevailing market practice. (D.10-04-029, pp 46)

[16] Commission staff indicate that this approach does not establish a precedent or represent the Commission staff's preferred analytic approach for the treatment of layering claims and *ex-post* measurements. This approach was taken to ensure consistency between targets and evaluated results in the 2010-2012 cycle.

2.3 Revisions to Integrated Standards and Savings Model (ISSM)

The ISSM is a flexible, Microsoft Excel-based model for calculating the energy and demand savings that may be credited to the California IOUs for their efforts in promoting the adoption of energy-efficient codes and standards. The model includes a dynamic user interface to allow standards to be analyzed by group, while the computations for individual standards are transparent in that they are Excel formulas, visible in the model. For the current evaluation, Cadmus reviewed the IOUs' most recent version of the model and used its data inputs to replicate the IOU savings estimates in an updated version of ISSM.

The updated version of ISSM includes:

- Addition of all post-2006 codes and standards
- Application of independent savings calculations for federal standards
- Support of residential and nonresidential whole-building efficiency modeling for a subset of newly constructed or remodeled buildings.

Enhancements to ISSM are:

- Savings for all individual standards are computed in one worksheet. This simplifies the addition or removal of standards, and makes changes to computations easier to implement. It also allows for easy perusal of computed values across individual standards.
- Separate CAF values are used for kWh, kW, and gas. This is necessary to reflect findings from Title 24 research, where the CAF for gas measures is much different from the CAF for kWh or kW.
- The measure-life adjustment to cumulative savings is applied to potential savings, instead of as an adjustment to net savings.
- Results can be computed and summarized by standard group (e.g., 2008 T-20), or by buildings vs. equipment, as well as by individually selected standard or standards.

These enhancements supplement the existing model inputs, which can be separated into static inputs, time-dependent inputs, NOMAD inputs, and attribution inputs. (See the ISSM Users Guide provided with the models for more details on inputs, outputs, and operation.)

Based on these inputs, the model calculates the net C&S Program electric energy and demand and gas savings for a single standard or a group of standards (depending on the user selection).

First, the model calculates the total potential savings of a standard by multiplying the volume of new units in the marketplace in each year by the per-unit potential energy savings. After this, the model makes a series of adjustments to account for noncompliance, naturally occurring market adoption, the effect of utility programs on market adoption, and the attribution credit for the IOU C&S Program. The model applies an adjustment to cumulative potential to account for expiring savings due to measure life. While differing in format, the ISSM is very similar to the IOU's version used to calculate claimed savings.

Table 19 summarizes the inputs and outputs for each stage defined by the codes and standards evaluation protocol. The inputs and parameters are factors to be determined or verified by the evaluators and are a concise summary of what is required to determine the energy and demand impacts of codes and standards.

Table 19. ISSM Inputs and Outputs

Protocol Stage	Inputs / Parameters	Outputs
Potential Savings	Unit energy savings (kWh, kW, Therms)	Potential standards energy savings (kWh, kW, therms)
	Annual installations (volume of units in marketplace)	
	Interactive effect (kWh/kWh, kW/kW, therms/kWh)	
	Start date (month, year when standard takes effect)	
	Measure life	
Gross Savings (Compliance)	Potential standards energy savings (kWh, kW, therms)	Gross standards energy savings (kWh, kW, therms)
	Annual compliance adjustment factors (CAF) for kWh, kW, and gas	
Net Savings (NOMAD)	Gross standards energy savings (kWh, kW, therms)	Net standards energy savings (kWh, kW, therms)
	NOMAD start year	
	Maximum market penetration	
	P value (for leading behavior)	
	Q value (for lagging behavior)	
	Utility program effects (units or percentage)	
Net Program Savings (Attribution)	Net standards energy savings (kWh, kW, therms)	Net program energy savings (kWh, kW, therms)
	Weighted attribution score	
Utility Savings (Allocation)	Net program energy savings (kWh, kW, therms)	Net IOU energy savings (kWh, kW, therms)
	IOU share of CA market (electricity, gas)	

2.4 Structure of this Report

The evaluators structured reporting on this evaluation to provide concise and readable summaries of the research and our significant findings. The broad scope of the statewide C&S Program made this challenging, since it includes the four subprograms identified above and estimates of savings from 79 distinct codes and standards. One decision that the evaluators made to address this challenge was to report on the evaluations of the CEP and Reach Code subprograms in separate, stand-alone documents.

This report provides the evaluation results for the appliance standard and building code subprograms. This main report provides complete evaluation results, but to manage the total length, the evaluators have included only brief descriptions of much of the evaluation team's work. The evaluation team recognizes that more detailed descriptions of the work are valuable to Commission staff, the IOUs, and other stakeholders. This is one reason that additional detail is provided on several aspects of the evaluation in a number of appendices. Taken together, the main report and appendices provide a complete description of the work, the evaluation results, and the significant findings.

The first two chapters provide descriptive information about the statewide C&S Program and an overview of the program evaluation.

Chapter 3 provides a brief description of evaluation methods.

Chapters 4 and 5 describe results for the individual protocol stages for appliance standards and building codes, respectively.

Chapter 6 describes the overall results for all codes and standards evaluated.

Chapter 7 presents conclusions and recommendations overall and for each stage of the evaluation.

3 Methodology

In this chapter, the evaluators briefly describe the methods used to determine values for the four main protocol stages: potential, compliance, NOMAD, and attribution. The methods used are sometimes specific to the type of code or standard: Title 20 appliance standard, federal appliance standard, or Title 24 building code.

Generally, methods to determine potential savings (based on unit energy savings and annual quantities) and gross savings (based on CAF) are very different for appliance standards and building codes. The evaluators provide separate descriptions of the methods used for each.

To determine NOMAD, the evaluators used only one method for all codes and standards, so the description below is applicable to all codes and standards evaluated.

To determine attribution for California Title 20 standards and Title 24 codes, the evaluators used the method defined and applied in the 2006-2008 evaluation. The IOUs claimed savings for the first time from federal standards during PY 2010-2012. The evaluators and Commission staff, with stakeholder input, have developed a method to determine attribution for the estimated savings from federal standards.[17] The methods used for California and federal codes and standards are described separately below.

3.1 Potential Savings

3.1.1 Title 20

The evaluation team estimated the first-year potential energy and demand savings (kWh and kW or therms) for each appliance standard evaluated. First, we determined the annual sales volume of products regulated by each standard and the per-unit energy and demand savings. Then we multiplied the number of units sold by the unit energy and demand savings to obtain the standard's potential energy and demand savings. To determine demand savings for most standards, we used the CPUC 2013 definition of peak period, which is from 2:00 p.m. to 5:00 p.m. For the general purpose lighting standards—25, 26, and 27—we used a coincidence factor derived from DEER 2008 data.

The evaluation team used multiple sources of data to determine sales volume and unit energy savings. Common sources of information were these:

- Codes and Standards Enhancement (CASE) reports commissioned by the IOUs
- Industry statistics published by product-manufacturing trade organizations
- Publicly available market characterization reports
- Data purchased from market research firms

[17] A Commission-staff-led public workshop was held on October 18, 2013, to discuss the policy issues related to attribution of federal standards as well as proposed methodology for collecting data and calculating attribution scores. Background materials, presentations, and public comments are available on www.energydataweb.com/cpuc and in Appendix D.

- Data obtained by DNV GL through other CPUC evaluation activities or obtained specifically to support this evaluation project
- U.S. Department of Energy Technical Support Documents for appliance and equipment standards
- U.S. Census data (used to scale national numbers to California-specific values).

For this evaluation, rather than replicating the CASE report methodologies, which may not exactly align with the final adopted standard, we developed savings values independently,[18] and then compared our results with those from the IOUs. Our methods for analyzing the potential savings from each standard evaluated are described in detail in Appendix E.

3.1.2 Title 24

The evaluation team reviewed the IOU Estimate of savings for the 2008 Title 24 building codes. For each of the codes, we investigated the unit energy savings and the corresponding construction and alteration activity that would generate total statewide energy savings.

The evaluation team used multiple sources of data to determine building volume, alterations, and unit energy savings. Common sources of information were these:

- Codes and Standards Enhancement (CASE) reports commissioned by the IOUs
- Industry statistics published by product-manufacturing trade organizations
- Publicly available market characterization reports
- Data purchased from market research firms such as McGraw Hill Construction (MHC) and the Construction Industry Research Board (CIRB)
- Data obtained by DNV GL through other CPUC evaluation activities or obtained specifically to support this evaluation project
- U.S. Census data (used to scale national numbers to California-specific values).

In the initial estimate provided by the IOUs[19], the total full-year[20] potential savings of 615 GWh per year included 235 GWh described as Standard B33 Composite for Remainder (CfR) savings. After a number of discussions with representatives of the statewide C&S program, the evaluators requested additional detail regarding the standards that produce the CfR savings. The IOUs provided a revised estimate[21] in which the total full-year potential savings of 683

[18] While we made every effort to use updated values in our analysis, we occasionally had to use some of the same assumptions as the CASE report.

[19] In the IOU response on May 13, 2011 to the data request identified as EEGA 1465, 1466, 1467, and 1468

[20] Due to the assumed six to nine month construction lag, 2010 savings are for only a partial year. 2011 and 2012 potential reflects full-year savings

[21] In the IOU response on February 15, 2013 to the data request identified as EEGA 2576, 2577, 2578, and 2579

GWh per year included 325 GWh in the CfR category. In the revised estimate, however, the CfR savings were clearly identified with six specific building codes. At the same time, the IOUs revised potential savings for a number of the other codes. This revised estimate of savings from the 2008 Title 24 code is used as the *ex ante* savings to which we compare the evaluated savings.

In the previous evaluation of savings from Title 24 codes, nearly all of the savings were expected to be the result of new construction. In the estimated potential for this evaluation, the IOUs identified 55% of the electric energy and demand savings with new construction and the remaining 45% with alteration projects. Since research firms like McGraw Hill Construction (MHC) track new construction activity, it was possible to revise the statewide potential to reflect the actual level of activity (where the IOU Estimate was based on projections made several years earlier). Information on alteration activity, however, is not generally available and so our estimates are (like the IOU Estimate) based on the existing building stock and assumed levels of renovation or replacement. For information about the total existing building stock in California, the evaluators relied on MHC reports. The CEC and the IOUs also use MHC reports on new construction and building stock for their analyses and savings estimates.

3.1.3 Interactive Effects

As noted above, interactive effects (IEs) are secondary energy impacts that may result from saving energy on a particular end-use. For codes and standards, IEs are associated with savings in total electricity usage and end-uses that are within conditioned space. When energy for a particular end-use such as lighting is reduced, the evaluators identify two types of IEs: negative gas savings due to increased heating and positive electric savings due to reduced cooling.

The evaluation team reviewed the IE factors the IOUs included with their model for codes and standards savings and documented the assumptions behind them. The IOUs included only negative gas IE factors (therms/kWh) in their estimate. The evaluation team used the same sources shown in Table 1 to estimate the positive electric (kWh/kWh) and demand factors (kW/kW).

Table 20. Values Used in IOU Estimate

Measure	IE (Therms/kWh)	Reference
Res CFL	-0.0234	Work Paper PGECOLTG107 Residential Upstream CFL Revision 2
Nonres CFL	-0.0119	Work Paper PGECOLTG111 Nonresidential Upstream CFL Revision 2
TV - BCR (res)	-0.0158	Work Paper PGECOAPP104 Energy Efficient Televisions Revision # 3
TV - ALC (nonres)	-0.0084	Work Paper PGECOAPP104 Energy Efficient Televisions Revision # 3

The evaluation team agreed with the IOUs' assumptions to estimate the gas IE factors (therms/kWh) by using the IE factors for lighting and televisions. For the lighting-HVAC IE factors, the evaluation team used the CPUC Energy Division's Database for Energy-Efficient Resources (DEER) as a reference[22]. We calculated the average of energy, demand, and gas interactive effects factors for PG&E, SCE, and SDG&E, and used the average values as IE factors

[22] LightingHVACInteractiveEffects_26Jan2012.xls, Database for Energy-Efficient Resources, California Public Utilities Commission, Version 2011 4.00, 2012.

for the standards related to lighting and plug load equipment. For this calculation we used the DEER values for residential and nonresidential CFLs for existing buildings. We assumed that the existing building types are dominant for most of the standards.

For the TV-HVAC IE factors, the evaluation team used the television measures disposition workpaper[23] on the DEER website as a reference. Again, we calculated the average of energy, demand, and gas interactive effects factors for PG&E, SCE, and SDG&E, and used the average values as a basis to estimate the IE factors for the standards related to lighting and plug load equipment. The workpaper summarizes the interactive effects factors for different residential building types. For this calculation, we used the average values for residential buildings for IOU climate zones.

We used the average lighting-HVAC and TV-HVAC IE factors in a combination or individually to estimate the approximate energy, demand, and gas interactive effects factors for each Title 20 and Title 24 standard similar to the approach used by the IOUs.

Table 21. Interactive Effects Factors used in Evaluation

Lighting	IE (kWh/kWh)	IE (kW/kW)	IE (Therms/kWh)	Reference
Res CFL Existing* Bldg. Avg	1.040	1.3200	-0.0207	CPUC DEER - LightingHVAC InteractiveEffects_26Jan2012
Com CFL Existing* Bldg. Avg	1.100	1.2267	-0.0040	
Com Non-CFL Existing* Bldg. Avg	1.100	1.3200	-0.0207	
TV				
TV Res PGE	1.0200	1.3300	-0.0250	2013-2014 Television Measures Disposition-1March2013
TV Res SCE	1.0700	1.4000	-0.0190	
TV Res SDG	1.0300	1.2300	-0.0180	
TV Res Avg IOU	1.0400	1.3200	-0.0207	
TV Com Avg IOU	1.0600	n/a	n/a	
* Used existing building data assuming existing buildings will be dominant for most of the standards.				

In addition, we used an HVAC IE factors sensitivity study[24] prepared for the CPUC to estimate approximate energy, demand, and gas interactive effects factors for some of the 2008 T24 standards. We used individual parameter results for glass type method for residential buildings to estimate interactive effects factors for standard B30 - Residential Fenestration and standard B33e - CfR Res Cool Roofs. On the other hand, we used individual parameter results for glass type method for commercial buildings to estimate interactive effects factors for standard B17 - Envelope insulation and standard B29 - Site Built Fenestration.

[23] 2013-2014 Television Measures Disposition, California Public Utilities Commission, Energy Division, March 1, 2013.

[24] Project Report: A Study of the Sensitivity of DEER HVAC Interactive Effects Factors to Modeling Parameters, Appendix H, James J. Hirsch and Associates for the CPUC, March 2012.

3.2 Gross Savings / Compliance

3.2.1 Compliance Rate and Adjustment Factor

Within the context of energy-efficiency programs, the word *compliance* has significantly different meanings to different audiences. For example, some individuals regard compliance as a *true or false* test for a given energy-efficiency measure, while others see compliance as a continuous variable based on energy consumption. For this reason, we provide definitions of compliance terms that are used in this report in Table 22.

Table 22. Definition of Compliance Rate and Adjustment Factor

Term	Definition	Methods
Compliance Rate	A measurement of the total installed building measures or equipment that comply with current code requirements.	Appliances Ratio: (equipment that meets the current standard) / (total market volume) Buildings *Prescriptive* Ratio: (equipment that meets the current standard) / (total market volume) *Performance* Ratio: (annual energy consumption of building that just meets the current standard) / (annual energy consumption of building as built)
Compliance Adjustment Factor	Measurement used to adjust IOU savings claims	Appliances Ratio: (equipment that meets the current standard) / (total market volume) Buildings Ratio: (gross savings) / (potential savings) calculated as $CAF = \frac{(2005 - AsBuilt)}{(2005 - 2008)}$

Compliance rate is a measurement of the measures or number of measures installed in buildings that meet building code requirements, or the appliances/equipment available for sale that meet appliance standards requirements.

For buildings, this measurement can be achieved in two ways: prescriptively or based on performance. The prescriptive method will assign a *yes/no* value for a measure as installed. If installation practices do not meet building standards requirements, the measure is deemed noncompliant. This method allows for a maximum of 1.0 for full compliance. Alternatively, compliance can be measured based on performance of a measure or suite of measures in a building using software modeling. This method measures the total consumption of a building if it was to just meet the code in comparison to what it consumes as built. This measurement allows for compliance to exceed 1.0 in cases where the as built/installed measures consume less energy than if the installation methods had just met code.

In this report, the evaluation team provides compliance rates whenever feasible using the performance method. This measurement compares the energy consumption of a building that would just meet Title 24 2008 code against consumption of buildings as built. In cases when modeling was not possible or feasible (e.g., cool roofs), we expressed compliance rates prescriptively.

Compliance Adjustment Factor (CAF) is the factor used to adjust the IOUs' savings claims to reflect the savings achieved. In the IOU Estimate and in this report, Title 24 potential savings (as provided by the IOUs and evaluated by Cadmus) are based on the difference in energy consumption between the baseline (2005 Title 24) and the new code (2008 Title 24).

Whenever feasible, the evaluation team used consumption modeling to determine this adjustment factor. For standards where compliance is essentially *true* or *false*, the value is the same as the general compliance rate. Since compliance—required by the C&S evaluation protocols to adjust potential to gross savings from a baseline year, and compliance rate—a factor to measure compliance with the current code, are somewhat ambiguous terms, we introduce the term Compliance Adjustment Factor (CAF) to describe the ratio of gross savings to potential savings.

3.2.2 Title 20

For a state-regulated or federally regulated product to be compliant[25] with the California Appliance Efficiency Regulations, the 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 California Energy Commission (CEC). The CEC maintains an online database of certified products at the model level. In practice that means that every code and standard must have a compliance methodology or test procedure as a means to demonstrate compliance.

Ideally, the appliance CAF would be determined based on the sales-weighted percentage of products sampled that was listed in the CEC database. However, this approach is not always feasible because:

- Product sales data at the model level are impractical or expensive to obtain.
- The product is often sold as a component of other products (e.g., motors).
- The product is sometimes custom-built and not listed in the CEC database (e.g., walk-in coolers).

Assuming that manufacturer product specifications are accurate, it is possible that some products not listed in the CEC database (not officially in compliance) still meet the efficiency regulation requirements. For purposes of consistency across all standards in this evaluation, our definition of compliance is based on the share of the market that meets the efficiency requirements in the California regulations, regardless of whether an individual product is listed in the CEC database.

[25] This requirement does not apply to certain products, such as walk-in refrigerators and freezers.

Table 23 shows the list of standards evaluated for compliance in the 2010-2012 program cycle, whether the product category was included in the CEC appliance database, and the claimed first-year savings.

Note: Compliance was not evaluated for federal standard 2, refrigerated beverage vending machines or federal standard 3, commercial refrigeration. These standards superseded California standards evaluated previously and the compliance found for the California standards was used for the Federal standards as well. Compliance was not evaluated for federal standard 4, commercial boilers due to the small magnitude of the estimated savings. The IOU Estimate for compliance was used in the savings calculations.

Table 23. List of Standards Evaluated for Compliance

Reference	Name	CEC Database Category?	IOU-Estimate Potential Savings* (GWh) unless noted
Std 4	Walk-In Refrigerators/Freezers	No	72.1
Std 9	Residential Pool Pumps, 2-Speed Motors, Tier 2	Yes	103.5
Std 11b	General-Service Incandescent Lamps, Tier 2	Yes	254.2
Std 22a	Residential Incandescent Reflector Lamps	Yes	81.1
Std 22b	Commercial Incandescent Reflector Lamps	Yes	158.2
Std 23	Metal Halide Fixtures	Yes	45.0
Std 24	Portable Lighting Fixtures	Yes	51.2
Std 25	General-Purpose Lighting – 100 W	Yes	254.5
Std 26	General-Purpose Lighting – 75 W	Yes	230.1
Std 28a	Televisions, Tier 1	Yes	528.0
Fed 1	Electric Motors 1-200 hp	Yes	63.7
Fed 5**	Residential Gas Ranges	No	0.37 Mtherms
Fed 6	Incandescent Reflector Lamps	Yes	538.5
Fed 7	General-Service Fluorescent Lamps	Yes	388.5

* Estimates provided by the IOUs on May 13, 2011 in response to EEGA data request 1465, 1466, 1467, and 1468.

We followed the California Energy Efficiency Evaluation Protocols[26] for estimating compliance through interviews with retailers and product distributors. For products where retail point-of-sale (POS) or retail shelf-stocking data were available, as indicated in Table 24, we implemented methods that allowed a higher level of rigor. A description of how we assessed compliance using each data source follows the table.

[26] http://www.calmac.org/events/EvaluatorsProtocols_Final_AdoptedviaRuling_06-19-2006.pdf

Table 24. Summary of Compliance-Evaluated Standards by Data Source

Retail Point of Sale Data	Retail Shelf-Stocking Data from DNV GL	Retailer/Distributor Interviews
Televisions (Std 28a, Std 28b)	General-Service Incandescent Lamps (Std11b)	Pool Pump (Std 9)
	General-Purpose Lighting (Std 25, Std 26, Std 27)	Walk-In Refrigeration (Std 4)
	Incandescent Reflector Lamps (Std 22a, Std 22b, Fed 6)	Residential Gas Ranges (Fed 5)
	Portable Lighting (Std 24)	General-Service Fluorescent Lamps (Fed 7)
		Metal Halide Fixtures (Std 23)
		Electric Motors 1-200 HP (Fed 1)

Analysis Using Point-of-Sale Market Data

Cadmus analyzed one product class, televisions, using purchased POS data from NPD Group.[27] We purchased quarterly data spanning 2010 Q3 through 2012 Q2 for California. (The television standard took effect in January 2011). The POS data encompass an estimated 60% of television sales. It provides the unit share from more than 60 NPD channel partners with brick-and-mortar stores across the United States. Channels not captured in the NPD data include e-commerce/catalog sales, Walmart, Costco, or "mom and pop" shops. Data are recorded at the model level. Models unique to a particular retailer are aggregated into an "all other" category due to retailer confidentiality limitations preventing finer granularity. Data from the entire POS database, including information from retailer-specific models, are also aggregated (on a unit share basis) by display size, ENERGY STAR® Version[28], LED vs. plasma, and other factors. This provides a more complete picture of the attributes of the POS dataset. Cadmus used the POS data to determine the compliance rate for televisions.

Cadmus used two approaches to analyze compliance from these data. First, we calculated the market share of models that were listed on the CEC list of Title 20 (T20) compliant models. This produced what is called a listed compliance rate. Next, we calculated the unlisted compliance rate, which is the market share of models that were not listed in the CEC database, but did meet the power consumption requirements for standard 28a. To determine if a product was unlisted compliant, we went through a series of steps:

1. Cadmus mapped the T20 and ENERGY STAR maximum allowable active mode power (in watts) as a function of screen size (Figure 2) to identify ENERGY STAR versions that met the requirements of standard 28a. This shows that all models that met ENERGY STAR 4.2 and 5.3, and those models up to 680 square inches that were ENERGY STAR 3.0 qualified, meet the energy consumption requirements for standard 28a and all models listed as ENERGY STAR 4.2 and 5.3 met requirements of standard 28b.

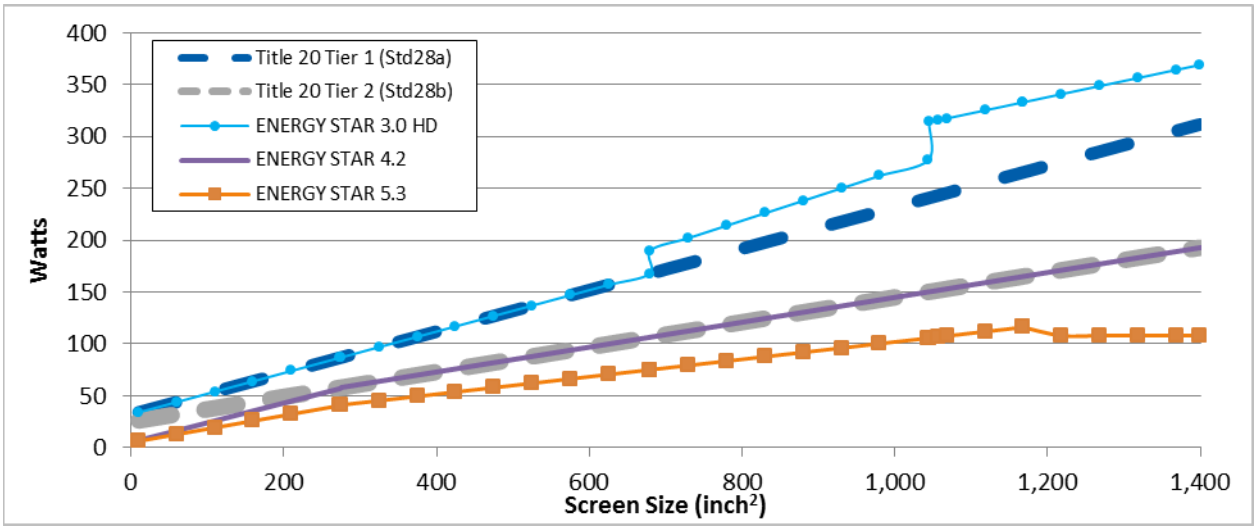
[27] www.npd.com

[28] NPD determines if a unit is ENERGY STAR by matching the model number with the list of qualified models on the energystar.gov website. Models that do not meet current ENERGY STAR requirements at the time of introduction to the market are not classified as ENERGY STAR models, even if they meet older ENERGY STAR version requirements.

2. For models over 680 square inches and ENERGY STAR 3.0 qualified, we calculated whether the model complied using the model's maximum active mode power usage (provided for ENERGY STAR models) and the model's screen size using a 16:9 aspect ratio to convert from the model's diagonal size to screen area.

3. For models not listed as ENERGY STAR products, we manually looked up the models' attributes to determine whether they complied. We did not include models with missing information in our calculation of the unlisted compliant market share.

Figure 2. Maximum Active Mode Power as a Function of Screen Size



Analysis using Shelf Survey Data

Cadmus analyzed retail shelf-stocking data, collected by DNV GL, to determine compliance for general-service incandescent lamps, general-purpose lighting, incandescent reflector lamps, and portable lighting. DNV GL collected the data for all lighting standards except portable lighting as part of a different study, and provided aggregated bulb counts and average wattages to Cadmus for analysis.

Cadmus and DNV GL collaborated to complete an add-on research study to include a shelf survey of portable lighting products (in August and September 2012). DNV GL provided the shelf survey results at the model level. As shown in Table 25, DNV GL staff members visited four stores in each of the three regions of California, visiting both chain and non-chain stores.

Table 25. Portable Lighting Shelf Survey Sample

Store Number	Region	Chain / Non-Chain	Store Name	City
1	North	Chain	Sears	Oakland
2	North	Chain	Fry's Electronics	Concord
3	North	Chain	Office Depot	Emeryville
4	North	Non-Chain	Berkeley Lighting Company	Berkeley
5	Central	Chain	Lowe's	Visalia
6	Central	Chain	Pier 1 Imports	Fresno
7	Central	Chain	Target	Merced
8	Central	Non-Chain	James & Co Lighting	Fresno
9	South	Chain	Walmart	Long Beach
10	South	Chain	Home Depot	City of Industry
11	South	Chain	IKEA	Costa Mesa
12	South	Non-Chain	Uni-Lite Lighting	Anaheim

DNV GL staff members recorded information for each unique portable lamp model encountered. They noted the brand, model number, quantity in stock, lamp type, and other data specified in a data collection form Cadmus developed. After visiting the store, the same staff entered the information into an Excel worksheet.

Cadmus used the data from the shelf survey to determine compliance. First, we removed products exempted from regulation from the dataset. Next, we calculated the listed compliance by comparing product model numbers and brands to the CEC list of approved products. Finally, we calculated the unlisted compliance rate for products not on the CEC list. By comparing the product attributes gathered from the shelf survey (such as product wattages) to the criteria laid out in the California appliance standards, we determined the percentage of products that met appliance efficiency standards. We did not include in the analysis of compliance any products without sufficient information to determine compliance. We were unable to evaluate compliance for approximately 19% of the portable lights counted through the shelf survey. These were not included in the compliance analysis.

Interviews with Distributors and Retailers

Cadmus relied on interviews with product suppliers to evaluate compliance when we were unable to obtain POS or shelf-stocking data. Products for which retail information was unavailable include those primarily sold through distributors and contractors (such as commercial lighting), products commonly sold as components of other finished goods (e.g., motors), and products sold as custom orders (walk-in refrigerators).

To create the interview sample frame, we obtained contacts from IOU program managers, web searches, and Cadmus staff members. We attempted to interview distributor and retail representatives from across the state of California, as well as manufacturers, where possible. Table 26 summarizes the population interviewed and the number of completed interviews.

Table 26. Compliance Interview Population Description and Sample Size

Standard	Population Description	Completed Interviews
Pool Pump (Std9)	Pool Supply Retailers	15
Walk-In Refrigeration (Std4)	Manufacturers	4
Residential Gas Ranges (Fed5)	Mass Market Retailer Web Chat	3
General-Service Fluorescent Lamps (Fed7)	Lighting Distributors Manufacturers	5 2
Metal Halide Fixtures (Std23)	Lighting Distributors Manufacturers	4 2
Electric Motors 1-200 HP (Fed1)	Distributors and Manufacturers	9

Cadmus developed an interview guide for each appliance standard that would collect the following information:

- Annual California sales (for weighting purposes)
- Awareness of appliance standard evaluated
- Promotion of energy-efficient products to customers
- Characteristics of products sold necessary to determine compliance; for example:
  - Automatic door closers and insulation levels for walk-in refrigeration
  - Probe-start ballasts for metal halide fixtures
  - Number of speeds and controls for pool pump motors.

After we completed the interviews, we scored the responses and, where feasible, weighted the results by the respondents' product sales volume.

3.2.3 Title 24

As noted in Section 1.2, the evaluation team decided, with regard to Title 24 compliance, to focus the primary research on nonresidential construction. Analysis of the IOU Estimate revealed that 430 GWh or 78% of nonresidential savings and 63% of all 2008 Title 24 savings were expected to result from new construction and lighting alteration projects. This was among the reasons that these two categories were given priority in the compliance research and in the 2010-2012 C&S evaluation overall. In addition to these two categories, we conducted research into nonresidential re-roofing (envelope insulation and cool roof) and outdoor lighting since these categories accounted for another 100 GWh of potential savings.

We applied the results of our compliance research for those codes that involved nonresidential new construction, lighting alterations, and re-roofing, as described in Section 2.2. For most other 2008 Title 24 codes, the evaluators used the IOU Estimate of compliance. The specific compliance values used for each 2008 Title 24 code are described in Chapter 5.

We followed these specific steps to determine compliance: sampling, recruitment, permit research, site data collection, analysis, and weighting. Each of these steps is described below.

Sampling

Based on the generally desired statistical rigor of 90% confidence with 10% precision, we targeted conducting site visits to 68 nonresidential buildings in each of four climate regions for a total of 272 total building surveys. The process for defining climate regions is discussed below. Because we had previously completed 10 surveys for the pilot study[29], we used 262 sites as an overall target for the remaining field work. In Table 27, nonresidential savings are broken down into a list of categories and standards. The fourth column (percent of savings) provides the share of nonresidential electric savings that each of the line items represents of potential savings in the IOU Estimate. The next column (Sample by percent) shows the number of sites that would be surveyed if the 262 total were to be distributed according to the percent of savings. The sample target column then shows our recommendation for energy survey targets.

- We reduced the target number of new construction surveys to 98 and the number of surveys for lighting alterations to 72 to allow for increasing the number of site visits for the two roofing measures (standards B17 and B31) to 72.
- The nonresidential lighting alterations category includes the tailored indoor lighting standard B21 and all other savings from lighting alterations.
- We grouped envelope insulation (B17) and cool roof expansion (B31) together, since savings from each of these standards are expected to result from re-roofing projects.
- We set sample targets of 10 site visits each for refrigerated warehouses (B26) and outdoor lighting (B23) to check compliance to these standards. We set this sample size target to balance the relatively small savings for these codes against the desired statistical significance.

Table 27. Field Energy Survey Targets

Ref.	2008 Title 24	Savings GWh*	Percent of Savings	Sample by Percent	Sample Target
NA	Nonresidential New Construction	228	41%	108	98
NA	Nonresidential Lighting Alterations	203	37%	97	72
B17	Envelope Insulation Alterations	42	8%	20	72
B31	Cool Roof Expansion Alterations	51	9%	24	
B26	Refrigerated Warehouses New Const.	10	2%	5	10
B23	Outdoor Lighting	8	1%	4	10
B29	Site Built Fenestration	7	1%	4	0
B24	Outdoor Signs	1	0%	1	0
	Total	550	100%	262	262

* Savings based on initial IOU Estimate of potential savings for nonresidential Title 24 codes

[29] Cadmus conducted a pilot study to develop methods for the Title 24 compliance research. The completed work, findings, and recommendations are summarized in a memo *Title 24 Compliance Evaluation, Pilot Study*, 11/23/2012 that is included in Appendix I.

Regarding the geographic distribution of these samples, we used the percent of construction[30] in each climate region to calculate the distribution shown in Table 28 for each of the standard categories shown in Table 27 above.

Table 28. Target Distribution of Sample by Climate Region

Ref.	Climate Region	CEC Climate Zone(s)	Percent of Construction	New Bldgs.	Lighting Altns.	B17 B31	B26	B23
A	North / Central Coastal	1, 2, 3, 5	21%	21	15	15	2	2
B	South Coastal	6, 7, 8, 9, 10	48%	47	35	35	5	5
C	Central Valley	4, 11, 12, 13	23%	23	17	17	2	2
D	Desert	14, 15	7%	7	5	5	1	1
E	Mountains	16	0.2%	0	0	0	0	0
		Total	100%	98	72	72	10	10

To develop a sampling strategy, we followed these key steps:

1. Define five climate regions based on CEC climate zones and shown in Table 28.
   Note: Cadmus determined that it was unnecessary to sample Region E based on the low level of construction activity.

2. Analyze new construction data (MHC data for 2009-2011) to determine the proportion of statewide construction activity in each climate region. These values are also shown in Table 28. New construction square footage was used as a proxy for the distribution of alteration activity since there isn't a source for statewide alteration activity. Further research may be warranted to validate these assumptions and to quantify alteration activity and the associated energy impacts.

3. Determine the total number of jurisdictions to be included in the study. Based on the small number of new construction projects found in each jurisdiction used in the pilot study, the evaluation team estimated that 34 jurisdictions would provide a sufficient pool of projects to reach the total sample targets.

4. Select specific jurisdictions from each climate region. We did this selection using a proportional-to-size method with replacement within each region. First, we determined the size in terms of new construction square footage of each jurisdiction from the MHC data (for 2009-2011). Next, we created a representative sample using an algorithm that is more likely to select a larger jurisdiction than a smaller jurisdiction. Where we were unable to reach the sample targets, the study added more jurisdictions to support the target number of energy surveys.

The primary data sources that we used to define the population of new construction projects and to identify specific survey sites were as follows:

[30] Based on McGraw Hill Construction report on California statewide construction activity from 2009 through 2011.

- McGraw Hill Construction (MHC): MHC collects data and maintains databases that describe total (aggregate) new construction activity and identify 80% to 90% of new construction projects. MHC tracks some alteration projects but we are uncertain about how well these data cover actual alteration activity. MHC also maintains a model of the total existing building stock.[31] Cadmus acquired these data to support the study with a provision that allowed the data to be shared with the CPUC.
- Building Departments (BD) for selected jurisdictions: Cadmus obtained lists of projects from each of the selected jurisdiction building departments. This data was used to determine the version of the Title 24 code under which the building was permitted prior to visiting specific project sites.

Recruitment Process

The evaluation team conducted a pilot effort in summer 2012 to determine the appropriate methodology through which we could identify eligible sample and recruit sites relevant for this study. Building permits are issued by local plan review jurisdictions for authorization to construct a new building or make alterations to an existing building. Based on the findings and recommendations from the pilot study, we requested commercial building permit data from January 1, 2010, to March 31, 2013,[32] for 51 California jurisdictions within the sampling frame. (We requested data for more than the targeted 34 jurisdictions to have replacements available when a jurisdiction was unable to provide permit data.) Building permit records may consist of the following information:

- Permit type and number
- Building address
- Owner's name and contact information
- Project valuation
- Work/job description or category
- Plan submittal and/or issue date.

From the total 51 jurisdiction data requests, we secured nearly 130,000 permit records from 41 jurisdictions with an estimated total valuation of over $12.5 billion. From these data, Cadmus recruited from more than 7,900 potentially eligible records with an estimated total valuation of $3.3 billion and was able to complete 207 field audits and 197 final analyses (not including refrigerated warehouses).

The evaluation team developed a unique recruiting process tailored specifically to the study criteria and constraints on the availability of the building department permit data. The evaluation team conducted on-site data collection for recruited eligible sites that agreed to participate in this study. The field auditors conducted additional research and provided field data, photos, and any available building plans and Title-24 documentation to the analysis team.

[31] The California Energy Commission (CEC) also maintains a model for the existing building stock in California. We obtained both models and learned that the CEC model is directly based on the MHC model.

[32] Cadmus determined this date, March 31, 2013, based on the typical amount of time for a construction/alteration project to be completed after the permit gets issued.

This section provides details about the following recruitment steps:

- **Requested commercial building permit data.** Obtained 129,507 permit records from 41 jurisdiction building departments within the sampling frame.
- **Conducted building permit data research and eligibility screen.** Reviewed and cleaned data, conducted eligibility screen of data, and finalized potentially eligible permit records for recruitment.
- **Recruited and scheduled eligible sites for visits**. Phone screened and scheduled audit appointments with a designated "anticipated audit type" to track recruiting progress against goals for each climate region, jurisdiction, and measure.

Building Permit Data Collection

We dropped some jurisdictions that had adopted beyond-code (Reach Code) requirements, while some other jurisdictions did not provide data because of limitations in staff capacity, internal challenges, or lack of accessibility. Table 29 shows the jurisdictions removed from the study.

Table 29. Removed Jurisdictions

Reasons for Removal from Sample	Jurisdiction	
REACH Code Overlap	Fremont	Oakland
	Malibu	
Data Not Available or Accessible	Huntington Beach	Stockton
	Huntington Park	Vacaville
	Montebello	Ventura
	Orange	

The evaluation team replaced dropped jurisdictions with others selected within the same climate region and within the original sampling frame. Table 30 shows the participating jurisdictions from which we received data for this study by climate region and California climate zone.

Table 30. Participating Jurisdictions by Climate Region and CA Climate Zone

Climate Region A North/Central Coastal		Climate Region B South Coastal		Climate Region C Central Valley		Climate Region D Desert	
Jurisdiction	*Zone*	*Jurisdiction*	*Zone*	*Jurisdiction*	*Zone*	*Jurisdiction*	*Zone*
Berkeley	3	Agoura Hills	6	Concord	12	Cty of San Bernardino	14
Carpinteria	5	Calabasas	6	County of Santa Clara	4	Hesperia	14
Eureka	1	Corona	8	County of Yolo	11	Rancho Mirage	15
Hayward	3	Costa Mesa	6	Davis	12		
Milpitas	3	County of Los Angeles	8	Lincoln	11		
San Bruno	3	County of San Diego	7	Los Banos	4		
San Jose	3	County of Ventura	6	Merced	12		
Santa Maria	5	Covina	9	Porterville	13		
		Irvine	6	San Luis Obispo	4		
		Murrieta	7	Tracy	12		
		Ontario	10	Tulare	13		
		Oxnard	6	Visalia	13		
		Rancho Cucamonga	10	Walnut Creek	12		
		San Bernardino	10				
		San Diego	7				
		Santa Ana	6				
		Westminster	6				

Building Permit Data Research

The evaluation team developed an in-depth data cleaning and eligibility screening process to address the challenges of using the building department permit data as the primary data source.

Responding jurisdictions provided an average of 3,000 records, ranging from 120 to more than 22,000 permit records. The raw permit data provided enough information to screen out sites that would not have been required to comply with 2008 Title 24.

The usability of jurisdiction building permit data depended mainly on the format in which the data were provided, completeness, and the amount of irrelevant permit types that required additional filtering to remove them from the sample. Most jurisdictions did not have the capacity to provide customized reports. Instead, the data were provided in many formats, including paper-based reports, scanned pdf documents, CDs, text files, Excel spreadsheets, and customized reports from web-based databases.

Jurisdictions provided permit data in either monthly or weekly reports, and in a few instances, provided customized, filtered reports. Most jurisdictions did not filter out the residential permits or other permit types ineligible for this study. In some cases, jurisdictions provided very limited data in the reports, but had online tools to allow for additional research on permit types for some sites. In addition, most jurisdictions did not provide site contact information, so the evaluation team researched viable contact information from public sources for recruitment.

Figure 3 illustrates the permit records received, results of data cleaning and eligibility screening, targeted recruitment (scheduling), completed field audits, and completed final analyses by each climate region. The top graph shows the total permit records received relative to the amount of eligible sample. By the end of the data research and screening process, the team reduced the number of permit records to about 7,900 potentially eligible records. The bottom half of the figure illustrates the scheduled, completed, and analyzed sites within the sample.

Figure 3. Summary of Records Received and Completed Analyses

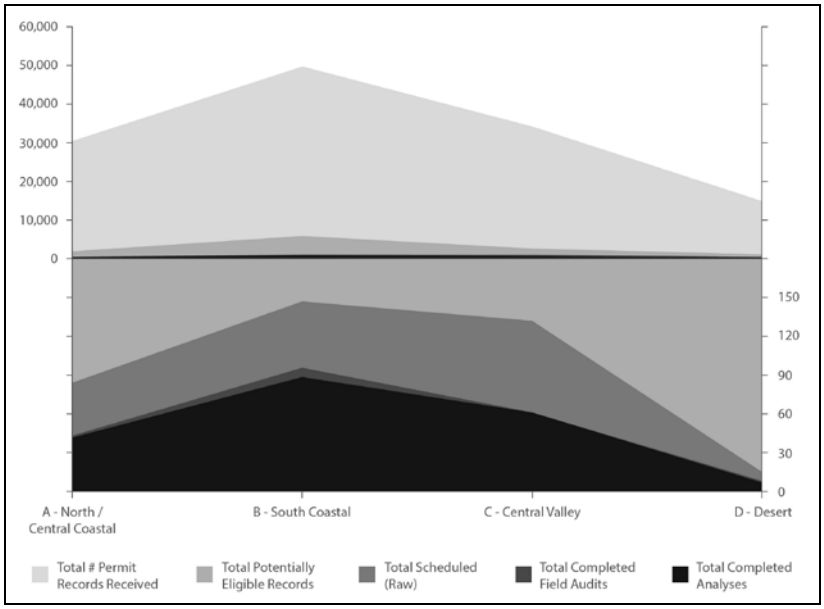
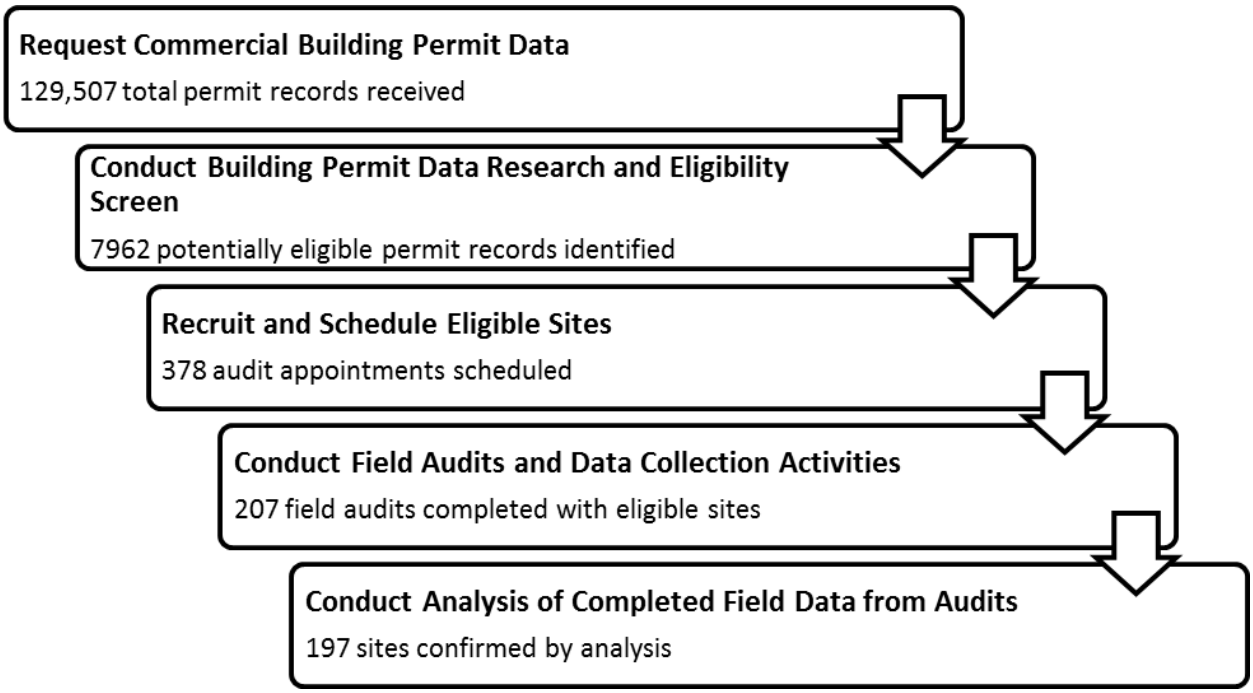


Figure 4 summarizes the process and overall results of the recruitment activity.

Figure 4. Summary of Results of Recruitment Activity



For every 38 potentially eligible permit records provided, the recruiters scheduled one viable audit appointment. Out of every 1.8 audits scheduled, one audit resulted in a confirmed, viable audit appointment. For every 1.05 viable audits, the evaluation team completed a full site analysis.

Screening of Projects Based on Eligibility Criteria

Cadmus conducted preliminary screening of projects based on all data available prior to contacting the sites to recruit them. After preliminary screening, we gave a call center our list of sites to contact to recruit for site visits. To be considered potentially eligible for the study, permit records were required to meet the data and phone screening criteria illustrated in Table 31. Cadmus cleaned the list based on criteria 1-3, while the call center used criteria 4-6 to screen the projects during the phone recruitment process.

Table 31. Eligibility Criteria for Data and Phone Screening

Permit Type	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
New Construction	Permitted per 2008 T24 code	Project valuation >$100,000	If Multifamily, have more than 3 stories	Include Conditioned Space	Construction completed and site accessible	Non-Participant in Utility Rebate Program
Alterations						
Reroof	Permitted per 2008 T24 code	Project valuation >$10,000	If Multifamily, have more than 3 stories	Completed reroof (no roof patch)	Added or changed insulation	Non-Participant in Utility Rebate Program
Cool Roof						
Indoor Lighting				Electrical permit acquired for lighting upgrade	More than 10 upgraded fixtures	
Outdoor Lighting						

The recruiters navigated each commercial site's contacts to determine the appropriate point of contact, through which they could determine whether a site was eligible for the study (beyond what can be found in the permit records), and if the property owner or manager would consent to participate. Recruiters called through the list until a jurisdiction, region, or project type goal was met or until the list was exhausted.

The call center confirmed 264 appointments. In some cases, the respondent canceled the appointment completely or left open the option to reschedule. In other instances, some of the scheduled audits resulted only in partial audits, or were disqualified due to the site's participation in utility energy-efficiency rebate programs (e.g., Savings by Design), or found to be not eligible during the site visit because the site was not built or renovated under 2008 Title 24. Consequently, the number of sites analyzed was less than the number of audits conducted.

The recruiters attempted calls with 64% of the permit records we provided and scheduled audits with 5% of the potentially eligible sample permit records.

Cadmus expected that it would be challenging to find building owners or managers willing to host site audits. Unlike most incentive programs where participants are required (or at least requested) to assist evaluators, the C&S Program has no participants. In this case, buildings qualified because they were built during a particular time period and their owners have no obligation to participate. To overcome this challenge, Cadmus used the methods described here on a large scale to reach the target number of audits.

Recruitment Results

The evaluation team determined the targets for each measure in each jurisdiction in each climate zone based on the sampling frame. Table 32 summarizes the results of completed field audits in each climate region.

Table 32. Field Audit Targets and Completes in Each Climate Region

Region	New Cons	Alteration		
	New Bldgs.	Lighting	Re-Roof & Cool Roof	Outdoor Lighting
A Target	21	15	15	2
A Complete	16	16	9	2
B Target	47	35	35	5
B Complete	52	31	11	1
C Target	23	17	17	2
C Complete	24	28	8	1
D Target	7	5	5	1
D Complete	4	2	1	1
Total Target	98	72	72	10
Total Complete	96	77	29	5

After we completed the field audits, the analysis team conducted additional research, simulated energy consumption of the sites, and reconciled field data with building department documents and EnergyPro simulations of each building. Table 33 shows the completed analyses in each climate region.

Table 33. Analysis Targets and Completes in Each Climate Region

Region	New Cons.	Alteration		
	New Bldgs.	Lighting	Re-Roof & Cool Roof	Outdoor Lighting
A Target	21	15	15	2
A Complete	15	16	8	2
B Target	47	35	35	5
B Complete	48	29	11	0
C Target	23	17	17	2
C Complete	24	28	8	1
D Target	7	5	5	1
D Complete	4	2	0	1
Total Target	98	72	72	10
Total Complete	91	75	27	4

Site Data Collection

The objectives of our field data collection included: (1) perform rigorous data collection based on the specifications of the critical measures covered by Title 24, (2) inform the analysis by incorporating all building parameters and characteristics that impact the savings associated with those measures in a measurable way, and (3) provide insights to improve savings estimates.

Cadmus deployed a range of methods and tools to achieve these objectives through a consistent, integrated, and transparent approach. We determined the appropriate measurement and verification (M&V) methods for each project and measure type by performing an in-depth review of the code compliance requirements and the scale of savings reported by the IOUs. From the code review, we identified the building and measure parameters that affect the compliance of a particular measure with the code; this informed the development of a custom data collection form for this study.

In choosing our data-gathering techniques, we sought to balance the certainty gained with project resources spent. We measured where experience has shown that energy use can vary widely, thus resulting in large uncertainty of estimates. Through this approach, we verified whether the applicable measures: (1) are in compliance with 2008 Title 24 code, (2) exceed the code requirements, or (3) do not meet the code requirements. We performed the following three steps to assess compliance of each site:

1. Research of Building Department Records

Cadmus staff researched all available documents kept by the building department related to the plan review and permitting process for each surveyed site. The documentation included but was not limited to:

- Architectural, electrical, and mechanical drawings
- Construction details and specification books
- Title-24 documentation (envelope, lighting and mechanical)
- Cool Roof Rating Certification (CRRC)

2. Site Measurement and Verification

Cadmus conducted site visits to physically verify the building's parameters and characteristics for new construction and alteration (lighting and roofing) commercial project types. The data collected in the field informed the input values that were specified in the whole-building energy modeling on a per-site basis.

While on-site, our field engineer documented accessible details regarding the facility's construction. This information included:

- Building configuration, footprint dimensions, orientation, and area of each activity type (square footage)
- Construction material type
- Envelope characteristics
- HVAC equipment and distribution system specifications (type, quantities, and efficiency rating)
- Envelope insulation material and thickness (R-value)
- Window glazing specifications (U-value and SHGC) and surface areas
- Lighting densities and control types.

3. Interviews with Facility Personnel

As part of the data collection process, we talked with staff familiar with the facility. Our data collection tools included a set of questions to ask facility personnel to confirm current occupancy or facility use, and other items with significant impact on facility energy consumption. This allowed us to further verify the accuracy of the assumptions that related to energy savings calculations. To maintain consistency across sites and assess compliance in accordance with the code-modeling requirements, we did not collect and use self-report data on operating hours. Alternately, we used EnergyPro's default schedules per each commercial building as certified by California Energy Commission (CEC).

To inform the analysis, the evaluation team also referred to manufacturers' cut sheets of installed equipment, when manufacturers' names and/or product numbers were provided, and satellite images of each site, where relevant. Where we found discrepancies between the as-built drawings and project documentations and the data collected on-site, the physically verified data supplanted the as-designed documentation.

Analysis Using Whole-Building Energy Simulation

We determined energy consumption using a simulation model approach based on site measurements and observations. To create these simulation models, the team used EnergyPro, a DOE-2 engine modeling software developed by EnergySoft, LLC using typical meteorological year, TMY3, data. Energy consumption for weather-sensitive measures is typically estimated using building simulation modeling as it is capable of producing hourly energy consumption estimates by applying location-specific historical weather information contained in the TMY files. The TMY3 data set represents typical rather than extreme conditions, and it is intended to represent the range of weather phenomena specific to that location with annual averages that are consistent with the location's long-term weather conditions.

The TMY3 datasets include the following hourly values of solar radiation and meteorological elements:

- Dry bulb and wet bulb temperature
- Relative humidity
- Wind speed and direction
- Cloud cover
- Multiple solar radiation values

Our analysis focused on the following:

- Quantifying the as-built building characteristics and energy-efficient measure characteristics (for example, quantities, capacities, efficiencies).
- Comparing the as-built model energy use results with 2005 Title 24 and 2008 Title 24 compliant baseline models of the same building configuration to determine individual building annual electricity, gas, and demand savings.

Cadmus calculated the site-level and measure-level energy savings by taking the difference between the modeled energy use of each building for two scenarios—if built to just meet the 2008 Title 24 code and if built to just meet the prior code, 2005 Title 24. Site visits and as-built

project documentation, including architectural drawings and Title 24 energy code compliance documentation from building code jurisdictions, provided the building parameters and characteristics for modeling. The parameters and characteristics used as input values for the baseline building were to reflect the building as if it were built to minimum requirements of the prior code. The evaluated 2005 and 2008 energy savings are the difference in annual energy use between the as-built and 2008 Title 24 code and the as-built and 2005 Title 24 code building, respectively.

In the course of the 2010-2012 PY evaluation, we have defined Compliance Rate (CR) for construction projects as the ratio of 2008 code baseline consumption to as-built consumption per site (i) as:

$$CR = \frac{2008}{AsBuilt}; at\ site\ i$$

Using this definition of CR, values greater than 1.0 indicate a site consumes less energy than if it just met the 2008 Title 24 and values less than 1.0 indicate a site does not comply with the 2008 Title 24.

We also calculated a Compliance Adjustment Factor (CAF) for each site (i) as:

$$CAF = \frac{(2005 - AsBuilt)}{(2005 - 2008)}; at\ site\ i$$

At the site level, the CAF multiplied by the difference between the modeled energy use of the site if the site just met the 2008 Title 24 and what it would have used if it just met the 2005 Title 24. These are the savings that were expected in the IOU and CEC estimates. These savings allowed us to compare this to the modeled savings of the site as-built. We used square footage data and energy consumption generated by EnergyPro models to determine each project's energy use intensity (EUI). As part of the quality assurance check on the results produced by the site-level analyses, Cadmus calculated and compared the site EUI for each building and compared it to other sources for the same building type. Our analysis documented trends in building performance and offered potential explanations for outliers.

New Construction

Cadmus used a customized performance report produced by EnergyPro that included energy consumption for different end-uses (lighting, heating, cooling, fan, and water heating). This report also isolated high-impact measures we wanted to analyze by performing automatic parametric runs that compared the as-built model with the 2008 Title 24 and 2005 Title 24 baseline models at a measure level. We selected these measures based on those for which the 2008 Title 24 was considerably more stringent than the 2005 Title 24 and would have a measurable impact on the energy consumption of the building. The measures included:

- Lighting (complete building, area category, and tailored methods)[33]

[33] See Lighting Alteration section for a detailed description of the measure.

- Skylighting
- Sidelighting
- Envelope Insulation (roof/attic insulation)
- Cool Roof[34]
- HVAC Efficiency
- DDC to Zone (five measures)[35]

Daylighting savings came from side-lighting (vertical fenestration) and sky-lighting. We calculated savings associated with daylighting by assessing the side lit/sky lit area, the effective aperture, the type of daylight sensor control, the number of lighting fixtures to which the daylight sensor is connected, and the wattage of the lighting fixtures. EnergyPro requires that daylight sensor control information, along with the physical skylight or sidelight (window or door) child component be assigned to the parent component (wall or roof) within the space. The sky-lit and/or side-lit area within each space is assigned upstream at the space parameter level. Daylighting savings are calculated only if there is a daylight sensor assigned for controlling lighting fixtures within the space that has side-lighting or sky-lighting. In the evaluation process, we discovered several projects in which skylights were installed but daylighting savings could not be claimed, as daylight sensors were not installed. This prevents the fixtures' capability from automatically dimming down when ample daylighting is available.

Lighting Alterations

California's Title 24 commercial building code regulates the intensity of installed lighting in commercial spaces by placing limits on the lighting power density (LPD), the total wattage of lighting installed per square foot of lit area. These regulations are set forth in the Building Energy Efficiency Standards (BEES) published for each code update[36], which contain administrative regulations relating to energy building codes in Title 24, Part 6. The compliance methods described below are also applicable to the savings per lighting load estimated for the new construction projects and are only mentioned once in this report to avoid redundancy.

The BEES requires that permitted buildings use one of three methods to calculate their maximum allowable LPD:[37]

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[34] See Roofing Alteration section for a detailed description of the measure.

[35] See Appendix H for a detailed definition of this measure.

[36] 2005 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. California Energy Commission. CEC-400-2006-015. http://www.energy.ca.gov/2006publications/CEC-400-2006-015/CEC-400-2006-015.PDF. September 2004, revised September 2006. Effective October 1, 2005, revisions effective September 11, 2006.
2008 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. California Energy Commission. CEC-400-2008-001-CMF. http://www.energy.ca.gov/2008publications/CEC-400-2008-001/CEC-400-2008-001-CMF.PDF. December 2008. Effective January 1, 2010.

[37] A whole-building performance-based path can also be taken in the case of new construction or, infrequently, for major alteration projects.

- **Complete Building method.** The Complete Building method may be used when more than 90% of a building is given over to a specific area type; in this case, the entire building is treated as a single unit, and an LPD cap relevant to that space type is applied. For example, if 90% or more of the total built area of a building is made up of office area type, any hallways, break rooms, and restrooms that cumulatively occupy less than 10% of the building area are not considered significant relative to the space's primary function. The space would be required to comply with the maximum LPD allowed for an office building.
- **Area Category method.** The Area Category method is used to provide differing LPD caps according to the function of each space within a building. Trade-offs between these area-specific allowances are permitted by Title 24, though not between conditioned and unconditioned spaces, whose allotments must be separate. An overall maximum lighting allowance is awarded based on the sum of allowances for all areas within the building.
- **Tailored method**. The Tailored method is used as an alternative to the Area Category method, typically (although not necessarily) when significant ornamental lighting is installed. This method is the most customized, and adjusts standard LPD allowances on the basis of lamp positioning and other critical factors.

Under all compliance methods, fixtures may be subject to a power adjustment factor (PAF) that reduces the effective installed wattage due to skylights or lighting controls.

In 2008, Title 24 underwent an extensive revision, with adjustments made to the allowable LPDs for all compliance methods. The new code introduced new categories of activity area and made adjustments to special allowances relating to lighting controls and other considerations[38]. In our code compliance analyses that involved lighting, Cadmus modeled the site with the installed lighting power observed by Cadmus staff on-site and comparing the energy consumption with the site using the lighting allowances permitted by the 2005 and 2008 Title 24 codes using one of the compliance methods discussed above.

The evaluation team elected to use detailed building energy simulations for this analysis, rather than a more simplified algorithm-based approach based on differences in wattage between the as-built and code, to obtain a more accurate estimate of savings associated with lighting upgrades. The detailed simulations allow for improved estimates of the effects of lighting alterations on heating, cooling, and fan end-uses by determining a heating/cooling interactive factor (HCIF)[39] specific to each building's unique envelope and HVAC characteristics, as well as to the climate in which the site is located. Moreover, the specialized exceptions stipulated by Title 24 code—including those regulating skylighting, lighting controls, and ornamental lighting—made a simplified calculation approach unwieldy and prone to error, leading the team to develop building simulations to improve the quality of results.

[38] See Appendix H for tables outlining LPDs per area type for 2005 and 2008 Title 24.

[39] A heating/cooling interaction factor (HCIF) is a multiplier applied to lighting savings in order to determine overall savings associated with lighting alterations, as to account for the secondary effects of lighting efficiency improvements on building HVAC usage (heating, cooling and fan end-uses).

To investigate compliance with the 2005 and 2008 Title 24 lighting codes, Cadmus conducted on-site data collection at 77 sites that underwent interior lighting alterations and were permitted according to the 2008 Title 24 code as well as 91 new construction sites. Cadmus also collected data for five sites that performed outdoor lighting alterations under the 2008 Title 24 code. We excluded sites from the sample if the owners had received any utility incentives for the lighting upgrade.

Among the critical inputs for these models were the various area functions within a site, as well as the square footage of each function. Under the Area Category method, these room or zone functions determine the maximum allowable lighting power for that space, with allowed LPDs shown in Appendix H.

Similarly, for the Complete Building method, a site-wide lighting power allowance is determined based on the building's primary function, for example, a restaurant or an office. Appendix H outlines the allowed LPDs per building category.

To be in compliance with Title 24, as stipulated in the 2005 and 2008 BEES, the cumulative wattage of installed lighting at a site cannot exceed an overall lighting allowance determined using the LPDs specified above. To determine the overall amount of permissible installed lighting, the square footage of each zone is multiplied by the zone's LPD; these products are then summed across all zones within the building. Under the Complete Building method, all spaces within a site are treated as a single zone.

$$Allowed\ Lighting\ (W) = \sum_{All\ zones} area_{zone} \times LPD_{zone}$$

A power adjustment factor (PAF) may be applied to lights operating under certain controls (e.g., occupancy sensors, dimming switches) within certain area types, and in areas with sky- or side-lighting under certain daylighting controls. The effective wattage of the controlled fixture may then be determined by subtracting the product of the PAF and the nameplate controlled wattage from the installed wattage.

To determine Title 24 lighting code compliance in commercial buildings, the team relied on all available data sources to determine location and characteristics of each lighting fixture, lamp technology and type, wattage per lamp, number of lamps per fixture. Our primary source was data collected during the site visit, and we supplemented those data with data from Title 24 compliance documentation and building plans. Where the data collected in the field differed from the characterization of installed lighting presented in building plans or in Title 24 compliance forms, Cadmus staff reviewed site photos and interviewed surveyors to ensure that the site simulation reflected the actual as-built levels of installed lighting. When documentation was unavailable, or where key data were missing, the evaluation team relied on professional judgment to determine a set of appropriate assumptions, which are detailed further in Appendix H.

To avoid potential threats to surveyor safety (such as accessing the fixtures installed on high bay ceilings), as well as to avoid disrupting surveyed businesses, Cadmus did not collect certain fixture characteristics through fieldwork. In particular, the fixture ballast factor was often indeterminable, necessitating additional research to attribute appropriate fixture wattages. The evaluation team used the 2011 DEER for default values when ballast factor data were not

collected[40]. When an appropriate ballast factor was not found in DEER, the team used additional sources, such as manufacturer specifications and the EnergyPro lighting library which is based on market frequency of the product. This process is detailed in Appendix H.

We used all this information to construct a detailed simulation of each sampled interior lighting alteration site. We supplemented this information with data on the building envelope and HVAC equipment because we did not assume that building envelopes and HVAC equipment complied with recent codes.

Roofing Alterations

Cadmus conducted site visits to physically verify the building parameters and characteristics for 29 roofing alteration projects, including reroof and cool roof. We also looked at the roof component for 91 new construction sites to assess the cool roof specification/compliance and the level of roof/ceiling insulation. When available, we assessed the Cool Roof Rating Certification (CRRC) documents provided by the site point of contact or the building department and compared them against on-site observations for confirmation. In the absence of CRRC documents, we used manufacturers' cut sheets and roofing material product numbers to research the physical attributions, aged solar reflectance index, and thermal emittance of the roofing material.

Cadmus analyzed data for 18 reroof and 11 cool roof projects using a binary compliance approach. We estimated a binary compliance factor by calculating the percentage of sites complying with or exceeding requirements of 2008 Title 24 divided by the total number of sites. One reason we used this approach instead of an engineering analysis or simulation model approach was that building departments often do not require applicants to submit a Title 24 document, and only request submittal of the CRRC document accompanied by the new roof/ceiling insulation-level specifications.

Cadmus created whole-building energy models for eight sites to assess the magnitude of the impact of the roofing measures on the energy consumption of the buildings. We used the data collected in the field to inform the input values required in the whole-building energy model for each site. These analyses are described briefly below; the results of this modeling effort is shown in Table 34.

Table 34. Simulated Electricity Savings for Roofing Alterations

	Number of Sites	Percent of Sites in Compliance with 2008 Title 24	Average Per-Site Reduction in Energy Consumption (kWh) Relative to 2005 Code		
			Cool Roof	Roof Insulation	Total
Cool Roof	3	100%	10,534.9	NA	10,534.9
Reroof	5	80%	2,210.8	2,397.4	4,608.2
* One reroof site was noncompliant with 2008 code and incurred high penalties, overriding savings from the remaining four sites. This site did not have a cool roof installed.					

[40] DEER Database for Energy-Efficient Resources, Version 2011 4.01. http://www.deeresources.com/index.php/deer2011-for-13-14.

Re-Roof Measure Analysis Methodology (Standard B17): The re-roof measure is a retrofit type of measure implemented on existing buildings undergoing roof replacement. Two components contribute to the performance of the re-roof measure: the roof/ceiling insulation and cool roof properties. For the cool roof component, we modeled the projects that implemented a cool roof as part of the re-roof project by using the actual reported/assumed aged solar reflectance index and thermal emittance. We modeled projects that did not have a cool roof by using an aged solar reflectance index (SRI) of 0.08 for asphalt shingles and 0.1 for all other roof surfaces, and used a thermal emittance of 0.85 (per CEC's requirement for performance compliance). The evaluation team conducted parametric runs to isolate the roof insulation savings from the envelope insulation as a whole. For the parametric runs, we ran the model iteratively, keeping the cool roof properties and envelope insulation constant, but changing the roof assembly insulation once to 2005 Title 24 baseline roof insulation and 2008 Title 24 baseline roof insulation values. These parametric runs provide varying levels of envelope insulation savings, but identical cool roof savings across runs. To calculate savings solely through the re-roof measure (roof insulation + cool roof), the cool roof savings are added to the difference of envelope insulation of the as-built project and the baseline (2005 and 2008 Title 24). Through this method, the evaluation team essentially neutralized any efficiency effects associated with other envelope parameters, such as wall insulation, and isolated savings associated with only implementing re-roof measure.

Cool Roof Measure Analysis Methodology (**Standard B31):** We found the cool roof Title 24 requirement by itself was implemented in existing and newly constructed sites. Given the impact that the cool roof has on lowering the cooling loads within a building, the 2008 Title 24 code requires new construction projects in most of the California climate zones (with some exceptions in Climate Zone 1 and 16) to have cool roof properties. Therefore, we found most of the newly constructed projects were required to, and had, cool roof membranes. We modeled the projects with cool roof applications/membranes using the actual reported/assumed aged solar reflectance index and thermal emittance. We modeled projects that did not have a cool roof by using an aged solar reflectance index (SRI) of 0.08 for asphalt shingles and 0.1 for all other roof surfaces, and used a thermal emittance of 0.85 (per CEC's requirement for performance compliance). EnergyPro summarizes the savings associated with cool roofs in two different categories. First, it summarizes the savings associated with cool roof application in isolation; second, it aggregates the interactive effect of the cool roof with the envelope insulation's effectiveness. In cases where a cool roof was prescribed based on the roof slope and the climate zone, but where the as-built project did not have a cool roof, an energy penalty was assigned to the envelope insulation performance as it relates to the cool roof associated interaction.

Weighting and Extrapolation

The evaluation team used a complex sample design in order to both minimize data collection costs and leverage auxiliary data available at the population level. The use of stratification (used at both the climate region and jurisdictional levels) introduces a non-random element to the sampling process (that is, sites now have differing sampling probabilities). This non-random component means that post-weighting is necessary to obtain unbiased estimates of population values. While this would be unnecessary if the achieved sample distribution matched the

population distribution, this was not the case here and therefore the evaluation team used post-weights to aggregate results.[41]

To aggregate site-level estimates of the compliance adjustment factor to the statewide level, Cadmus used the following formula (summing across all sites) for new construction:

$$Realization\ Rate_{NC} = \frac{\sum w_i * As\ Built\ Savings_i}{\sum w_i * 2008\ Code\ Savings_i}$$

$$CAF_{NC} = \frac{\sum w_i * As\ Built\ Savings_i}{\sum w_i * 2008\ Code\ Savings_i}$$

$$w_i = \left(\frac{\sum S_j}{\sum S_{hj}}\right) * \frac{S_{hj}}{s_{hj}}$$

Where:

w_i = the sampling weight for site, i, in jurisdiction, h, and climate region, j;

S_{hj} = the total square footage of new construction over the study period for jurisdiction, h, in climate region, j;

s_{hj} = the sampled square footage for jurisdiction, h , in climate region, j; and

S_j = the total square footage of new construction over the study period for climate region, j.

This aggregation approach uses sampling weights that account for the proportional allocation of square footage of construction both within and between climate regions. The weights are nested, where extrapolation is first made to the climate region level by taking the ratio of the population square footage to the sample square footage within a given jurisdiction. The ratio of the square footage of the climate region to the total of the population square footages for all jurisdictions sampled within that climate region then gives a value weighted to the statewide level. The population square footage values for each stratum designation is calculated from the McGraw Hill data.

For lighting alterations, population square footages of altered space were not available from McGraw Hill. We therefore used the new construction square footages as a proxy, but adjusted for the relative distribution of alteration to new construction projects found in the raw jurisdiction data we collected.

$$CAF_{Alt} = \frac{\sum v_i * w_i * As\ Built\ Savings_i}{\sum v_i * w_i * 2008\ Code\ Savings_i}$$

[41] Note that this is only true in the case that the distributions match exactly, so even in cases where they are closely aligned it is generally best practice to post-weight the results.

$$v_i = \left(\frac{N_{hj}^{(Alt)}}{N_{hj}^{(NC)}}\right) * \frac{1}{\sum S_j} \sum \frac{S_j}{\sum S_{hj}} \sum \left(\frac{N_{hj}^{(Alt)} * S_{hj}}{N_{hj}^{(NC)}}\right)$$

Where:

$v_i w_i$ = the alteration adjustment for site, i, in jurisdiction, h, and climate region, j;

$N_{hj}^{(Alt)}$ = the number of qualified alteration projects over the study period in jurisdiction, h,

in climate region, j; and

$N_{hj}^{(NC)}$ = the number of new construction projects over the study period in jurisdiction, h, in climate region, j.

This formula adjusts the square footage weights by the relative distribution of observed alterations compared to new construction projects. If we had used only the new construction square footage as a proxy, the assumption would have been that the relationship between new construction square footage and alteration square footage is constant across the state. Because we made our adjustments, the assumption is less restrictive. Here we are assuming that the relationship between total square footage of alterations and total square footage of new construction follows the relationship between the number of alterations and the number of new construction sites.[42]

Given the small number of roofing alterations, we used a simple proportion to estimate the compliance rate for these projects.

3.3 Net Savings / NOMAD

3.3.1 Title 20, Federal, and Title 24

This section presents the methodology to estimate the Naturally Occurring Market Adoption (NOMAD) trend for each of the products or technologies regulated by the 2010 Title 20 and federal appliance standards, and Title 24 building codes. The natural market is an important factor in determining the net savings from the adoption of new standards.

It is important to understand what is meant by *naturally occurring market adoption*. The naturally occurring market adoption is a projection of what the annual sales or installations of items meeting the standards would have been if the standards had not been adopted. The naturally occurring market adoption is an estimate of energy-efficient product sales or installations over time. Once the standard is in effect, the natural market no longer exists in reality. However, the evaluation methodology requires that the naturally occurring market trend—the counterfactual—be estimated to derive the net savings for each standard.

[42] That is, the evaluation team is assuming that the relative size of alterations compared to new construction is relatively constant across the state. If the team had simply weighted by new construction square footage, the assumption would have been that both the size and number of alteration projects is consistently proportional to new construction.

Appliance Standards (Title 20 and Federal Standards)

To determine ISSM model coefficients necessary to calculate net energy savings for each Title 20 and federal standard, the evaluation team used a modified Delphi approach. The Delphi 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 are given an opportunity to revise their forecasts and again provide their supporting arguments. The process ends after a number of rounds with the intention of reaching consensus or stability. Cadmus' modified Delphi approach used a convenient, flexible, web-based data-collection application developed by Cadmus, which allowed the experts to provide their input when convenient, view the anonymous responses of the other experts, and revise their input. The Cadmus Market Adoption Tool (MAT), as configured for this study, assumed that market adoption over time can be characterized with an exponential diffusion curve (the Bass S-shaped curve). This way of representing market diffusion of technologies and products has been used widely in prior market studies. More detailed information about the exponential diffusion curve is provided in Appendix C.

Cadmus attempted to build ideal expert panels for each of the Title 20 and federal appliance standards. Due to practical limits on time available to recruit experts and other real-world constraints, actual panels did not meet every goal described. Cadmus dedicated more evaluation resources to those standards with the greatest energy savings, and we focused attempts on building ideal expert panels on these standards. Cadmus' strategy to develop ideal expert panels considered the following issues:

- Selection criteria/qualifications
- Approach to managing bias
- Approach to identifying conflict of interest.

Prior Program Adjustment

The IOUs often implement resource acquisition programs for energy-efficiency measures or efficient appliances that are adopted as requirements in subsequent codes or standards. Such programs sometimes have a significant effect on the market in terms of product or measure sales and installations over several years; therefore, we chose to regard them as a part of the naturally occurring market when we solicited expert opinions on the market trends. We considered asking the expert panels to estimate market trends in the absence of these programs, but we determined it would be too complex and introduce too much uncertainty to try to estimate market trends under this assumption. Therefore, we instructed the experts to estimate the natural market (in the absence of the standard) 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 raises the issue of how prior programs affect projections into the future of the naturally occurring market. In cases where the programs had a significant impact on the market, it seemed likely that the natural market estimates would reflect this program effect. Since NOMAD constitutes a

savings deduction, the upward shift in the adoption curve due to programs run in previous years means net savings would be underestimated.

To correct for the possible inappropriate deduction due to the effects of prior IOU programs, we made an adjustment to each NOMAD estimate. At our request, the IOUs provided data from their records on every program that affected the product volumes of appliances and measures regulated by the codes and standards being evaluated. We used these data to adjust each NOMAD estimate as shown in section 4.3.1 below. In this way, the methodology took into account the fact that prior utility programs may have had a persistent impact on the market for each efficient appliance or measure[43].

In the course of implementing this adjustment during the 2006-2008 PY evaluation, we decided to limit the ongoing adjustment for these prior utility programs to ten years. In the Integrated Standards Savings Model (ISSM), we are reducing the utility program adjustment on NOMAD by 10% each year. In this way, the adjustment is greatest shortly after the programs were active and then it is gradually reduced each year.

Our report on the 2006-20008 PY evaluation includes additional detail on the reasoning that went into this methodology adjustment.

3.4 Net Program Savings / Attribution

Attribution refers to the portion of energy savings that can be credited to utilities' C&S Program efforts for enabling or assisting the adoption of each appliance or building standard. The evaluation team calculated attribution for both state and federal codes and standards in the 2010-2012 program cycle. The state-level attribution approach is the same as the 2006-2008 program cycle methodology submitted to Commission staff in 2009.[44] Based on Commission staff direction, Cadmus developed a methodological approach for the federal standards, as this was the first year these standards have been evaluated. Cadmus submitted a memorandum detailing the proposed federal methodology to Commission staff in September 2013. Cadmus presented the proposed method at a Commission-staff-sponsored public workshop in October 2013.[45]

The attribution analysis results in an attribution score (a percentage between 0% and 100%) that represents the relative contribution of the program to adoption of the standard. The evaluators then multiplied the score by the energy savings from the standard, after adjusting potential savings for NOMAD and compliance.

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[43] After the effective date of the standard, utilities do not receive savings credit for post-program units through (incentive) programs, so this adjustment does not represent a double-count of savings.

[44] The Cadmus Group. March 9, 2009. "The Proposed Cadmus Attribution Methodology (Revised)." This document is available at http://www.energydataweb.com/cpuc/default.aspx

[45] A Commission-staff-led public workshop was held on October 18, 2013, to discuss the policy issues related to attribution of federal standards as well as proposed methodology for collecting data and calculating attribution scores. Background materials, presentations and public comments are available on www.energydataweb.com/cpuc and in Appendix D.

The process of determining both state and federal attribution entailed the following steps:

1. Cadmus 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 codes and standards experts assessed the program's contributions to the adoption of each standard based on a careful and systematic review of the evidence. The evaluation of program contributions by independent parties lessened concerns about potential biases from individuals who could have been directly involved in adopting standards determining credit for their own efforts.

3. Cadmus estimated the relative effort required to adopt a new code or standard in three factor areas, described in more detail in the next subsection. We applied these weights to the factor score to calculate an overall attribution score.

The following sections provide a description of the Cadmus attribution model, data collection, and attribution analysis for both the state and federal codes and standards. More complete descriptions of the state and federal models are contained in the memoranda cited above and in Appendix D.

3.4.1 The Attribution Model

The model sets forth specific criteria for evaluating the contributions of the C&S Program to standards development and adoption. It applies to both federal and California rulemaking. The model focuses on three areas of activity representing the fundamental requirements that must be met for the California Energy Commission (for state standards), the U.S. Department of Energy (for federal administrative rulemaking), or the U.S. Congress (for federal legislative rulemaking) to adopt a standard; these are referred to as "factors" in the model. The factors are:

1. **The Development of Compliance Determination Methods and Other Special Analytic Techniques**

End-users must be able to determine that they are in compliance with the standards. Similarly, code officials (in the case of 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 having a reliable test method. In other cases, it involves having an analytical tool that produces results indicating whether compliance is achieved. In addition, some standards require the development of new analytic methods to estimate energy and demand savings.

2. **The Development of Code Language and Technical, Scientific, and Economic Information in Support of the Standard**

The standard must be defined in careful technical language that spells out covered products, effective dates, and required efficiency levels. Also, significant scientific, engineering, and economic research must be completed before a standard can be adopted. This research typically concerns estimates of energy and peak demand savings and the cost-effectiveness of measures. Since implementation of the C&S Program began, much of this research and development at the state level has been summarized in CASE reports funded by the utilities for codes and

standards in which they played a significant role. At the federal level, the research completed through CASE reports can be adapted for the federal standards; however, the C&S Program often conducts additional research or teams with other stakeholders who have conducted their own technical research in support of the federal rulemaking process.

3. Demonstrating the Feasibility or Market Acceptance of Standard Adoption

An implicit requirement for adopting a new standard is that compliance with the standard be practical and feasible. Supporters of the standard must address stakeholder concerns and demonstrate through market research that stakeholders can comply with the standard. Three conditions must be met to satisfy this requirement. First, the market must be capable of supplying the products and services necessary to comply with the standard. If a product is not readily available in the marketplace, the technology must be well developed and manufacturers capable of increasing supply before the standard goes into 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.

Cadmus reviewed information provided by the C&S Program team, available in the rulemaking docket, and from interviews with stakeholders. Cadmus summarized the contributions of the C&S Program team and other stakeholders and presented them to an independent panel of codes and standards experts. During three all-day sessions, Cadmus presented findings about stakeholder contributions, which decided a percentage score between 0% and 100% reflecting the contribution of the C&S Program to each factor in the development of a code or standard.

To account for the relative importance of these three factors, we determined a percentage weight between 0% and 100% for each factor. The weights, which must sum to 100% across the three factors for each standard, represented the relative amount of effort required to address the factor for adoption of the specific standard.

Cadmus estimated factor weights for each code or standard based on data from the IOUs and other sources about the resource distribution across factors. The C&S Program team proposed factor weights for each standard and a brief explanation of the weights for the evaluators' consideration.

Cadmus then estimated the attribution score for a standard as a weighted average of the factor scores and multiplied each factor score by the respective weight. The sum was the attribution score.

3.4.2 Data Collection Activities

The evaluators based the actual determination of C&S Program credit on a systematic and thorough review of available evidence about program activities. Cadmus collected information from a variety of sources, including documents provided by the C&S Program (CCTR, CASE reports, etc.), public documents (transcripts, public comments, etc.), and stakeholder interviews. This section describes the sources.

Review of public documents. The evaluation team collected information about C&S Program and other stakeholder contributions to development and adoption of each standard 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, and stakeholder letters, e-mails, and comments to the CEC and DOE. The public record was more limited for federal legislative standards; however, Cadmus searched the legislative docket and reviewed transcripts, formal comments, and communication logs for these standards. We carefully read these sources, and extracted information about C&S Program and other stakeholder activities and entered it into a spreadsheet for future reference in determining C&S Program credit.

Request for information about federal codes and standards rulemaking activities. After the Commission staff accepted the state and federal attribution methodology, Cadmus requested information from the C&S Program team about activities that contributed to the adoption of the codes and standards. The California IOUs responded by providing Code Change Theory Reports (CCTRs), which provided the IOU perspective about the C&S Program team's contributions to rulemaking. Cadmus relied on the CCTRs when presenting information about the development of the standard to the panel of independent experts.

Stakeholder interviews. The evaluation team conducted interviews with key stakeholders to fill remaining gaps in its understanding of the development of standards. As the documentation for the federal rulemaking process was less detailed, Cadmus focused significant effort on recruiting interviewees for the federal standards. We conducted a total of 15 interviews with stakeholders closely involved in the development of the state standards; we conducted nine interviews with federal stakeholders.

Cadmus relied on interviews with stakeholders involved in the state rulemaking process to fill information gaps in the public record. Often, the C&S Program team's technical research and involvement in stakeholder outreach were the focus of the interviews. The federal interviews focused more on the involvement of the C&S Program team compared to other efficiency advocates, the type of technical data provided by the C&S Program team to DOE, and the federal rulemaking process as a whole.

3.4.3 Estimation of Factor Scores

The following three principles guided the 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, Cadmus convened a panel of independent codes and standards experts to determine the C&S Program credit. While Cadmus provided background information to the panel, the panel was entirely responsible for determining the attribution levels. The panel consisted of four experts: one represented the Midwest Energy Efficiency Alliance; one represented the Northwest Energy Efficiency Alliance; one was an independent consultant who has worked with the Southwest Energy Efficiency Project, and one was an independent consultant who is on the board of several energy-efficiency organizations. The

panel convened in Cadmus' Portland offices for a two-day session in June 2013, during which it discussed attribution for the state appliance standards and building codes.

A separate panel was held in March 2014 via teleconference to determine attribution for the federal standards. For this panel, Cadmus recruited a fifth panel member: a federal standards expert who recently retired from Lawrence Berkeley National Laboratory and is familiar with the federal rulemaking process.

At the first meeting of the panel, Cadmus explained the attribution model and the scoring protocol and instructed the panelists about the kinds of evidence they should consider and the determination of the factor scores. We told the panelists that the contribution of the program to each factor was to be judged relative to the contributions of other stakeholders such as industry member, efficiency advocated, the CEC, and the DOE. In addition, we told the panelists that the amount of effort required for a factor should not influence the determination of the factor score. For example, the panel considered a large number of standards for which a test method already existed. The C&S Program and other stakeholders did not need to devote many resources to the development of compliance methods (factor 1) in such cases. However, the program could still receive a high score for the factor if the program identified and proposed the test method that was adopted. The presentations, the Code Change Theory, the CASE report, and the spreadsheet summarizing stakeholder contributions were available for the panel members' reference during the sessions.

The deliberations of the panel began with a presentation by Cadmus. Cadmus briefly explained the development of the standard, including the prescriptive or performance requirements, the key stakeholders, and the history of the development of the standard. The facilitator then presented evidence about the C&S Program contributions.

The panel members discussed their thoughts on the three factors for each code or standard. The discussion often included the members expressing an opinion on each factor score, asking questions of Cadmus about the rulemaking activities, and discussing any issues or thoughts among themselves. After this discussion, the panel could come to a mutual agreement on the factor scores, vote on the scores as individuals, or ask Cadmus for more information and reach agreement at a later time in light of 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.

3.4.4 Estimation of Factor Weights

In the previous evaluation, Cadmus relied on a survey of outside stakeholders, who were involved in the rulemaking processes, to determine the factor weights.[46] As recruitment for this survey was difficult in the previous program cycle, and in an effort to remove bias from the methodology, Cadmus developed factor weights, internally, for each code or standard for this program cycle. We based the factor weights on our understanding of how resources were allocated across the factor areas for each code or standard. This assessment was based on the data collected through our review of rulemaking documents and stakeholder interviews.

[46] Since the panel members were not directly involved in the adoption of the standards, they were not included in this survey effort.

As a check against Cadmus' 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 evaluation. 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.

Cadmus compared our weights to those provided by the IOUs. If the weights were relatively close, Cadmus used the weights developed internally. If large discrepancies existed between Cadmus and the IOUs (generally 10% or more), Cadmus reviewed the justification provided by the IOUs, conducted additional research, and then made adjustments to the weights as necessary. For example, if Cadmus gave a low weight to factor two based on the assumption that a data collection activity described in the CCTR required minimal resources, but the IOUs weighted factor two very highly, Cadmus reviewed the IOUs' explanation as well as the supporting documentation and, if the additional detail was convincing, we adjusted the weight upward.

3.4.5 Estimation of the Attribution Scores

As a final step in the process, Cadmus calculated the attribution score for each state or federal code or standard. The attribution score measures the contribution of the C&S Program to adoption of a standard and multiplies net energy savings to determine the amount attributable to the C&S Program. Cadmus calculated the attribution score by multiplying the factor weight and factor score for each factor within a standard, then summing those weighted scores.

4 Results for Title 20 and Federal Appliance Standards

This chapter includes evaluation results for each of the individual protocol stages for appliance standards. As noted in Chapter 2, evaluation results in this report are presented under the Scenario One assumption that savings from superseded standards (layering) are included (unless otherwise noted).

4.1 Potential Savings

Table 35 shows the evaluated first-year energy and demand potential savings by standard, along with the original potential savings estimated by the IOUs. The evaluated savings were higher for Standards 9, 24, and 28a. In most cases, gas savings are negative due to interactive effects. The only standards for which there are positive first-year potential gas savings are Federal Standard 4 and Federal Standard 5. All of the values shown reflect full year potential. If a standard takes effect after January 1, the evaluated potential for that year is adjusted accordingly.

Table 35. IOU Estimated and Evaluated First-Year Potential Savings by Standard

Standard		IOU-Estimated Savings*			Evaluated Savings**		
		GWh	MW	Mtherms	GWh	MW	Mtherms
Std 9	Res. Pool Pumps, 2-Speed Motors, Tier 2	103.5	23.9	0.0	336.6	24.5	0.0
Std 11b	General-Service Incand. Lamps, Tier 2 (2010)	254.2	31.4	-4.5	224.0	36.8	-2.6
Std 22a	Residential Incandescent Reflector Lamps	81.1	10.1	-1.9	10.2	2.3	-0.2
Std 22b	Commercial Incandescent Reflector Lamps	158.2	21.2	-1.9	4.2	1.2	-0.1
Std 23	Metal Halide Fixtures	45.0	8.0	-0.5	44.2	9.3	-0.8
Std 24	Portable Lighting Fixtures	51.2	4.8	-0.9	86.3	15.3	-1.0
Std 25	General-Purpose Lighting 100 W	254.5	17.8	-4.5	194.2	31.9	-2.2
Std 26	General-Purpose Lighting 75 W	230.1	16.1	-4.1	134.0	22.0	-1.6
Std 27	General-Purpose Ltg 60 / 40 W**	441.8	30.9	-7.8	303.5	49.7	-3.5
Std 28a	Televisions, Tier 1	528.0	49.9	-6.4	385.5	44.1	-7.6
Std 28b	Televisions, Tier 2**	336.0	30.2	-4.1	357.5	39.7	-7.0
Fed 1	Electric Motors 1-200 HP	63.7	8.7	0.0	146.2	20.1	0.0
Fed 2	Refrig.Beverage Vending (Std 5 in 06-08)	5.8	0.8	0.0	15.2	2.3	-0.2
Fed 3	Commercial Refrig. (Std 1, 2, 3 in 06-08)	37.8	5.0	-0.5	29.1	4.9	-0.6
Fed 4	ASHRAE Products (Commercial Boilers)	0.0	0.0	0.3	0.0	0.0	0.3
Fed 5	Residential Gas Ranges	0.0	0.0	0.4	0.0	0.0	0.1
Fed 6	Incandescent Reflector Lamps	538.5	96.0	-9.5	25.6	13.2	-0.6
Fed 7	General-Service Fluorescent Lamps	388.5	69.3	-4.6	328.3	90.4	-1.2

* Estimates provided by the California IOUs on May 13, 2011, in response to EEGA data request 1465, 1466, 1467, and 1468.
** Pre-Effective Date Forecast only

4.1.1 Federal Pre-Emption

As noted above, potential savings from some Title 20 standards are affected by federal pre-emption (see Table 17). For example, there are potential savings from Title 20 Standards 1 and 2 (commercial refrigeration equipment) in 2010 and 2011, but in January 2012, Federal Standard 3 became effective and these savings are then evaluated as part of the federal standard group.

The evaluation of federal standards produces a third major category in addition to the Title 20 and Title 24 standards. In the case of federal pre-emption, the potential savings for a standard are moved from Title 20 to the federal group. From an evaluation and modeling perspective, each federal standard is evaluated and any savings that result can be identified with a category such as Title 20 standards. As with any other standard, the potential is adjusted for compliance, NOMAD, and attribution. The total savings from federal standards are then treated as another part of the IOU portfolio of C&S savings.

The potential savings shown in Table 36 reflect the impact of federal pre-emption and the potential savings input to the ISSM. To improve the comparability of the IOU Estimate to the evaluated savings, we made these changes in both sets of values. (This is among the adjustments made to the values provided by the IOUs that are described in Appendix A.)

The shaded cells indicate pre-empted standards for which potential savings for Title 20 standards were reduced by the adjustment for federal pre-emption. In cases where the IOUs include a corresponding federal standard in their estimate, some or all of these potential savings will be evaluated with the federal standards group as shown in the lower section of Table 36. The EISA lighting standards are a notable exception: the IOUs did not include EISA with the federal standards in their estimate.

Table 36. Potential Savings Adjusted for Federal Pre-emption (in GWh)

Potential Savings (GWh) for Title 20 Standards (GWh)									
	Refrigeration, Ice Makers			BVMs	GP Lighting			IRLs	
Year	Std 1	Std 2	Std 3	Std 5	Std 11b	Std 25	Std 26	Std 22a	Std 22b
Federal Pre-Emption Date	Federal Standard 3 Jan 2012			Federal Std 2 Aug 2011	EISA Jan 2012		EISA Jan 2013	Federal Standard 6 Jul 2012	
2010	9.6	12.8	6.6	15.4	224.0	0.0	0.0	10.2	4.2
2011	9.6	12.8	6.6	10.2	183.9	194.2	0.0	10.2	4.2
2012	0.0	0.0	0.0	0.0	88.4	0.0	134.0	5.4	2.3

Potential Savings (GWh) Due to Pre-emptive Federal Standards (GWh)									
2011	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0
2012	9.6	12.8	6.6	15.4	0.0	0.0	0.0	4.8	1.9

Note: Shaded cells indicate when potential savings for Title 20 C&S have been adjusted due to federal pre-emption

4.2 Gross Savings / Compliance Adjustment Factors

Table 37 shows our results for the compliance adjustment factor for each standard evaluated. Lighting standards that took effect during the 2010-2012 cycle had the lowest CAFs. The CAF

for Federal Standard 6, incandescent reflector lamps, was the lowest at 6.9%; however, compliance with standards is based on date of manufacture, not date of sale, and this standard did not take effect until July 2012. Because data collection for this standard took place only a few months after the standard had gone into effect, products found in stores were likely to be existing stock manufactured prior to the effective date of the standard. Limiting the compliance adjustment factor to only a brief period after the standard became effective is consistent with the M&V effort to measure savings that actually occur in the time period studied. In the next evaluation cycle, it would be appropriate to revisit and adjust this factor for the savings in that cycle.

Table 37. Compliance Adjustment Factor by Standard

Standard		IOU Estimate CAF*	Evaluated CAF**
Std 4	Walk-In Refrigerators/Freezers	88%	91%
Std 9	Residential Pool Pumps, 2-Speed Motors, Tier 2	94%	86%
Std 11b	General-Service Incandescent Lamps, Tier 2	44%	72%
Std 22a	Residential Incandescent Reflector Lamps	85%	82%
Std 22b	Commercial Incandescent Reflector Lamps	85%	82%
Std 23	Metal Halide Fixtures	85%	95%
Std 24	Portable Lighting Fixtures	85%	93%
Std 25	General-Purpose Lighting – 100 W	85%	2011: 36% 2012: 88%
Std 26	General-Purpose Lighting – 75 W	85%	40%
Std 28a	Televisions, Tier 1	85%	98%
Fed 1	Electric Motors 1-200 HP	95%	91%
Fed 2	Refrigerated Beverage Vending Machines (Std 5 in 06-08)	95%	37%
Fed 3	Commercial Refrigeration (Std 1, 2, and 3 in 06-08)	95%	70%
Fed 4	ASHRAE Products (Commercial Boilers)	95%	N/A
Fed 5	Residential Gas Ranges	95%	100%
Fed 6	Incandescent Reflector Lamps	95%	6.9%
Fed 7	General-Service Fluorescent Lamps	95%	95%

* Estimates provided by the California IOUs on May 13, 2011, in response to EEGA data request 1465, 1466, 1467, and 1468.
** Rows shaded in grey contain evaluation results from the 2006-2008 PY Evaluation

4.3 Net Savings / NOMAD

4.3.1 Appliance Standards (Title 20 and Federal Standards)

Cadmus evaluated market adoption rates by collecting input from category experts using the modified Delphi approach described in Section 3.3. Table 38 shows the market share forecast used in the IOU Estimate and the evaluation for the years 2010 through 2012. Higher NOMAD estimates lead to lower net savings.

In their estimate, the IOUs used the same market adoption curve for all lighting standards: Standards 22a through 27 and Federal Standards 6 and 7. Cadmus solicited separate panelist input for each standard.

Since Cadmus conducted a NOMAD evaluation of refrigerated beverage vending machines and commercial refrigeration during the 2006-2008 Codes and Standards evaluation, Cadmus applied the parameters calculated from the previous evaluation to the current federal standards for these appliances, because the underlying adoption without the codes would not be different and the Delphi participants in the prior cycle would be closer to the no-code experience than if we repeated the process in 2013. Projected savings are small for federal standards for boilers and electric/gas ranges, so Cadmus used the parameter assumptions used in the utility savings claim as evaluated inputs to the ISSM model.

Table 38. Title 20 and Federal Appliance Standards NOMAD Market Share

Standard		IOU Estimates			Evaluation Result		
		Market Share in			Market Share in		
		2010	2011	2012	2010	2011	2012
Std 22a	Residential Incandescent Reflector Lamps	6%	6%	6%	14%	15%	17%
Std 22b	Commercial Incandescent Reflector Lamps	6%	6%	6%	14%	15%	17%
Std 23	Metal Halide Fixtures	6%	6%	6%	11%	15%	19%
Std 24	Portable Lighting Fixtures	6%	6%	6%	8%	10%	13%
Std 25	General-Purpose Lighting – 100 W	6%	6%	6%	4%	6%	7%
Std 26	General-Purpose Lighting – 75 W	6%	6%	6%	5%	6%	8%
Std 27	General-Purpose Lighting – 60 / 40W	6%	6%	6%	6%	7%	8%
Std 28a	Televisions, Tier 1	36%	50%	62%	53%	62%	69%
Std 28b	Televisions, Tier 2	9%	14%	21%	42%	50%	57%
Std 29	Battery Charger – Consumer, Tier 1	26%	30%	34%	19%	23%	27%
Std 31	Battery Charger – Large, Tier 1	26%	30%	34%	9%	11%	13%
Std 32	Battery Charger – Large, Tier 2	26%	30%	34%	26%	30%	34%
Fed 1	Electric Motors 1-200 HP	8%	8%	9%	4%	5%	5%
Fed 2	Refrig. Beverage Vending Machines	93%	94%	95%	93%	94%	95%
Fed 3	Commercial Refrigeration	74%	76%	77%	38%	40%	41%
Fed 4	ASHRAE Products (Commercial Boilers)	27%	28%	28%	27%	28%	28%
Fed 5	Residential Gas Ranges	27%	28%	28%	27%	28%	28%
Fed 6	Incandescent Reflector Lamps	6%	6%	6%	1%	1%	2%
Fed 7	General-Service Fluorescent Lamps	6%	6%	6%	26%	31%	36%

For Standard 22b, we used the same parameter assumptions found for Standard 22a. For Standard 32, we used the same parameter assumptions used by the IOUs.

Prior Program Adjustments

As we discussed in Section 3.3, the NOMAD estimates that resulted from the work of the expert panels are assumed to include the market effects of IOU resource programs. For this reason, we worked with the IOUs and Commission staff to identify the IOU programs that offered incentives for measures or efficient appliances that were later requirements of the C&S being evaluated. This effort found two product types for which incentives were paid through IOU programs in the years immediately preceding a Title 20 regulation: metal halide fixtures and

energy-efficient televisions. Larger program adjustments lead to lower NOMAD effects and, thus, higher net savings.

Metal halide fixtures are regulated under Standard 23, which took effect at the beginning of 2010. Research by Commission staff and the IOUs found that IOU programs paid incentives for 16,978 metal halide fixtures in 2008. (The research did not identify the same level of program activity in 2009.) We used the 2008 volume to adjust the expert-based NOMAD estimate beginning in 2010, as shown in Table 39. Market share percentage was calculated using the market size of 234,000 units per year determined through our research on potential savings.

Table 39. Prior Program Adjustment for Standard 23 Metal Halide Fixtures

Year	Prior Program Adjustment		NOMAD	Net NOMAD
	Units	Market Share		
2010	16,978	7.3%	-11.1%	-3.9%
2011	15,280	6.5%	-14.7%	-8.2%
2012	13,582	5.8%	-18.9%	-13.1%

Table 39 shows that the quantity of incentive-based units is first converted to a market share percentage and then combined with the expert-based NOMAD estimate to determine a Net NOMAD value. For the three years from 2010 through 2012, this adjustment has the effect of reducing the estimated natural market adoption by an average of about 6.5 percentage points each year. In this way, the evaluated C&S savings are not reduced by the market impact of earlier IOU incentive programs.

Energy-efficient televisions are regulated by Standard 28a which took effect at the beginning of 2011. Research by Commission staff and the IOUs found that IOU programs paid incentives for 579,131 high-efficiency televisions in 2010. Our research into potential savings determined that the market for televisions was about 3.34 million units per year during the evaluation period. Table 40 shows the Net NOMAD calculation for Standard 28a.

Table 40. Prior Program Adjustment for Standard 28a Televisions

Year	Prior Program Adjustment		NOMAD	Net NOMAD
	Units	Market Share		
2011	579,131	17.3%	-61.8%	-44.4%
2012	521,218	15.6%	-68.8%	-53.1%

In our review of the adjustments to the television standard saving, Cadmus considered the following additional information:

- The Business and Consumer Electronics (BCE) Program paid incentives to retailers for sales of high-efficiency televisions. This program was targeted as products that were above the level of efficiency required by Standard 28a.
- The impact evaluation of the BCE program[47] estimated the Net-To-Gross ratio for the program to be 39%. This finding suggests that there was significant freeridership in the program results.
- The ENERGY STAR program reports[48] that ENERGY STAR televisions represented 84% of the television market nationally during the evaluation period.

We discussed this information with Commission staff. We agreed to follow the method used in the 2006-2008 PY evaluation and to base the adjustment on the full program volume. However, we also note that this information raises a question about using the full program volume to make the adjustment: Did all of the IOU program units increase the natural market for code-compliant televisions? Cadmus and Commission staff agree that this is an area that should be explored in greater depth in C&S evaluations that follow.

4.4 Net Program Savings / Attribution

Table 41 reports the factor scores, factor weights, and final attribution score for each of the state (Title 20) and federal appliance standards. The factor scores indicate the percentage contributions of the C&S Program to the development of the standards in each factor area. The final attribution score is the weighted average of the factor scores.

[47] Vencil, Jon. *Impact Evaluation Report Business and Consumer Electronics Program (WO34).* April 2013. CPUC (CALMAC #CPU0060.01

[48] Source: ENERGY STAR® Unit Shipment and Market Penetration Report Calendar Year 2012 Summary (http://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2012_USD_Summary_Report.pdf). Note 2011 market penetration value is 96%.

Table 41. Title 20 and Federal Standards – Attribution Scores

Standard		Factor Score			Weight			Final Attribution Score
		Compliance	Technical	Feasibility	Compliance	Technical	Feasibility	
Std 22a	Residential IRLs*	90%	75%	40%	10%	45%	45%	61%
Std 22b	Commercial IRLs	90%	75%	40%	10%	45%	45%	61%
Std 23	Metal Halide Fixtures	70%	70%	75%	15%	40%	45%	72%
Std 24	Portable Lighting Fixtures	40%	50%	50%	10%	50%	40%	49%
Std 25	General-Purpose Lighting – 100 W	90%	80%	65%	10%	55%	35%	76%
Std 26	General-Purpose Lighting – 75 W	90%	80%	65%	10%	55%	35%	76%
Std 27	General-Purpose Lighting – 60 / 40W	90%	80%	65%	10%	55%	35%	76%
Std 28a	Televisions, Tier 1	50%	65%	65%	30%	20%	50%	61%
Std 28b	Televisions, Tier 2	50%	65%	65%	30%	20%	50%	61%
Fed 1	Electric Motors	0%	75%	40%	5%	40%	55%	52%
Fed 2	Refrig. Beverage Vending Machines	26%	45%	75%	30%	50%	20%	45%
Fed 3	Comm. Refrigeration	20%	63%	40%	28%	40%	33%	44%
Fed 4	ASHRAE Products (Comm. Boilers)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fed 5	Res. Gas Ranges	0%	20%	25%	0%	60%	40%	22%
Fed 6	IRLs	0%	25%	35%	10%	45%	45%	27%
Fed 7	General-Service Fluorescent Lamps	0%	10%	35%	10%	50%	40%	19%

* Incandescent Reflector Lamps

5 Results for Title 24 Building Codes

This chapter includes results for each of the protocol stages conducted for the evaluation of the 2008 Title 24 building codes.

In Cadmus' evaluation of the Title 20 standards, we typically determine a value for potential, CAF (compliance), NOMAD, and attribution for each standard. Our approach to the Title 24 codes differs, in that our field research found code-specific values for potential, NOMAD, and attribution but we determined CAF values for two groups of codes collectively. For these two categories, nonresidential new construction and nonresidential lighting alterations, we used building simulation to determine a typical CAF value that was then applied to all of the codes in this category. This will be shown in more detail in Section 5.2.

5.1 Potential Savings

Following the methods described in Section 3.1.2, Cadmus reviewed both the unit energy savings and the level of construction activity to determine the potential savings for each of the Title 24 codes. The details of these reviews for individual codes are included in Appendix G.

For nearly all of the Title 24 codes, Cadmus found that the potential savings were smaller than the IOU Estimates. The major reason for these reductions was that actual construction activity during the years 2010-2012 was much lower than the forecasts that were the basis for the IOU Estimate. In Table 42, we compare the actual level of residential construction—based on CIRB permit data and industry data[49]—for single family homes, multifamily buildings, and swimming pools, to the forecasted values used in the IOU Estimate. We found the largest difference in single family homes, where construction dropped to 22% of the earlier forecast. Swimming pool construction decreased slightly less, to about 31% of the IOU Estimate. Multifamily construction had the smallest drop, with actual construction at nearly 64% of the earlier estimate.

Table 42. Residential Construction Activity

	IOU Estimate	Evaluation	
	2007 AEC/CEC Report	2010-2012 Average	Evaluation / IOU Estimate
Source	CIRB	CIRB	
Single Family Permits	108,021	23,944	22.2%
Multifamily Permits	37,505	23,852	63.6%
Source	IOU Estimate	PKG Report	
Swimming Pools	34,848	10,999	31.6%

Table 43 provides a similar comparison of the forecasted level of nonresidential construction activity to the updated tracking data from MHC that Cadmus used for the evaluation. For some categories in the IOU Estimate, such as food stores, small office, and small retail, Cadmus could not identify a similar category in the MHC data. Overall, the actual level of construction was about 22% of the forecast used by the IOUs. The potential for individual standards is typically

[49] P.K. Data report available from the Association of Pool & Spa Professionals, https://apsp.org/

based on specific subcategories. Cadmus generally used the same assumptions as the IOUs regarding the percentage of square footage in each category affected by a particular code, so the change in potential savings is not the same as the change in overall construction. The table does provide some indication of the magnitude of the change in most categories.

Table 43. Nonresidential Construction Activity

IOU Estimate			Evaluation based on MHC Data		
Building Type	Area (Sq. Ft.)		Building Type	Area (Sq. Ft.)	Evaluation / IOU Estimate
Colleges, Universities Elem/Scndry Schools	8,499,725 15,177,259		Schools, Libraries, and Labs	8,591,507	36.3%
Food Stores	6,409,739				
Hospitals	3,184,652		Hospitals	3,183,420	100.0%
Hotel/Motel	1,841,389		Hotels and Motels	1,327,207	72.1%
Large Office	25,714,071		Office and Bank Buildings	3,497,347	13.6%
Large Retail	21,202,453		Shopping Centers Stores	5,045,187	23.8%
Medical Clinic	3,462,130		Clinics/Nursing Conval. Facilities	1,907,147	55.1%
Miscellaneous	36,045,368		Miscellaneous Nonresidential Amusement, Social and Recreation Government Service Buildings Religious Buildings Manuf. Labs, Plants, Warehouses Refrigerated Warehouses Dormitories	10,284,227	28.5%
Non-Refrg Warehouses	23,078,756		Warehouses (Non-Refrigerated)	4,918,967	21.3%
Restaurants	1,420,262		Food/Beverage Service	455,847	32.1%
Small Office	23,154,550				
Small Retail	11,809,647				
Total	181,000,000			39,210,853	21.7%

Table 44 shows the evaluated first-year energy and demand potential savings by code, along with the potential savings estimated by the IOUs.

Additional detail on the evaluated potential savings including the potential savings associated with new construction and alteration projects is included in Appendix G.

Table 44. Title 24 Codes – Potential Savings

Standard		IOU-Estimated Savings*			Evaluated Savings		
		GWh	MW	Mtherms	GWh	MW	Mtherms
Std B17	Envelope Insulation	73.1	14.5	6.4	55.9	3.3	5.9
Std B18	Overall Envelope Trade-off	-	-	-	0.2	-	-
Std B19	Skylighting	3.7	0.2	-	3.3	0.2	-
Std B20	Sidelighting	1.2	0.5	-	1.3	0.6	-
Std B21	Tailored Indoor Lighting	30.9	6.8	-0.4	27.6	6.1	-0.1
Std B22a	TDV lighting Controls	-	-	-	-	-	-
Std B22b	DR Indoor Lighting	-	-	-	-	-	-
Std B23	Outdoor Lighting	7.8	-	-	7.8	-	-
Std B24	Outdoor Signs	1.2	-	-	1.2	-	-
Std B26	Refrigerated Warehouses	10.4	1.7	-	0.9	0.1	-
Std B27	DDC to Zone	61.7	24.5	6.4	30.8	13.1	0.4
Std B28	Residential Swimming Pool	56.6	31.6	-	17.9	10.0	-
Std B29	Site Built Fenestration	7.4	-	0.2	1.9	-	-
Std B30	Residential Fenestration	31.2	25.6	6.6	4.5	3.4	1.2
Std B31	Cool Roof Expansion	72.9	6.7	-0.3	22.7	2.1	-0.1
Std B32	MF Water Heating Control	-	-	-	-	-	-
Std B33a	CfR IL Complete Building Method	149.6	33.3	-	124.6	27.7	-0.5
Std B33b	CfR IL Area Category Method	82.5	18.5	-	68.6	15.4	-0.3
Std B33c	CfR IL Egress Control	30.0	-	-	5.7	-	-
Std B33d	CfR HVAC Efficiency	17.5	9.6	-	3.8	2.1	-
Std B33e	CfR Res Cool Roofs	11.9	8.3	-0.2	3.1	2.4	-0.1
Std B33f	CfR Res Central Fan WL	33.6	22.6	-	8.4	6.6	-0.2

* Estimates provided by the California IOUs on May 13, 2011, in response to EEGA data request 2576, 2578, 2579

5.2 Gross Savings / Compliance

Cadmus' research produced compliance values used in the evaluation for four standards or standard categories: nonresidential new construction, interior lighting alteration projects, envelope insulation projects (B17), and cool roof projects (B31). For all other categories, compliance was not evaluated and the IOU Estimate was used in the savings calculation.

For the first two categories, simulation models provided energy consumption values that we used to calculate the Title 24 compliance rates shown in Table 45. A compliance rate of over 100% indicates that the as-built energy consumption is better than required under the 2008 Title 24 code.

Table 45. Compliance Rates based on Energy Consumption Analysis

Category	Type	Energy Consumption		Compliance Rate
		2008 Code	As-Built	
Nonresidential New Construction (91 sites)	kWh	22,847,342	19,886,535	114.9%
	kW	6,838	5,865	116.6%
	Therms	193,601	191,551	101.1%
Lighting Alterations (68 sites)	kWh	14,213,347	13,168,667	107.9%
	kW	4,627	4,322	107.0%

Cadmus presents the compliance rates for each 2008 Title 24 code in Table 46. If all savings from a standard were from nonresidential new construction, such as for standards B18, B19, and B27, then we applied the nonresidential new construction rate. However, if some of the potential savings were from new construction and the rest were from alteration projects, we calculated a weighted average of the compliance rates. We did this for five of the codes: B17, B21, B31, B33a, and B33b. For standards that were not covered by the four categories evaluated, such as B28, which governs residential swimming pools, Cadmus applied the value used in the IOU Estimate.

Table 46. Compliance Rates for 2008 Title 24 Standards

REF	2008 Title 24	GWh	MW	MTherms
Std B17	Envelope insulation	87%	117%	84%
Std B18	Overall Envelope Tradeoff	115%	117%	101%
Std B19	Skylighting	115%	117%	101%
Std B20	Sidelighting	115%	117%	101%
Std B21	Tailored Indoor lighting	108%	107%	107%
Std B22a	TDV Lighting Controls	NA	NA	NA
Std B22b	DR Indoor Lighting	115%	117%	NA
Std B23	Outdoor Lighting	83%	83%	NA
Std B24	Outdoor Signs	83%	83%	83%
Std B26	Refrigerated warehouses	83%	83%	83%
Std B27	DDC to Zone	115%	117%	101%
Std B28	Residential Swimming pool	83%	83%	NA
Std B29	Site Built Fenestration	83%	83%	83%
Std B30	Residential Fenestration	83%	83%	83%
Std B31	Cool Roof Expansion	89%	90%	106%
Std B32	MF Water heating control	NA	NA	101%
Std B33a	CfR IL Complete Bldg Method	108%	107%	107%
Std B33b	CfR IL Area Category Method	108%	108%	107%
Std B33c	CfR IL Egress Control	115%	117%	101%
Std B33d	CfR HVAC Efficiency	115%	117%	101%
Std B33e	CfR Res Cool Roofs	83%	83%	83%
Std B33f	CfR Res Central Fan WL	83%	83%	83%

The results of the field research in terms of CAFs are presented in Table 47.

Since potential for Title 24 standards used by the IOUs and in the ISSM is based on the expected energy savings going from the 2005 Title 24 code to the 2008 Title 24 code, our finding that the typical project is more efficient than required by code is expressed as a CAF greater than 100%. For nonresidential new construction, for example, the energy models for the buildings we visited showed potential energy savings (in kWh) from the 2005 code to the 2008 code would be about 3.6% (of the building energy consumption if it just met the 2005 code)[50].

A final step in determining the CAFs was weighting the results by jurisdiction and climate region to match the total construction or alteration volumes. We did so, and the weighted values are also given in Table 47. We note that the weighting made only a small difference in the factors for new construction but a much larger difference in the factors for lighting alterations. We did not apply a weighting adjustment for standards B17 and B31 because we did not have regional project population data and the small sample sizes were not sufficiently representative of the population distribution.

Table 47. Compliance Adjustment Factors

Category	Type	kWh	kW	Therms
Nonresidential New Construction (98 Sites)	*Unweighted*	*409%*	*332%*	*118%*
	Weighted (by Sq Ft)	397%	329%	141%
Interior Lighting Alterations (68 Sites)	*Unweighted*	*304%*	*292%*	*349%*
	Weighted (by Sq Ft)	580%	582%	476%
B17 Envelope Insulation (Re-Roof) (18 Sites)		83%	83%	83%
B31 Cool Roof Expansion (Re-Roof) (11 Sites)		82%	82%	82%
IOU Estimate		83%	83%	83%

The evaluation team calculated precision around the compliance adjustment factors using the formula for a stratified ratio estimator found in both the California Evaluation Framework and USDOE's Uniform Methods Project Sample Design Cross-Cutting Protocols.[51] Here we estimate the standard error of the weighted total as-installed savings as:

$$SE(Total\ As\ Built\ Savings) = \sqrt{\sum w_i * (w_i - 1) * (As\ Built\ Savings_i - 2008\ Code\ Savings * CAF)^2}$$

Where:

CAF $Energy\ Compliance\ Index$= the population-weighted energy compliance index; and

[50] By comparison, AEC/CEC Impact Analysis (2007) found that the kWh savings from 2005 to 2008 code were expected to be 4.9%

[51] https://www1.eere.energy.gov/wip/pdfs/53827-11.pdf

$w_i Energy\ Compliance\ Index$= is the sampling.

We then calculated the standard error and precision about the CAF as:

$$SE(CAF) = \frac{SE(Total\ Installed\ System\ BTU)}{Total\ As\ Built\ Savings}$$

$$Precision(CAF) = 1.645 * SE(CAF)$$

Table 48 below shows the results of this uncertainty analysis. Due to both the larger sample size and a more representative sample design, the new construction CAF fell within ±10% relative precision for electric energy and demand savings. The CAF for alterations was less precise, with confidence interval half-widths between 26% and 47%. In all cases, however, it should be noted that the null hypotheses that the CAF equals 100% (meaning that as built savings do not differ from expected code savings) can be rejected with 90% confidence.

Table 48. Precision Results for Compliance Adjustment Factors

New Construction			
Statistic (n=90)	kWh	kW	Therms
CAF	397%	329%	141%
SE(CAF)	14%	11%	12%
Absolute Precision (90% confidence)	23%	17%	20%
Relative Precision (90% confidence)	6%	5%	14%
Alterations			
Statistic (n=68)	kWh	kW	Therms
CAF	580%	582%	476%
SE(CAF)	92%	147%	135%
Absolute Precision (90% confidence)	151%	241%	222%
Relative Precision (90% confidence)	26%	41%	47%

For each 2008 Title 24 code, Cadmus applied the adjustment factors shown above as appropriate. If all savings from a standard were from nonresidential new construction, such as for standards B18, B19, and B27, then we applied the nonresidential new construction factors. However, if some of the potential savings were from new construction and the rest were from alteration projects, we calculated a weighted average of the adjustment factors. We did this for five of the codes: B17, B21, B31, B33a, and B33b. For standards that were not covered by the four categories evaluated, such as B28, which governs residential swimming pools, Cadmus applied the value used in the IOU Estimate. The evaluators determined the appropriate method for each standard to produce the values shown in Table 49.

Table 49. CAF for Nonresidential New Construction

REF	2008 Title 24	Compliance Adjustment Factor		
		GWh	MW	MTherms
Std B17	Envelope Insulation	123%	329%	86%
Std B18	Overall Envelope Trade-off	397%	329%	141%
Std B19	Skylighting	397%	329%	141%
Std B20	Sidelighting	397%	329%	141%
Std B21	Tailored Indoor Lighting	573%	572%	462%
Std B22a	TDV Lighting Controls	NA	NA	NA
Std B22b	DR Indoor Lighting	397%	329%	NA
Std B23	Outdoor Lighting	83%	83%	NA
Std B24	Outdoor Signs	83%	83%	83%
Std B26	Refrigerated Warehouses	83%	83%	83%
Std B27	DDC to Zone	397%	329%	141%
Std B28	Residential Swimming Pool	83%	83%	NA
Std B29	Site Built Fenestration	83%	83%	83%
Std B30	Residential Fenestration	83%	83%	83%
Std B31	Cool Roof Expansion	153%	138%	400%
Std B32	MF Water heating Control	NA	NA	141%
Std B33a	CfR IL Complete Bldg Method	571%	569%	459%
Std B33b	CfR IL Area Category Method	569%	567%	456%
Std B33c	CfR IL Egress Control	397%	329%	141%
Std B33d	CfR HVAC Efficiency	397%	329%	141%
Std B33e	CfR Res Cool Roofs	83%	83%	83%
Std B33f	CfR Res Central Fan WL	83%	83%	83%

5.3 Net Savings / NOMAD

Cadmus evaluated market adoption rates by collecting input from category experts using the modified Delphi approach described in Section 3.3. Table 50 shows the market share forecast used in the IOU Estimate and the evaluation for the years 2010 through 2012.

Table 50. 2008 Title 24 NOMAD Market Share

Standard		IOU Estimates Market Share in			Evaluation Result Market Share in		
		2010	2011	2012	2010	2011	2012
Std B17	Envelope Insulation	22%	23%	24%	21%	25%	29%
Std B18	Overall Envelope Trade-off	22%	23%	24%	22%	23%	24%
Std B19	Skylighting	14%	17%	20%	5%	6%	7%
Std B20	Sidelighting	2%	4%	5%	8%	9%	11%
Std B21	Tailored Indoor Lighting	32%	34%	36%	29%	32%	35%
Std B22a	TDV Lighting Controls	28%	33%	39%	28%	33%	39%
Std B22b	DR Indoor Lighting	28%	33%	39%	1%	1%	1%
Std B23	Outdoor Lighting	53%	55%	57%	37%	40%	43%
Std B24	Outdoor Signs	13%	16%	19%	2%	2%	2%
Std B26	Refrigerated Warehouses	12%	14%	16%	12%	14%	16%
Std B27	DDC to Zone	19%	23%	26%	17%	20%	23%
Std B28	Residential Swimming Pool	8%	10%	12%	9%	10%	12%
Std B29	Site Built Fenestration	12%	14%	16%	20%	24%	28%
Std B30	Residential Fenestration	12%	14%	16%	49%	54%	58%
Std B31	Cool Roof Expansion	12%	14%	16%	23%	26%	28%
Std B32	MF Water Heating Control	23%	27%	31%	10%	12%	13%
Std B33 a thru f	Composite for Remainder*	32%	34%	36%	29%	32%	35%

* As noted in Section 2.2, we did not break out CFR by component, because the breakouts were not available by the time the NOMAD analysis was completed

5.4 Net Program Savings / Attribution

Table 51 reports the factor scores, factor weights, and final attribution score for each of the state (Title 24) building codes. The factor scores indicate the percentage contributions of the C&S Program to the development of the standards in each factor area. The final attribution score is the weighted average of the factor scores.

Table 51. Title 24 Building Codes– Attribution Scores

Standard		Factor Score			Weight			Final Attribution Score
		Compliance	Technical	Feasibility	Compliance	Technical	Feasibility	
Std B17	Envelope Insulation	90%	80%	65%	15%	55%	30%	77%
Std B18	Overall Envelope Trade-off	85%	85%	90%	70%	25%	5%	85%
Std B19	Skylighting	80%	70%	80%	20%	40%	40%	76%
Std B20	Sidelighting	70%	75%	85%	45%	30%	25%	75%
Std B21	Tailored Indoor Lighting	70%	70%	65%	30%	35%	35%	68%
Std B22a	TDV Lighting Controls	90%	85%	90%	65%	25%	10%	89%
Std B22b	DR Indoor Lighting	90%	75%	75%	25%	35%	40%	79%
Std B23	Outdoor Lighting	85%	65%	80%	25%	40%	35%	75%
Std B24	Outdoor Signs	85%	70%	85%	15%	50%	35%	78%
Std B26	Refrig. Warehouses	75%	80%	70%	15%	45%	40%	75%
Std B27	DDC to Zone	90%	60%	70%	30%	35%	35%	73%
Std B28	Res. Swimming Pool	65%	75%	60%	30%	40%	30%	68%
Std B29	Site Built Fenestration	70%	65%	65%	35%	15%	50%	67%
Std B30	Residential Fenestration	90%	75%	80%	25%	35%	40%	81%
Std B31	Cool Roof Expansion	80%	70%	70%	25%	30%	45%	73%
Std B32	MF Water Heat Control	85%	80%	85%	30%	30%	40%	84%
Std B33 a,b,c**	Nonres. Interior Lighting Methods, Egress Control	0%	5%	5%	30%	10%	60%	4%
Std B33d**	Nonres. HVAC Efficiency	0%	10%	20%	10%	80%	10%	10%
Std B33e**	Residential Cool Roofs	5%	10%	30%	30%	40%	30%	15%
Std B33f**	Res. Cent Fan Watt Limit	20%	30%	0%	40%	40%	20%	20%

* Incandescent Reflector Lamps

**The attribution scores are much lower for the CFR standards than the other building codes. The CEC takes on a larger role in the development and adoption of these standards, including working with stakeholders and conducting analysis. The lowest factor score for the building codes was 65%, while the highest for CFR was 30%. This resulted in a much lower total attribution score for the CFR standards relative to others.

6 Results for the Statewide Program

In this chapter, Cadmus summarizes the findings of the impact evaluation at three different levels: overall, group, and single code or standard. We identified the C&S groups and the constituent standards of each in Table 3 and Table 5.

In Section 6.1, we present the overall evaluation results for the Title 20, Federal, and Title 24 standards. This is followed by a summary of results for each of the Title 20, federal, and Title 24 groups. Generally, the 2005 Title 20 and 2005 Title 24 groups were not re-evaluated[52] and annual savings changed only slightly from the findings of the 2006-2008 PY evaluation. As noted earlier, Cadmus reduced Title 20 potential and increased federal potential to reflect federal pre-emption. We incorporated these changes into the IOU Estimate and the Title 20 standards. We then evaluated these savings as part of the federal standard group and credited them back to the total evaluated savings.

In Section 2.2.2 above, we explained that the CPUC determined (in D. 10-04-029) that savings from earlier superseded standards end when a new, more stringent standard takes effect. However, portfolio savings targets were set assuming layering of superseded standards. For this reason, we defined two scenarios under which results are reported. In Scenario One, results include savings from superseded standards for consistency with the savings targets. In Scenario Two, these savings are not included. Most of this main report provides Scenario One results. Section 6.1.2 provides a summary of the difference between the two scenarios and Appendix B provides more detail on the Scenario Two results.

Section 6.2 presents findings for the individual Title 20 standards evaluated. Section 6.3 presents findings for the individual federal standards evaluated. Section 6.4 presents findings for the individual Title 24 standards evaluated.

In following the evaluation protocol, we have determined savings—potential, gross, net, and net program—at the statewide level for all standards initially. In most of the Chapter 6 tables, the "net program" savings reflect the application of an attribution value to the statewide net savings. We note that actual net program savings occur within the IOU service territories. We provide net program (statewide) values in most instances to be consistent with the statewide values for potential, gross, and net savings. In Section 6.1.1, we have also provided the "IOU Share." In these tables, all savings values have been adjusted to reflect results in the IOU territories.

6.1 Findings for the Program and Groups

6.1.1 Total C&S Program Impacts

In this section we present the overall evaluation results. The tables are presented in pairs with the first table in each pair providing statewide results and the second table providing results for each of the IOUs. For example, Table 52 and Table 53 summarize electric energy savings (in

[52] Additional analysis is required to determine appropriate construction measure volume for each standard from the available data. For this reason, the annual volume values for 2005 Title 24 codes were not updated for this evaluation.

GWh) for each of the major code and standard groups for 2010-2102. In the last row of these two tables, we provide a comparison of the total evaluated savings to the IOU Estimate. As shown, evaluated net program savings were found to be 98% of the value included in the IOU Estimate.

Additional discussion of the energy (GWh and Mtherms) and demand (MW) results is included in sections 6.1.2, 6.1.4, and 6.1.5.

Table 52. Evaluated vs. IOU Estimate:
2010-2012 PY Statewide Total Savings for Title 20, Federal, and Title 24 (GWh)

GWh	IOU Estimated Savings				Evaluated Savings			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2005 T-20	1,743	1,620	820	601	1,832	1,712	870	637
2006-2009 T-20	3,405	2,637	2,026	1,510	3,033	2,517	2,012	1,417
Fed Appliance	610	580	508	254	533	452	371	161
2005 T-24	936	797	509	280	939	797	509	280
2008 T-24	1,588	1,320	965	498	902	3,656	2,512	583
2010-2012 Total	8,282	6,954	4,828	3,142	7,239	9,134	6,273	3,078
Evaluated / IOU Estimated					87%	131%	130%	98%

Table 53. Evaluated vs. IOU Estimate:
IOU Share of 2010-2012 PY Statewide Total Savings (GWh)

GWh	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
IOU		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	2,616	2,196	1,525	992	2,286	2,885	1,981	972
SCE	32.6%	2,698	2,265	1,573	1,024	2,358	2,976	2,044	1,003
SDG&E	7.4%	612	514	357	232	535	675	464	228
All IOUs	71.6%	5,926	4,976	3,454	2,248	5,180	6,536	4,489	2,203
Evaluated / IOU Estimated						87%	131%	130%	98%

The next two tables present our findings in terms of demand (in MW). Table 54 presents the statewide results and Table 55 includes demand savings in the IOU service territories. The last row provides a comparison of the evaluated savings to the IOU Estimate. We observe that evaluated net program savings were found to be 89% of the IOU Estimate.

Table 54. Evaluated vs. IOU Estimate:
2010-2012 PY Statewide Total Savings for Title 20, Federal, and Title 24 (MW)

MW	IOU Estimated Savings				Evaluated			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2005 T-20	250	233	124	92	310	291	152	112
2006-2009 T-20	404	315	253	190	380	307	248	170
Fed Appliance	101	96	85	43	98	83	64	25
2005 T-24	270	221	140	72	270	221	140	72
2008 T-24	482	401	300	160	217	845	584	144
2010-2012 Total	1,508	1,266	902	556	1,275	1,747	1,187	523
Evaluated / IOU Estimated					85%	138%	132%	94%

Table 55. Evaluated vs. IOU Estimate:
IOU Share of 2010-2012 PY Statewide Total Savings (MW)

MW IOU	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	31.6%	476	400	285	176	403	552	375	165
SCE	32.6%	491	412	294	181	415	569	387	170
SDG&E	7.4%	111	94	67	41	94	129	88	39
All IOUs	71.6%	1,079	906	645	398	912	1,250	850	374
Evaluated / IOU Estimated						85%	138%	132%	94%

The next two tables present our findings in terms of gas energy (in MTherms). Table 56 presents the statewide results and Table 57 includes gas savings in the IOU service territories. The SCG line is shaded since this table includes interactive effects and CPUC policy is to exclude interactive effects from SCG savings estimates. No percentage comparison of the evaluated savings to the IOU Estimate is provided for these tables since the negative values make these percentages less meaningful. One of the reasons that the impact of some standard groups is negative is the interaction between electricity savings and gas heating. As a result of the large electric savings shown above we expect that additional heating will be required. The overall impact of interactive effects is shown in Appendix K.

Table 56. Evaluated vs. IOU Estimate:
2010-2012 PY Statewide Total Savings for Title 20, Federal, and Title 24 (Mtherms)

Mtherms	IOU Estimated Savings				Evaluated			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2005 T-20	(10.18)	(9.20)	(1.77)	(1.13)	(20.02)	(18.69)	(6.46)	(4.40)
2006-2009 T-20	(46.84)	(34.85)	(27.35)	(20.19)	(30.89)	(26.33)	(18.20)	(11.71)
Fed Appliance	(6.60)	(6.27)	(5.62)	(2.81)	(1.32)	(0.73)	(0.38)	(0.11)
2005 T-24	12.94	13.08	11.24	8.29	13.04	13.06	11.22	8.27
2008 T-24	43.77	36.40	29.15	20.70	14.08	4.33	3.29	7.00
2010-2012 Total	(6.91)	(0.84)	5.65	4.85	(25.10)	(28.35)	(10.54)	(0.94)

Table 57. Evaluated vs. IOU Estimate:
IOU Share of 2010-2012 PY Statewide Total Savings (Mtherms)

Mtherms IOU	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	(2.52)	(0.31)	2.06	1.77	(9.15)	(10.34)	(3.84)	(0.34)
SCG	58.4%	(4.03)	(0.49)	3.30	2.83	(14.66)	(16.56)	(6.16)	(0.55)
SDG&E	4.1%	(0.29)	(0.03)	0.23	0.20	(1.04)	(1.18)	(0.44)	(0.04)
All IOUs	99.0%	(6.84)	(0.83)	5.59	4.81	(24.85)	(28.07)	(10.44)	(0.93)

In Table 58 and Table 59, we present gas savings when interactive effects are not considered. As noted above, this is the correct approach to reporting savings for SCG (the lines for the other utilities are shaded since the appropriate values—with interactive effects—are shown in Table 57 above).

Table 58. Evaluated vs. IOU Estimate (Excluding Interactive Effects): 2010-2012 PY Statewide Total Savings for Title 20, Federal, and Title 24 (Mtherms)

Mtherms	IOU Estimated Savings				Evaluated			
	Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
2005 T-20	7.42	7.42	5.38	3.91	7.42	7.42	5.38	3.91
2006-2009 T-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fed Appliance	0.49	0.46	0.33	0.17	0.31	0.30	0.22	0.07
2005 T-24	13.22	13.14	11.30	8.33	13.22	13.14	11.30	8.33
2008 T-24	44.73	37.19	29.69	21.08	17.96	15.42	10.70	8.30
2010-2012 Total	65.86	58.22	46.70	33.50	38.91	36.28	27.59	20.61
Evaluated / IOU Estimated					59%	62%	59%	62%

Table 59. Evaluated vs. IOU Estimate (Excluding Interactive Effects): IOU Share of 2010-2012 PY Statewide Total Savings (Mtherms)

Mtherms	Percent of Statewide Sales	IOU Estimated Savings				Evaluated Savings			
IOU		Potential	Gross	Net	Net Program	Potential	Gross	Net	Net Program
PG&E	36.5%	24.02	21.23	17.03	12.22	14.19	13.23	10.06	7.52
SCG	58.4%	38.46	34.00	27.27	19.56	22.72	21.19	16.11	12.04
SDG&E	4.1%	2.73	2.41	1.94	1.39	1.61	1.50	1.14	0.85
All IOUs	99.0%	65.20	57.64	46.23	33.17	38.53	35.92	27.32	20.41
Evaluated / IOU Estimated						59%	62%	59%	62%

6.1.2 Title 20 Standards (Scenario One: Includes Superseded Standards)

As noted above, the evaluation focused on the codes and standards adopted since 2005. For Title 20, the evaluation focused on the 2006-2009 standards (listed in Table 4). This includes nine individual standards that became effective between 2008 and 2012. The savings are calculated using ISSM and the parameters found through the evaluation methods described above.

Figure 5 presents the evaluated electric energy savings for this group of standards compared to the IOU Estimate. The evaluated total is less than the IOU Estimate for all of the savings categories shown.

Figure 5. 2010-2012 PY Electric Savings for 2006-2009 Title 20 Standards, in GWh

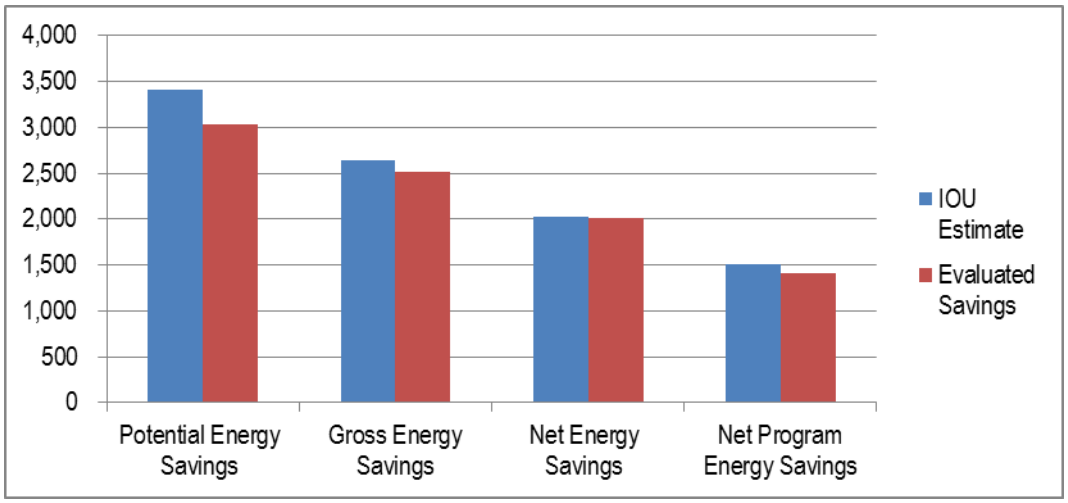

Table 60 presents the evaluation results in additional detail. This summary includes the annual and 2010-2012 PY totals for the 2005 Title 20 standards and the 2006-2009 Title 20 standards.

As expected, the savings for the 2005 Title 20 group only changed slightly because the IOU Estimate used nearly all of the parameters found in the 2006-2008 PY evaluation. Changes we made in the following three areas were responsible for the revised results:

- **Interactive effects.** Cadmus incorporated positive IEs as described in Section 3.1.3 for fifteen of the 2005 Title 20 standards. The average IE increased kWh savings by over 5%.
- **Updated CAF.** Cadmus re-evaluated the CAF for Standard 4, Walk-In Refrigerators / Freezers. We found the CAF to be 91%, or 3% higher than the value found in the prior evaluation.
- **Prior Program Adjustment.** Cadmus corrected the adjustment made for utility programs to align the start of the prior program effect to the year the standard became effective.

Together, these changes increased electric savings (GWh and demand) for this group by about 6% over the prior evaluated savings.

Table 60 also presents the savings for the 2006-2009 standards that are graphed in Figure 5. The last row of the table shows the ratio of the evaluated savings to the IOU Estimate in percentage

terms. We found that gross savings for the 2006-2009 standards are 121 GWh, or 5% less than the IOU Estimate, and that net program savings are 93 GWh, or 6% below the IOU Estimate. Following the aggregate summaries for demand and gas savings, we provide additional detail on results for the nine individual standards.

Table 60. Electric Energy Savings for Title 20 Standards: Evaluated vs. IOU Estimate

Electric Energy (GWh)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	597	549	299	219	693	491	462	345
	2011	592	547	275	202	1,476	1,153	887	659
	2012	554	524	245	180	1,236	993	678	505
	Total	1,743	1,620	820	601	3,405	2,637	2,026	1,510
Evaluated Savings	2010	627	580	317	233	706	585	545	395
	2011	622	578	292	214	1,245	1,004	789	549
	2012	583	554	260	191	1,083	928	678	473
	Total	1,832	1,712	870	637	3,033	2,517	2,012	1,417
Eval / IOU		105%	106%	106%	106%	89%	95%	99%	94%

Figure 6 presents the overall evaluated electric demand savings for the 2006-2009 Title 20 standards compared to the IOU Estimate. For demand, the evaluated total is less than the IOU Estimate for all of the savings categories shown.

Figure 6. 2010-2012 PY Electric Demand Savings for 2006-2009 Title 20 Standards, in MW

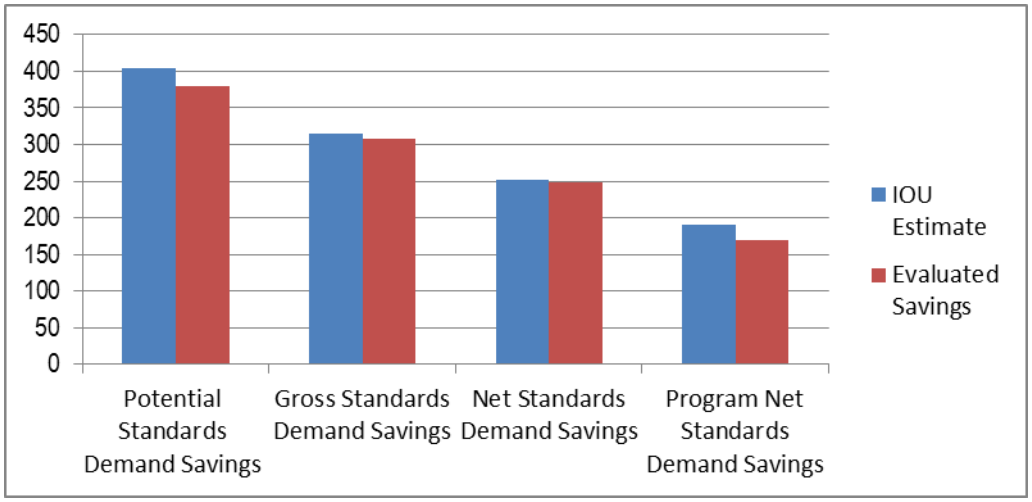

Table 61 presents the evaluation results for demand in additional detail. This summary includes the annual totals for the 2005 Title 20 standards and the 2006-2009 Title 20 standards.

In terms of demand, Camus found that evaluated savings for the 2005 Title 20 group are at least 22% higher than the IOU Estimate at all stages. Nearly all of the increased savings resulted from the incorporation of IEs. Cadmus included IEs for fifteen of the 2005 Title 20 standards. The average IE increased kW savings by 28%. Most of the other parameters were unchanged

because the IOU Estimate used the parameters found in the 2006-2008 PY evaluation. Re-evaluation of the compliance rate for Standard 4, Walk-In Refrigerators / Freezers, along with a correction to the prior program adjustment, increased demand savings for this group by about 1% compared to the previous evaluation.

The table also presents the demand savings for the 2006-2009 standards that are graphed in Figure 6. As shown in the graph and by the ratio at the bottom of the table, we found that gross savings are 8 MW, or 2% less than the IOU Estimate, and that net program savings are 20 MW, or 11% lower than the IOU Estimate. Following the aggregate summary for gas savings, we provide additional detail on the nine individual 2006-2009 Title 20 standards.

Table 61. Demand Savings for Title 20 Standards: Evaluated vs. IOU Estimate

Electric Demand (MW)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	85.4	78.8	45.2	33.5	99.4	73.3	68.8	51.8
	2011	84.7	78.6	41.6	30.8	167.1	130.6	103.9	77.7
	2012	79.7	75.5	37.1	27.5	138.0	111.3	80.1	60.2
	Total	249.8	233.0	123.8	91.8	404.5	315.2	252.7	189.7
Evaluated Savings	2010	105.8	98.4	55.7	41.0	89.3	73.4	68.6	47.8
	2011	105.0	98.2	51.0	37.6	158.7	123.3	98.1	66.7
	2012	98.7	94.3	45.3	33.4	131.6	110.6	81.2	55.0
	Total	309.5	290.9	152.0	112.0	379.6	307.3	247.9	169.6
Eval / IOU		124%	125%	123%	122%	94%	98%	98%	89%

Figure 7 presents the overall evaluated gas savings for the 2006-2009 Title 20 standards compared to the IOU Estimate. For gas, the evaluated total is higher (less negative) than the IOU Estimate for all of the savings categories shown. For these standards nearly all of the gas impact is due to negative IEs that are based on kWh savings. The evaluated negative gas impact is smaller as a result of lower kWh savings and the evaluated IEs. Fewer kWh savings result in fewer gas IE losses.

Figure 7 2010-2012 PY Gas Savings for 2006-2009 Title 20 Standards, in MTherms

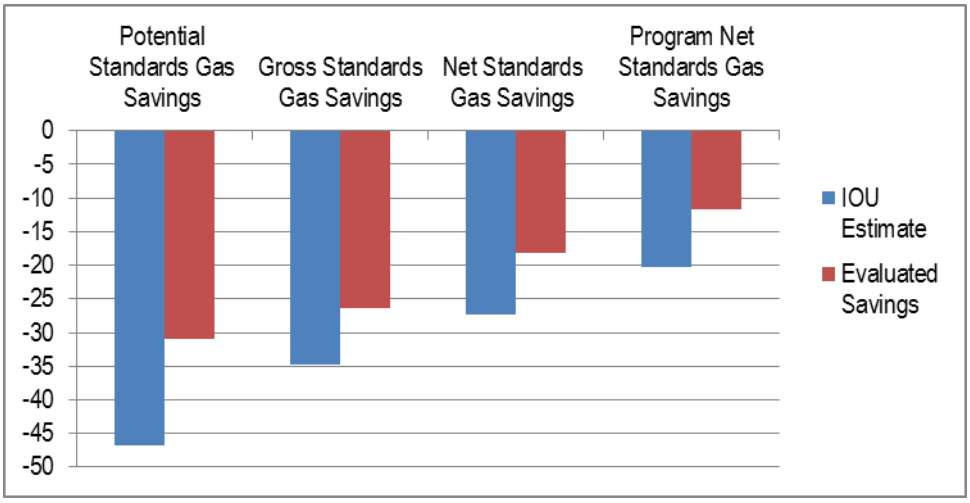

Table 62 presents the evaluation results for gas savings. The 2005 Title 20 standards included a few measures that had a direct gas impact while the 2006-2009 standards had no measures with direct gas impact. As noted above, Cadmus incorporated negative gas IEs for the majority of the Title 20 standards. This increased the negative gas impact for the 2005 group and decreased the impact for the 2006-2009 group.

Table 62. Gas Savings for Title 20 Standards: Evaluated vs. IOU Estimate

Gas Energy (MTherms)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	-3.5	-3.2	-0.9	-0.6	-9.7	-6.4	-6.0	-4.4
	2011	-3.5	-3.1	-0.6	-0.4	-20.6	-15.6	-12.3	-9.1
	2012	-3.1	-2.9	-0.3	-0.2	-16.6	-12.9	-9.1	-6.7
	Total	-10.2	-9.2	-1.8	-1.1	-46.8	-34.8	-27.3	-20.2
Evaluated Savings	2010	-6.9	-6.4	-2.6	-1.8	-4.7	-3.8	-3.6	-2.4
	2011	-6.9	-6.4	-2.2	-1.5	-14.1	-11.7	-8.1	-5.2
	2012	-6.2	-6.0	-1.7	-1.1	-12.1	-10.8	-6.5	-4.1
	Total	-20.0	-18.7	-6.5	-4.4	-30.9	-26.3	-18.2	-11.7

6.1.3 Title 20 Standards (Scenario Two: Excludes Superseded Standards)

In Section 2.2.2, we discussed treatment of savings when a California standard is superseded by a later state standard. In Table 18, we identified Standard 11b and Standard 18a as two standards that were superseded during the current evaluation period. All of the results presented in this report include savings from superseded standards, unless otherwise noted. As discussed above, we did this to provide results consistent with the assumptions used when portfolio savings targets were set. Additional detail on the standards affected is included in Appendix A.

Table 63, Table 64, and Table 65 compare the evaluation results for Title 20 standards when savings from the superseded standards are included to the results when such savings are excluded. The last line in each table provides a comparison. We find that removing the savings from the superseded standards reduces net program savings by 3% to 4% for energy (GWh and Mtherms) and demand (MW). The impact in the current cycle is small due to the few measures that are affected during PY 2010-2012.

Table 63. Electric Energy Savings for Title 20 Standards for Two Evaluation Scenarios

Electric Energy (GWh/Year)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
Evaluated Scenario One Savings	2010	627	580	317	233	706	585	545	395
	2011	622	578	292	214	1,245	1,004	789	549
	2012	583	554	260	191	1,083	928	678	473
	Total	1,832	1,712	870	637	3,033	2,517	2,012	1,417
Evaluated Scenario Two Savings	2010	627	580	317	233	706	585	545	395
	2011	558	516	283	207	1,196	968	755	524
	2012	518	492	252	183	1,052	900	652	454
	Total	1,703	1,588	852	623	2,953	2,453	1,952	1,373
Scenario One/ Scenario Two		108%	108%	102%	102%	103%	103%	103%	103%

Table 64. Electric Demand Savings for Title 20 Standards for Two Evaluation Scenarios

Electric Demand (MW/Year)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
Evaluated Scenario One Savings	2010	105.8	98.4	55.7	41.0	89.3	73.4	68.6	47.8
	2011	105.0	98.2	51.0	37.6	158.7	123.3	98.1	66.7
	2012	98.7	94.3	45.3	33.4	131.6	110.6	81.2	55.0
	Total	309.5	290.9	152.0	112.0	379.6	307.3	247.9	169.6
Evaluated Scenario Two Savings	2010	105.8	98.4	55.7	34	89.3	73.4	68.6	47.8
	2011	95.6	89.1	49.7	30	150.6	117.5	92.6	62.7
	2012	89.4	85.3	44.1	27	126.4	106.0	76.9	51.9
	Total	290.8	272.8	149.4	91	366.4	297.0	238.1	162.4
Scenario One/ Scenario Two		106%	107%	102%	102%	104%	103%	104%	104%

Table 65. Gas Energy Savings for Title 20 Standards for Two Evaluation Scenarios

Gas (MTherms)		2005 Title 20				2006-2009 Title 20			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
Evaluated Scenario One Savings	2010	-6.9	-6.4	-2.6	-1.8	-4.7	-3.8	-3.6	-2.4
	2011	-6.9	-6.4	-2.2	-1.5	-14.1	-11.7	-8.1	-5.2
	2012	-6.2	-6.0	-1.7	-1.1	-12.1	-10.8	-6.5	-4.1
	Total	-20.0	-18.7	-6.5	-4.4	-30.9	-26.3	-18.2	-11.7
Evaluated Scenario Two Savings	2010	-6.9	-6.4	-2.6	-1.8	-4.7	-3.8	-3.6	-2.4
	2011	-5.6	-5.1	-2.0	-1.3	-13.5	-11.3	-7.7	-4.9
	2012	-5.0	-4.7	-1.5	-1.0	-11.8	-10.5	-6.2	-3.9
	Total	-17.5	-16.2	-6.1	-4.1	-30.0	-25.6	-17.5	-11.2

6.1.4 Federal Appliance Standards

Cadmus evaluated the seven standards that make up the Federal appliance standards group. Figure 8 presents the overall evaluation electric energy savings results for this group of standards. Cadmus found that compared to the IOU Estimate, the evaluated total is less than the IOU Estimate for all of the savings categories shown.

Figure 8. 2010-2012 PY Electric Savings for Federal Standards, in GWh

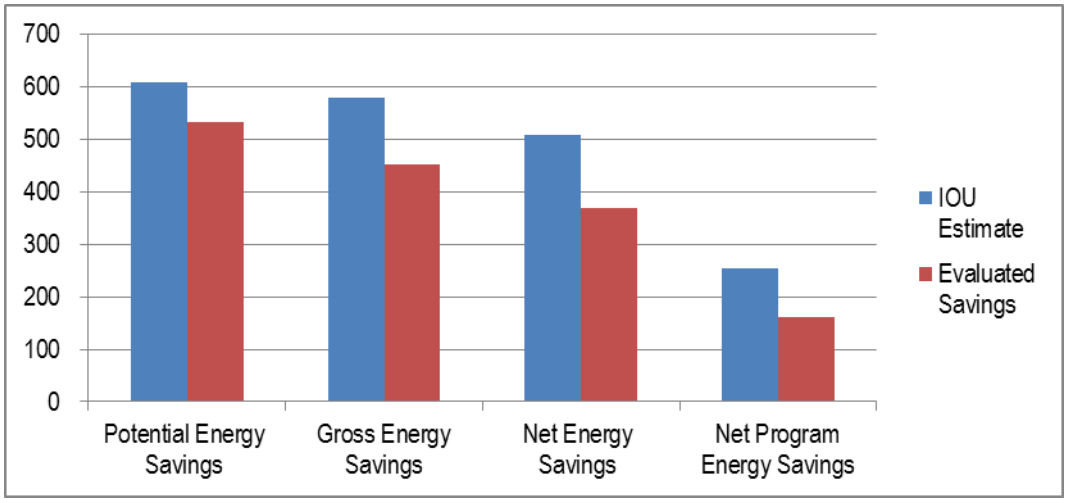

Table 66 presents the evaluation results in additional detail. We found that the gross savings are 127 GWh or 22% less than the IOU Estimate and that net program savings are 93 GWh or 37% less than the IOU Estimate. Following the aggregate summaries for demand and gas savings, we provide additional detail on results for the seven individual standards.

Table 66. Electric Energy Savings for Federal Standards: Evaluated vs. IOU Estimate

Electric Energy (GWh)		Federal Appliance			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	5	5	5	2
	2011	66	62	56	28
	2012	539	512	448	224
	Total	610	580	508	254
Evaluated Savings	2010	12	11	11	6
	2011	151	135	127	66
	2012	369	306	233	89
	Total	533	452	371	161
Eval / IOU		87%	78%	73%	63%

Figure 9 presents the overall evaluated electric demand savings for the Federal standards. Compared to the IOU Estimate, the evaluated total is lower than the IOU Estimate for all savings categories shown.

Figure 9. 2010-2012 PY Electric Demand Savings for Federal Appliance Standards, in MW

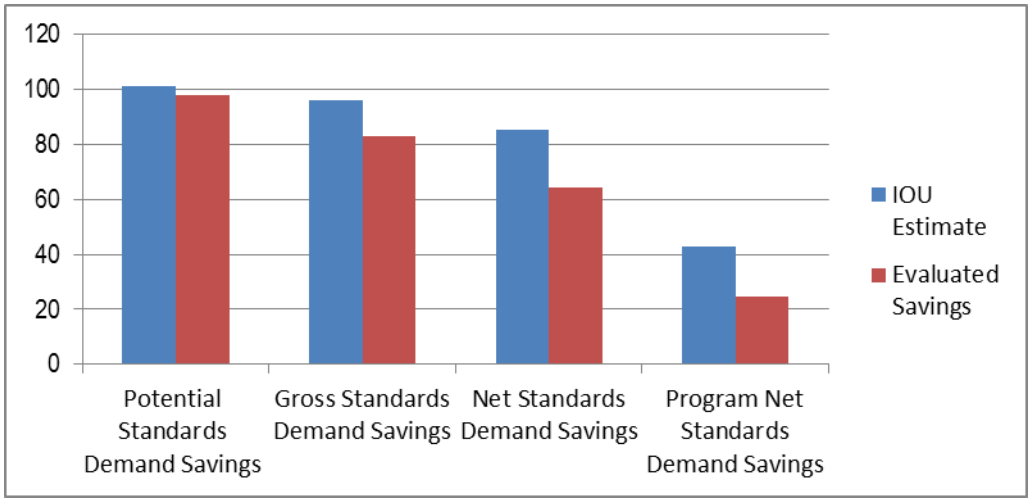

Table 67 present the evaluation results in additional detail. We found that the gross savings are 13 MW or 14% less than the IOU Estimate and that net program savings are 18 MW or 42% less than the IOU Estimate.

Table 67. Electric Demand Savings for Federal Standards: Evaluated vs. IOU Estimate

Electric Demand (MW/Year)		Federal Appliance			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	0.7	0.7	0.6	0.3
	2011	9.0	8.5	7.6	3.8
	2012	91.5	86.9	77.1	38.6
	Total	101.2	96.1	85.4	42.7
Evaluated Savings	2010	1.7	1.6	1.5	0.8
	2011	20.9	18.6	17.4	9.1
	2012	75.5	63.0	45.4	14.9
	Total	98.1	83.1	64.3	24.7
Eval / IOU		97%	86%	75%	58%

Figure 10 presents the overall evaluation gas savings results for this group of standards. Nearly all of the gas impact is due to negative IEs. Cadmus found that, compared to the IOU Estimate, the evaluated total is greater—less negative-- than the IOU Estimate for all categories.

Figure 10. 2010-2012 PY Gas Savings for Federal Appliance Standards, in MTherms

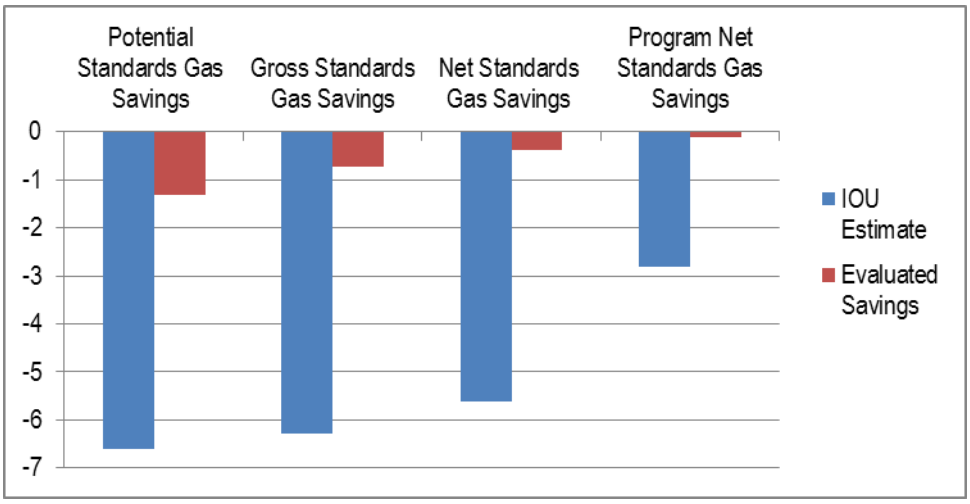

Table 68 presents the evaluation results in additional detail. The main reasons for these results are that the IOU Estimate includes larger negative gas IEs for Federal standards 6 and 7 than Cadmus found in the evaluation. Following the aggregate summaries for demand and gas savings, we provide additional detail on results for the seven individual standards.

Table 68. Gas Savings for Federal Appliance Standards: Evaluated vs. IOU Estimate

Gas Energy (MTherms)		Federal Appliance			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	0.0	0.0	0.0	0.0
	2011	0.0	0.0	0.0	0.0
	2012	-6.6	-6.3	-5.6	-2.8
	Total	-6.6	-6.3	-5.6	-2.8
Evaluated Savings	2010	0.0	0.0	0.0	0.0
	2011	-0.1	0.0	0.0	0.0
	2012	-1.3	-0.7	-0.4	-0.1

6.1.5 Title 24 Standards

As noted throughout this report, the evaluation focused on the codes and standards adopted since 2005. For Title 24, the evaluation focused on the 2008 Title 24 building codes listed in Table 5. This includes 22 individual codes that became effective in 2010. Cadmus calculated the savings using ISSM and the parameters found through the methods described above.

Figure 11 presents the evaluated electric energy savings for this group of codes compared to the IOU Estimate.

As discussed in Section 5.1, the main reason evaluated potential is lower than the IOU Estimate is that the actual level of construction activity was much lower than the forecast used in the estimate, probably due to the extended economic downturn in building activity.

Cadmus found gross savings to be much larger than potential since actual savings in construction under the 2008 Title 24 code are typically four times larger than the savings expected for buildings that just meet the code (which is the basis for potential). This converts to a compliance rate of 114.9% compared to T-24 2008 code. Cadmus described these compliance results in Section 5.2.

Although Cadmus found NOMAD to be about 31% across all of the 2008 Title 24 codes while the IOUs estimated NOMAD of about 27%, net savings are also much larger than the IOU Estimate.

Net program savings are 86 GWh, or 17% larger than the IOU Estimate, although we found attribution overall to be about 23%. One reason for the low average attribution is that a large part of the savings was identified with codes for which the IOUs did not produce a CASE report (these are also described as CfR codes). Attribution for these codes averaged around 9%.

Figure 11. 2010-2012 PY Electric Savings for 2008 Title 24 Standards, in GWh

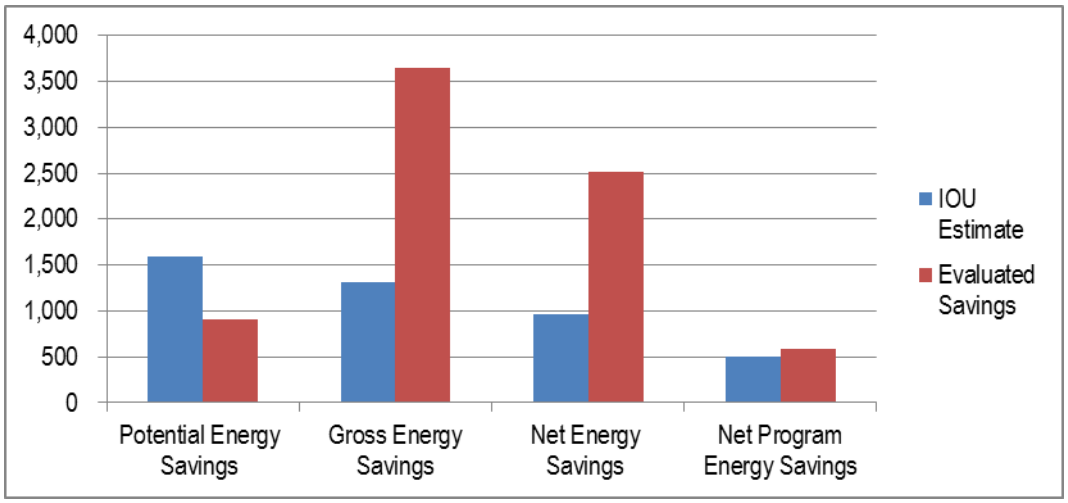

Table 69 presents the evaluation results in additional detail. This summary includes the annual and 2010-2012 PY totals for the 2005 Title 24 codes and the 2008 Title 24 codes.

As expected, the savings for the 2005 Title 24 group changed only slightly since the IOU Estimate used nearly all of the parameters found in the 2006-2008 PY evaluation.

Overall results for the 2008 Title 24 codes were discussed above. Savings in 2010 are lower than the years following due to the construction lag. (Although the 2008 codes took effect on January 1, 2010, they did not begin to produce savings until six to nine months later.)

Table 69. Electric Energy Savings for Title 24 Standards: Evaluated vs. IOU Estimate

Electric Energy (GWh/Year)		2005 Title 24				2008 Title 24			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	312	266	184	98	221	184	140	72
	2011	312	266	170	93	683	568	418	216
	2012	312	266	155	89	683	568	406	210
	Total	936	797	509	280	1,588	1,320	965	498
Evaluated Savings	2010	313	266	184	98	122	497	361	74
	2011	313	266	170	93	390	1,579	1,099	260
	2012	313	266	155	89	390	1,579	1,052	250
	Total	939	797	509	280	902	3,656	2,512	583
Eval / IOU		100%	100%	100%	100%	57%	277%	260%	117%

Figure 12 presents the evaluated electric demand savings for the 2008 Title 24 codes compared to the IOU Estimate. For demand, the evaluation results are very similar to the electric energy results discussed above.

Figure 12. 2010-2012 PY Electric Demand Savings for 2008 Title 24 Standards, in MW

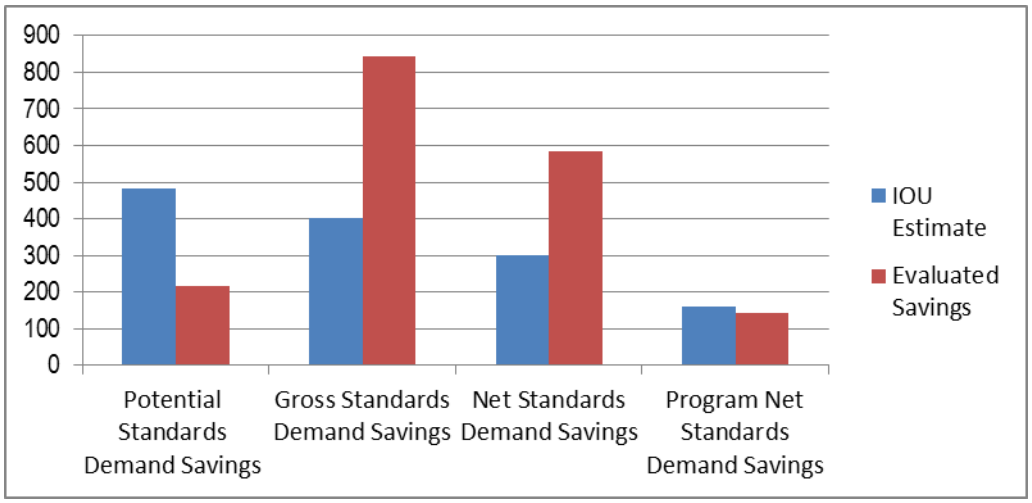

Table 70 presents the evaluation results in additional detail. This summary includes the annual and 2010-2012 PY totals for the 2005 Title 24 codes and the 2008 Title 24 codes.

As expected, the savings for the 2005 Title 24 group match closely since the IOU Estimate used nearly all of the parameters found in the 2006-2008 PY evaluation.

The explanation of results for electric energy above applies to demand as well, and therefore is not repeated here. Overall, net program savings for demand are 16 GWh or 10% less than the IOU Estimate for the 2008 Title 24 group.

Table 70. Demand Savings for Title 24 Standards: Evaluated vs. IOU Estimate

Electric Demand (MW/Year)		2005 Title 24				2008 Title 24			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	90.1	73.5	50.4	25.3	73.5	61.1	48.3	26.3
	2011	90.1	73.5	46.5	24.1	204.4	170.0	127.8	67.8
	2012	90.1	73.5	42.7	22.9	204.4	170.0	124.0	65.8
	Total	270.2	220.5	139.5	72.3	482.4	401.1	300.1	159.9
Evaluated Savings	2010	90.1	73.5	50.4	25.3	31.3	116.0	84.7	19.0
	2011	90.1	73.5	46.5	24.1	93.0	364.5	254.9	63.9
	2012	90.1	73.5	42.7	22.9	93.0	364.5	244.0	61.4
	Total	270.2	220.5	139.5	72.3	217.3	844.9	583.7	144.3
Eval / IOU		100%	100%	100%	100%	45%	211%	194%	90%

Figure 13 presents the evaluated gas savings for the 2008 Title 24 codes compared to the IOU Estimate. Cadmus found that the evaluated total was less than the IOU Estimate for all stages of the protocol.

Figure 13. 2010-2012 PY Gas Savings for 2008 Title 24 Standards, in MTherms

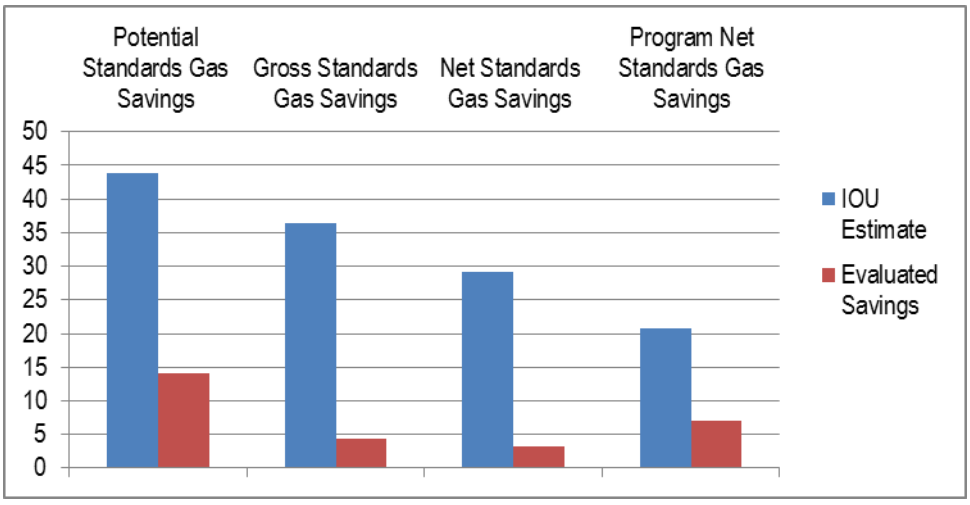

Table 71 presents the evaluation results in additional detail. This summary includes the annual and 2010-2012 PY totals for the 2005 Title 24 codes and the 2008 Title 24 codes.

As expected, the savings for the 2005 Title 24 group match closely since the IOU Estimate used nearly all of the parameters found in the 2006-2008 PY evaluation.

For the 2008 Title 24 codes, there are several factors that account for the differences between the IOU Estimate and the evaluated gas savings:

- **Construction activity.** Due to the much lower level of construction, the evaluation found lower positive gas savings.

- **Interactive effects.** Cadmus incorporated negative IEs as described in Section 3.1.3.for thirteen of the 2008 Title 24 codes where the IOU Estimate only included IEs for three of the codes.

Unlike most of the energy and demand quantities in the scope of this project, the gas results include a combination of negative and positive values. For this reason, the difference in attribution values produces a net program value that is greater than the net savings total.

For the 2008 Title 24 group, Cadmus found evaluated savings of 7.0 Mtherms per year which is 14.0 Mtherms less than the IOU Estimate.

Table 71. Gas Savings for Title 24 Standards: Evaluated vs. IOU Estimate

Gas Energy (MTherms)		2005 Title 24				2008 Title 24			
		Potential Savings	Gross Savings	Net Savings	Net Program Savings	Potential Savings	Gross Savings	Net Savings	Net Program Savings
IOU Estimate	2010	4.3	4.4	3.8	2.8	6.4	5.3	4.5	3.2
	2011	4.3	4.4	3.7	2.8	18.7	15.6	12.5	8.9
	2012	4.3	4.4	3.7	2.7	18.7	15.6	12.2	8.6
	Total	12.9	13.1	11.2	8.3	43.8	36.4	29.1	20.7
Evaluated Savings	2010	4.3	4.4	3.8	2.8	1.8	0.4	0.3	0.9
	2011	4.3	4.4	3.7	2.8	6.2	2.0	1.5	3.1
	2012	4.3	4.4	3.7	2.7	6.2	2.0	1.4	3.0
	Total	13.0	13.1	11.2	8.3	14.1	4.3	3.3	7.0
Eval / IOU		101%	100%	100%	100%	32%	12%	11%	34%

6.2 Findings for 2006-2009 Title 20 Standards

6.2.1 Standard 9: Residential Pool Pumps, Two-Speed Motors, Tier 2

For Standard 9 (residential pool pumps, two-speed motors, tier 2), Table 72 provides a comparison of the IOU Estimate of savings and the values found in the evaluation scenarios. We found nearly three times the energy savings the IOUs estimated. The main reason for this difference is that the evaluators found unit savings of 2,065 kWh per year, whereas the IOU Estimate was 725 kWh per year. The evaluated savings are based on a weighted average of annual savings for two-speed pumps and variable-speed pumps. This finding is also validated through comparison to a number of industry sources and prior reports. Details can be found in Appendix E.

Table 72. Energy Savings for Standard 9 (in GWh)

Std 9: Residential Pool Pumps	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	142,700	103.5	94%	96.9	-8%	89.6	79%	70.7	16.3	0.0
	2011	142,700	103.5	94%	96.9	-8%	89.1	79%	70.4	16.2	0.0
	2012	142,700	103.5	94%	96.9	-8%	88.7	79%	70.0	16.2	0.0
Evaluated Savings	2010	163,000	336.6	86%	289.5	-7%	268.0	79%	211.6	15.4	0.0
	2011	163,000	336.6	86%	289.5	-8%	266.6	79%	210.5	15.3	0.0
	2012	163,000	336.6	86%	289.5	-8%	265.3	79%	209.5	15.2	0.0

6.2.2 Standard 11b: General Service Incandescent Lamps, Tier 2

For Standard 11b (General Service Incandescent Lamps, Tier 2), Table 73 provides a comparison of the IOU Estimate to the evaluated electric energy savings. Cadmus found 21% higher net program savings than the IOU Estimate.

The evaluation used updated market information and results from two years of shelf-stocking studies (conducted by KEMA/DNV GL) to inform the revised unit quantities and compliance. Based on the product mix, unit savings were revised from the 3.6 kWh per year estimated by the IOUs to approximately 2.6 kWh per year. (It varied based on the scenario year product mix.) Product sales volumes for all three years are revised based on more recent market data. The 2012 volumes for the IOU Estimate and evaluated savings have had the products in the 100-watt range removed, since these products are regulated (and pre-empted) by the federal EISA standard. Although evaluated potential was somewhat lower than the IOUs estimated, the increased compliance values resulted in higher evaluated gross savings and net program savings.

Table 73. Energy Savings for Standard 11b (in GWh)

Std 11b GSI Lamps Tier 2	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	74,316,888	254.2	44%	110.8	-6%	104.6	74%	76.9	9.5	-1.4
	2011	74,316,888	254.2	44%	110.8	-6%	104.1	74%	76.5	9.5	-1.4
	2012	43,923,981	150.2	44%	65.5	-6%	61.3	74%	45.0	5.6	-0.8
Evaluated Savings	2010	80,220,000	224.0	72%	161.3	-6%	152.3	74%	111.9	18.4	-1.3
	2011	65,850,000	183.9	72%	132.4	-6%	124.4	74%	91.4	15.0	-1.1
	2012	44,320,000	88.4	89%	78.7	-6%	73.6	74%	54.1	8.9	-0.6

6.2.3 Standards 22a and 22b: BR, ER, and R20 Incandescent Reflector Lamps

Evaluation results for the two incandescent reflector standards are shown in Table 74 for the residential market and Table 75 for the commercial market. The large differences between the IOU Estimates and the evaluated savings are due to differences in savings per unit and market size.

Note that in the IOU Estimates for these standards, unit energy savings was assigned at an arbitrary 1,000 kWh per year and the market size (shown in the tables) was then back-calculated based on expected annual aggregate savings. We found the original basis for the total annual savings including unit savings and market size estimates in the CASE reports, as discussed below:

- For the residential market, the IOU Estimate assumes nearly 11 kWh savings per year per lamp and an annual market of 7.45 million units. We found, based on more recent market information, savings per unit of less than 6 kWh per year and a market size of 1.69 million units.
- For the commercial market, the IOU Estimate assumes more than 47 kWh savings per year, per lamp and an annual market of 3.34 million units. We found, based on more recent market information, savings per unit of less than 34 kWh per year and a market size of 114,000 units.

In 2012, product volumes for the IOU Estimate and evaluated savings are adjusted for federal pre-emption of these product categories. The regulation took effect in mid-July and product volumes have been adjusted accordingly.

Table 74. Energy Savings for Standard 22a (in GWh)

Std 22a: BR, ER and R20 IRL:s Residential	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	81,100	81.1	85%	68.6	-6%	64.7	74%	47.8	5.9	-1.2
	2011	81,100	81.1	85%	68.6	-6%	64.4	74%	47.6	5.9	-1.2
	2012	43,327	43.3	85%	36.6	-6%	34.3	74%	25.3	3.1	-0.6
Evaluated Savings	2010	1,688,793	10.2	82%	8.3	-14%	7.2	61%	4.4	1.0	-0.1
	2011	1,688,793	10.2	82%	8.3	-15%	7.1	61%	4.3	1.0	-0.1
	2012	902,232	5.4	82%	4.4	-17%	3.7	61%	2.2	0.5	0.0

Table 75. Energy Savings for Standard 22b (in GWh)

Std 22b: BR, ER and R20 IRLs: Commercial	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	158,200	158.2	85%	133.8	-6%	126.3	74%	93.3	12.5	-1.2
	2011	158,200	158.2	85%	133.8	-6%	125.7	74%	92.9	12.5	-1.2
	2012	84,518	84.5	85%	71.5	-6%	66.9	74%	49.4	6.6	-0.6
Evaluated Savings	2010	113,902	4.2	82%	3.4	-14%	3.0	61%	1.8	0.5	0.0
	2011	113,902	4.2	82%	3.4	-15%	2.9	61%	1.8	0.5	0.0
	2012	60,852	2.2	82%	1.8	-17%	1.5	61%	0.9	0.3	0.0

6.2.4 Standard 23: Metal Halide Fixtures

For Standard 23 (metal halide fixtures), Table 76 provides a comparison of the IOU Estimate and the evaluated savings. As with Standards 22a/b, the IOU Estimate does not reflect the actual unit savings and market size. Instead, our further research found that the IOU Estimate is based on 159 kWh per year unit savings and a market size of 254,000 annual units. We found the market to be slightly smaller at 234,000 units annually, but we found similar unit energy savings of 171 kWh per unit and similar evaluated net program savings. The market data and unit savings analysis are described in detail in Appendix E.

Table 76. Energy Savings for Standard 23 (in GWh)

Std 23: Metal Halide Fixtures	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	45,000	45.0	85%	38.1	-6%	35.9	74%	26.5	4.7	-0.3
	2011	45,000	45.0	85%	38.1	-6%	35.8	74%	26.4	4.7	-0.3
	2012	45,000	45.0	85%	38.1	-6%	35.6	74%	26.3	4.7	-0.3
Evaluated Savings	2010	234,000	44.2	95%	42.0	-3%	40.5	72%	29.3	6.2	-0.5
	2011	234,000	44.2	95%	42.0	-8%	38.7	72%	27.9	5.9	-0.5
	2012	234,000	44.2	95%	42.0	-13%	36.6	72%	26.4	5.6	-0.5

6.2.5 Standard 24: Portable Lighting Fixtures

As shown in Table 77, evaluated potential and gross savings were found to be 60% to 70% larger than the IOU Estimate. The evaluation results are based on recent market data and in-store surveys to determine compliance. Unit savings and product volumes are not comparable because the IOU Estimate used a nominal 1000 kWh / unit value and back-calculated the

volume to match an estimate of annual total savings. Net program savings in GWh, however, were found to be about 20% higher than the IOU Estimate as larger NOMAD and smaller attribution—49% versus the IOU Estimate of 74%—resulted in a large discount of gross savings.

Table 77. Energy Savings for Standard 24 (in GWh)

Std 24: Portable Lighting Fixtures	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	51,200	51.2	85%	43.3	-6%	40.9	74%	30.2	2.8	-0.6
	2011	51,200	51.2	85%	43.3	-6%	40.7	74%	30.1	2.8	-0.6
	2012	51,200	51.2	85%	43.3	-6%	40.5	74%	29.9	2.8	-0.6
Evaluated Savings	2010	3,156,743	86.3	93%	80.3	-8%	74.0	49%	36.3	6.4	-0.4
	2011	3,156,743	86.3	93%	80.3	-10%	71.9	49%	35.2	6.2	-0.4
	2012	3,156,743	86.3	93%	80.3	-13%	69.7	49%	34.1	6.0	-0.4

6.2.6 Standards 25/26: General-Purpose Lighting, 100 watt / 75 watt

For Standard 25 and Standard 26 (general–purpose lighting 100W and 75W, respectively), the evaluation results are shown in Table 78 and Table 79. In both cases, we found savings to be much lower than the IOU Estimates: evaluated net program savings are 31% of the IOU Estimate for Standard 25 and 26% for Standard 26. We are not able to provide a complete explanation of the differences, because the IOU documentation did not present meaningful market size and unit energy saving values (instead, an arbitrary unit energy savings of 1000 kWh per year was used). The evaluators found unit energy savings for Standard 25 of 14.85 kWh per year and for Standard 26 of 10.79 kWh per year. Combined with the evaluated market size for qualifying lamps, potential savings were found to be 71% of the IOU Estimate for Standard 25 and 54% of the estimate for Standard 26. Evaluated savings were further reduced when we applied the compliance rates of 36% to 40% derived from shelf-stocking (inventory) research.

Table 78. Energy Savings for Standard 25 (in GWh)

Std 25: General Purpose Lighting -- 100 watt	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	85%	0.0		0.0		0.0	0.0	0.0
	2011	254,500	254.5	85%	215.2	-6%	202.2	74%	149.4	10.5	-2.6
	2012	0	0.0	85%	0.0		0.0		0.0	0.0	0.0
Evaluated Savings	2010	0	0.0	0%	0.0		0.0		0.0	0.0	0.0
	2011	12,220,000	194.2	36%	69.9	-6%	66.0	76%	50.0	8.2	-0.6
	2012	0	0.0	88%	0.0		0.0		0.0	0.0	0.0

Table 79. Energy Savings for Standard 26 (in GWh)

Std 26: General Purpose Lighting -- 75 watt	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	85%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	85%	0.0		0.0		0.0	0.0	0.0
	2012	230,140	230.1	85%	194.6	-6%	182.1	74%	134.5	9.4	-2.4
Evaluated Savings	2010	0	0.0	0%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	0%	0.0		0.0		0.0	0.0	0.0
	2012	11,610,000	134.0	40%	53.6	-8%	49.5	76%	37.5	6.2	-0.4

6.2.7 Standard 28a: Televisions Tier 1

For Standard 28a (Televisions, Tier 1), Table 80 provides a comparison of the IOU Estimate of savings and the values found in the evaluation scenarios. For this standard, the evaluated savings are less than the IOU Estimate. There are differences at each stage of the savings calculation, beginning with unit energy savings. The IOU Estimate was based on expected unit savings of 132 kWh per year, calculated as the difference between the energy consumption of baseline televisions that did not meet the standard and their consumption if they just met the standard. We found savings of 110 kWh per year, based on using the difference between (1) the baseline market average energy use before the standard (or prevailing market practice[53]) and (2) the energy use of televisions just meeting the standard. Since we also found that the market was smaller than the IOU Estimate, the evaluated potential is about 70% of the IOU value.

Evaluated net savings, however, are 94% of the IOU Estimate, due to higher values for compliance and lower NOMAD. Overall, we found net attributable savings of 61%, which was somewhat less than the 74% in the IOU Estimate (based on a broad average from the prior evaluation).

All told, the evaluated net program savings are just over 77% of the IOU Estimate.

[53] D.10-04-029 p. 46, which defines the baseline for gross savings as the "previous standard or the prevailing market practice," and D.12-05-015 p. 351, which defines the baseline in absence of an existing code or standard as "[i]n the cases when there is no regulation, code, or standard that applies, which would normally set the baseline equipment requirements, the baseline must be established using a 'standard practice' choice. For purposes of establishing a baseline for energy savings, we interpret the standard practice case as a choice that represents the typical equipment or commonly used practice, not necessarily predominantly used practice" should be used to define unit savings as the difference between prevailing market practice energy use of televisions and the energy use of televisions just meeting the standard.

Table 80. Energy Savings for Standard 28a (in GWh)

Std 28a: Televisions - Tier 1	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	85%	0.0		0.0		0.0	0.0	0.0
	2011	4,000,000	528.0	85%	446.5	-50%	224.8	74%	166.1	15.7	-2.0
	2012	4,000,000	528.0	85%	446.5	-62%	168.5	74%	124.5	11.8	-1.5
Evaluated Savings	2010	0	0.0	98%	0.0		0.0		0.0	0.0	0.0
	2011	3,338,000	385.5	98%	377.8	-44%	211.3	61%	127.9	14.6	-2.5
	2012	3,338,000	385.5	98%	377.8	-53%	178.2	61%	107.8	12.3	-2.1

6.3 Findings for Federal Appliance Standards

6.3.1 Federal 1: Electric Motors 1-200HP

Table 81 provides a comparison of the evaluation results to the IOU Estimate of savings for Federal Standard 1 with the electric energy in GWh shown in detail. Compared to the IOU Estimate, Cadmus found potential savings to be more than twice the estimate due to higher average unit savings (575 kWh/year vs. 366 kWh/year) and higher annual volume (254,000 vs. 87,000). The evaluation found compliance more than 90%, NOMAD similar to the IOU Estimate, and an attribution score that was slightly higher than the IOU Estimate. Altogether these parameters resulted in Net Program savings that, like potential savings, are more than twice the annual total in the IOU Estimate. Cadmus found that demand savings were also more than double the estimate.

Table 81. Energy Savings for Federal 1

Fed 1: Electric Motors 1-200HP	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	NA	5.4	95%	5.1	-8%	4.7	50%	2.4	0.3	0.0
	2011	NA	63.7	95%	60.5	-8%	55.5	50%	27.8	3.8	0.0
	2012	NA	63.7	95%	60.5	-9%	55.3	50%	27.6	3.8	0.0
Evaluated Savings	2010	254,280	12.4	91%	11.3	-4%	10.8	52%	5.6	0.8	0.0
	2011	254,280	146.2	91%	133.1	-5%	126.7	52%	65.9	9.0	0.0
	2012	254,280	146.2	91%	133.1	-5%	126.1	52%	65.6	9.0	0.0

6.3.2 Federal 2: Refrigerated Beverage Vending Machines

Cadmus' evaluation agreed with the IOU Estimate in finding very small savings for this standard as shown in Table 82. Beginning in January 2006, California regulated this category under Title 20 Standard 5. Federal standard 2 pre-empted the Title 20 standards in August 2011. The IOUs and Cadmus agreed that potential for the Title 20 standard in California was more than 15 GWh per year and Cadmus found this same potential for the federal standard. Although the IOU Estimate included a higher CAF, the high NOMAD estimate reduced net savings to near zero in both cases.

Table 82. Energy Savings for Federal 2

Fed 2: Refrigerated Beverage Vending Machines	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	NA	2.0	95%	1.9	-94%	0.1	50%	0.1	0.0	0.0
	2012	NA	5.8	95%	5.5	-95%	0.3	50%	0.1	0.0	0.0
Evaluated Savings	2010	0	0.0	37%	0.0		0.0		0.0	0.0	0.0
	2011	48,020	5.1	37%	1.9	-94%	0.1	45%	0.0	0.0	0.0
	2012	48,020	15.1	37%	5.6	-95%	0.3	45%	0.1	0.0	0.0

6.3.3 Federal 3: Commercial Refrigeration

As of January 2012, this federal standard pre-empted three Title 20 standards (Standard 1, Standard 2, and Standard 3). Cadmus evaluation relied on the potential, CAF, and NOMAD values from the 2006-2008 PY evaluation. Based on higher values for potential and compliance, the IOU Estimate included higher gross savings than were found by the evaluators as shown in Table 83. After taking into account the 77% NOMAD (from the prior evaluation) and the attribution adjustment, the IOU Estimate was for 4.1 GWh net program savings in 2012 while the evaluators found 2.0 GWh for the same year.

Table 83. Energy Savings for Federal 3

Fed 3: Commercial Refrigeration	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2012	NA	37.8	95%	35.9	-77%	8.3	50%	4.1	0.5	-0.1
Evaluated Savings	2010	0	0.0	70%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	70%	0.0		0.0		0.0	0.0	0.0
	2012	50,617	29.1	70%	20.4	-41%	11.9	44%	5.2	0.9	-0.1

6.3.4 Federal 4: ASHRAE Products (Commercial Boilers)

Table 84. Energy Savings for Federal 4

Fed 4: ASHRAE Products (Commercial boilers)	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2012	25,652	0.0	95%	0.0		0.0		0.0	0.0	0.1
Evaluated Savings	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2012	25,652	0.0	95%	0.0		0.0		0.0	0.0	0.1

6.3.5 Federal 5: Residential Electric and Gas Ranges

Table 85. Energy Savings for Federal 5

Fed 5: Residential Electric & Gas Ranges	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2012	37,268	0.0	95%	0.0		0.0		0.0	0.0	0.1
Evaluated Savings	2010	0	0.0	100%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	100%	0.0		0.0		0.0	0.0	0.0
	2012	4,448	0.0	100%	0.0		0.0		0.0	0.0	0.0

6.3.6 Federal 6: Incandescent Reflector Lamps

This standard took effect in July 2012 at which time it pre-empted two Title 20 standards (22a and 22b). Cadmus found large differences between the IOU Estimate and evaluated savings as shown in Table 86. For potential savings, the IOU Estimate assumes that this regulation covers a large part of the IRL market. Cadmus found that a large part of this market was already regulated by EPACT 2007. Our analyses of the market size, unit energy savings, and unit demand savings are included in Appendix D. Based on our evaluation, we found the potential savings to be about 10% of what the IOUs estimated.

Based on a 2011 shelf survey, Cadmus found that 7% of the IRLs in the market at that time complied with the standard compared to the IOUs assumption that CAF would be 95% in 2012. The above factors explain why the evaluated gross savings are less than 1% of the IOU Estimate and why the net program savings are near zero.

Table 86. Energy Savings for Federal 6

Fed 6: Incandescent Reflector Lamps	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2012	NA	250.8	95%	238.2	-6%	222.9	50%	111.4	19.9	-2.1
Evaluated Savings	2010	0	0.0	7%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	7%	0.0		0.0		0.0	0.0	0.0
	2012	7,239,740	25.6	7%	1.8	-2%	1.7	27%	0.5	0.1	0.0

6.3.7 Federal 7: General Service Fluorescent Lamps

As shown in Table 87, Cadmus found that potential and gross savings for federal standard 7 which took effect in July 2012 were much larger than the IOU Estimate. Our compliance research validated the IOU assumption when we found that 95% of the market was compliant with the federal law.

We found higher NOMAD of 36% than the IOUs used in their estimate and lower attribution. As a result, net program savings for this standard are just under half of what the IOUs estimated.

Table 87. Energy Savings for Federal 7

Fed 7: General Service Fluorescent Lamps	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2012	NA	181.0	95%	171.9	-6%	160.8	50%	80.4	14.3	-1.0
Evaluated Savings	2010	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	95%	0.0		0.0		0.0	0.0	0.0
	2012	9,212,320	152.9	95%	145.3	-36%	93.0	19%	17.7	4.9	-0.1

6.4 Findings for 2008 Title 24 Building Codes

6.4.1 Standard B17: Envelope Insulation

Table 88. Energy Savings for Standard B17

Std B17: Envelope insulation	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	73,100	18.4	83%	15.3	-22%	12.0	71%	8.5	1.7	0.7
	2011	73,100	73.1	83%	60.8	-23%	46.8	71%	33.1	6.6	2.9
	2012	73,100	73.1	83%	60.8	-24%	46.2	71%	32.6	6.5	2.9
Evaluated Savings	2010	367,380,000	14.1	123%	17.3	-21%	13.6	77%	10.5	1.7	0.8
	2011	367,380,000	55.9	123%	68.5	-25%	51.4	77%	39.5	6.3	2.9
	2012	367,380,000	55.9	123%	68.5	-29%	48.8	77%	37.6	6.0	2.8

6.4.2 Standard B18: Overall Envelope Trade-off

Table 89. Energy Savings for Standard B18

Std B18: Overall Envelope Trade-off	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	83%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	83%	0.0		0.0		0.0	0.0	0.0
	2012	0	0.0	83%	0.0		0.0		0.0	0.0	0.0
Evaluated Savings	2010	1,159,200	0.1	397%	0.2	-22%	0.2	85%	0.1	0.0	0.0
	2011	1,159,200	0.2	397%	0.9	-23%	0.7	85%	0.6	0.0	0.0
	2012	1,159,200	0.2	397%	0.9	-24%	0.7	85%	0.6	0.0	0.0

6.4.3 Standard B19: Skylighting

Table 90. Energy Savings for Standard B19

Std B19: Skylighting	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	3,700	0.9	83%	0.8	-14%	0.7	71%	0.5	0.0	0.0
	2011	3,700	3.7	83%	3.1	-17%	2.6	71%	1.8	0.1	0.0
	2012	3,700	3.7	83%	3.1	-20%	2.5	71%	1.7	0.1	0.0
Evaluated Savings	2010	1,832,940	0.8	397%	3.3	-5%	3.1	76%	2.4	0.1	0.0
	2011	1,832,940	3.3	397%	13.1	-6%	12.3	76%	9.4	0.4	0.0
	2012	1,832,940	3.3	397%	13.1	-7%	12.1	76%	9.2	0.4	0.0

6.4.4 Standard B20: Sidelighting

Table 91. Energy Savings for Standard B20

Std B20: Sidelighting	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	1,200	0.3	83%	0.3	-2%	0.2	71%	0.2	0.1	0.0
	2011	1,200	1.2	83%	1.0	-4%	1.0	71%	0.7	0.3	0.0
	2012	1,200	1.2	83%	1.0	-5%	0.9	71%	0.7	0.3	0.0
Evaluated Savings	2010	1,447,050	0.3	397%	1.3	-8%	1.2	75%	0.9	0.3	0.0
	2011	1,447,050	1.3	397%	5.3	-9%	4.8	75%	3.6	1.2	0.0
	2012	1,447,050	1.3	397%	5.3	-11%	4.7	75%	3.5	1.2	0.0

6.4.5 Standard B21: Tailored Indoor Lighting

Table 92. Energy Savings for Standard B21

Std B21: Tailored Indoor lighting	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	30,900	7.8	83%	6.5	-32%	4.4	71%	3.1	0.7	-0.1
	2011	30,900	30.9	83%	25.7	-34%	16.9	71%	12.0	2.6	-0.2
	2012	30,900	30.9	83%	25.7	-36%	16.4	71%	11.6	2.5	-0.2
Evaluated Savings	2010	8,637,000	7.0	573%	39.9	-29%	28.3	68%	19.3	4.2	-0.1
	2011	8,637,000	27.6	573%	158.2	-32%	107.1	68%	73.1	16.0	-0.2
	2012	8,637,000	27.6	573%	158.2	-35%	102.3	68%	69.8	15.3	-0.2

6.4.6 Standard B22a: TDV Lighting Controls

Table 93. Energy Savings for Standard B22a

Std B22a: TDV Lighting Controls	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	0	0.0	83%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	83%	0.0		0.0		0.0	0.0	0.0
	2012	0	0.0	83%	0.0		0.0		0.0	0.0	0.0
Evaluated Savings	2010	0	0.0	0%	0.0		0.0		0.0	0.0	0.0
	2011	0	0.0	0%	0.0		0.0		0.0	0.0	0.0
	2012	0	0.0	0%	0.0		0.0		0.0	0.0	0.0

6.4.7 Standard B22b: Demand Response Indoor Lighting

Table 94. Energy Savings for Standard B22b

Std B22b: DR Indoor Lighting	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	10	0.0	83%	0.0	-28%	0.0	71%	0.0	0.0	0.0
	2011	10	0.0	83%	0.0	-33%	0.0	71%	0.0	0.0	0.0
	2012	10	0.0	83%	0.0	-39%	0.0	71%	0.0	0.0	0.0
Evaluated Savings	2010	10	0.0	397%	0.0	-1%	0.0	79%	0.0	0.0	0.0
	2011	10	0.0	397%	0.2	-1%	0.2	79%	0.1	0.0	0.0
	2012	10	0.0	397%	0.2	-1%	0.2	79%	0.1	0.0	0.0

6.4.8 Standard B23: Outdoor Lighting

Table 95. Energy Savings for Standard B23

Std B23: Outdoor Lighting	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	7,820	2.0	83%	1.6	-53%	0.8	71%	0.5	0.0	0.0
	2011	7,820	7.8	83%	6.5	-55%	2.9	71%	2.1	0.0	0.0
	2012	7,820	7.8	83%	6.5	-57%	2.8	71%	2.0	0.0	0.0
Evaluated Savings	2010	26,855,000	2.0	83%	1.6	-37%	1.0	75%	0.8	0.0	0.0
	2011	26,855,000	7.8	83%	6.5	-40%	3.9	75%	2.9	0.0	0.0
	2012	26,855,000	7.8	83%	6.5	-43%	3.7	75%	2.8	0.0	0.0

6.4.9 Standard B24: Outdoor Signs

Table 96. Energy Savings for Standard B24

Std B24: Outdoor Signs	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	1,210	0.3	83%	0.3	-13%	0.2	71%	0.2	0.0	0.0
	2011	1,210	1.2	83%	1.0	-16%	0.8	71%	0.6	0.0	0.0
	2012	1,210	1.2	83%	1.0	-19%	0.8	71%	0.6	0.0	0.0
Evaluated Savings	2010	1,210	0.3	83%	0.3	-2%	0.2	78%	0.2	0.0	0.0
	2011	1,210	1.2	83%	1.0	-2%	1.0	78%	0.8	0.0	0.0
	2012	1,210	1.2	83%	1.0	-2%	1.0	78%	0.8	0.0	0.0

6.4.10 Standard B26: Refrigerated Warehouses

Table 97. Energy Savings for Standard B26

Std B26: Refrigerated warehouses	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	10,400	2.6	83%	2.2	-12%	1.9	71%	1.4	0.2	0.0
	2011	10,400	10.4	83%	8.6	-14%	7.4	71%	5.2	0.9	0.0
	2012	10,400	10.4	83%	8.6	-16%	7.2	71%	5.1	0.8	0.0
Evaluated Savings	2010	109,000	0.2	83%	0.2	-12%	0.2	75%	0.1	0.0	0.0
	2011	109,000	0.9	83%	0.7	-14%	0.6	75%	0.5	0.1	0.0
	2012	109,000	0.9	83%	0.7	-16%	0.6	75%	0.4	0.1	0.0

6.4.11 Standard B27: DDC to Zone

Table 98. Energy Savings for Standard B27

Std B27: DDC to Zone	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	61,700	15.6	83%	12.9	-19%	10.5	71%	7.4	2.9	0.8
	2011	61,700	61.7	83%	51.3	-23%	39.8	71%	28.1	11.1	2.9
	2012	61,700	61.7	83%	51.3	-26%	37.9	71%	26.7	10.6	2.8
Evaluated Savings	2010	64,812,000	7.8	397%	30.8	-17%	25.6	73%	18.6	6.5	0.1
	2011	64,812,000	30.8	397%	122.1	-20%	98.1	73%	71.1	25.0	0.3
	2012	64,812,000	30.8	397%	122.1	-23%	94.5	73%	68.5	24.1	0.3

6.4.12 Standard B28: Residential Swimming Pool

Table 99. Energy Savings for Standard B28

Std B28: Residential Swimming pool	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	56,600	28.5	83%	23.7	-8%	21.8	71%	15.4	8.6	0.0
	2011	56,600	56.6	83%	47.1	-10%	42.4	71%	29.9	16.7	0.0
	2012	56,600	56.6	83%	47.1	-12%	41.5	71%	29.3	16.4	0.0
Evaluated Savings	2010	10,999	9.0	83%	7.5	-9%	6.8	68%	4.6	2.6	0.0
	2011	10,999	17.9	83%	14.8	-10%	13.3	68%	9.0	5.0	0.0
	2012	10,999	17.9	83%	14.8	-12%	13.1	68%	8.8	4.9	0.0

6.4.13 Standard B29: Site Built Fenestration

Table 100. Energy Savings for Standard B29

Std B29: Site Built Fenestration	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	7,400	1.9	83%	1.6	-12%	1.4	71%	1.0	0.0	0.0
	2011	7,400	7.4	83%	6.2	-14%	5.3	71%	3.7	0.0	0.1
	2012	7,400	7.4	83%	6.2	-16%	5.1	71%	3.6	0.0	0.1
Evaluated Savings	2010	1,606	0.5	83%	0.4	-20%	0.3	67%	0.2	0.0	0.0
	2011	1,606	1.9	83%	1.6	-24%	1.2	67%	0.8	0.0	0.0
	2012	1,606	1.9	83%	1.6	-28%	1.1	67%	0.8	0.0	0.0

6.4.14 Standard B30: Residential Fenestration

Table 101. Energy Savings for Standard B30

Std B30: Residential Fenestration	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	31,200	15.7	83%	13.1	-12%	11.5	71%	8.1	6.7	1.7
	2011	31,200	31.2	83%	25.9	-14%	22.3	71%	15.7	12.9	3.3
	2012	31,200	31.2	83%	25.9	-16%	21.7	71%	15.3	12.6	3.2
Evaluated Savings	2010	32,097	2.3	83%	1.9	-49%	1.0	81%	0.8	0.6	0.2
	2011	32,097	4.5	83%	3.8	-54%	1.7	81%	1.4	1.1	0.4
	2012	32,097	4.5	83%	3.8	-58%	1.6	81%	1.3	1.0	0.3

6.4.15 Standard B31: Cool Roof Expansion

Table 102. Energy Savings for Standard B31

Std B31: Cool Roof Expansion	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	72,900	18.4	83%	15.3	-12%	13.5	71%	9.5	0.9	0.0
	2011	72,900	72.9	83%	60.6	-14%	52.0	71%	36.7	3.4	-0.1
	2012	72,900	72.9	83%	60.6	-16%	50.7	71%	35.8	3.3	-0.1
Evaluated Savings	2010	23,695,000	5.7	153%	8.7	-23%	6.7	73%	4.9	0.4	0.0
	2011	23,695,000	22.7	153%	34.6	-26%	25.7	73%	18.6	1.6	-0.1
	2012	23,695,000	22.7	153%	34.6	-28%	24.9	73%	18.0	1.5	-0.1

6.4.16 Standard B32: Multifamily Water Heating Control

Table 103. Energy Savings for Standard B32

Std B32: MF Water heating control	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	5,500	0.0	83%	0.0		0.0		0.0	0.0	0.0
	2011	5,500	0.0	83%	0.0		0.0		0.0	0.0	0.0
	2012	5,500	0.0	83%	0.0		0.0		0.0	0.0	0.0
Evaluated Savings	2010	7,853	0.0	0%	0.0		0.0		0.0	0.0	0.0
	2011	7,853	0.0	0%	0.0		0.0		0.0	0.0	0.0
	2012	7,853	0.0	0%	0.0		0.0		0.0	0.0	0.0

6.4.17 Standard B33a: CfR Interior Lighting Complete Building Method

Table 104. Energy Savings for Standard B33a

Std B33a: CfR IL Complete Building Method	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	149,600	50.0	83%	41.6	-32%	28.4	26%	7.4	1.6	0.0
	2011	149,600	149.6	83%	124.4	-34%	82.0	26%	21.4	4.8	0.0
	2012	149,600	149.6	83%	124.4	-36%	79.2	26%	20.7	4.6	0.0
Evaluated Savings	2010	136,748,157	41.6	571%	237.6	-29%	168.9	4%	5.9	1.3	0.0
	2011	136,748,157	124.5	571%	710.8	-32%	481.1	4%	16.8	3.7	-0.1
	2012	136,748,157	124.5	571%	710.8	-35%	459.6	4%	16.1	3.6	-0.1

6.4.18 Standard B33b: CfR Interior Lighting Area Category Method

Table 105. Energy Savings for Standard B33b

Std B33b: CfR IL Area Category Method	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	82,500	27.6	83%	22.9	-32%	15.7	26%	4.1	0.9	0.0
	2011	82,500	82.5	83%	68.6	-34%	45.2	26%	11.8	2.6	0.0
	2012	82,500	82.5	83%	68.6	-36%	43.7	26%	11.4	2.6	0.0
Evaluated Savings	2010	207,259,815	22.9	569%	130.5	-29%	92.7	4%	3.2	0.7	0.0
	2011	207,259,815	68.6	569%	390.4	-32%	264.3	4%	9.2	2.1	0.0
	2012	207,259,815	68.6	569%	390.4	-35%	252.4	4%	8.8	2.0	0.0

6.4.19 Standard B33c: CfR Interior Lighting Egress Control

Table 106. Energy Savings for Standard B33c

Std B33c: CfR IL Egress Control	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	30,000	10.0	83%	8.3	-32%	5.7	26%	1.5	0.0	0.0
	2011	30,000	30.0	83%	24.9	-34%	16.4	26%	4.3	0.0	0.0
	2012	30,000	30.0	83%	24.9	-36%	15.9	26%	4.1	0.0	0.0
Evaluated Savings	2010	6,999,325	1.9	397%	7.5	-29%	5.3	4%	0.2	0.0	0.0
	2011	6,999,325	5.7	397%	22.5	-32%	15.2	4%	0.5	0.0	0.0
	2012	6,999,325	5.7	397%	22.5	-35%	14.6	4%	0.5	0.0	0.0

6.4.20 Standard B33d: CfR HVAC Efficiency

Table 107. Energy Savings for Standard B33d

Std B33d: CfR HVAC Efficiency	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	17,500	5.8	83%	4.9	-32%	3.3	26%	0.9	0.5	0.0
	2011	17,500	17.5	83%	14.6	-34%	9.6	26%	2.5	1.4	0.0
	2012	17,500	17.5	83%	14.6	-36%	9.3	26%	2.4	1.3	0.0
Evaluated Savings	2010	3,798	1.3	397%	5.0	-29%	3.6	10%	0.4	0.2	0.0
	2011	3,798	3.8	397%	15.1	-32%	10.2	10%	1.0	0.5	0.0
	2012	3,798	3.8	397%	15.1	-35%	9.7	10%	1.0	0.4	0.0

6.4.21 Standard B33e: CfR Residential Cool Roofs

Table 108. Energy Savings for Standard B33e

Std B33e: CfR Res Cool Roofs	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	11,900	4.0	83%	3.3	-32%	2.3	26%	0.6	0.4	0.0
	2011	11,900	11.9	83%	9.9	-34%	6.5	26%	1.7	1.2	0.0
	2012	11,900	11.9	83%	9.9	-36%	6.3	26%	1.6	1.1	0.0
Evaluated Savings	2010	2,766	1.0	83%	0.9	-29%	0.6	15%	0.1	0.1	0.0
	2011	2,766	3.1	83%	2.5	-32%	1.7	15%	0.3	0.2	0.0
	2012	2,766	3.1	83%	2.5	-35%	1.6	15%	0.2	0.2	0.0

6.4.22 Standard B33f: CfR Residential Central Fan Watt Limit

Table 109. Energy Savings for Standard B33f

Std B33f: CfR Res Central Fan WL	Year	Units	GWh							MW	Mtherms
			Potential Savings	CAF	Gross Savings	Net NOMAD	Net Savings	Attrib.	Net Program Savings	Net Program Savings	Net Program Savings
IOU Estimate	2010	33,600	11.2	83%	9.3	-32%	6.4	26%	1.7	1.1	0.0
	2011	33,600	33.6	83%	27.9	-34%	18.4	26%	4.8	3.2	0.0
	2012	33,600	33.6	83%	27.9	-36%	17.8	26%	4.6	3.1	0.0
Evaluated Savings	2010	8,039	2.8	83%	2.3	-29%	1.6	20%	0.3	0.3	0.0
	2011	8,039	8.4	83%	6.9	-32%	4.7	20%	0.9	0.7	0.0
	2012	8,039	8.4	83%	6.9	-35%	4.5	20%	0.9	0.7	0.0

6.5 Uncertainty Analysis

As described in Section 2.1, the evaluation protocol is used to determine energy and demand savings attributable to the C&S Program. The protocol defines the major factors used to calculate savings. The process begins with an estimate of potential savings, a product of unit savings and market-size estimates, and continues with a series of adjustments to the potential to arrive at savings for each utility. The methods used to determine the various parameters are described in Chapter 3.

Due to the variety of methods used, this process does not lend itself to a simple approach of developing confidence level and precision estimates based on sampling statistics, as each evaluation component is subject to different uncertainties and measurement errors that affect the confidence and precision associated with the estimated value. Therefore, Cadmus used a Monte Carlo simulation approach, built into the ISSM calculation engine, to examine the uncertainty around the estimates of cumulative savings through 2012.

The Monte Carlo method uses a random selection from a defined range of values for each of the major evaluation inputs. In general, each of the major inputs were varied using a triangular distribution centered on the evaluated value and limited to plus or minus 20% of the evaluated value. The specific inputs that were allowed to vary and the allowed range for each is summarized in Table 110.

Table 110. Inputs to Uncertainty Analysis

Protocol Stage	Inputs	Range for Uncertainty Analysis
Potential Savings	Unit energy savings	Triangular distribution, Plus or minus 20%
	Annual installations (market volume)	Triangular distribution, Plus or minus 20%
	Interactive effects	Not varied for analysis
	Effective Date	Not varied for analysis
	Measure life	Not varied for analysis
Gross Savings (Compliance)	Compliance Adjustment Factors (CAF)	Triangular distribution, Plus or minus 20%
Net Savings (NOMAD)	NOMAD start year	Not varied for analysis
	Market Adoption Curve	Three alternate adoption curves, Original, ~20% higher, or ~20% lower
	Utility program effects	Not varied for analysis
Net Program Savings (Attribution)	Weighted attribution score	Triangular distribution, Plus or minus 20%
Utility Savings (Allocation)	IOU share of CA market (electricity, gas)	Not varied for analysis

Since a small number of standards are responsible for a large part of the net program savings, Cadmus reviewed the parameters for some standards in greater depth. Specifically, we reviewed the parameters for the seven standards that are responsible for 76% of the net program savings (for the standards being evaluated). The results of this review are summarized in Table 111.

Table 111. Inputs for Standards Responsible for Most (76%) GWh Savings

REF	Standard	Unit Energy Savings	Market Volume	Compliance	Comments
Std 9	Residential Pool Pumps, 2-speed Motors, Tier 2	30.0%	20.0%	10.0%	Estimates for unit savings range widely both higher and lower than evaluated values. Assume 30% variability. Compliance is less variable since 96% of qualifying motors are sold with controls.
Std 11b	General Service Incand. Lamps, Tier 2	20.0%	20.0%	10.0%	Compliance based on KEMA shelf studies. Assume sample supports 90/10 conf. / precision
Std 28a	Televisions - Tier 1	20.0%	20.0%	10.0%	Compliance based on analysis of product mix. Assume sample supports 90/10 conf. / precision.
Std B21	Tailored Indoor lighting	20.0%	20.0%	33.5%	Compliance is average of relative precision for kWh and kW lighting alteration CAFs.
Std B27	DDC to Zone	30.0%	20.0%	5.5%	Unit savings based on building simulations reported in the CASE report only. Assume 30% variability. Compliance is average of relative precision for kWh and kW new construction CAFs.
Fed1	Electric Motors 1-200HP	20.0%	20.0%	20.0%	No change from general assumptions
Std 24	Portable Lighting Fixtures	10.0%	20.0%	10.0%	Unit energy savings based on analysis of shelf stock. Analysis of nearly 4,000 lamps. Assume 10% variability. Compliance based on KEMA shelf studies. Assume sample supports 90/10 conf. / precision.

We ran the model 500 times to generate a distribution of savings and adjustment estimates, shown below in Table 112. Because we observed that the combination of positive and negative values for gas savings resulting from the inclusion of interactive effects indicated a great deal of uncertainty in the estimates, we ran the uncertainty analysis with interactive effects turned off, as noted, below.

We note that the 90% confidence interval is within 8% of the evaluated values for program net energy savings (see the bolded lines in the table). We interpret this as an indication that the overall evaluation results are fairly robust—that is, the savings results vary less than 10% when the inputs are allowed to vary by as much as 20% (with the exceptions noted above).

Table 112. Uncertainty Analysis Results

3-Year Uncertainty Statistics			Percentiles			90% Confidence Interval, Plus / Minus %	
	Mean	StdDev	5.0%	50.0%	95.0%		
ENERGY - GWh							
Potential Energy Savings	10,106	221	9,789	10,115	10,469	4%	3%
Adjustment for Non-Compliance	1,443	256	1,059	1,420	1,854	29%	27%
Gross Energy Savings	11,549	363	10,968	11,544	12,154	5%	5%
Adjustment for Net NOMAD	(3,609)	193	(3,927)	(3,615)	(3,300)	9%	9%
Net Energy Savings	7,940	291	7,492	7,927	8,437	6%	6%
Adjustment for Attribution	(3,840)	222	(4,207)	(3,838)	(3,499)	9%	10%
Program Net Energy Savings	4,100	162	3,832	4,094	4,354	6%	7%
DEMAND - MW							
Potential Energy Savings	1,920	40	1,858	1,920	1,984	3%	3%
Adjustment for Non-Compliance	373	55	284	370	462	24%	24%
Gross Energy Savings	2,293	75	2,172	2,293	2,420	6%	5%
Adjustment for Net NOMAD	(708)	39	(773)	(708)	(645)	9%	9%
Net Energy Savings	1,584	56	1,495	1,584	1,680	6%	6%
Adjustment for Attribution	(829)	46	(911)	(829)	(760)	8%	10%
Program Net Energy Savings	755	28	712	755	800	6%	6%
GAS- Mtherms							
Potential Energy Savings	72	2	68	72	76	5%	5%
Adjustment for Non-Compliance	(3)	1	(4)	(3)	(1)	56%	54%
Gross Energy Savings	69	3	66	69	74	6%	5%
Adjustment for Net NOMAD	(14)	1	(16)	(14)	(13)	10%	10%
Net Energy Savings	55	2	52	55	59	6%	6%
Adjustment for Attribution	(15)	1	(18)	(15)	(13)	15%	15%
Program Net Energy Savings	40	2	36	40	43	8%	8%

7 Conclusions and Recommendations

Throughout the evaluation, the IOUs provided essential support through the documentation provided in response to the CPUC data requests and also through meetings with the CPUC and the evaluation team. While we were able to complete our impact evaluation of the Title 20, Title 24, and Federal codes and standards, we also identify several areas where specific actions could mitigate issues encountered, improve forecast accuracy, and support future evaluations. We recognize that some recommendations require additional resources, but this seems justifiable in the context of the magnitude of C&S savings.

This chapter summarizes the evaluation team's conclusions and recommendations regarding:

- Information the IOUs provide to evaluators
- Potential improvements to the statewide program
- Documentation of direction provided on evaluation methods

The first section addresses overarching topics that came up in more than one part of the evaluation. The sections following discuss more specific issues in the context of the four stages of the evaluation protocol.

7.1 Overall

Conclusion: Program saving estimates are not initially well-documented in the IOU savings estimate and CCTRs

The statewide C&S program differs from resource-acquisition programs in that there are no participant databases that define program savings for evaluators. Generally, the statewide program activity is focused on the development and adoption of new codes and standards. We also note that significant IOU resources are spent in support of compliance improvement.

Evaluators generally depend on resource programs to provide documentation of estimated savings. For the C&S program however, it was necessary for the evaluation team to spend considerable effort to collect information that would ordinarily be provided by the program. Examples of such information include:

- Product market volumes. For the majority of the codes and standards, market data from around the time of the CEC approval process was used to support the IOU Estimate. Many of the product mix and annual volume values are taken from the CASE reports which are usually dated between 2004 and 2008. Their sources are necessarily somewhat older.
- Potential Title 24 savings from new construction. The IOU Estimate included 377 GWh per year of savings (based on a 2006 estimate of construction) while the evaluators found 112 GWh (based on actual data for 2010-2012). Nearly all of the change was due to the adjustment for construction volume.

- Delays in the availability of CASE reports and CCTRs[54]. It took sixteen months for the IOUs to deliver all of the CCTRs. Since the CCTRs are critical to the determination of attribution, the contents and availability of these documents had a direct impact on the evaluation.

Data requests are a normal part of any evaluation, but the limited initial documention of the program by the utilities required 14 formal data requests to improve documentation of the initial IOU savings estimate.

Recommendation: Dedicate additional resources to documentation of program savings and the program's role in code development and adoption through the CCTRs

The IOUs should consider providing greater support to documentation of program impact in at least these two areas: market volume estimates and development of CCTRs.

Since a relatively small number of standards produce nearly all of the expected savings, the IOUs could improve their forecast by tracking the product markets for the standards with the greatest savings. For these standards in particular, out-of-date information should be replaced with data about the market during the program years being evaluated.

In addition, improved documentation of IOU efforts at the federal level would be helpful to the evaluators' attribution research.

Commission staff should continue to develop C&S-specific reporting guidelines and processes for the IOUs to follow. A clearly-defined process for reporting at defined intervals would enable the CPUC to provide more timely feedback to the IOUs on their documentation of expected savings from codes and standards.

Conclusion: Commission staff and the evaluators have developed additional methods in several areas over the course of the two C&S impact evaluations.

The evaluation protocol provides an essential framework for the evaluation process. During the two impact evaluations, the evaluation team and Commission staff defined methods in several areas that were not completely defined in the protocol. Examples include:

- Development of a general attribution method for the PY 2006-2008 evaluation and a method for federal attribution for the current evaluation.
- Definition of a method to adjust natural market adoption for IOU resource programs that may affect the market prior to code adoption.
- Application of Title 24 compliance findings based on performance (energy consumption).

In these cases and several others, methods were defined to address areas that are not directly addressed in the evaluation protocol.

[54] The advocacy subprograms create two documents that capture key information for evaluators: Codes and Standards Enhancement (CASE) reports and Code Change Theory Reports (CCTRs) These documents summarize much of the work done by the advocacy subprograms.

Recommendation: Consider development of a summary document that describes areas where evaluation methods have been developed

Documentation of evaluation methods would be helpful to identify which areas have required the most additional development and what analytic areas might be the focus of future modifications or updates to the existing protocol.

7.2 Potential Savings

Conclusion: Savings for alterations projects depend heavily on assumptions regarding the quantity and scope of alterations.

In the current evaluation of Title 24, substantial potential savings are identified for lighting alteration projects and reroofing projects. The potential is based on assumed replacement rates for these construction types. The savings are calculated using these assumptions and the estimates of specific building types within the overall existing building stock. Since there is no comprehensive statewide report on alteration projects, it is difficult to validate these assumptions.

The following codes are of particular concern:

- **Standard B21: Tailored Indoor Lighting.** The IOUs estimated that 59% of savings associated with the lighting measures is contributed by the tailored method. However, the evaluation team found that the majority of sites (for both new construction and lighting alteration sites) used the Area Category method for code compliance. Only 2 sites out of 91 new construction sites and 8 sites out of 75 lighting alterations sites had chosen the tailored method. Therefore, savings associated with this method were small when compared to the overall sampled population.
- **Standard B27: DDC to Zone.** It is possible that the impact of this code is overestimated based on the assumed project frequency. The evaluation team observed only one site out of 91 new construction sites that had this measure installed. It is possible that this measure is typically installed in above-code buildings, such as those in utility-sponsored programs and, therefore, we excluded from our field research.

Recommendation: The CPUC, CEC, and IOUs should consider research to verify the quantity of alteration projects.

The PY2010-2012 evaluation obtained building permit data from over 30 specific jurisdictions. We suggest that targeted research be conducted to compare jurisdiction-level construction data to the assumed level of alteration construction in order to validate the assumptions currently in use.

7.3 Net Savings / NOMAD

Conclusion: NOMAD analysis process improved over prior evaluation.

From an evaluation perspective, the NOMAD process was improved over the previous evaluation through rigorous qualification of experts and a systematic recruiting effort implemented by a dedicated call center. Our approach achieved a higher number of expert inputs for each standard, improved quantity and quality of expert comments, and higher participation in the second round. The most notable issue was that we were unable to collect

NOMAD inputs for the Composite for Remainder (CfR) standards (B33 a through f) since the specific CfR standards were not defined until much later in the evaluation. This is also noted in section 5.3.

Recommendation: No specific recommendations for NOMAD.

Note: Cadmus has relied on the Bass diffusion curve to model natural market adoption. The IOUs have expressed interest in the use of alternative diffusion models. We anticipate that future Title 24 evaluations may use whole building models and that an alternative diffusion model might be more appropriate in that case.

7.4 Net Program Savings / Attribution

Conclusion: Determination of attribution for Federal standards and some Title 24 codes was limited by the availability of documentation.

For federal standards, the CCTRs received were focused on the efforts that took place at the state level for the appliance codes and included only a few references to federal efforts. These references were often to letters and testimony submitted to DOE, but few copies of these items were included.

Regarding the CCTRs provided for Title 24 codes, the contents and quality of the CCTRs prepared for the Title 20 standards was considerably higher. We found that many of the Title 24 CCTRs relied on "boilerplate" text, were repetitive, and did not provide important details.

Recommendation: The IOUs should consider dedicating more resource to documenting the program's activities.

Although the protocol includes a fairly detailed description of the documentation needed to determine attribution, it is possible that some information was not captured for federal standards since the current evaluation was the first project to need this information. Some of the areas for improvement identified in the current evaluation include:

- Detail on the federal rulemaking process and the program's role in that process
- Identification of key stakeholders including non-IOU staff, that were integral to the adoption of each standard and code
- Consistent high level of quality in all CCTRs similar to the Title 20 documents.

Note on Changes to the Report and Appendices

Changes made independently by the evaluators—to the DRAFT 08192014 versions of the report and appendices documents that were published on energydataweb.com—are noted below.

Changes made in response to comments received are noted in Appendix L.

Report

Chapter 6. A paragraph was added to the chapter introduction to highlight the difference between statewide savings and savings that occur within the IOU service territories (identified as the "IOU share").

Appendices

In Appendix section F.9, the evaluation team added an explanation for the use of a Department of Energy estimate of market size.