ED_D_CS_2

Findings from Review of the Process for Codes & Standards Program Cost-effectiveness Reporting

California Public Utilities Commission
Energy Division

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LEGAL NOTICE

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List of Abbreviations

ATR – **All Things Reported**, database used as basis for Impact Evaluation Standard Reporting (IESR) tables. Made available to IOUs to perform additional analysis on evaluation data.

CASE - **Codes and Standards Enhancement**, a study that calculates, documents, and reports technical performance, savings and cost-effectiveness information on compliance with proposed regulations.

CCTR – **Code Change Theory Report**, prepared by the IOUs to document the process from initial concept to preparation of a CASE report and on to code adoption by the CEC.

CEC – **California Energy Commission**, the State of California's primary energy policy and planning agency. One of their responsiblities is setting the building codes and appliance standards for the entire State.

CEDARS - **California Energy Data and Reporting System**, securely manages data associated with California demand-side management programs

CET – **Cost-effectiveness Tool**, on-line (SQL based) cost-effectiveness calculator based on E3.

CPUC – **California Public Utilities Commission**, oversees and regulates energy efficiency program implementation and evaluation

E3 calculator - **cost-effectiveness calculator**, Microsoft Excel®-based spreadsheet tool. Built and maintained by Energy+Environmental Economics until 2015 when it was superseded by the CET.

IOU – **investor-owned utility**, the program administrators for the statewide codes and standards advocacy programs

ISSM – **Integrated Standards and Savings Model**, Microsoft Excel®-based model used by the impact evaluators to process and assign estimated savings

NOMAD - **normally occurring market adoption**, the changes in equipment efficiencies, building processes, codes, and standards that would have happened in the market even without intervention by the IOU codes and standards programs

PAC - **Program Administrator Cost**, similar to TRC but excludes costs incurred by particpants.

RIM - **Ratepayer Impact Measure**, measure what happens to customer bills or rates due to changes in utility revenues and operatsing costs caused by the program. A ratio above 1.0 indictaes that the program will lower rates and bills.

TRC - **Total Resource Cost**, measures the net cost of energy efficiency programs as a resource option based on total costs of the prorgam. A ratio above 1.0 indicates that the benefits from the prgram are greater than the costs.

UES – **unit energy savings**, the savings resulting from a code or standard for each unit installed

1 EXECUTIVE SUMMARY

1.1 Introduction

This report reviews the process and results from the cost-effectiveness calculation for the 2013-2105 Codes and Standards (C&S) program. The C&S program implemented by the California Investor Owned Utilities under the auspices of the California Public Utilities Commission (CPUC) aims to save energy on behalf of ratepayers by influencing continuous improvements in energy efficiency regulations, improving compliance with existing codes and standards, and working with local governments to develop ordinances that exceed statewide minimum requirements. To date, C&S's costs and benefits have not been included in the cost effectiveness threshold requirements for prospective budget approval[1], but have been included in the calculations for overall portfolio prospective cost-effectiveness[2]. For shareholder incentive, the IOUs are reimbursed 12 percent of their costs to administer the program.[3]

During the 2010-12 evaluation cycle, the data submitted by the IOUs required several steps, including transforming it, to support the CPUC reporting structure. The results were inconclusive partly because there was misalignment between the reporting structure of C&S and the savings claims database which feeds into the Cost Effectiveness Tool. CPUC Energy Division could not reconcile data using traditional approaches. The IOUs asserted this confusion was due to a lack of understanding of the data by the CPUC data team. The data team believed the confusion stemmed from inconsistencies in reporting by the IOUs. To help resolve these disparate perspectives DNV GL was asked to trace the data path for the statewide codes and standards programs and to map inputs and outputs for cost-effectiveness calculations along with their sources.

This study was conducted in three phases. The first two phases, which focused on C&S treatment in other states and on data flows between key modeling tools, were completed in April 2015 and in February 2016. This report represents the last phase of research under this scope, which involves assessing the process from first forecast filing to evaluated cost-effectiveness calculations. The purpose is to find the areas in the process that can create confusion and recommend steps to eliminate or mitigate this confusion.

1.2 Research and findings

This research began by comparing the inputs and outputs from two of the main tools used for evaluating the program. The impact evaluation generates gross and net savings outputs from the Integrated Standards and Savings Model (ISSM). The ISSM inputs include information about the code effective date, first-year and lifecycle savings, compliance rates, natural market activity, and program effectiveness. The resulting program first year and lifecycle net savings become inputs for developing benefits through the Cost-effectiveness Tool (CET).[4] The remaining inputs are administrative costs and equipment costs supplied by the IOUs through their regulatory filings. Two key findings from that research were that:

[1] Decision Approving 2013-2014 Energy Efficiency Programs and Budgets (D.12-11-015) at p. 100: "we included in the proposed decision the requirement that each utility's portfolio to have a TRC ratio of at least 1.25, independent of: The costs and benefits of the REN and MEA programs; Spillover effects; and Codes and Standards program costs and benefits."

[2] Ibid at p. 53: 'Thus, for the purposes in this decision, each utility's portfolio must pass both the TRC and PAC [Participant Cost Test] tests on a prospective basis, after subtracting ETP [Emerging Technologies Program] costs."

[3] Decision Adopting Efficiency Savings and Performance Incentive Mechanism (D. 13-09-023)

[4] The CET in an online cost-effectiveness calculator used by the utilities and the CPUC to assess program cost effectiveness. It supersedes the prior tool referred to as the E3 calculator, which was developed by Energy+Environment Economics and was in use until 2015.

- CET requires single year (static) inputs, and ISSM produces a vector of multiyear (dynamic) outputs. As a result, there is not a direct transfer of data from one model to the other.
- The ISSM has 12 inputs related directly to calculating net savings for a code or standard. The CET has 10 inputs related directly to calculating net savings and cost-effectiveness. Even though both can be used to calculate net savings independently, when compared, the two models have only four inputs in common. These are:
  - Assumed measure life,
  - 1st Year Energy Savings per Unit (kWh),
  - 1st Year Demand Savings per Unit (kW),
  - 1st Year Gas Savings per Unit (therm).

This research also included a review of regulatory decisions at the national level and prior research on California C&S cost-effectiveness issues. The hope was to identify context for the seeming confusion in the C&S cost-effectiveness process and find out if and how other states have addressed such issues. Our research found no decisions or documentation from other states addressing codes and standards cost-effectiveness. See APPENDIX B for the first memo from this research.

The second memo provided a hypothetical flow of sample data from the ISSM to CET. The savings output from the ISSM can be considered inputs for cost-effectiveness calculations. The finding was that the CET could not accept a stream of inputs for gross savings, net savings, or the ratio between net and gross savings, but these are the outputs that ISSM provides. Hence, ISSM outputs needed to be condensed, by creating averages. The CET also treated any negative measure costs as zero for the cost-effectiveness calculations. While negative costs are not common, they are a possibility for C&S programs over time. The CET treatment of negative costs overstates costs, does not fully capture benefits, and understates the total-resource-cost (TRC) ratio. Memo two is provided in APPENDIX C.

This last phase of the study involved following, step-by-step, the process of calculating the cost-effectiveness of the C&S program from initial IOU filing to final calculations by the Energy Division. This approach revealed that the calculation process:

- Is not completely or consistently defined for the C&S program
- Is very different from resource programs such as lighting or HVAC
- Includes multiple labor-intensive steps that can be eliminated

The full process, findings, and recommendations are discussed in the body of this report.

In addition to documenting tools, auditing existing data flows, and creating new tools to fills gaps or streamline the reporting process, one other outcome of the study was the calculation of cost-effectiveness values, which are based on reported costs (which were not evaluated) and evaluated energy savings. TRC ratios by IOU and statewide are provided in Table 1. As shown, the C&S programs are all cost effective. Variations between the IOU's seem to be driven by assumed equipment costs, which were not examined in this study. Additional detail on cost effectiveness results is presented in Section 5 and Appendix A of this report.

Table 1: TRC Ratios by IOU (evaluated)

IOU	TRC Ratio[5]
PG&E	3.7
SCE	22.8
SoCalGas	2.6
SDG&E	4.8
Statewide	6.2

1.3 Conclusion and Recommendations

A review of the process for calculating C&S cost-effectivenes revealed that no consistent process exists. In this research we mapped the steps required to make C&S data conform with the existing process used for resource programs. Currently IOUs submit C&S program data in separate Excel workbooks. This creates a highly manual and cumbersome process prone to data errors. To make C&S data compatible with the existing process, it must not only be automated (to reduce time and avoid errors), it must be changed to streamline the process and improve the audit trail.

Finally, it is worth noting that administrative costs reported in the filing and used in the cost-effectiveness calculations are the costs to implement the current year advocacy program, while the savings reported for the current program year are the result of administrative expenses from prior year advocacy. This lag between expenditures and savings makes the C&S program different from other energy efficiency programs, but the CPUC has recognized that costs and benefits for this program even out over time.

Key recommendations for improving the C&S data management process include:

- C&S evaluation results should be formatted to go directly into the All Things Reported (ATR) database. This will require a modification of the current ISSM.
- Have IOUs file directly into California Energy Data and Reporting System (CEDARS). This will eliminate the need for the seprate excel workbooks, reduce data transfer errors and structure data so that it can readily be interpreted by the evaluation and data teams.

[5] Total Resource Cost – a measure of cost effectiveness based on a benefit –cost ratio

2 INTRODUCTION AND BACKGROUND

California Statewide Codes and Standards (C&S) programs are predominantly advocacy programs targeting performance criteria for buildings (codes) and appliances (standards). These CPUC-authorized programs serve as an advocacy arm of the investor-owned utilities (IOUs) for stricter energy usage rules at the state and federal levels. The programs also include technical research and support for the California Energy Commission (CEC) during the standards-setting process.

IOUs accomplish this advocacy effort by developing Code Change Theory Reports (CCTR) and Codes and Standards Enhancement (CASE) studies. When adopted by the CEC, this results in changes to either California Title 24[6] for buildings or Title 20[7] for appliances.

Traditionally C&S programs have not been accounted for in prospective total-resource-cost (TRC) tests. This contrasts with resource programs. In prior cycles C&S program cost-effectiveness was reported but took significant post-processing time by the CPUC data team to translate IOU and evaluation C&S data into claims and evaluation results which would work with the portfolio claims and evaluation results.

The CPUC Energy Division work order (ED_D_CS_2) created an ongoing investigation into ways to calculate cost-effectiveness for IOU codes and standards programs. This report is the final deliverable under this work order. Deliverables to date included two memos on interim findings.

The first memo provided findings from background research covering the California C&S advocacy programs, regulatory decision history and prior research on C&S cost-effectiveness issues. In addition, the memo provided a comparison and contrast between the Integrated Standards and Savings Model (ISSM) and the Cost-effectiveness Tool (CET) in terms of inputs and outputs. Finally, the memo reviewed the cost-effectiveness methods and criteria used by the California Energy Commission to adopt codes and standards.

The second memo used sample data to produce a hypothetical flow of data from the ISSM to CET. That exercise produced inputs for the CET and compared CET output under different cost scenarios that included reported measure costs, zero measure costs and negative measure costs. The finding was that the CET treated negative measure costs as zero for the cost-effectiveness calculations. This treatment overstates costs, does not fully capture benefits, and understates the TRC ratio.

In this report, we use actual C&S tracking and evaluation data from the 2013-2105 program and follow the same data flows as other “resource” programs to produce cost-effectiveness results. The process of transforming data from various sources provides insights into the modifications in reporting needed to produce future data flows that are relatively seamless for cost-effectiveness purposes.

2.1 Purpose

There was considerable confusion during the 2010-2012 program cycle regarding the savings reported through the forecast filing and the claims database. This confusion generated several questions about the process for reporting codes and standards. These questions are:

- Do the E3 Calculator and CET inputs match the forecast and claims for each IOU?
- Are the code year groupings of standards provided by the IOUs valid? Are they even necessary?

[6] California Building Energy Efficiency Standards for residential and non-residential buildings, Title 24, Part 6 and associated administrative regulations in Part 1. http://www.energy.ca.gov/title24

[7] California Code of Regulations Title 20. Public Utilities and Energy. http://www.energy.ca.gov/appliances

- Are data transformations necessary to run the cost-effectiveness models? If so, what type and how many are needed?
- Do IOU and evaluator claims correlate?
- How do IOU E3 calculators and CPUC tools (CET) compare? How do these compare to 2010-12 impact evaluation results (revised forecast)?
- How should the claim data be developed to sync with CPUC needs?
- Once all the inputs line up, does the CET produce the same results as those reported by IOUs though the E3 calculators?
- How should 2013-15 evaluation results be applied to claims? Should the reporting template used for resource programs be applied for C&S? If not possible, what modifications should be made to the reporting template to accommodate C&S?
- Do evaluation results applied to CEDARS and CET, reflect findings from the impact evaluation or do any data transformations distort the values?
- Can the ISSM model be reprogrammed to provide savings from multiple prior program years in addition to multiple-years from the program years being evaluated?
- What should the C&S Claims and Filing look like in the rolling portfolio paradigm?

These remaining report topics are split into four sections. The next section (Section 3) outlines the tools used to calculate cost-effectiveness. In Section 4 the current process and flow of data is outlined. Section 5 includes the findings from the process research and calculations. Section 6 concludes with recommendations on how the tools and process can be modified to accommodate C&S reporting.

The appendices include prior memos produced as part of this research. Appendix B compares ISSM and CET in detail. Appendix B reviews policy related questions related to cost-effectiveness inputs and their sources.

3 CURRENT TOOLS USED TO PROCESS DATA

3.1 E3 calculators

E3 calculators have been the Excel-based spreadsheet tool for cost-effectiveness calculations in California since 2006. During the 2013-15 C&S program cycle, E3 calculator was used by the IOUs to provide C&S program savings and cost-effectiveness estimates. The E3 calculator is developed and maintained by Energy+Environmental Economics, or E3.

The E3 calculator examines unique combinations of measures, climate zones, target sectors, and end-use load shapes for the program being modeled. Each unique combination is linked by the E3 calculator to the avoided cost stream used by the calculator to produce benefits for the cost effectiveness results. For costs, the E3 calculator analyzes measure- and program-level costs, and then produces a final cost-effectiveness calculation for the program being modeled. Figure 1 shows an example C&S E3 calculator application filing submission.

Figure 1. C&S E3 calculator application filing input screen

Statewide		**Program Budget ($)**					
		a. Administrative Costs	2013	2014	2015	NPV	
Proposer General Information		a.i. Overhead and G&A	$ -				d. Incentives and Rebates ($
Proposer Name		a.ii. Other Admin costs	$ -				d.i. User Input Incentive (
Program Name		b. Marketing/Outreach	$ -				d.ii. Rebate
Service Territory	Statewide	c. Direct Implementation (non incentive)					d.iii. Direct Install Labor
First Year of Program Implementation	2013	c.i. Activity	$ -				d.iv. Direct Install Material
Contact Information		c.ii. Installation	$ -				d.v. Upstream payments
Name		c.iii. Hardware & Materials	$ -				Subtotal Incentives and Reba
Address		c.iv. Rebate Processing an	$ -				
ZIP code		d. Total Incentives and Rebates	$ -	$ -	$ -		
Telephone		e. EM&V					f. Costs recovered from other s
Email		**Total**	**$ -**	**$ -**	**$ -**		**Program Budget w/ Other Cos**
Market Sectors- Primary:							$0.00
Program Inputs Secondary:					**0.00**		$0.00

Measure Name	DEER RunID	Climate Zone	Target sector	Measure Electric End Use Shape	CZ, Sector, Measure combination found?	Expected Useful Life for New/ROB, RUL for retrofit. (yrs)	Program Type (To look up Net-to-gross Ratio)	Unit Definition (e.g. homes)	Program Type (NEW/ROB or Early Repl(RET))	Gross Measure Cost (Total Cost for Retrofit, Incr Cost for New/ROB) ($/unit)
2005 T-20										
Commercial Refrigeration Equipment, Solid Door	1	System	COMMERCIAL	4 = Commercial Refrigeration	TRUE	9	0.18			$80.52
Commercial Refrigeration Equipment, Transparent Door	1	System	COMMERCIAL	4 = Commercial Refrigeration	TRUE	9	0.40			$140.23
Commercial Ice Maker Equipment	1	System	COMMERCIAL	4 = Commercial Refrigeration	TRUE	9	0.60			$66.30
Walk-In Refrigerators / Freezers	1	System	COMMERCIAL	4 = Commercial Refrigeration	TRUE	10	0.00			$317.57
Refrigerated Beverage Vending Machines	1	System	COMMERCIAL	4 = Commercial Refrigeration	TRUE	10	0.03			$50.13
Large Packaged Commercial Air-Conditioners, Tier 1	1	System	COMMERCIAL	3 = Commercial HVAC	TRUE	15	0.00			$502.91
Large Packaged Commercial Air-Conditioners, Tier 2	1	System	COMMERCIAL	3 = Commercial HVAC	TRUE	15	0.00			$0.00
Residential Pool Pumps, High Eff Motor, Tier 1	1	System	Residential	24 = Res. Refrigeration	TRUE	10	0.00			$82.76
Portable Electric Spas	1	System	Residential	24 = Res. Refrigeration	TRUE	10	0.00			$299.97
General Service Incandescent Lamps, Tier 1	1	System	Residential	25 = Res. Lighting	TRUE	1	0.00			$0.00
Pulse Start Metal Halide HID Luminaires, Tier 1	1	System	COMMERCIAL	1 = Commercial Indoor Lighting	TRUE	13	0.27			$15.09
Pulse Start Metal Halide HID Luminaires, Tier 2	1	System	COMMERCIAL	1 = Commercial Indoor Lighting	TRUE	13	0.27			$18.86
Modular Furniture Task Lighting Fixtures	1	System	COMMERCIAL	1 = Commercial Indoor Lighting	TRUE	15	0.06			$4.02
Hot Food Holding Cabinets	1	System	COMMERCIAL	5 = Commercial Food Service	TRUE	15	0.13			$453.27
External Power Supplies, Tier 1	1	System	COMMERCIAL	7 = Commercial Process	TRUE	7	0.21			$0.53
External Power Supplies, Tier 2	1	System	COMMERCIAL	7 = Commercial Process	TRUE	7	0.35			$0.53

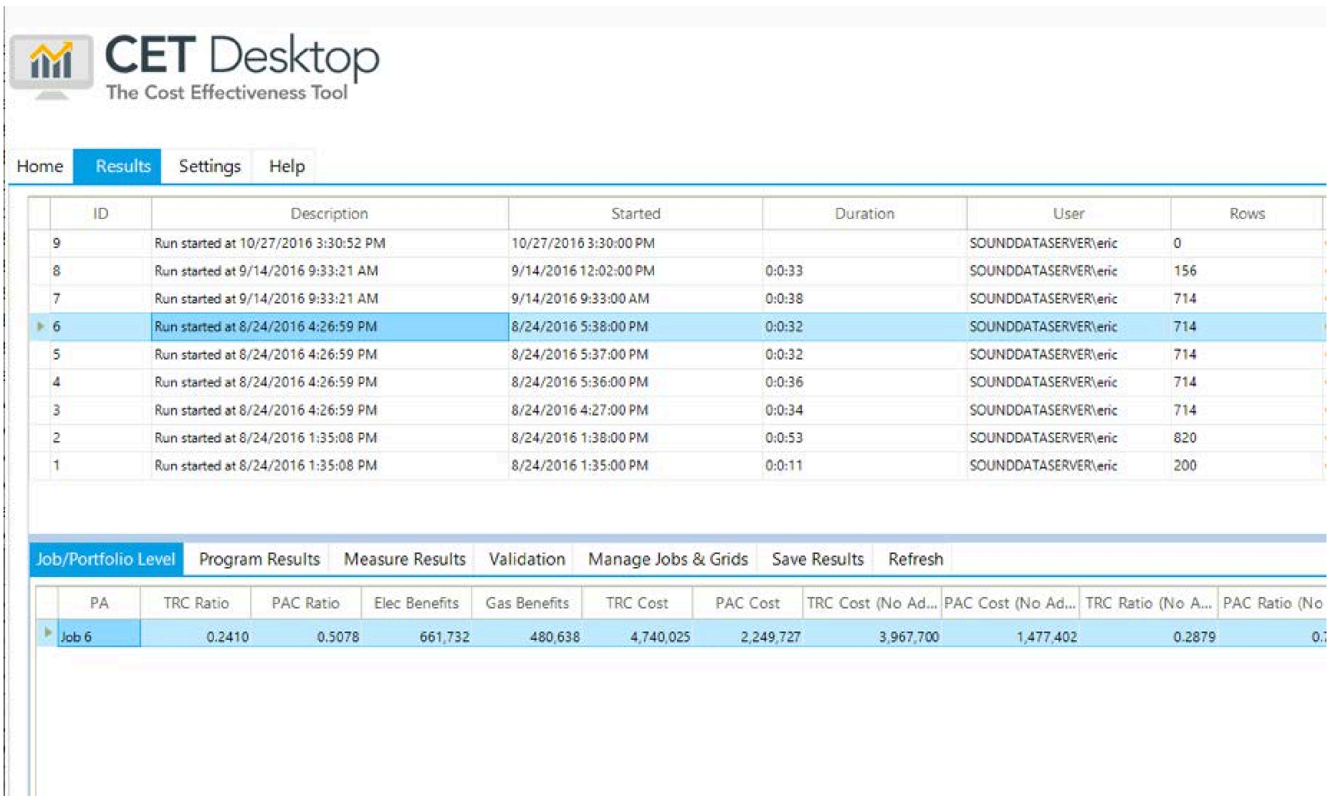
Currently, the E3 calculator's cost-effectiveness calculations are being replicated in the SQL Server-based CET for all cost-effectiveness calculations in CPUC-sponsored evaluations and reports.

3.2 Cost-effectiveness tool (CET)

The CPUC cost-effectiveness tool (CET) provides users a robust SQL Server-based application for calculating the cost-effectiveness of energy efficiency measures, programs, and portfolios in California. The CPUC formerly employed a Microsoft Excel-based E3 calculator for cost-effectiveness calculations. Currently, the CET uses E3's avoided-cost schedules and largely replicates the E3 calculator's cost-effectiveness calculations, while providing a more robust and transparent code base. Moving forward into the rolling portfolio paradigm, the CET will reflect CPUC policy and provide a stable and user-friendly platform for calculating cost-effectiveness. The CET is developed and maintained by Pinnacle Consulting and is funded by the CPUC.

For purposes of this report, we utilized the CET for all cost-effectiveness calculations. The screenshot below shows the CET Desktop. The Results tab in Figure 2 shows a log of calculation runs in the top half of the screen and results for selected runs in the bottom half. This feature allows users to process multiple programs simultaneously or multiple scenarios of one program for comparison purposes.

Figure 2. CET desktop

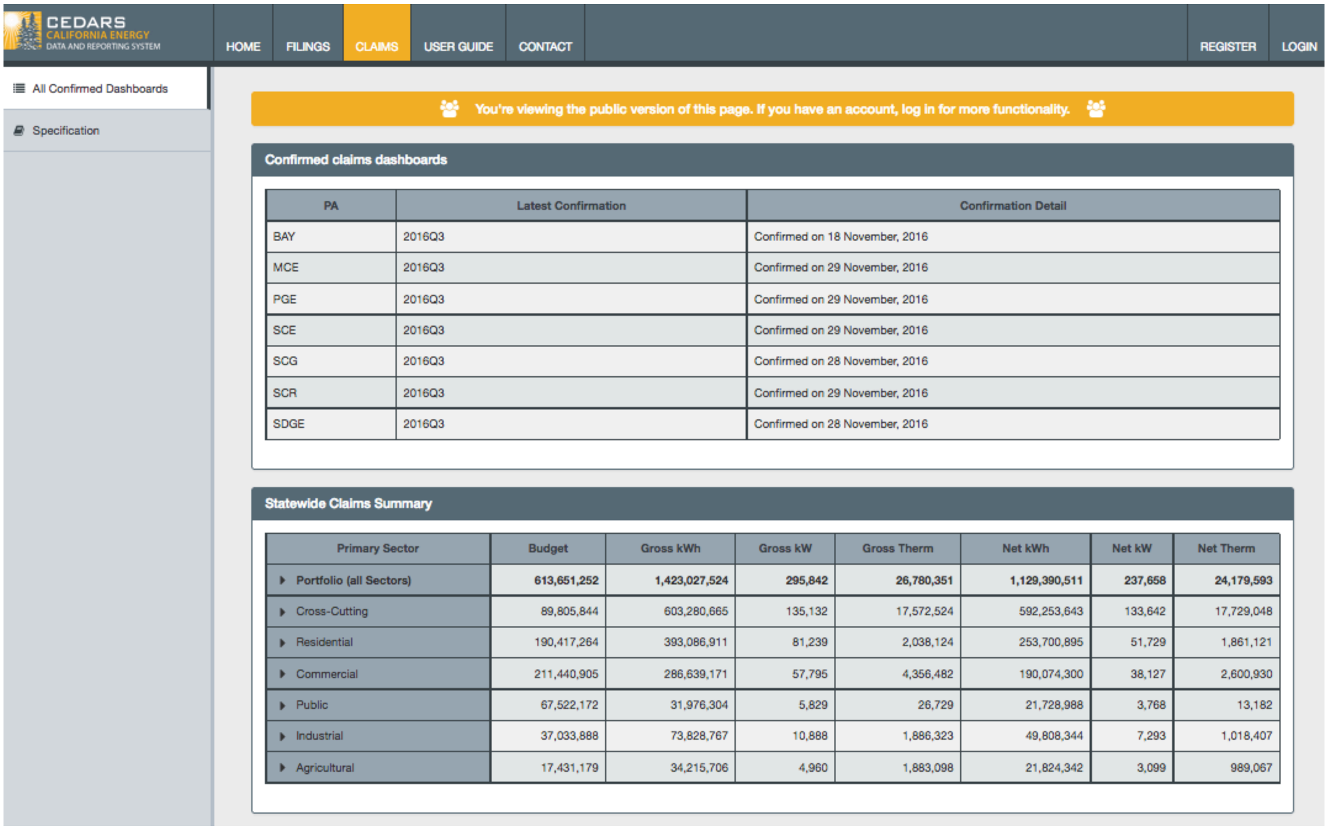


3.3 California Energy Data and Reporting System (CEDARS)

The California Energy Data and Reporting System (CEDARS) securely manages data associated with California demand-side management programs, ensuring data quality and improving communication between DSM Program Administrators (PAs), the CPUC, and the public. Beginning in 2016, CEDARS is the official site for submission of California DSM Program Claims and Application Filings. CEDARS is developed and maintained by Sound Data Management and is funded by the CPUC. Figure 3 shows the Claims Module of CEDARS.

In the Claims Module, CA DSM PAs submit quarterly EE program tracking data to CEDARS for real-time validation, QA/QC, and feedback. Once a quarterly submission passes all validation, as outlined in the CEDARS data specification, the submission is accepted and processed for reporting in CEDARS. CEDARS is currently being developed such that quarterly claims are automatically processed through the CET for cost effectiveness results after the submission is finalized by the PA.

Figure 3. CEDARS claims module screenshot



Confirmed claims dashboards

PA	Latest Confirmation	Confirmation Detail
BAY	2016Q3	Confirmed on 18 November, 2016
MCE	2016Q3	Confirmed on 29 November, 2016
PGE	2016Q3	Confirmed on 29 November, 2016
SCE	2016Q3	Confirmed on 29 November, 2016
SCG	2016Q3	Confirmed on 28 November, 2016
SCR	2016Q3	Confirmed on 29 November, 2016
SDGE	2016Q3	Confirmed on 28 November, 2016

Statewide Claims Summary

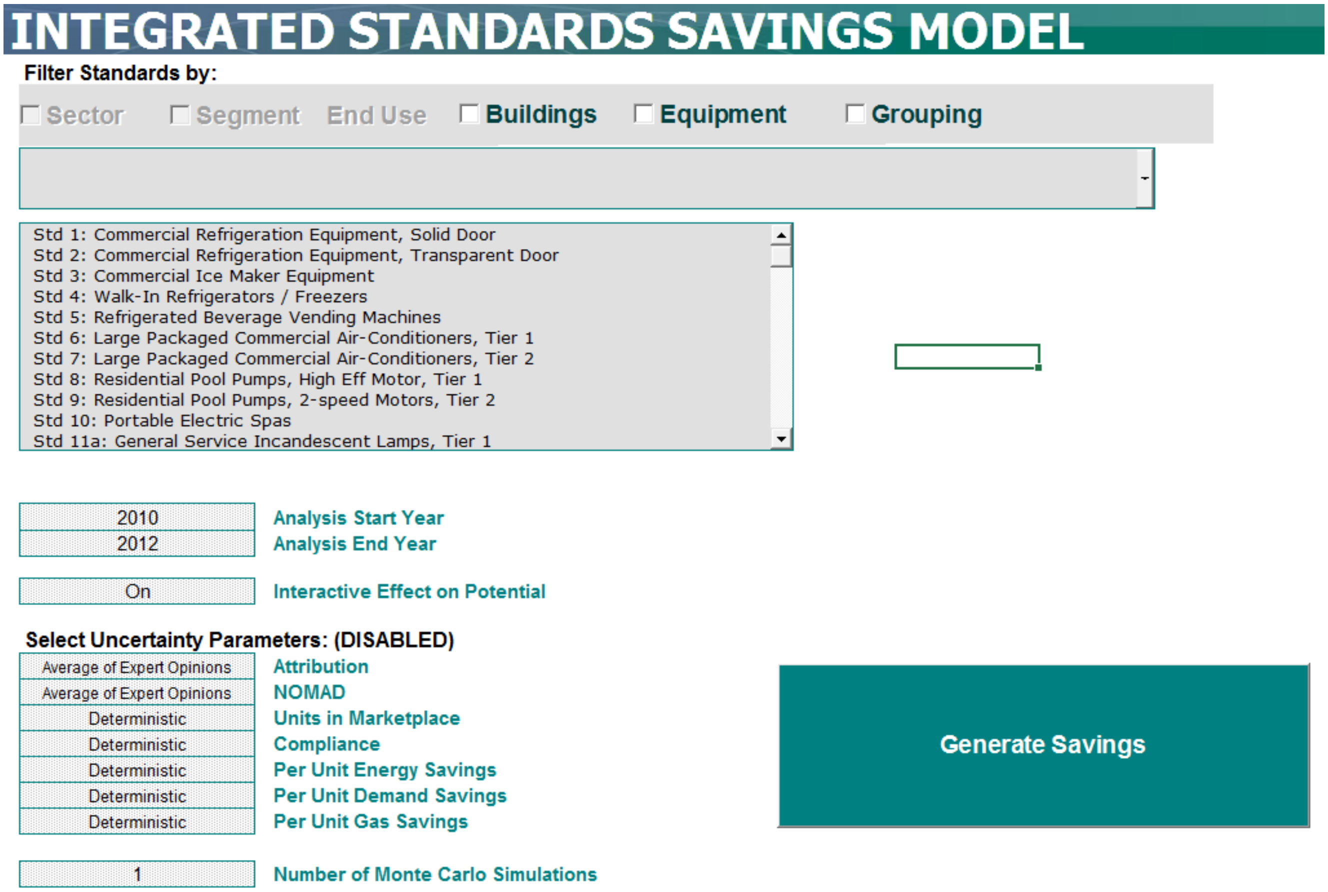
Primary Sector	Budget	Gross kWh	Gross kW	Gross Therm	Net kWh	Net kW	Net Therm
Portfolio (all Sectors)	**613,651,252**	**1,423,027,524**	**295,842**	**26,780,351**	**1,129,390,511**	**237,658**	**24,179,593**
Cross-Cutting	89,805,844	603,280,665	135,132	17,572,524	592,253,643	133,642	17,729,048
Residential	190,417,264	393,086,911	81,239	2,038,124	253,700,895	51,729	1,861,121
Commercial	211,440,905	286,639,171	57,795	4,356,482	190,074,300	38,127	2,600,930
Public	67,522,172	31,976,304	5,829	26,729	21,728,988	3,768	13,182
Industrial	37,033,888	73,828,767	10,888	1,886,323	49,808,344	7,293	1,018,407
Agricultural	17,431,179	34,215,706	4,960	1,883,098	21,824,342	3,099	989,067

3.4 Integrated Standards and Savings Model (ISSM)

The Integrated Standards and Savings Model (ISSM) is a Microsoft Excel®-based model used by the impact evaluators to process and assign estimated savings. It calculates the energy, demand, and gas savings statewide that may be credited to the IOUs for their efforts in promoting the adoption of energy-efficient codes and standards. Currently the model produces savings for up to 15 years for the code and standards being evaluated. The model includes a built-in Monte Carlo simulation tool to allow for uncertainty in various inputs and to quantify the effects of variation on the confidence and precision of final savings estimates.[8] This tool calculates gross and net energy savings over time, includes an estimate for normally occurring market adoption (NOMAD) and assigns attribution weights. The ISSM process represents one step in determining cost-effectiveness. A screen shot of the Dashboard is shown in Figure 4. See APPENDIX B for a detailed discussion.

[8] Cadmus, Energy Services Division, "Integrated Standards Savings Model (ISSM): User's Manual," November, 2014

Figure 4: ISSM Dashboard



4 DATA COLLECTION

To perform an in-depth review of the process for calculating cost-effectiveness for the C&S program, data were collected from several sources:

- Initial data prepared by IOUs and submitted to the CPUC in the form of Excel-based E3 calculators during the 2013-15 program application filing. We refer to these as "forecast 1".
- Program tracking data, or claims, submitted by the IOUs and processed by the CPUC reporting team in 2016. This is "forecast 2". 2016 also was the first year using CEDARS to process data.
- Evaluated savings provided by the EM&V contractors from the ISSM (evaluated)

Before these data sources could be compared directly, several data transformations had to be completed. These data sources and the transformations are explained in the remainder of this section.

4.1 IOU E3 calculators (forecast 1 - filing)

During the 2013-2015 C&S program cycle, as well as previous cycles, the E3 calculator was used by the IOUs to provide C&S program savings and cost-effectiveness estimates for the application filing. The E3 calculator application filings were then used as the basis for the C&S claims for the cycle. An updated E3 calculator was used at the end of each cycle as the basis for an updated C&S claim. This process is discussed in more detail in section 5.1.

The evaluation team requested the IOUs provide all E3 calculators used for 2013-2015 application filings and claims. The following E3 calculators were provided by each IOU:

- 2013-2014 C&S application filing E3 calculator
- 2015 C&S application filing E3 calculator
- 2013-2014 C&S update E3 calculator for claims
- 2015 C&S update E3 calculator for claims

One aspect of cost-effectiveness that is unique for C&S programs is that the administrative costs reported in the current year filing are not the costs associated with the current year savings in the same filing. Codes and standards is an advocacy program. Administrative costs produce savings several years later – when the code or standard goes into effect. There may always be a lag of up to several years between expenditures and savings. The CPUC has considered this issue in terms of the old Performance Earnings Base (PEB) and acknowledged the lag but recognized that costs and benefits even out.[9]

4.2 IOU program tracking data (forecast 2 - earnings claims)

During the 2013-15 C&S program cycle, for the first time, IOUs submitted IOU program tracking data to the CPUC in the same format as the other resource program claims. Although the E3 calculators, and the end-of-cycle E3 calculator updates, are supposed to be the basis of the IOU claims, the actual IOU claims frequently do not match the E3 calculators. Anytime manual translation from the E3 calculator to claim formats occurs, it is likely for clerical errors to be introduced to the data. This process is discussed in more detail in section 5.1.

[9] Interim Opinion on Phase 1 Issues: Shareholder Risk/Reward Incentive Mechanism for Energy Efficiency Programs (D.07-09-043) at 45.

Since the CPUC considers IOU claims as the official submission of record (as opposed to the IOU E3 calculators addressed above), the IOU claims were used to populate the All Things Reported (ATR) database. This database applies and stores the evaluation results and the savings forecasts submitted by the IOUs. Once populated, it serves as the input to the CET for purposes of calculating cost effectiveness.

4.3 Ex post data (impact evaluation)

To move savings values from the evaluation report to the CET, the data were transformed to the CPUC ATR[10] format. For the 2015 C&S claim, the ATR contained 9,662 records and 197 fields. Of these 197 fields, 40 were for results from the evaluation. These are related to net and gross savings, net-to-gross ratio, effective and remaining useful life, realization rates, and costs by code or standard and IOU. Since C&S data has not historically been processed in the same manner as other programs for cost-effectiveness reporting, several manual steps were required to move data from ISSM format to ATR format. These specific steps are listed in Table 2.

[10] Not to be confused with Affiliate Transaction Rules (ATRs)

Table 2. Steps from ISSM and program tracking data to ATR

Step	Action
1	Map evaluated standard to forecast standard from claim database.
2	Populate gross pass-thru field with value of 1 for standards not evaluated.
3	Select claims with quantity=0, mark as net pass-through = 1.
4	Populate standard report group with zero quantity or year from claim year quarter.
5	Assign strata – PA/Standard/Claim Year.
6	Calculate Claim Year forecast first year claimed Gross and Net savings total per strata for kW, kWh, and therm.
7	Calculate proportion of forecast first year net savings per claim for kW, kWh, and therm.
8	Populate all parameters for gross pass-through.
9	Identify what standards have (or have not) been mapped to tracking data —add indicator field to individual evaluated sheets.
10	Create new sheet for evaluated net calculations; combine lists of standards from individual evaluated sheets.
11	Pull in forecast values where available, to evaluated net list.
12	Indicate strata on ATR sheet, present on evaluated net list.
13	On ATR, if N/A on evaluated Net list, flag as net pass-thru and carry through first year net savings.
14	Bring in the first-year evaluated savings total for each stratum into ATR sheet.
15	At claim level, multiply evaluated strata total savings by forecast proportion of strata savings to get savings per claim.
16	For cost-effectiveness format alignment, remove extra fields and copy strata into Standard Report Group.

An example of a summary for one standard is shown in Figure 5.

Figure 5. ATR summary for one standard

Row Labels	Sum of EvalExPostFirstYear NetkW	Sum of EvalExPostFirstYear NetkWh	Sum of EvalExPostFirstYear NetTherms
PGE-Std 11b-2013	1,960.93	3,118,701.92	285.49
PGE-Std 11b-2014	1,927.96	3,035,817.69	280.84
PGE-Std 11b-2015	1,894.11	2,952,758.32	276.05
SCE-Std 11b-2013	2,022.57	3,216,726.62	-
SCE-Std 11b-2014	1,988.56	3,131,237.23	-
SCE-Std 11b-2015	1,953.64	3,045,567.20	-
SDGE-Std 11b-2013	458.98	729,969.56	32.45
SDGE-Std 11b-2014	451.26	710,569.51	31.92
SDGE-Std 11b-2015	443.34	691,128.47	31.37
Grand Total	**13,101.35**	**20,632,476.54**	**938.12**

The CPUC Cost-effectiveness Tool was used to process data from each source. The resulting TRC and PAC test ratios are discussed in the next section under 5.1.4.

5 FINDINGS

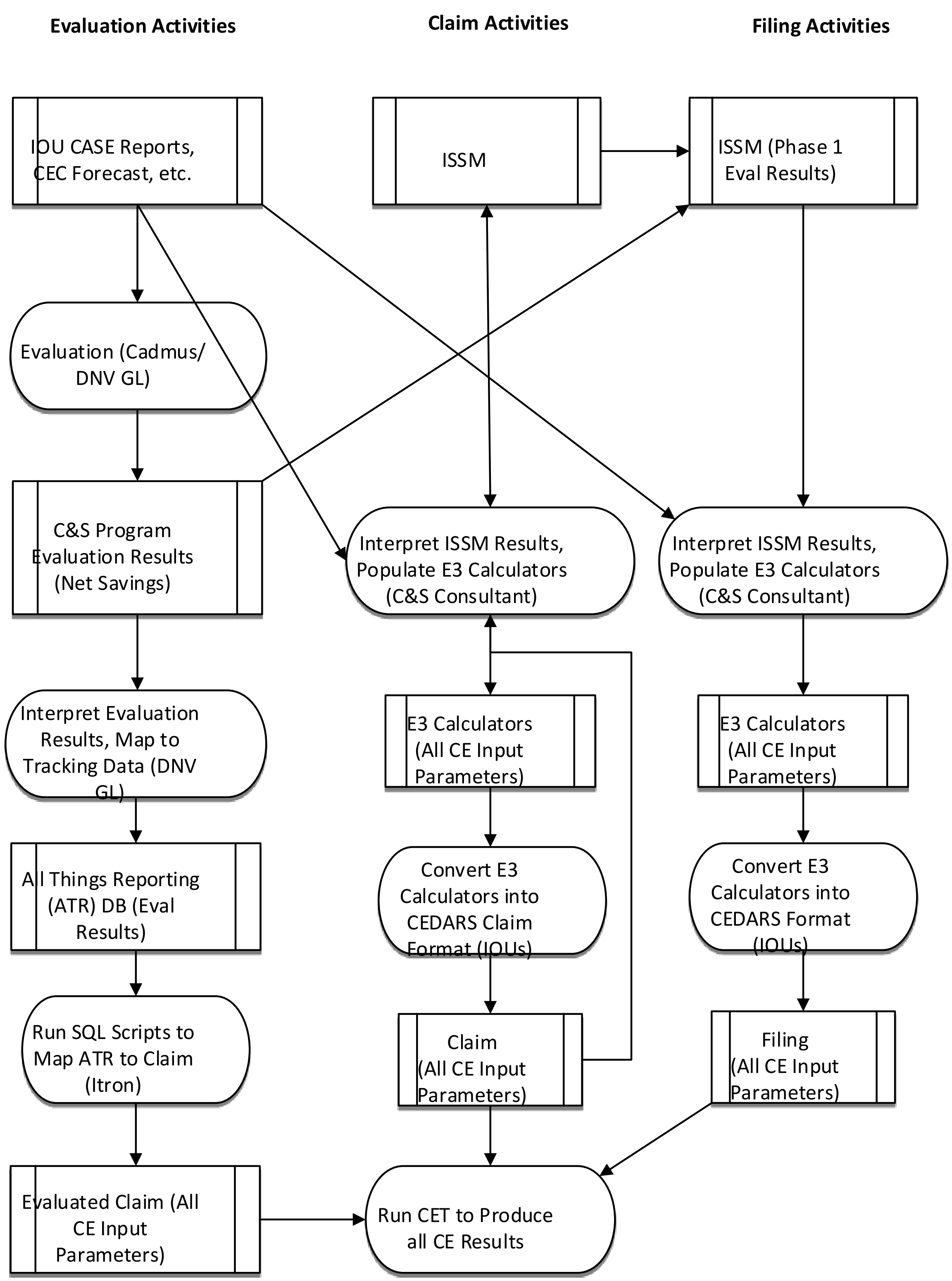
In this section, we discuss the step-by-step process of current state reporting along with cost-effectiveness results. This includes quality control and quality assurance of several factors for cost-effectiveness.

5.1 Current C&S data process

The process for generating forecast C&S data (by the IOUs) and evaluated C&S results (from the evaluation team) has been relatively stable for the past several program cycles. One change marked by the 2013-15 program cycle was that IOUs submitted C&S estimates into the "Claims" data.[11] In previous cycles, the CPUC utilized IOU-submitted E3 calculators as the Claim, which required significant post-processing by the CPUC. Figure 6 below illustrates the current C&S data process, including evaluation activities, claim activities, and application filing activities. These activities are discussed further next.

[11] Commonly referred to as "program tracking data."

Figure 6. Current C&S data process



5.1.1 Evaluation activities

The C&S evaluation activities begin with the Codes and Standards Enhancement (CASE) reports, CEC forecasts, Code Change Theory Reports (CCTR), and federal standards. The CASE initiative presents IOU technical analysis to support CEC's efforts to update California's Building Energy Efficiency Standards (Title 24), California's Appliance Standards (Title 20) to include new requirements or to upgrade existing requirements for various technologies. In 2010-2012 cycle, the IOUs claimed savings from Federal standards advocacy which do not have CASE reports. CEC forecasts, Code Change Theory Reports (CCTR), and federal standards also provide key C&S data points. As shown in Figure 6 above, the IOU-submitted CASE reports, CEC forecasts, and federal standards feed into evaluation, claim, and application filing activities.

The C&S program evaluation, led by Cadmus and supported by DNV GL in the 2013-15 program cycle, produces evaluation results in the form of gross and net savings that are used as a basis to update the ISSM model. To this end, Cadmus employed CASE reports and primary research reports which document the derivation of unit energy savings (UES) per standard in the ISSM model. Cadmus performed a review of the primary data sources and documented the estimated UES, construction activity, assumptions, and any discrepancies between analyses and estimates. Next, a gap analysis was performed to identify additional information required to complete the evaluation. After any gaps were resolved, Cadmus evaluated UES estimates and appliance sales/construction volumes to finally report evaluated savings. These evaluated savings were used 1) to update the ISSM for future claim and filing activities and 2) to provide the basis for evaluated results for the 2013-15 cycle, including calculating overall program cost-effectiveness.

DNV GL then employed the Phase One evaluation results, performing significant post-processing to align the results with the IOU C&S program tracking data (claims). The "All-Things Reporting" (ATR) database provided the template for mapping IOU C&S claims to evaluation strata and, eventually, evaluated results.

Finally, the ATR was processed, along with the IOU C&S program tracking data containing the remaining necessary cost-effectiveness parameters, through the CET to produce 2013-15 C&S cost-effectiveness results. This processing was performed by Itron for the 2013-15 program cycle.

5.1.2 Claim activities

The C&S claim activities begin with a data request to the IOU's in a format compatible to the ISSM. This data request provides a forecast of state-wide C&S savings and serves as a compendium of evaluation results and other primary data sources outlined earlier in section 3.3. Currently, for the statewide program, the IOU C&S independent consultant[12] plays a pivotal role in both C&S claim and application filing activities. For the remainder of this report we refer to this role as "C&S consultant." The IOUs assign the task of providing ISSM inputs for new codes and standards to the C&S consultant. This assignment includes the interpretation of prior ISSM results, along with the interpretation of primary C&S data sources (when they exist) to produce IOU forecast claims data and future year application filing data.

In the 2013-15 program cycle, in line with prior program cycles, the C&S consultant populated an E3 calculator for the 2013-15 C&S program application filing, giving projected savings, quantities, and program cost-effectiveness. A similar E3 calculator was also produced for the 2015 program application filing as a continuation of the 2013-15 cycle. Those E3 calculators served as the basis for the 2013-15 C&S program

[12] Currently Yanda Zhang.

tracking claims submitted by the IOUs to the CPUC. However, as documented in Figure 6, the C&S consultant updates the E3 calculators at the end of the cycle (both 2013-15) to reflect updated ISSM outputs, new primary C&S data, and more refined UES and quantity estimates. This forecast 'true-up' causes some additional complexity on both the evaluation activities and the IOU claims reporting process. We discuss some potential improvements to this process in later sections.

Each time the C&S consultant provides the populated E3 calculator to the IOU, there is an iterative process required to fix errors and inconsistencies in the E3 calculator data. The IOU reporting representatives work with the C&S consultant to produce a final, valid E3 calculator for the cycle.

During the 2013-15 cycle, a departure from prior C&S reporting cycle, C&S claims were included in the IOU portfolio quarterly claims submissions to the CPUC. Once the valid E3 calculator was iteratively validated, the IOU reporting representatives manually translated that E3 calculator into the cycle program tracking (claims) data. This manual process is error-prone, and we will discuss potential improvements to this process in the following sections.

As previously mentioned, the claim is updated at the end of the cycle, and true-ups are necessary both on the IOU claims reporting and evaluation activities. This final claim serves as the official claim for the cycle and is what CPUC evaluators use to calculate the forecast cost-effectiveness.

5.1.3 Filing activities

In September of the year preceding the program cycle, IOUs submit a program application filing to be reviewed and approved by the CPUC. As discussed earlier, during the 2013-14 and 2015 cycles, the C&S consultant populated an E3 calculator, which was iteratively validated by the IOUs and ultimately submitted to the CPUC. The C&S consultant employed the ISSM, which was revised based on evaluation results, as well as other data sources to populate the filing E3 calculator. The filing E3 calculator then served as the basis for the initial 2013-14 and 2015 claims, which are trued up again at the end of the cycle. In the 2017 application filing, those E3 calculations were required to be translated into the CEDARS Filing Module submission format, which required significant manual translation, like the translation required for claims.

5.1.4 Cost-effectiveness tables

Once evaluation data is transformed and formatted for the ATR, the dataset can be imported directly into the CET. The tables in this section present the results of these calculations. The tables in this section show cost-effectiveness from several perspectives:

- Total-resource-cost[13] (TRC) ratio
- Program Administrator cost (PAC)[14]
- Ratepayer Impact Measure (RIM)[15]

The changes in evaluated values are due solely to changes from the impact evaluation. This evaluation adjusted unit energy savings and quantities, which only impacted the benefits side of the cost effectiveness equation. Unit energy savings and quantities not evaluated remain the same. These values "pass through"

[13] TRC = NPV benefits / NPV costs. Where benefits are avoided supply costs. Costs are the sum of equipment costs and administrative costs.

[14] PAC = NPV benefits/NPV costs. Where benefits are avoided supply costs. Costs are administrative costs only.

[15] RIM = NPV Benefits / NPV Costs. Where benefits are avoided supply costs + revenue gains from increased sales. Costs are administrative cost + revenue gains from decreased sales

the evaluated calculations. Similarly, incremental equipment costs and administrative costs pass through from forecast to evaluated values. There are no incentives paid in these programs, so incentive dollars do not factor into any calculations.

Table 3 shows the TRC values for four IOU programs for the period 2013-15.

Table 3. TRC values by program

IOU	Total Resource Cost Test Ratio		Percent Change	Program Administrator Cost Test Ratio		Percent Change
	Forecast	Evaluated		Forecast	Evaluated	
Pacific Gas and Electric Company (PG&E)	3.36	3.69	10%	204.97	224.65	10%
Southern California Edison (SCE)	19.54	22.77	17%	314.20	366.18	17%
Southern California Gas Company (SoCalGas)	7.51	2.57	-66%	321.62	109.89	-66%
San Diego Gas and Electric Company (SDG&E)	4.17	4.82	16%	624.93	722.01	16%

Of the four IOU program administrators (PAs), SoCalGas shows the largest difference between forecast and evaluated cost-effectiveness. It also is the only utility with a decrease. While remaining above the TRC threshold of 1.0 the program experienced a TRC ratio decrease of 66% due to evaluation results. In other words, benefits per dollar spent from the program are estimated to be two-thirds lower than expected. Since only benefits (and not costs) changed from forecast to evaluated, the PAC ratio shows the same changes.

The percentage change for SCE was in line with SDG&E and PG&E, but the TRC base for SCE is much larger than the other two IOUs. SCE's forecast TRC value of 22.8 is over 4.5 times larger than SDG&E and over 5.5 times larger than PG&E. One reason for this may be the relatively low equipment cost reported by SCE. See Table 4 for TRC benefit and cost dollar values for the program from 2013 through 2015.

Table 4. Breakdown of TRC cost-effectiveness dollars (evaluated), 2013-15

IOU	Benefit $	TRC Cost $	PAC Cost $	PAC Cost as a % of TRC Cost
PG&E	1,233,794,154	334,709,518	5,492,083	2%
SCE	1,374,560,243	60,358,226	3,753,819	6%
SoCalGas	57,763,485	22,511,056	525,634	2%
SDG&E	308,840,479	64,030,784	427,754	1%

For C&S cost-effectiveness, the difference between the TRC and PAC tests is the incremental equipment costs associated with the new standards. Comparing PAC cost to TRC cost in Table 4 shows that equipment costs make up most costs associated with the program. Administrative costs range from a low of 1% for SDG&E to a high of 6% for SCE.

Reviewing the evaluated TRC ratio on an annual basis provides insights into the forecasting and reporting changes that have been taking place in the codes and standards programs. Table 5 shows these TRC value changes.

Table 5. TRC by year (evaluated)

IOU	2013	2014	2015	Overall
PG&E	7.13	9.68	2.73	3.69
SCE	8.12	11.07	364.46	22.77
SoCalGas	109.89	109.89	1.40	2.57
SDG&E	722.76	723.31	3.04	4.82
Statewide	8.66	11.75	4.93	6.18

The statewide number is a weighted value. Although SoCalGas and SDG&E have very high TRC values in 2013 and 2014, they account for a very small percentage of statewide code and standard activity. This makes sense given that SoCalGas is limited to gas savings from appliances and in buildings. SDG&E has a smaller service territory and therefore the smallest allocation of electric savings. In 2015, SCE received the highest TRC value, reporting the highest benefits with very low costs. For example, Table 6 shows that even though benefits for PG&E and SCE are comparable, costs for PG&E are nearly 100 times greater than SCE. This supports the notion that some verification for measure cost reasonableness should be included as part of the impact evaluation.[16]

Table 6: TRC benefits and costs

IOU	Benefits	Costs
PG&E	757,055,863	277,562,729
SCE	821,384,015	2,253,730
SoCalGas	31,222,606	22,269,540
SDG&E	193,871,259	63,871,783

The extreme swings in TRC for each year are shown in Table 7. The difference between TRC costs and PAC costs is incremental equipment costs. A review of the table shows that administrative (PAC) costs reported for the program were much higher in 2015 than in 2013 or 2014. In addition, incremental equipment costs were higher in 2015 than in 2013 and 2014. The exception is SCE who reported much lower equipment costs in 2015 than the preceding years. This also explains their very high TRC in 2015.

[16] Currently there is no standardized method to determine IMC for C&S programs.

Table 7. Benefits and costs (evaluated)

PA	Year	Benefits	TRC Costs	TRC	PAC Costs	PAC
PGE	2013	213,850,844	29,979,022	**7.13**	948,009	225.58
	2014	262,887,447	27,167,767	**9.68**	1,164,209	225.81
	2015	757,055,863	277,562,729	**2.73**	3,379,865	223.99
SCE	2013	248,050,678	30,532,473	**8.12**	677,407	366.18
	2014	305,125,550	27,572,023	**11.07**	833,275	366.18
	2015	821,384,015	2,253,730	**364.46**	2,243,137	366.18
SCG	2013	14,767,395	134,380	**109.89**	134,380	109.89
	2014	11,773,484	107,136	**109.89**	107,136	109.89
	2015	31,222,606	22,269,540	**1.40**	284,118	109.89
SDGE	2013	49,256,796	68,151	**722.76**	68,151	722.76
	2014	65,712,425	90,850	**723.31**	90,850	723.31
	2015	193,871,259	63,871,783	**3.04**	268,753	721.37

The codes and standards program provides advocacy in three areas. These are California appliance standards (Title 20), California building codes (Title 24) and federal appliance standards. Looking at TRC cost-effectiveness only, Title 20 provides the highest overall benefits relative to costs and Title 24 provides the least. As discussed earlier, the cost side of the equation has not been validated via an evaluation.[17]

Table 8. TRC by measure group (evaluated)

IOU	Title 20	Title 24	Federal	Overall
PG&E	5.22	3.10	3.64	3.69
SCE	9.94	56.88	313.70	22.77
SoCalGas	109.89	2.57	1.30	2.57
SDG&E	3.72	3.95	12.46	4.82
Statewide	7.33	5.51	6.60	6.18

[17] This cost-effectiveness run does not include the evaluated savings for non-residential building codes. At the time of this analysis, the code savings were being evaluated in Phase II of the 2013-15 impact evaluation.

6 CONCLUSION AND RECOMMENDATIONS

This section highlights ways to streamline codes and standards program reporting. The recommendations will not only streamline the process but also help ensure greater accuracy and consistency with the forecast and reported claims.

6.1 C&S data process improvements

As discussed in section 5, there are several potential process improvements which would help reduce error-prone manual data intervention and translation, increasing data fidelity, and reducing data processing time. Figure 7 at the end of this section illustrates the proposed C&S data process that addresses these improvements.

6.1.1 Evaluation activity improvement: C&S evaluation results directly to ATR Database

The main difference between the status quo evaluation activity process illustrated above in Figure 6 and the proposed process is the elimination of the interpretation and mapping of evaluation results to the IOU C&S claims via the ATR database. In the proposed process, evaluation results are provided by the C&S evaluator using the ATR database directly. Based on our experience with the 2013-15 evaluation, this would eliminate significant evaluation time interpreting and transforming evaluation results so they can be applied to IOU C&S claims and flow through to generate robust CET cost-effectiveness results.

In the rolling portfolio framework, the format of the ATR is known from the beginning of the year being considered in the C&S evaluation, and, if other recommendations presented below are implemented, the data within the ATR will also be known from that year's application filing. This means there will be a stable dataset for purposes of evaluation, and the evaluation results will align precisely with the application filing.

6.1.2 Statewide validation or updates to incremental measure costs

The cost-effectiveness values are driven by savings and equipment costs. To date, no method for calculating IMC for C&S has been proposed and approved. The broad range of TRC values across IOU programs is driven mainly by unit level incremental measure costs. These costs should be validated by a third party – either as part of the impact evaluation or through other independent studies comparing CASE studies to DEER or other sources. This would help keep the benefit and cost values in sync for cost-effectiveness and support comparisons of market transformation due to C&S program activity.

6.1.3 Filing activity improvement: eliminate submission of E3 calculators

The main difference between the status quo application filing activity process illustrated in Figure 6 and the proposed process in Figure 7 below is the elimination of the exchange of E3 calculators between the C&S consultant and the IOUs. There are two main benefits associated with the elimination of E3 calculators in the filing process. First, there is significant manual intervention necessary to translate the E3 calculator data into the CEDARS Filing Module input format. This translation process has proven to be error-prone, producing significant and unexpected issues with the IOU filing data. Second, there is currently a lengthy iterative process between the IOUs and the C&S consultant to true-up data in the E3 calculators to prepare for the filing submission. A contributing factor to this lengthy process is the fact that the E3 calculator does not have clear and transparent quality control feedback for bad data.

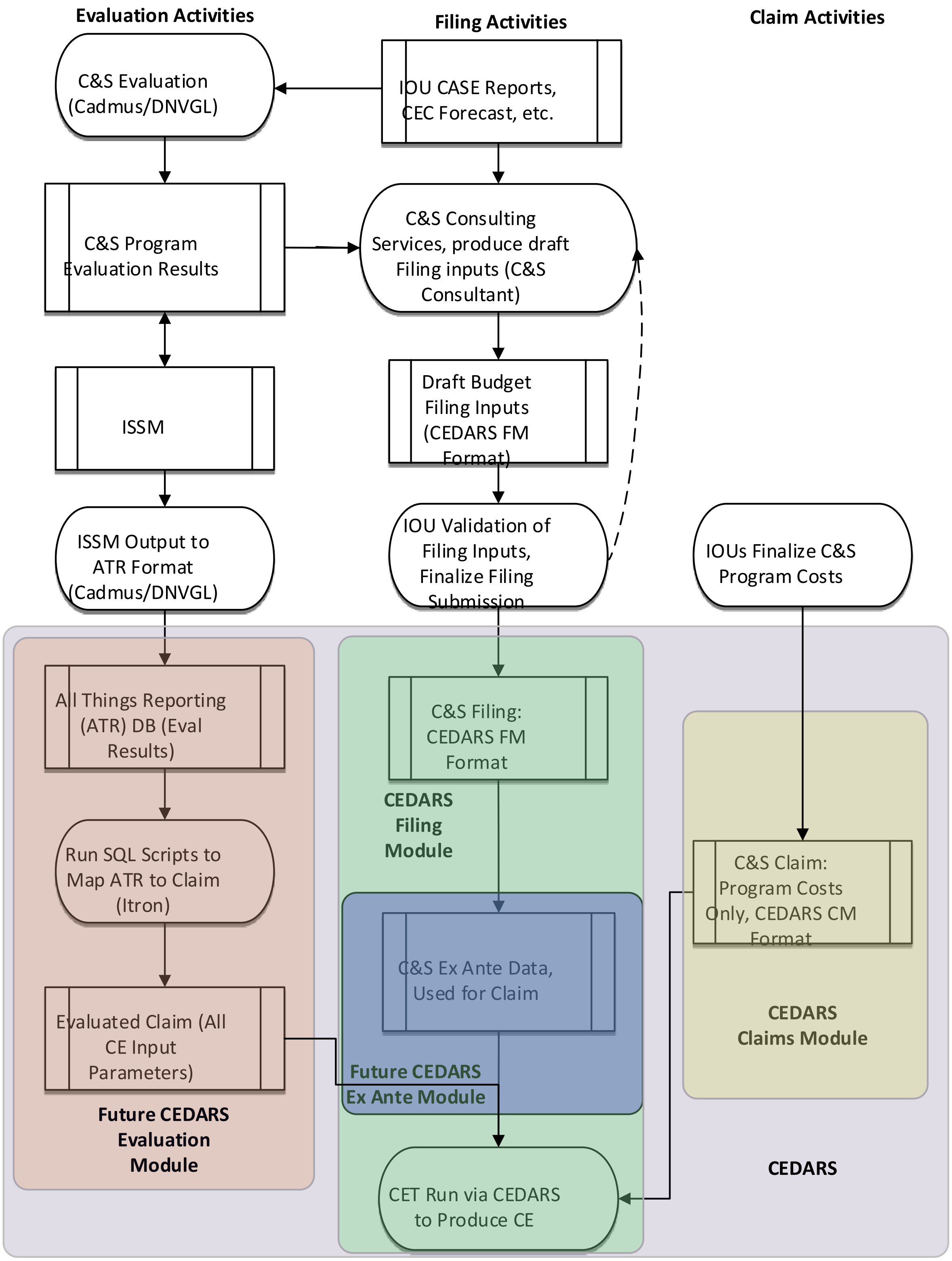
The IOU’s may still use the E3 for planning if they wish, but the CET has replaced the E3 calculator as the official cost-effectiveness tool of the CPUC.

Therefore, in a rolling portfolio framework, the recommended approach is to have the C&S consultant (or simply the IOU) submit the filing data directly to CEDARS in the CEDARS/CET format. CEDARS provides instant and transparent quality control feedback for the filing data, as well as instant cost-effectiveness results, since filing data is automatically processed through the CET.

6.1.4 Claim activity improvement: eliminate IOU claim submission

The shaded portion on the bottom half of Figure 7 denotes the activities expected to be automated within CEDARS. The CEDARS filing module and CEDARS claims module are active. The remaining shaded areas are identified as “future CEDARS” modules. The main difference between the status quo IOU claim activity process illustrated in Figure 6 and the proposed process in Figure 7 is the elimination of the IOU claim, as well as the elimination of the end-of-cycle claim true-up. If implemented, the actual C&S program costs would still need to be submitted once per year via CEDARS, but the claims would be based on the C&S program application filing. This should accomplish two things: 1) Streamlines the C&S data reporting process, largely reducing manual intervention and errors; 2) Move toward increasing the accuracy of the C&S program application each year by placing more emphasis on up-front estimation of per unit energy savings and market levels of unit activity.

Figure 7. Proposed C&S data process



The items in the shaded region exist now, but are discreet activities. For the future state these items are to be moved into CEDARS to streamline reporting requirements and increase data quality and consistency.

6.2 Data tool enhancements

6.2.1 ISSM enhancements

The current version of ISSM (Version 5) contains all the components to update the savings values needed for the cost-effectiveness calculations for every standard evaluated. An example of the output is presented in Figure 8. The model also includes annual estimates for all savings parameters for a period of 15 years, but it does not include measure cost (full or incremental), since this historically has been outside the scope of the impact evaluation.

Figure 8. ISSM table output

	Std 1	Std 2	Std 3
Name	**Commercial Refrigeration Equipment, Solid Door**	**Commercial Refrigeration Equipment, Transparent Door**	**Commercial Ice Maker Equipment**
C&S Start Year	Jan-06	Jan-07	Jan-08
Utility Programs Effect (Units)	25	22	26
Assumed Measure Life	9	9	9
1st Year Potential Energy Savings Per Unit (kWh)	433.57	1555.58	297.42
1st Year Potential Demand Savings Per Unit (kW)	0.06	0.20	0.04
1st Year Potential Gas Savings Per Unit (therms)	0	0	0
Interactive Energy Savings Factor (GWh)	0.00	0.00	0.00
Interactive Demand Savings Factor (MW)	0.00	0.00	0.00
Interactive Gas Savings Factor (GWh/Therm)	-0.0121	-0.0121	-0.0060
Natural Market Adoption (Yrs)	9	9	9
NOMAD Start Year	1995	1995	1995
Weighted Attribution Score	80%	80%	80%
Max Saturation	79%	50%	25%
p-value	0.01	0.00	0.01
q-value	0.43	0.51	0.53

6.2.2 Outputs

As discussed in section 5.1, the ISSM outputs require a considerable amount of manual true-up, refactoring, and translation to properly align outputs with IOU application filings, claims, and evaluation strata. Ideally, the evaluation team would modify ISSM outputs to feed directly into the ATR database, aligning one-to-one with IOU application filings. This would almost eliminate the need for interpretation, post-processing, and manual translation of evaluation data to populate the ATR.

6.2.3 CET enhancements

The IOUs made a suggested modification to the CET to allow for more accurate reporting of C&S data. An annual net-to-gross (NTG) ratio vector for C&S measures would allow the NTG ratio to vary by year, which is more in line with C&S reporting. The CET would need to be modified to accept this NTG ratio vector, and the input specification would also need to be modified.

6.2.4 CEDARS enhancements

CEDARS will need to be updated to support the recommendations outlined in 6.1. At a high level, the following enhancements should be made:

- Adjust claims codebase for C&S programs such that IOU claims submissions are not expected; only program costs are expected for C&S programs.
- Adjust claims reporting for C&S programs such that claims for C&S programs are reported from the application Filing.
- Ensure C&S measure names are consistent across all Program Administrators and map directly to codes and standards.
- If the CET NTG ratio vector is allowed and added, the filing specification would need to be modified to allow the submission of such a vector.

This study reviewed the process of filing forecast and evaluated claims for the statewide Codes and Standards program. The current process for C&S reporting and cost-effectiveness differs from other resource programs. These differences cause delays and errors in claims processing and evaluation activities. This report provides and overview of the tools in use, outlines the current process and recommends several changes to this process for future reporting cycles. These changes not only will improve the quality and audit trail of the of the C&S program data, they also will reduce the time and resources needd to process statewide C&S program data.

APPENDIX A. COST-EFFECTIVENESS TOOL OUTPUT TABLES

The forecast and evaluated cost-effectiveness ratios are reported in Table 9 for three California cost-effectiveness tests. These are:

- Total Resource Cost (TRC)
- Program Administrator Cost (PAC)
- Ratepayer Impact measure (RIM)

The TRC and PAC values were discussed in section 5.1.4. Table 9 shows all three tests. Of the four IOUs, RIM is greater than 1.0 only for SDG&E. Based on this ratio the C&S program implemented by SDG&E will support lower rates for SDG&E customers.

Table 9. Forecast and evaluated CE values by IOU

PA	Program ID	TRC Forecast	TRC Evaluated	PAC Forecast	PAC Evaluated	RIM Forecast	RIM Evaluated
PGE	PGE21051	3.36	3.69	204.97	224.65	0.70	0.69
SCE	SCE-13-SW-008A	19.54	22.77	314.20	366.18	0.83	0.85
SCG	SCG3724	7.51	2.57	321.62	109.89	0.87	0.87
SDGE	SDGE3249	4.17	4.82	624.93	722.01	1.79	1.60
Statewide	NA	5.69	6.18	268.80	291.68	0.81	0.81

In Table 10 cost-effectiveness is presented by program group. Overall, all three activities result in high TRC values. Activity that supports Title 20 appliances standards shows the highest evaluated cost-effectiveness ratio at 7.33. Federal Appliance standards is the next highest (6.60) followed by Title 24 building codes at 5.51.

Table 10: Forecast and evaluated CE values by Group

PA	Group	TRC Forecast	TRC Evaluated	PAC Forecast	PAC Evaluated	RIM Forecast	RIM Evaluated
All	Title 20	8.72	7.33	265.85	299.82	0.71	0.73
All	Federal	3.70	6.60	263.53	297.80	0.89	0.81
All	Title 24	4.72	5.51	272.63	284.88	0.92	0.88

These program groups are broken out by PA in Table 11. Extremely high values for TRC show up in SCE (T24 and Fed) and SCG (T20). Research on TRC values is outside the scope of this project, but the high cost-effectiveness values are driven by low incremental equipment costs.

Table 11: Forecast and evaluated CE values by PA and Group

PA	Group	TRC Forecast	TRC Evaluated	PAC Forecast	PAC Evaluated	RIM Forecast	RIM Evaluated
PGE	T24	2.70	3.10	210.44	224.87	0.93	0.81
	T20	5.91	5.22	198.78	224.17	0.53	0.56
	Fed	2.13	3.64	205.94	224.96	0.81	0.70
SCE	T24	41.97	56.88	314.20	366.18	0.82	0.86
	T20	11.85	9.94	314.20	366.18	0.83	0.82
	Fed	247.84	313.70	314.20	366.18	0.92	0.87
SCG	T24	6.75	2.57	321.62	109.89	0.86	0.87
	T20	321.62	109.89	321.62	109.89	0.91	0.91
	Fed	2.85	1.30	321.62	109.89	0.78	0.78
SDGE	T24	2.94	3.72	633.26	722.73	1.64	1.46
	T20	14.87	12.46	616.21	720.56	2.21	2.36
	Fed	1.87	3.95	624.10	722.44	1.25	1.21
Statewide	T24	4.72	5.51	272.63	284.88	0.92	0.88
	T20	8.72	7.33	265.85	299.82	0.71	0.73
	Fed	3.70	6.60	263.53	297.80	0.89	0.81
Statewide	All	5.69	6.18	268.80	291.68	0.81	0.81

Table 12: Evaluated savings (net MW)

IOU	2013	2014	2015	Overall
PG&E	42.77	49.91	146.44	239.12
SCE	45.22	53.08	160.39	258.69
SoCalGas	0.00	0.00	0.00	-
SDG&E	10.02	11.69	34.28	55.99
Statewide	98.02	114.68	341.11	553.80

Table 13: Evaluated savings (net GWh)

IOU	2013	2014	2015	Overall
PG&E	276.32	314.95	757.18	1,348.46
SCE	288.47	331.28	805.31	1,425.07
SoCalGas	--	--	--	--
SDG&E	64.76	73.80	177.23	315.79
Statewide	629.56	720.03	1,739.72	3,089.32

Table 14: Evaluated savings (net MMtherms)

IOU	2013	2014	2015	Overall
PG&E	0.65	0.51	-0.74	0.42
SCE	--	--	--	--
SoCalGas	1.46	1.22	3.14	5.82
SDG&E	0.07	0.06	-0.08	0.05
Statewide	2.18	1.79	2.32	6.29

APPENDIX B. MEMO 1: CODES & STANDARDS COST-EFFECTIVENESS INPUTS AND TOOLS: BACKGROUND RESEARCH

Memo to:		**Memo No:**	ED_D_CS_2-task 2.v2
Paula Gruendling, CPUC		**From:**	Jon Vencil
		Date:	April 22, 2015
Copied to:		**Prep. By:**	DNV GL (Jon Vencil, Max Neubauer, Cameron Tuttle, Jonathan Taffel)
John Stoops, DNV GL			

Re: Codes & Standards Cost-effectiveness Inputs and Tools: Background Research

This review of the current cost-effectiveness models and methods is part of a broader inquiry to develop a standardized method for evaluating cost-effectiveness of Codes and Standards (C&S) programs implemented by the California Investor Owned Utilities (IOUs).

This memo covers several elements of the current C&S cost-effectiveness process in California. These are,

1. An overview of the C&S program as it relates to cost-effectiveness
2. An outline of recent decisions by the California Public Utilities Commission (CPUC) regarding the treatment of C&S programs (including a scan of relevant decisions and practices from other jurisdictions)
3. An overview of the current California cost-effectiveness tools with pros and cons relative to C&S programs
4. Recommendations for next steps

This memo identifies and highlights gaps in current C&S cost-effectiveness process and tools. Its purpose is to serve as the basis for discussions with stakeholders on developing standardized specifications for cost-effectiveness model inputs.

Code and standards program overview

In California, the California Energy Commission (Energy Commission) sets state level standards for appliances through Title 20 and for residential and nonresidential buildings through Title 24. Adopted codes are submitted to the California Buildings Standards Commission for approval, checked for conflicts with other codes, and published as Title 24, Part 6, of the California Code of Regulations.[18,19] The IOUs implement state-wide C&S programs to achieve energy savings by encouraging and supporting the adoption of more stringent energy efficient codes and standards for buildings and appliances. The IOUs also participate to a lesser extent[20] in the development of national appliance and equipment standards since these national standards can pre-empt state standards.

[18] https://www.energycodes.gov/adoption/states/california

[19] This is now done in conjunction with the California Air Resources Board (CARB) to include CO_2E emissions

[20] "2010-12 California Statewide Codes and Standards Program Process Evaluation Final Report", Cadmus, May 28, 2012 and "Impact Evaluation Report Business and Consumer Electronics Program (WO34)", Kema, Inc. April 15, 2013.

The development and vetting of codes and standards can span several years.[21] Consideration of a new CA requirement starts with a Codes and Standards Enhancement (CASE) study. According to the Energy Commission the CASE study considers the degree that target technologies:

- Have been developed and are (or will be) available from multiple providers
- Have been proven effective[22] and are commercially available
- For Title 24 (codes) are they cost-effective when comparing lifecycle Time Dependent Valuation (TDV) to equipment incremental costs and economic impacts. For Title 20 (standards) customer lifecycle benefits must be greater than the cost of implementing the standard.
- For Title 20 are they cost-effective when comparing lifecycle customer benefits (present value bill savings) to equipment incremental price
- Are they a cost-effective means to California[23] for achieving energy efficiency goals?

These codes and standards are developed to coincide with the triennial publication of the state and model building codes after a formal rulemaking proceeding. Input from the public and stakeholders[24] are sought throughout the staff analysis stage and throughout the rulemaking proceeding. The CASE studies prepared by the IOUs are just one of the input documents used in the code or standard setting process.

Cost-effectiveness

The IOUs claim C&S energy and demand savings under various categories of C&S involvement. C&S programs are subject to the same cost-effectiveness tests, outlined in the Standard Practice Manual, as other resource acquisition programs.

C&S programs differ from most energy efficiency programs however because they include unique elements such as up-front development cycle time, staggered duration of these savings, savings from prior codes or standards that have been superseded, and for codes, the ambiguous nature of adoption and compliance. To capture all the unique factors that influence benefits and costs for C&S programs, the critical inputs must be identified and explicitly specified for use in the current cost-effectiveness tool used by the CPUC and by the IOUs to evaluate other energy efficiency programs.

It’s worth noting that the California’s C&S setting entity, the California Energy Commission, uses its own method (lifecycle costing) to establish cost-effectiveness. One implication of using different criteria is that a code or standard can be cost-effective under one set of rules, but not the other. This has not been an issue to date since IOU advocacy have not been subject to cost-effectiveness tests. For comparison, a high-level overview of the Energy Commission’s lifecycle costing approach is presented Appendix B.

Costs

IOU program activities include research, advocacy, and compliance improvement. These activities consist of staff labor time and associated expenses such as travel, facilities and building code inspector training. As a result, these tangible expenses can be accounted for through program cost accounting and reporting.

Incremental measure costs do change over time because equipment and building costs in effect in the first years of a code or standard typically decline over time as builders improve processes and manufacturers modify designs, in part, to comply with the new standards. Due to these changes, it is even possible that

[21] California updates building codes every three years. Appliance standards are based on market and technology trends.

[22] Effective for the application it is designed for. Additional detail is not specified.

[23] As determined in the Integrated Energy Policy Report (IEPR) issued by the Energy Commission.

[24] Examples of stakeholders include, California investor owned utilities, California Building Industry Association, Natural Resources Defense Council, Alliance to Save Energy, and American Council for an Energy Efficient Economy.

new efficient buildings or equipment can be less expensive than the same building built or equipment manufactured earlier under the same code or standard. This represents a negative incremental cost. Thus, an appliance or building built in the later years of a new code may be more cost-effective than the same building built in the first years under that same code. The approach to cost-effectiveness should align the timing for costs with the timing for energy savings. It may not be practical to collect new cost data for each standard for each year, or estimate overall costs at the building level, but the fact the costs do change over time should be recognized.

In addition, for building performance the actual costs may not be known until the market has responded to the new code by using a common mix of design practice and equipment.

Benefits

Assigning benefits is a bit more complex not only due to the presence of past standards (and treatment of their residual benefits) discussed earlier, but also due to the nature of the market the codes operate in. Savings estimates for a building can be modelled, but savings for the program is subject to the level of uncertainty in the market growth, adoption rates, compliance rates,[25] and period being measured. Calculating program level benefits involves,

1) Identifying the energy use baseline – depending on the focus of the C&S, this may be the current C&S or current market efficiency levels.
2) Establishing the market size baseline
3) Identifying the number of buildings built or altered, and the volume of appliances sold meeting or exceeding the standard during each year the standard is in effect. (market potential)
4) Calculating the level of savings potential by sector and building type. This typically is calculated as – or converted to - square feet (Energy Unit Savings)
5) Estimate the duration of savings at the building level, or by appliance category for the duration of the code's effectiveness (effective useful life)
6) Apply operating schedules to apply appropriate IOU avoided costs (Examples include run hours or load shapes)
7) Level of actual compliance with the code or standard (compliance rate)

Once the gross savings for the C&S program are determined, the attribution factors that determine net savings/benefits need to be applied. To calculate net energy savings attributable to the program evaluators must consider,

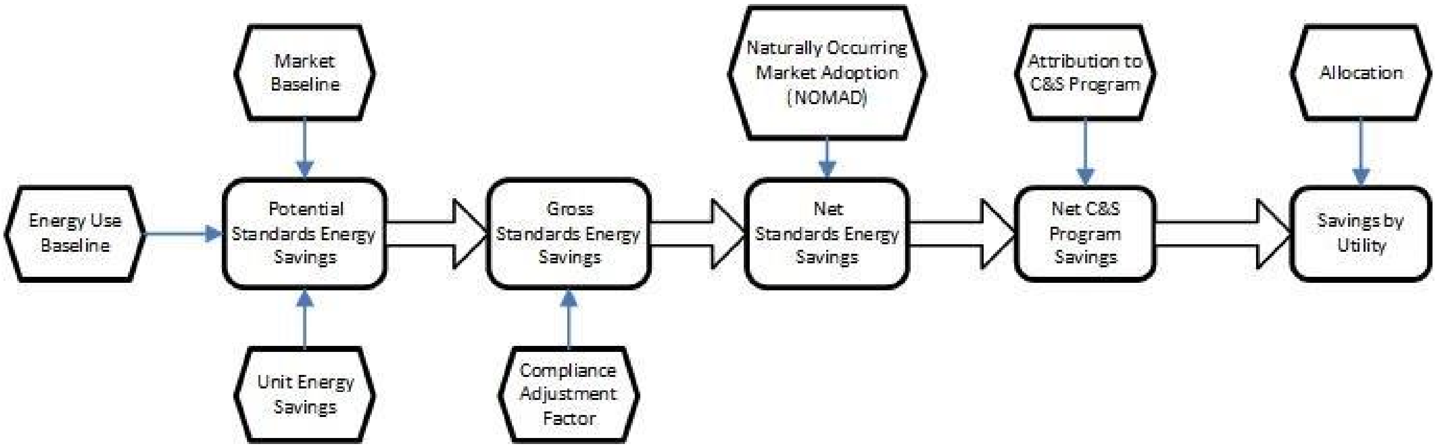
- Naturally occurring market adoption (NOMAD) and
- The level of attribution assigned to each IOU program (allocation)

The process to determine gross and net savings for cost-effectiveness purposes is illustrated in the 2010-2012 codes and standards impact evaluation report.[26] That chart is reproduced here.

[25] Even the definition of building compliance is not universally agreed upon.

[26] Cadmus Energy Services division and DNV GL, "State-wide Codes and Standards Program Impact Evaluation Report for Program years 2010-2012," California Public Utilities Commission, August 2014, CALMAC ID CPUC0070.03

Figure 9. C&S advocacy program evaluation protocol



Once these are developed, energy savings must be converted to benefits and compared to implementation costs of the IOUs and consumers. Developing these savings and converting them to benefits is discussed in the Cost-effectiveness Tool and ISSM sections of this memo.

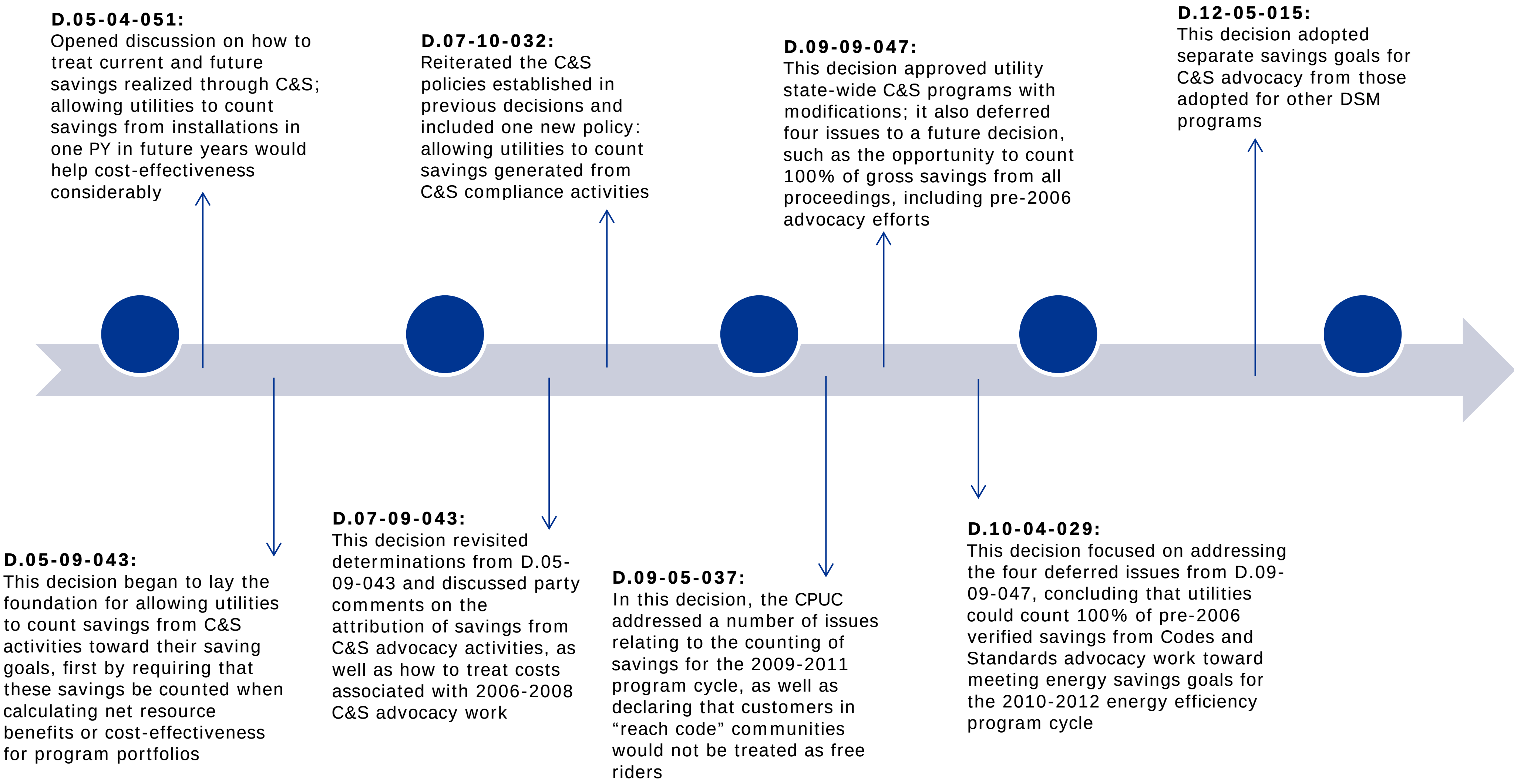
The next section provides a timeline of regulatory decision history that has helped shape this process. A detailed overview, along with findings from other jurisdictions is provided in Appendix A of this memo.

Regulatory decision history

Timeline of key decisions in california

To understand the regulatory decisions that have guided the development of this process for California C&S a timeline of key CPUC decisions is provided in Figure 10. Appendix A provides a detailed review of each California decision along with the implications for cost-effectiveness. That appendix also includes a summary of how several jurisdictions outside California address cost-effectiveness for C&S programs.

Figure 10. California C&S decision timeline



Integrated standards and savings model (ISSM)

Description and definition

The ISSM model is a Microsoft Excel-based model for calculating the energy, demand, and gas savings state wide 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 built-in Monte Carlo simulation tool to allow for uncertainty in various inputs and to quantify the effects of variation on the confidence and precision of final savings estimates.[27] This tool calculates gross and net energy savings over time, includes an estimate for NOMAD and assigns attribution weights. The ISSM process should represent one step in determining cost-effectiveness.

Input Definitions and Sources

The ISSM model has five main data input groups. These are:

- **Static inputs** (do not vary by year)
  - Codes & Standards implementation month/year
  - Attribution to the C&S Program – generated by a weighted factor incorporated in the ISSM model. See Attribution inputs later in this section.
  - Effective measure life – from DEER or other sources cited in IOU work papers.
  - First year potential energy, demand, and gas savings per unit for Title 20 and Title 24 – from CASE studies, third-party data provided by government agency, industry, and research firm statistics, and publicly available market characterization reports.
  - Interactive effect adjustment factors for energy, demand, and gas – standard engineering calculations, DEER, CASE reports and IOU work papers.
- Time dependent compliance inputs (do vary by year)
  - Annual compliance rates – these are ratios that compare total units that meet the current standards to total market volume. Unit definitions vary between appliances and buildings depending on the code or standard being evaluated. These are derived from information provided through structured interviews or Delphi panels.
  - Compliance Adjustment Factor (CAF) - the factor applied to the IOU savings claims to adjust from ex-ante savings values to ex-post.
  - Volume of units in marketplace
- **Naturally occurring market adoption (NOMAD) inputs**. NOMAD is an estimate of what the annual sales or installations of items meeting the standards would have been if the standards had not been adopted.[28] These inputs feed a BASS diffusion curve generator. These values are developed leveraging a Delphi approach and/or analysis of relevant IOU program tracking data.
  - NOMAD start year

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[27] Cadmus, Energy Services Division, "Integrated Standards Savings Model (ISSM): User's Manual," November, 2014

[28] Cadmus Energy Services division and DNV GL, "State-wide Codes and Standards Program Impact Evaluation Report for Program years 2010-2012", California Public Utilities Commission, August 2014, CALMAC ID CPUC0070.03

- Maximum achievable penetration. Technically all new buildings should adopt the codes in effect at that time. In this case the theoretical maximum achievable penetration of code adoption would be 100% for buildings built during the code period. Code adoption and compliance is different from the modelled building performance however.[29]
- "Leading" behavior coefficient (innovation). This coefficient reflects the expected rate of adoption once the code changes.
- "Following" behavior coefficient (imitation). This coefficient reflects the expected rate of adoption after the code has been in effect for a time. In theory, it is positively influenced by the percentage of adoption that has already occurred in the market.

- **Attribution inputs**. Accounts for the influence the program had in the code adoption. These parameters are developed using a variety of sources such as Code Change Theory Reports (CCTR), rulemaking dockets, stakeholder interviews and expert opinions. The model contains the attribution score inputs and calculation for each standard. The attribution score is one of the static inputs and is developed within the model by combining the weights assigned to three factors for each standard. These are,
  - "development of compliance determination methods" such as testing specifications
  - "development of code language" products covered, effective dates, and efficiency levels
  - "market acceptance of standard adoption" by addressing stakeholder concerns and conducting market research

The resulting score is a measure of C&S program attribution for its contribution toward adoption of the code or standard.

- **Uncertainty analysis for savings inputs**. To account for uncertainty inherent in parameters such as NOMAD, the model develops probability distributions using a Monte Carlo simulation driven by user supplied parameters. The input value typically is supplied by the IOU. To produce the distribution the value of each parameter range is assigned. This should be assigned to each input according to the anticipated level of uncertainty and can be up to 20 percent plus and minus the IOU value.
  - Per unit energy savings
  - Annual installations (market volume)
  - Compliance adjustment factor (CAF)
  - Market adoption curve
  - Weighted attribution score

Outputs: ISSM

The ISSM model has three main data output groups. The outputs from ISSM are,

[29] Non-compliant buildings may have better energy performance than code compliant ones. The fact that a compliance factor is over 100% is model driven and based on assumed weather, hours of operation, and facility management practices. In addition, a building may not be code "compliant" for any number of reasons. For example, the HVAC system was not inspected and permitted or the windows are different than the approved building design.

- Expected potential and net savings state wide. This includes average annual and cumulative potential, net, and program energy savings. Net savings are developed as a subset of potential savings (gross) and adjusting for non-compliance and naturally occurring market adoption.
- Expected potential and net savings by IOU. These values are allocated from the state-wide estimates using IOU service territory population size as the allocation factor.
- Savings uncertainty analysis. This is a probability distribution using a Monte Carlo simulation technique. The result may or may not be subjective (i.e. 20% bound assigned) depending on the availability of a priori data to assign the range.

Once the ISSM output data are generated, the next logical step is to use these parameters as inputs to the cost-effectiveness model. Since the ISSM model concentrates on energy savings only, most of the ISSM output parameters used to calculate unit energy savings are not used directly to calculate cost-effectiveness. The next section addresses the cost-effectiveness tool and discusses the overlap of ISSM and CET data

Cost-effectiveness tool

Description and definition

This tool is based on definitions and equations presented in the CPUC Standard Practice Manual. The Cost-Effectiveness Tool (CET) can be considered the last calculation step for determining cost-effectiveness.

If the ISSM is considered an input into the CET, then lifecycle gross and net energy, demand, and gas savings output from ISSM should be identical to those from CET. Using the last cycle as an example, at the measure level all utilities used identical inputs for a subset of variables. This is not surprising since the ISSM used data from IOU (existing ex-ante work papers, CASE, DEER) as inputs. These four matching variables are:

- Assumed measure life
- 1st Year Potential Energy Savings per Unit (kWh)
- 1st Year Potential Demand Savings per Unit (kW)
- 1st Year Potential Gas Savings per Unit (therm)

A key gap between these two tools lies in connecting the net-to-gross ratio between the ISSM and the CET. In the CET, the net-to-gross variable should be derived from the ISSM, but an initial pass at recreating that calculation was unsuccessful. The values between the two were close but not exact, and may be explained as differences in ISSM model versions being used.

Inputs: CET

For the last several program cycles, measure-level cost-effectiveness of C&S has been calculated using an Excel based model produced by Energy Environment + Economics (E3). Future calculations will be performed using the same calculation structure, but through the CPUC's SQL based CET.

In either case, this tool was built to calculate the cost-effectiveness of stand-alone equipment based energy efficiency programs. By design the inputs more easily accommodate static costs and consistent savings associated with an equipment rebate program rather the dynamic changes associated with market transformation programs. C&S programs are a hybrid of both program types. The stream of costs and savings is important because the CET provides results in present value terms. As a result, the duration of the savings and the period that the savings occur in will change the outputs.

Using these sources as inputs, each utility produces one Code or Standard run of the CET calculator and reports measure-level net present value costs and savings in their EE forecast and compliance filing. Below, in Table 15, CET inputs are listed. The tool outputs are shown in Table 16.

Table 15. CET inputs

Variable	Source
Measure Name	IOU/ISSM
Expected Useful Life (years)	IOU CASE reports / work papers
Gross Unit Annual Electricity Savings (kWh/unit)	IOU CASE reports / work papers
kW Savings (kW/unit)	IOU CASE reports / work papers
Gross Unit Annual Gas Savings (therm/unit)	IOU CASE reports / work papers
Net-to-Gross Ratio	ISSM
Gross Measure Cost ($/unit)	IOU CASE reports / work papers
Installation estimates per year (units/year)	IOU CASE reports / work papers
Measure Electric Load Shape	IOU CASE reports / work papers
Target Sector	IOU
Electric Rate Schedule	IOU (optional)
Gas Sector	IOU
Gas Rate Schedule	IOU (optional)
Gas Savings Profile	IOU
Combustion Type	IOU (optional)

Outputs: CET

The CET results, based on the input data, are used in regulatory filings.

Table 16. CET outputs

Grouping	Output
Energy Savings (Net and Gross Provided Annually)	Weighted Annual Electricity Savings (kWh) Lifecycle Electricity Savings (kWh) Weighted Annual Gas Savings (therm) Lifecycle Gas Savings (therm)
Peak Energy Reductions (Provided Annually)	Weighted Net July-Sept Peak (kW) Weighted Net Dec-Feb Peak (kW)
Cost-effectiveness (Lifecycle Present Value Dollars for Program TRC, PAC, and RIM tests)	Cost (Present Value Dollars) Savings Electric (Present Value) Savings Gas (Present Value) Incentives Benefit-Cost NPV Benefit-Cost Ratio
Gas and Electric Leveled Cost and Benefit (TRC, PAC, and RIM for All Measures Installed through Modeled Period)	Discounted Savings (kWh or therm) Cost Benefits Benefit-Cost NPV

Grouping	Output
Weighted Average Emissions Reductions (Net and Gross Annual Reductions for Gas and Electric)	CO_2 (ton) NOX (lb) PM-10 (lb)
Weighted Average Net Impacts by Sector, by CPUC End Use Categories, and Climate Zone	Annual Weighted Average Net Savings (kWh and therm) Lifecycle Net Savings (kWh and therm) Net July-Sept Weighted Average Peak (kW) Net Dec-Feb Weighted Average Peak (kW) Weighted Average User Entered kW TRC Lifecycle Net Benefits ($)
Gross Savings for Goal Attainment (Annual for kWh, kW, and therm)	First Year Annual Savings Decay of Single or First Baseline Second Baseline Savings Second Baseline Decay Total Cumulative Net Annual Savings
Persistent Reductions in the summer or winter of each year	Net July-Sept Peak (kW) Net Annual Dec-Feb Peak (kW)
Monthly Impacts	Hour Average or TOU Peak Net Monthly NCP (kW) Monthly Net kWh Monthly Net therm

Summary

Cost-effectiveness calculations for most energy efficiency programs compare the present value of program and equipment costs to the present value of the benefits they generate.

For EE programs, costs include the implementer's program administration expenses (excludes incentive payments) and the cost of equipment regardless of who pays for it (participant or program administrator). These costs may include the full cost of the equipment in a retrofit situation or the incremental cost over the cost of standard equipment for new construction or to replace on burnout.

Benefits are the value of the savings (by costing period) in terms of avoided generation costs to the IOU plus adders for benefits to society from avoided air pollution. The current practice developing benefits is by calculating the EE equipment's first year savings and carrying that savings over the expected life of the measure.

C&S programs lend themselves to these same types of cost-effectiveness calculations. There are differences however. First, savings for C&S programs can be dynamic over time. This is especially true for building codes. Even after a building code is effective, due to the lag from design to build the rate of compliance with the code will change – usually increasing over time. This directly affects the actual savings from the code. In addition, building materials and construction methods change over time. If these reduce costs or customers demand certain attributes, builders and manufacturers may adopt these changes without IOU C&S programs or even without new codes in place. The result is a "naturally occurring" increase in the efficiency of the building stock over time.

As each new C&S comes into effect, the equipment built under prior C&S continues to produce energy savings – but by definition these savings are at a level lower than the newest C&S. This may influence the NOMAD adjustment. Since the savings stream of older C&S do not automatically disappear when the new

C&S takes effect, these savings should continue to be accounted for even when newer C&S are in effect. The question is, “how?” and “for how long?” Is it the effective useful life of the measure, the building, or another metric?

Similarly, costs for the equipment change over time. The magnitude of the change may not change the cost-effectiveness of an entire program, but knowing if the C&S program influenced the price change may influence future prioritization of CASE studies for particular C&S.

Unlike other EE measures or programs, a tool exists to calculate dynamic lifecycle savings for C&S. The ISSM tool estimates the savings stream for each standard or code in the IOUs portfolio over multiple C&S adoption periods. No financial data such as equipment cost, avoided costs or billing rates are included.[30] The ISSM then computes an adoption curve of what would have resulted without the program (counter-factual) and calculates and assigns an attribution factor to each C&S.

The savings output from the ISSM can be considered inputs for cost-effectiveness calculations. The CET then computes the cost-effectiveness ratios for IOU programs and portfolios. Its main purpose is to standardize the quantification of monetary benefits and costs.

As stated earlier however, the CET model savings stream is static and was developed to be applied to a single program cycle. As a result, in its current form it is not equipped to handle programs with variable costs or savings over time.

All of this means that linking the inputs and outputs of the two tools is difficult at best. The ISSM has 12 inputs related directly to calculating net savings for a code or standard. The CET has 10 inputs related directly to calculating net savings and cost-effectiveness. When compared, the two models have only four inputs in common.

Issues for Codes and Standards Cost-effectiveness

We have discussed the tools used to estimate savings and calculate cost-effectiveness. While C&S programs are subject to the same evaluation criteria as other publicly funded IOU activities, there are several questions that weigh more heavily on C&S for cost-effectiveness. A list of these key issues is provided in Table 17 followed by short discussion of each topic.

[30] It is worth noting that this counter-factual approach differs from traditional market potential studies that use customer payback between standard and high efficiency to estimate market adoption.

Table 17. Key questions about cost-effectiveness

Topic	Questions
Baseline consumption identification	• For buildings is it code or market practice? • For appliances is it the standard or market efficiency level? • Should there be a standardized data source to estimate market potential and/or a protocol for developing market potential and updating that estimate on a continuous basis?
Accounting for benefits	• What is the persistence of savings from a code or standard? • How should building compliance vs. performance be defined and measured for C&S cost-effectiveness?
Static cost and savings inputs	• Should we compare the prior standard cost estimate to the current standard cost estimate? • Should we utilizer equipment pricing data trends? • How does the anticipation of new C&S effective dates affect manufacturers, designers, builders and in turn, the NOMAD adjustments?
Applicable default load shapes	• What are the default whole building load shapes?
Static net-to-gross calculations	• For savings, how should the dynamic saving diffusion curve produced by the ISSM model be reflected in the CET given that CET is based on a static savings level and duration? • How should savings streams be addressed when federal pre-emption takes place? • Should there be a standardized operational protocol for developing naturally occurring market adoption beyond the EM&V protocols? If so, what should it be?
What are the costs to comply?	• What is the product cost? • What is the testing procedure? • How is inspection/enforcement conducted?
Different decision criteria	• Does the difference between IOU and Energy Commission benefit calculations add risk to IOU C&S advocacy activities?

Baseline identification – To account for savings, measured consumption should be compared to a starting point. For appliance standards, this baseline measure has been the prior code. For most technologies, this is appropriate. This approach may not be as applicable in (less frequent) situations when technology is rapidly evolving and renders the existing test protocols obsolete.

For building codes, the ongoing question for C&S has been, “what should the starting point be?” Is it the prior code performance as modelled or the level of actual building performance relative to the existing code?

Accounting for benefits- As Codes and Standards change over time, how does the cost-effectiveness account for the effects of prior cycles? In the present cycle, the CET calculates an average lifetime savings, but prior overlapping C&S cycles are excluded as part of the benefit stream. This is especially true where part of the IOU claim is based on accelerating the adoption of new standards. The CET can account for this, but the inputs would need to be adjusted to include line items for prior standards.

Another issue that affects the stream of benefits is persistence. How long does the “to code” condition last? Some segments may continue with the same equipment for 30 years –as in the case of institutional chillers. In other cases, the equipment may be changed out every 5-10 years during remodels –as in the case of lighting for hotels or office buildings. What are the conditions that cause buildings or equipment to no longer be in compliance with the applicable code or standard?

Due to these issues, changes over time such as a change in equipment persistence, in cost savings, and in end use load shape for the effective C&S, effects the cost-effectiveness that span several C&S cycles may not be accurately accounted for in the CET since it uses first year savings as the basis for calculations.

Static costs and savings inputs – The current approach to calculating cost-effectiveness does not consider the nuances of adoption curves, changes in measure costs or federal pre-emption. While the program cycle is relatively short for C&S, measure costs can shift dramatically over time, and factor influencing adoption curves can alter savings significantly, especially with high-impact measures.

Lack of applicable load shapes may reduce precision of benefits - The CET calculator is heavily dependent on end-use load shapes to determine lifetime measure benefits. For efficiency programs these load shapes are pre-defined. For Codes and Standards at the measure level load shapes are not always available. In addition, building can comply with performance codes using any combination of design and equipment. As a result, the accuracy of benefit calculations could be improved with the addition of load shapes specifically for C&S programs.

Static net-to-gross calculations - Net-to-gross ratios are being calculated in the ISSM as an annual average for the length of the C&S program in review, three years or so. This net-to-gross ratio is then used throughout the model’s ten-year calculation. Given that the CET calculates the present value of benefits and costs, what should the treatment of annual net-to-gross be for cost-effectiveness?

Different decision criteria: The California Energy Commission uses different criteria to assess cost-effectiveness for C&S than the CPUC does. Benefits are driven by avoided generation costs for the IOUs and Time Dependent Valuation (TDV) or consumer savings for the Energy Commission. The period of evaluation is 30-years for the Energy Commission and the effective useful life (as reported in DEER) for the IOUs. Both value energy savings higher based on seasons and time-of-day, but the differences in benefit values and costing duration has the potential to set up situations where a code or standard deemed cost-effective and adopted by the CEC may not be cost effective under IOU calculations. Even though CPUC uses TRC to evaluate cost-effectiveness, does this difference put the IOU advocacy activities at risk for being adopted by the Energy Commission but not being cost-effective for CPUC purposes? If so, how are savings counted?

Next steps

This memo outlines the current state of C&S cost-effectiveness calculations and poses questions to begin a discussion on how cost-effectiveness should be conducted for C&S. For example, what should the key inputs be? How much detail is necessary? Where and how can the data collection protocols be standardized? Many of these questions are similar or related to market transformation (MT) programs and we suggest monitoring Commission MT evaluation efforts as part of this C&S research.

Comment period

CPUC and IOU stakeholder comments and suggestions on findings and implications for future C&S cost-effectiveness research should be solicited and incorporated into any C&S cost-effectiveness whitepaper.

Working group formation

To facilitate discussion to identify and prioritize C&S research DNV GL will coordinate the formation of a working group to provide technical input going forward. To provide expert input and feedback at key stages of the project this working group will include experts not only from California but also other jurisdictions. The working group will include subject matter experts in societal cost-effectiveness analysis, as expressed in the Standard Practice Manual, in building code and standard development and implementation and market transformation. This working group will be leveraged during concept development and throughout the research until the final document is delivered.

California decisions and implications

Below we present summaries of regulatory decisions pertinent to the implementation and evaluation of codes and standards support programs in California over the last 10 years. For each decision, we provide context, a list of key decisions, and implications these decisions had on cost-effectiveness of C&S programs.

2005

D.05-04-051: "INTERIM OPINION: UPDATED POLICY RULES FOR POST-2005 ENERGY EFFICIENCY AND THRESHOLD ISSUES RELATED TO EVALUATION, MEASUREMENT AND VERIFICATION OF ENERGY EFFICIENCY PROGRAMS"

Context: This decision focused on how to treat savings realized through prior-year commitments. This was important in considering how to treat installations resulting from C&S advocacy program activities, which would produce new installations and new annual savings for every year in current and future program cycles.

Key Decisions:

- Established "performance basis" for resource programs;
- CPUC did not allow utilities to count C&S savings for pre-2006 (2002-2004 program cycle) advocacy work toward their savings goals in their 2006-2008 program plans;
- CPUC directed Joint Staff to develop savings attribution protocols.

Implications: Accounting for the current and future program savings from new installations in any program year or cycle would increase savings benefits and improve the overall cost-effectiveness of C&S advocacy programs.

D.05-09-043: "Interim Opinion: Energy Efficiency Portfolio Plans and Program Funding Levels for 2006-2008 - Phase 1 Issues"

Context: In this decision, the CPUC directed utilities to assess whether the 2006- 2008 portfolio compliance plans were expected to meet the savings goals using "with and without" scenarios with respect to savings from pre-2006 codes and standards.

Key Decisions:

- Utilities must complete a market survey on compliance by March 1, 2007;
- In evaluating whether 2006-2008 portfolios will meet or exceed adopted goals, utilities should credit 50% of verified savings associated with pre-2006 C&S work;

- Determine (later) if savings from pre-2006 codes and standards advocacy work should also count towards the updated goals for 2009 and beyond;
- Determine if these savings should count towards the minimum performance threshold for performance that is tied to savings goals;
- In the future, savings from codes and standards advocacy work undertaken in 2006 and beyond shall be counted when calculating either net resource benefits ("performance basis") or cost-effectiveness (TRC or PAC tests);
- Savings from pre-2006 C&S work shall not be counted when calculating net resource benefits (performance basis) or cost-effectiveness associated with portfolio plans for 2006 and beyond.

Implications: This decision began to lay the foundation for allowing utilities to count savings from C&S activities toward their saving goals, first by requiring that these savings be counted when calculating net resource benefits or cost-effectiveness for program portfolios. One caveat to these decisions is that the definition of "compliance' is not yet fully defined.

2007

D. 07-09-043: "INTERIM OPINION ON PHASE 1 ISSUES: SHAREHOLDER RISK/REWARD INCENTIVE MECHANISM FOR ENERGY EFFICIENCY PROGRAMS"

Context: This decision revisited determinations from D.05-09-043 and discussed party comments on the attribution of savings from C&S advocacy activities, as well as how to treat costs associated with 2006-2008 C&S advocacy work.

Key Decisions:

- Include C&S advocacy costs as they are incurred when calculating Performance Earnings Basis (PEB);
- Deferred consideration of whether savings from pre-2006 advocacy work will also count towards the updated goals for 2009 and beyond
- Solicited comment on whether CPUC should reconsider what savings will count toward fulfillment of goals, including those associated with C&S advocacy, irrespective of whether the goals are modified.

Implications: Addressing the timing of costs is important for EM&V and determining cost-effectiveness.

D. 07-10-032: "Interim Opinion on Issues Relating to Future Savings Goals and Program Planning for 2009-2011 Energy Efficiency and Beyond"

Context: This decision simply reiterated the C&S policies established in previous decisions and included one new policy.

Key Decisions:

- Commission noted it was open to "allowing utility efforts in support of **compliance** if the utilities choose to include these in their portfolios to strengthen the total expected energy savings"
- The existing practice for counting verified energy savings for pre-2006 codes and standards (C&S) advocacy work is continued for the 2009-2011 budget cycle. The utilities may propose ways to count work on C&S compliance toward energy savings goals.

Implications: The possibility for utilities to count savings generated from C&S compliance activities was another important means of generating significant energy savings at a relatively low cost and driving program cost-effectiveness up.

2009

D. 09-05-037: REACH CODES Counting Issues for 2009-2011 Programs

Context: In this decision, the CPUC addressed several issues relating to the counting of savings for the 2009-2011 program cycle, which would become the 2010-2012 program cycle. In particular, IOUs had proposed, in their program filings, that energy savings by customers who are influenced by factors in addition to the utility programs' incentives and outreach (e.g. general 'green' awareness, national energy efficiency influences, etc.) should still be credited fully to the utility programs. The CPUC rejected this with one exception: for customers in communities with reach codes.

Key Decisions:

- Provided that customers in "reach code" communities shall be allowed to fully participate in utility programs and incentives, and shall not be treated as free-riders.

Implications: Treating savings and costs associated with reach codes similarly ensured that communities would not be discouraged in adopting reach codes. Allowing utilities to count these savings (and costs) should increase net savings and, ultimately, cost-effectiveness.

D. 09-09-047: "DECISION APPROVING 2010 TO 2012 ENERGY EFFICIENCY PORTFOLIOS AND BUDGETS"

Context: This decision approved utility state wide C&S programs with modifications, which included four sub-programs: building codes advocacy; appliance standards advocacy; Compliance Enhancement Programs (CEP); and Reach Codes. It also discussed utilities' proposed amendments from 1st and 2nd Amended Applications to allow additional energy savings to be attributed to C&S programs.

Key Decisions:

- Deferred four issues proposed by utilities in the 2009 Second Amended Application, to a forthcoming decision on EM&V issues:
    - Count 100% of gross savings from all proceedings including pre-2006 advocacy efforts;
    - Gain credit for savings achieved through CEP and Reach Code sub-programs;
    - Clarify calculation methodology of gross savings for C&S;
        - o Reconsider and calculate savings resulting from non-utility territories;
- Directed utilities to ensure that the activities in CEP only target Federal Standards and pre-existing codes and standards that have low compliance rates in the IOU's service territories;
- Directed utilities to ensure that activities that are related to voluntary programs related to reach codes support activities associated with other energy efficiency programs such as New Construction programs.

Implications: The opportunity for utilities to count 100% of gross savings from all proceedings while also allowing them to gain credit for savings achieved through the CEP and Reach Code sub-programs would again contribute to improved program cost-effectiveness.

2010

D. 10-04-029: "DECISION DETERMINING EVALUATION, MEASUREMENT AND VERIFICATION PROCESSES FOR 2010 THROUGH 2012 ENERGY EFFICIENCY PORTFOLIOS"

Context: This decision focused on addressing the four deferred issues from D.09-09-047.

Key Decisions:

- Reversed the pre-2006 50% rule and allows for 100% of pre-2006 verified savings from Codes and Standards advocacy work to count toward achievement of Commission energy savings goals for the 2010 through 2012 energy efficiency program cycle. Verified Codes and Standards savings pre-and post-2006 shall count only for savings within the utility's service territory;
- Clarified how gross and net savings should be calculated for C&S activities, where net savings equals gross savings adjusted by the rate of "naturally occurring market adoption" (NOMAD) and the attribution level for each IOU within the IOUs' service territories.

Implications: The ability to count 100% of pre-2006 verified savings from C&S advocacy work toward savings goals in PY 2010-2012 could improve cost-effectiveness.

2012

D. 12-05-015: "Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education and Outreach"

Context: This decision adopted separate savings goals for C&S advocacy from those adopted for other DSM programs.

Key Decisions:

- C&S savings are overestimated in the draft Goals Proposal and should be adjusted for attribution and realization of verified savings;
- It is prudent to develop and hold utilities accountable for separate C&S and IOU program savings goals; there is no inherent reason why C&S and IOU program goal structures should be aligned;
- C&S goals are adopted on an adjusted net basis.

Implications: Opens the door for additional or alternate calculation methods when preparing C&S data for program planning and evaluation.

Other jurisdiction approaches to C&S cost-effectiveness

In this section, we briefly cover the regulatory grounds and processes for codes and standards support programs in a handful of other states across the country. While well over a dozen states have some sort of utility code support program in place, only a few have begun to tackle the issue of C&S cost-effectiveness screening in earnest.

Massachusetts/National Grid: Utilities proposed methodologies for savings attribution from codes and standards in their 2013-2015 program plans, informed by CA and AZ. The framework has not officially been adopted. According to the NEEP/IMT/IEE codes study, National Grid's attribution is pre-determined to be 40%, assuming all activities are met.

Rhode Island/National Grid: There is no methodology in place to provide for the attribution of energy savings to utilities for their efforts, according to NEEP/IMT/IEE codes study. ACEEE notes however that National Grid can claim savings.

National Grid, in its 2013 Energy Efficiency Program Plan,[31] proposed an attribution rate of 40% supported by a set of self-met conditions, where savings are adjusted based on the percent of total potential activities met. The conditions, or activities, included are: 1) trainings (classroom, webinars, focus group, on-site demonstrations); 2) circuit rider technical assistance; 3) 3rd party inspection support, and; 4) documentation tools. National Grid also proposed establishing a working group to address several related issues, including establishing a methodology for savings attribution.

National Grid implements a medium- to long-term market transformation approach to C&S support programs, with the goal of net-zero energy new construction. Its model for savings attribution is different for residential and commercial buildings, but it is still evolving. While C&S have not been screened for cost-effectiveness independently, it is screened as part of the residential and commercial new construction programs, which are also implemented with a market transformation strategy.

Minnesota: Utilities can count savings from codes and standards toward annual energy efficiency targets, but no attribution model exists.

Arizona: Arizona is unique in that it is considered a "home rule state" and has no state-wide building codes. Municipalities set their own codes. In section R14-2-2404, part E, of Arizona's Electric Energy Efficiency Standards (Docket No. RE-00000C-09-0427, Title 14, Chapter 2, Article 24), the Arizona Corporation Commission (ACC) allows for utilities to count to one-third (1/3) of verified energy savings resulting from building codes toward meeting the state's annual savings goals. The ACC also allows Arizona Public Service (APS) to include savings "resulting from improved energy efficiency appliance standards".

Northeast Energy Efficiency Alliance (NEEA): NEEA implements a holistic market transformation strategy with a goal of net-zero energy buildings. Its various initiatives are intended to continually influence codes and standards changes/updates within the context of market transformation. In addition to initiatives, many of which focus on specific technologies (e.g. ductless heat pumps), NEEA also focuses on market transformation through infrastructure development, such as code official training or certification programs. The Northwest region has a robust stakeholder process that includes NEEA and the Northwest Power and Conservation Council; the latter coordinates a Regional Technical Forum comprised of various public and private stakeholders that serves to develop standards and to verify and evaluate savings.

What is the California Energy Commission's life cycle cost (LCC) for C&S cost-effectiveness?

For the Energy Commission analysis of cost-effectiveness standards are based on the lifecycle cost of the building[32] and Time Dependent Valuation (TDV) methodology.[33]

Several steps are required to perform the calculation:

1. The building must be modelled using approved simulation software

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31 Energy Efficiency Program Plan for 2013, Settlement of the Parties, Docket No. 4366.

32 Per the Warren-Alquist Act.

33 Energy+Environmental Economics, "Time dependent Valuation of Energy for Developing Building Efficiency Standards," February 2013 www.energy.ca.gov/title24/2013stnadards/prerulemaking/documents/general_cec_documents/Title24_2013_TDV_Methodology_Report_23Feb2011.pdf

2. Improvements to building energy efficiency are incorporated into the model. (i.e. improved wall insulation or HVAC equipment)
3. Electricity, natural gas, and propane savings from improvements are converted to kBtu
4. KBtu is converted to a Time Dependent Valuation. TDV is a value for energy that varies in each climate zone for each of three building types and fluctuates by time of day over 8760 hours annually. It includes generation energy, system capacity, ancillary services, T&D capacity, greenhouse gas emissions and a retail rate adjuster. The affect is to put a higher benefit value for load reduction during high value (i.e. system peak) periods.
5. Building lifecycle is 30 years for residential and either 15 years or 30 years for non-residential.
6. Implementation costs are the incremental equipment cost over the life of the building (capital, operation, and maintenance) is provided in the CASE report. Another source, such as DEER or RS Means, may be used if a CASE report is not available for the target technology.
7. LCC is the present value of TDV minus the present value of implementation cost.

APPENDIX C. MEMO 2: COST-EFFECTIVENESS FOR CODES AND STANDARDS PROGRAMS

Memo to:		**Memo No:**	C&S_2_7
Paula Gruendling, CPUC		**From:**	DNV GL
Nikhil Gandhi, CPUC		**Date:**	Feb 18, 2016
Copied to:		**Prep. By:**	Jon Vencil, DNV GL
Fred Coito, DNV GL			Jim McMahon, CPUC Consultant
John Stoops, DNV GL			
Allen Lee, CADMUS			
Dan Groshans, CADMUS			

Subject: Cost-effectiveness for Codes and Standards programs

This memo is a follow-up to memo C&S_2_6. That memo outlined issues for calculating cost-effectiveness for codes & standards programs. After that memo, a meeting was held with Yanda Zhang (consultant to four IOUs) and Craig Tyler (consultant to PG&E) to understand the steps used or needed to develop inputs for the tools used to report the C&S program cost-effectiveness.

In this memo, we report the findings from that meeting and recommend steps to streamline the reporting process for C&S.

C&S cost-effectiveness

The California Standard Practice Manual[34] (SPM) specifies five tests for assessing program cost-effectiveness. The primary test in California is the Total Resource Cost (TRC). Program Administrator Cost (PAC) is the secondary test used to assess program cost-effectiveness. Cost-effectiveness tests for building codes and appliance standards programs (C&S) are the same as those used for other energy efficiency (EE) resource programs. The tests apply when programs are administered by an Investor Owned Utility (IOU) or another Program Administrator (PA). The difference between resource programs and C&S programs is in how the benefits and costs of each type of program are generated.

The California C&S program focuses on advocacy and support. The program activities support new C&S levels, increased adoption of energy conserving measures, and increased compliance with C&S. According to PG&E,

"The codes and standards (C&S) Program saves energy on behalf of ratepayers by directly influencing standards and code-setting bodies to strengthen energy efficiency regulations, by improving compliance with existing codes and standards, and working with local governments to develop ordinances that exceed state wide minimum requirements."[35]

In the context of C&S, utilities implement a program for multiple years (not one year only) and claim credit for savings over multiple years. Savings come from equipment that was installed to meet a standard efficiency level influenced by the IOU in a particular year.

[34] Economic Analysis of Demand-Side Programs and Projects, October 2001

[35] 2010-2012 Energy Efficiency Portfolio Program Implementation Plan State-wide Program Codes and Standards PGE2107, Jan, 31, 2011

Codes and standards, by design, affect both the entire market for appliance sales and new building construction and large renovation. To calculate cost-effectiveness for C&S, four sets of inputs are required. These are:

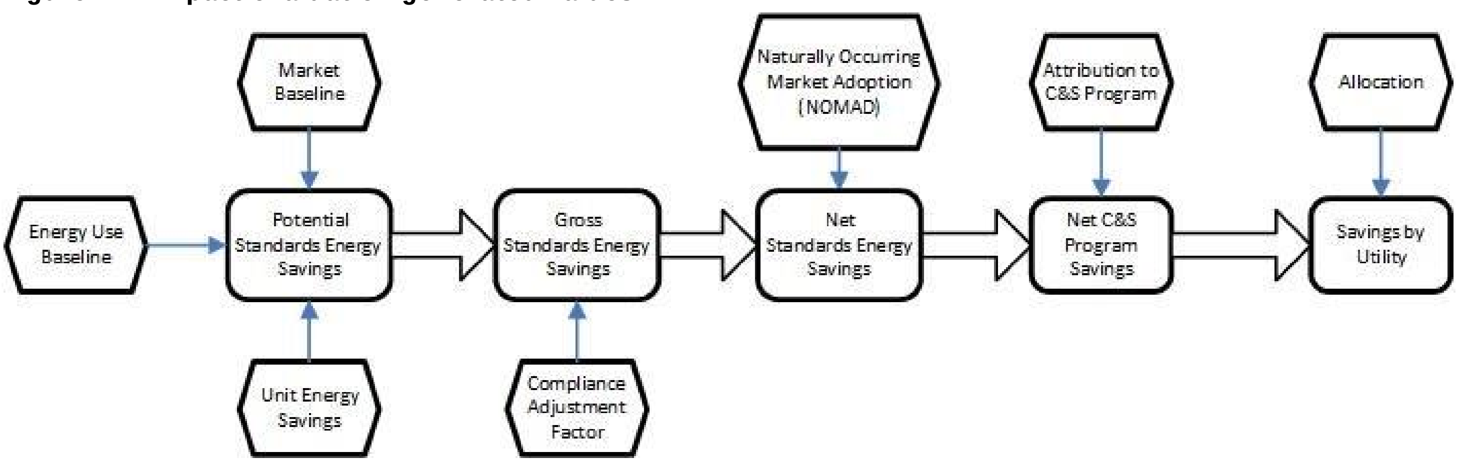
1. Market size in terms of units
2. Energy savings per unit
3. Equipment costs
4. Program administrative costs

Incomplete understanding about any of these inputs introduces uncertainty into the savings calculation. Developing cost-effectiveness inputs to reduce this uncertainty for C&S requires several steps. We discuss these steps, and how inputs are developed and reported, in the following sections.

Energy savings development

The first step for calculating cost-effectiveness is to develop the requisite data. Some of these come directly from the utilities. Others come from the impact evaluation via the Integrated Standards and Savings Model (ISSM).[36] This model generates results as part of the impact evaluation. The steps are represented in Figure 11.

Figure 11. Impact evaluation generated values



The steps from the evaluation to develop the savings inputs are:

1) **Potential Standards Energy Savings** – unit energy savings and estimated units entering the market each year. Sources include: CASE reports, industry statistics on shipments and data purchased from data tracking firms

2) **Gross Standards Energy Savings** – For standards, this is determined by comparing energy consumption of units sold in the market to prevailing state or federal consumption standards for each unit. For buildings, a performance comparison is used to assess whole building consumption at code and as built. This approach allows for a compliance rating of greater than 100% when modelled consumption is below code consumption, or less than 100% when modelled consumption is above code consumption.

3) **Net Standards Energy Savings** - judgements of experts through a two-round Delphi approach.

[36] CADMUS/DNV GL Statewide Codes and Standards Program Impact Evaluation Report for Program Years 2010-12, August 2014, CALMAC ID CPU0070.03, http://www.calmac.org/publications/CS_Evaluation_Report_FINAL_10052014-2.pdf

4) **Net Program Savings** – developed using Code Change Theory Reports (CCTR), rulemaking dockets, stakeholder interviews and judgements of experts through an in-person interactive panel.

5) **Savings by Utility** – allocated by appliance sales or new construction activity.

6) **Net-to-gross ratio (NTG)** – The NTG is the product of the NOMAD and attribution adjustments.

Data preparation for cost-effectiveness

Assembling the full set of inputs requires a blending of data sources. The four sets of inputs required for cost-effectiveness calculations are restated here:

- Market size in terms of units
- Energy savings per unit
- Equipment costs
- Program administrative costs

Inputs 1 and 2 are outputs from the ISSM model. The ISSM model is used during the impact evaluation to provide annual estimates of electric and gas savings attributed to each IOU over a 10-year period. The ISSM model does not however include the cost information necessary to complete cost-effectiveness calculations in the Cost-Effectiveness Tool (CET). Input 3 comes from the Codes and Standards Enhancement (CASE) studies produced by the IOUs as part of their advocacy effort with the California Energy Commission.[37] Input 4 is produced by IOU internal accounting systems.

The CET is the means for conducting cost-effectiveness analysis on all resource programs. Unfortunately, due to the structure of the CET, the outputs from the ISSM are not in a form that translates directly to the CET. They must be transformed before they can be used. The mechanics of transforming ISSM data from the C&S impact evaluation to fit in the CET structure is the main source of confusion between inputs and outputs during the review process.

For resource programs, first year gross savings are an input to CET. The lifecycle stream of savings is determined by multiplying first year gross savings by the measure life. In addition, net savings are generated by adjusting first-year gross savings by a NTG ratio. The ISSM is not designed for, or applied to, resource programs.

For C&S programs the savings stream is not static over the life of the measure. In CET, multiplying first year savings by the measure life will not provide a value that accurately reflects the savings stream generated by ISSM. Although ISSM applies adjustment factors in separate steps, effectively the NTG ratio produced by the impact evaluation is a product of the naturally occurring market adoption (NOMAD) and attribution score. As a result, these can vary, by standard, across years.

With the exception of administrative costs, the CET is not set up to process multi-year inputs. These differences create several disconnects for C&S reporting. As a result, evaluation outputs from ISSM must be modified for use in the CET. Without clear documentation providing an audit trail of these data transformations, CET output will be extremely difficult to review or replicate. The remainder of this memo identifies the key issues that need to be clearly documented before the next CET review.[38]

[37] Other sources for cost include the DEER database or US Department of Energy Technical Support Documents (TSD) or another IOU work papers.

[38] The authors wish to thank Yanda Zhang and Craig Tyler for sharing their time and expertise to help us understand these issues.

Energy savings and net-to-gross ratio

The IOUs report savings for Title 20 (California appliance standards), Title 24 (California residential and commercial building codes), and Federal appliance standards. Where standards are excluded from the analysis (usually standards that contribute less than 1% to total saving) ISSM and IOU portfolios will not match exactly.[39] This "discrepancy" can cause a discrepancy between the savings reported by the IOUs and the savings reported from the evaluation.

The ISSM produces both gross and net savings. Gross savings are based on actual and expected appliance sales, or new construction activity, multiplied by unit energy savings. Net savings are derived by applying the NOMAD and attribution adjustment factors developed for each year to the corresponding year's gross savings.

To calculate cost-effectiveness, the C&S impact evaluation outputs must be processed through the CET. As stated earlier in the memo, the CET input allows only one year of gross savings and reduces this savings by a static net-to-gross ratio. To compensate for the difference between the ISSM dynamic outputs and the CET static inputs, the IOUs generate an average NTG value for each standard. This average NTG is calculated by dividing the sum of annual net savings (from ISSM) by the sum of annual gross savings (from ISSM) over the program cycle years being evaluated. This calculation is limited to savings. To generate annual installations,[40] total savings are divided by the unit energy savings (UES).

Mathematically the data transformations used to populate the CET input form should produce the same results as the ISSM outputs over multiple years. Without an audit trail linking the calculations however, comparing the two is difficult at best.[41]

Finally, the C&S impact evaluation reviews all California state standards supported and reported by the IOU programs in its preliminary review. The evaluation focuses on the standards that became effective during the program period and that contribute at least 1.0% of the savings in the IOU C&S portfolio. The IOU forecast estimates of savings are modified using the results from the most recent evaluation.

The current structure of the ISSM and CET cause several disconnects for codes and standards cost-effectiveness reporting.

Demand savings

Savings at system peak are calculated by applying CET deemed load shapes to evaluated savings. The end-use load shape selected is the one that most closely matches the end-use of the standard being evaluated. This works for most appliance end uses, but may not accurately reflect whole buildings.

Equipment Costs

The source of costs for appliances or building costs to meet compliance for C&S is the CASE reports. Where CASE reports are not developed, other sources are used.[42] Measure costs typically are incremental but may reflect full cost depending on the situation. Modifications to an existing appliance is one example where an incremental cost would be appropriate. A change to an existing whole building construction process is

[39] Another source that can contribute to a potential disconnect is the state-wide savings potential study produced by Navigant Consulting. This study includes existing and scheduled state and federal standards that may not be accounted for by the IOUs or that may not become effective.

[40] These estimates may be generated by the CEC, third party providers, or the IOUs themselves.

[41] A list of values from the 2010-12 impact evaluation that did not match ISSM after being processed through CET does exist as a starting place, if reconciliation is requested.

[42] US Department of Energy Technical Support Documents (TSD) for Federal appliance standards is one example of an alternate data source

another. Where new systems are installed, in lighting alterations or building recommissions for example, full measure cost may be appropriate.

Due to timing issues and the code or standard being addressed these may, or may not, match or agree with measure costs reported in DEER.[43] For C&S in some cases, equipment costs can be zero or even negative. This may occur when buildings are reconfigured to meet design requirements but reduce the performance budget (cost are lower than the original design).

CET allows for these cost values to be entered but like all inputs, the CET allows input for one year only. To understand how different cost values might affect TRC, we ran sample data sets through the CET.[44] The first set included positive equipment costs for all projects. The second set includes all negative costs. The third set used equipment costs of zero. Comparisons of TRC and PAC for three measure cost scenarios are in Table 18. The TRC ratio is the same for both the “all negative” and “all zero” cases. This indicates negative values are treated as zero in the calculation.

Table 18. CET TRC comparison

Equipment Costs	TRC ratio	PAC ratio*
All Positive	1.57	2.79
All Negative	3.67	2.79
All Zero	3.67	2.79

*PAC does not include equipment costs

Measure life

For cost-effectiveness, the effective useful life of each measure is consistent with source data. These are not necessarily driven by DEER. Measure life for state level codes and standards come from the evaluation (for evaluated standards) or CASE reports (for non-evaluated measures). Measure lives for federal standards come from the Federal Register.

Program administrative costs

The administrative costs to operate the program are reported directly from IOU accounting systems. The first three years of these annual values can be input, without adjustment, into the CET. As a result, there is no disconnect between CET and program administrative costs.

Summary

A review of cost-effectiveness calculations for the C&S programs revealed several disconnects between the reporting of impact evaluation results and reporting of cost-effectiveness results. These disconnects are a result of the current structure of ISSM and CET model inputs and outputs. IOUs must adjust data to translate data from ISSM to CET. The result is that the adjustments performed outside the ISSM or CET models may cause confusion when interpreting the IOU C&S cost-effectiveness calculations and reporting.

[43] Costs are factored into the impact evaluation during the determination of net standards and net program savings, but they are not reported.

[44] Dataset contained 12,250 observations and covered all IOU resource programs.

Specifically, for a typical measure the CET multiplies gross savings by the approved net to gross ratio to calculate net savings. From the impact evaluation, the NOMAD adjustment for natural market adoption effectively reduces total savings each year by reducing the market size available to the utility programs by the free rider estimate. The attribution adjustment further reduces net savings. To populate the CET, inputs must be adjusted outside the model to reflect the net savings from the evaluation report. This adjustment process is the primary source of confusion when the reported C&S cost-effectiveness results are reviewed.

Table 19. Summary of C&S cost-effectiveness issues

Item	Disconnect	Resolution Options
Energy Savings	CET input allows one year of annual gross savings only. Net saving for CET and ISSM should match. This also requires a way to account for legacy standards – previously evaluated that continue generate savings.	1) Adjust CET to accept multi-year ISSM outputs directly 2) Have ISSM output savings values in a format ready for CET upload. 3) Continue data transformation, but have IOUs provide all calculation steps and formulas when CET results are submitted.
Demand Savings	No Disconnect	4) Continue current practice of applying load shape closest to standard end-use
NTG Ratio	The ISSM implies a different NTG over each year of a standard's life. The CET requires NTG for a single year. Aggregate net saving for CET and ISSM should match, but calculating NPV may be problematic since NTG change annually.	5) Adjust CET to accept multi-year ISSM outputs directly 6) Focus on Net for review, accept Gross or NTG disconnect
Equipment Costs	CET input allows one year of gross savings only. Negative equipment costs are set to zero.	7) Expand input form to accept multiple years 8) Develop protocol/calculation approach for reporting negative values
Program Administrative Costs	No Disconnect	9) Continue current practice of reporting program administrative costs

See Section 4 below for further discussion of benefit and cost inputs to the TRC analysis.

Additional issues

There are several questions that came up as part of this research. These questions, along with any answers discovered along the way are summarized in Table 20.

Table 20. Questions and recommendations related to C&S cost-effectiveness

	Question	Recommendations
1	Does the CEC estimate lifecycle savings for C&S and include those in its forecast, and, if so, how? Should the CPUC method consider the CEC approach? If not how should savings be reconciled for procurement planning?	• Resolution will require additional research and is outside scope
2	What is the "useful life" of a code or standard?	• Measure life should be used
3	For how many years of savings should the program take credit? Is there a cut-off year? This could be the same as measure life, longer if replacements in kind are included, or shorter if limited to a particular time period. Long time periods encounter uncertainties in forecasts, while short time periods fail to account for all the savings. Alternatively, a fixed time period, rather than measure life, facilitates comparison of savings among standards with different measure lives.	• Measure life should be used
4	How should kW benefits be developed for the calculations? By default, load shapes or another method? How should any changes in load shapes due to codes and standards be accounted for?	• Apply existing load shapes (closest to the standard's end-use).
5	How is equipment cost treated once it becomes the minimum efficiency? Incremental costs for codes on new construction depend upon the baseline and may be more challenging. Should learning (reduction in cost as production volumes increase) be considered as contributing to lowering costs over time?	• Resolution will require additional research. The cost of obtaining and updating this information should be assessed relative to any increase in cost-effectiveness precision it may provide.
6	How should the cost-effectiveness model C&S measures where savings, but not net benefits, are allowed?	• Current option is to apply an empty load shape so savings are not applied to any avoided cost periods.
7	Is the current cost-effectiveness model capable of handling zero or negative incremental measure costs associated with some standards?	• The CET can accept zero values for 1st-year measure costs. • Negative costs are converted to zero by the CET so reported TRC is lower than it should be. • CET cannot accept a stream of costs regardless of whether they are positive or negative.
8	Which C&S savings estimates are appropriate for procurement planning?	• Resolution will require additional research and is outside of this scope. Key difference is that CEC uses 2-year procurement cycle. IOU planning is 6-7 years.
9	How should potential double counting of savings be addressed across standards?	• Resolution requires additional research. This applies primarily to application of Federal standards by

	Question	Recommendations
		NOMAD process.
10	Should the savings allocation be adjusted? State wide savings are allocated across utilities by electricity sales, but municipal and water project sales are in the mix.	• Savings are allocated by IOU sales. On the electric side, approximately 75% of sales are allocated to IOU service territories. About 25% of state wide sales are omitted due to muni or other entity sales. • On the gas side, nearly 99% of sales are allocated to IOU service territories. • This issue will become more relevant if C&S earnings are based on savings - like resource programs.

APPENDIX D. COMMENTS AND REPLIES

Comment #	Commenter	Page (as shown in at bottom of document page); or "Overarching" for general comments	Comment/feedback/change requested	Comment Type (i.e. clarification needed, request for additional analysis, general question, general comment, other)	Evaluator's Response
1	IOU C&S staff	p.21 (section 6.1.1)	The IOUs support the recommendation to require the impact evaluation consultant to place evaluation results direct into the ATR database, with the caveat that some annual data additions and modifications are needed to support accurate cost effectiveness reporting. The ability to both add new C&S measures and adjust evaluated values is required in order to capture savings from standards enacted subsequent to the impact evaluation. We suggest that the IOUs make annual adjustments with true-up by the Commission's impact evaluation consultant on an agreed upon cycle (e.g., every 3 years).	General comment; clarification needed.	We feel this comment is reasonable and suggest that the IOUs, Commission staff, and the evaluators meet early during the next evaluation cycle to jointly address this comment.

Comment #	Commenter	Page (as shown in at bottom of document page); or "Overarching" for general comments	Comment/feedback/change requested	Comment Type (i.e. clarification needed, request for additional analysis, general question, general comment, other)	Evaluator's Response
2	IOU C&S staff	p.21 (section 6.1.2)	The IOUs believe that incremental measure costs should be updated on a regular basis and that this task could be conducted by the impact evaluation consultant. The IOUs would still need the ability to update measures (and their associated incremental measures costs) in the periods between incremental cost evaluations, i.e., annually as discussed in comment 1.	General comment; clarification needed.	We agree that the evaluators or the DEER team should update costs as either part of the C&S impact evaluation or as part of a DEEER update.
3	IOU C&S staff	p.21 (section 6.1.3)	The recommendation to eliminate submission of E3 calculators has been implemented.	General comment.	Comment noted.
4	IOU C&S staff	p.22 (section 6.1.4)	Eliminating the IOU C&S claim submission, other than an annual reporting of program costs will not maintain an accurate accounting of C&S program savings and cost-effectiveness. Annual IOU updates of measures and associated data, as mentioned in comment 1, are necessary.	General comment; clarification needed.	The IOUs, Commission staff, and the evaluators meet early during the next evaluation cycle to jointly address this comment.

Comment #	Commenter	Page (as shown in at bottom of document page); or "Overarching" for general comments	Comment/feedback/change requested	Comment Type (i.e. clarification needed, request for additional analysis, general question, general comment, other)	Evaluator's Response
5	IOU C&S staff	p.24 (section 6.2.1)	The IOUs support the recommendation to require the impact evaluation consultant to enhance ISSM to include incremental measure costs, but further note that the ability to modify incrmental costs regularly would enhance the accuracy of C&S cost effectiveness calculations.	General comment.	Comment noted.
6	IOU C&S staff	p.24 (section 6.2.2)	Requiring the impact evaluation consultant to make ISSM outputs feed directly into the ATR database is supported by the IOUs.	General comment.	Comment noted.
7	IOU C&S staff	p.24 (section 6.2.3)	It may not be necessary to modify the CET to allow the NTG ratio to vary by year since the CET currently requires quarterly entries, which could, presumably, be modified annually to reflect changing NOMAD (i.e., NTG) values.	General comment.	The IOUs, Commission staff, and the evaluators meet early during the next evaluation cycle to jointly address this comment.

Comment #	Commenter	Page (as shown in at bottom of document page); or "Overarching" for general comments	Comment/feedback/change requested	Comment Type (i.e. clarification needed, request for additional analysis, general question, general comment, other)	Evaluator's Response
8	IOU C&S staff	p.24 (section 6.2.4a)	The recommendation that only program costs are expected from the IOUs was discussed in comment 2 and 4 above. The IOUs believe that annual updates to the C&S measure list and measure values is required for accurate estimation of program cost-effectiveness.	General comment; clarification needed.	The IOUs, Commission staff, and the evaluators should meet early during the next evaluation cycle to jointly address this comment.
9	IOU C&S staff	p.24 (section 6.2.4b)	The recommendation that claims reporting only be done from the application filing requires clarification. The IOUs believe that annual adjustments are needed to reflect measure changes that occur between applications. Annual adjustments are most appropriate as discussed in previous comments.	General comment; clarification needed.	The IOUs, Commission staff, and the evaluators should meet early during the next evaluation cycle to jointly address this comment. Annual modifications could make sense, provided there is an efficienct process for these adjustments.
10	IOU C&S staff	p.24 (section 6.2.4c)	The IOUs agree that measure names should be consistent across all program administrators. This will be implemented with the next filing showing C&S details.	General comment.	Comment noted.

Comment #	Commenter	Page (as shown in at bottom of document page); or "Overarching" for general comments	Comment/feedback/change requested	Comment Type (i.e. clarification needed, request for additional analysis, general question, general comment, other)	Evaluator's Response
11	IOU C&S staff	p.24 (section 6.2.4d)	It may not be necessary to modify the CEDARS to allow for a NTG vector since the Cedars currently requires quarterly entries, which could, presumably, be modified annually to reflect annually changing NOMAD (i.e., NTG) values.	General comment.	The IOUs, Commission staff, and the evaluators should meet early during the next evaluation cycle to jointly address this comment.
12	IOU C&S staff	Table 1 and Appendix A	The cost effectiveness results shown in Table 1 of the report and in more detail in Appendix A are surprising in many instances (e.g., SCE T24 evaluated TRC of 56.88; SCE Federal Standards TRC of 313.70; SCG Title 20 TRC of 109.89). The consultant may have made transcription errors in entering the data for analysis by the CET. The IOUs would need to examine the input files actually employed by the consultant in order to comment further. We are willing to examine the files if they could be provided to us.	General comment	As noted in the report, the variation in cost-effectiveness results are largely driven by variations in incremental measure costs. The IOUs, Commission staff, and the evaluators should meet early during the next evaluation cycle to reconcile the incremental measure costs across IOUs.

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13	IOU C&S staff	Table 1 and Appendix A	Reported cost effectiveness measures for C&S and related savings should provide a level of reconciliation as it relates it to other similar reported savings provided in other proceedings (i.e. IEPR, etc.)	General comment	As noted in the report, the variation in cost-effectiveness results are largely driven by variations in incremental measure costs. The IOUs, Commission staff, and the evaluators should meet early during the next evaluation cycle to reconcile the incremental measure costs across IOUs.
14	CodeCycle	Overarching	Make it explicit that this report's analysis is specific to the Cost Effectiveness of the IOU C&S Advocacy subprograms	General comment	When and if other subprograms have measured savings, the distinction will be made.

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