



Date: October 13, 2017
To: Kay Hardy, CPUC
From: Kris Bradley and Corina Jump

Memorandum: 2013-2015 Custom Impact Evaluation Results

California PA-led custom programs are currently evaluated on an annual basis to provide faster feedback to the PAs with regard to their program activities, and to support the Efficiency Savings and Performance Incentive (ESPI) award.¹ The Industrial Agricultural and Large Commercial (IALC) Roadmap impact evaluation focused on nonresidential custom measures implemented by the 2013-2015 California Program Administrator's (PAs)² energy efficiency programs. The overarching goals and objectives for the IALC evaluation were: to verify and validate the energy efficiency savings claims reported from PA energy efficiency programs; to provide feedback on how well program procedures and savings calculation methods align with the CPUC's energy efficiency policies, requirements, and expectations; and to provide recommendations on how custom programs can be improved or refined. Gross energy savings, free ridership levels, and net energy savings (in kWh, kW and Therms) were estimated and compared to PA savings claims annually, using evaluation-based realization rates and NTG ratios.

The IALC Final Annual Reports³ discuss in detail the methods used to select gross and net sample, to evaluate the projects selected, and to extrapolate project-specific results to their respective PA populations. Given the expected range of error ratios (coefficient of variation for a ratio estimator) for the gross realization rates (roughly 0.6 to 1.0 based on the 2010-2012 and 2013-2015 custom impact evaluations), and the small number of impact and NTG points implemented (roughly 150 M&V points and slightly more NTG points per year,) only a relatively small number of sampling domains could be supported

¹ CPUC Decision 13-09-023 established the ESPI mechanism, which awards PAs for performance in both resource and non-resource activities supporting energy efficiency.

² California energy efficiency program administrators include PG&E, SCE, SCG, SDG&E, Marin Clean Energy, the Bay Area Regional Energy Network (REN), and the Southern California REN. However, this evaluation only addresses programs under the administration of PG&E, SCE, SCG and SDG&E.

³ http://calmac.org/publications/IALC_2013_Report_Final_071715ES.pdf
http://calmac.org/publications/2013_NRNC_Eval_Final_ReportES.pdf
http://calmac.org/publications/IALC_2014_Final_Report_April_2016ES.pdf
http://calmac.org/publications/IALC_2015_Custom_Report_FinalES.pdf



for each annual study. Since the IALC Custom evaluation was expected to provide results at the PA-level, M&V and NTG samples were designed and implemented at the PA-level. To allow evaluation of both electric and gas projects in a single domain (each) for PG&E and SDG&E, kWh electric savings and Therms gas savings at the project level were converted into source energy (MMBtu) savings for stratification and sampling purposes.⁴ Sampling and analysis on the basis of source energy savings were conducted for SCE and SCG as well, for consistency in reporting and easy comparison of results across the PAs. Analysis of M&V and NTG data yielded weighted MMBtu gross realization rates (GRRs) and net-to-gross ratios (NTGRs) for each PA, as well as weighted kW GRRs for PG&E, SCE and SDG&E. The annual MMBtu GRRs and NTGRs were used to estimate both electric kWh ex-post savings and gas Therm ex-post savings for each PA.

At the end of the 2013-2015 evaluation cycle, IALC had completed 513 impact (M&V) points and 575 free ridership (NTG) surveys. This memo presents the MMBtu GRR and NTGR results obtained by combining and analyzing the 2013, 2014 and 2015 samples and populations jointly. This is straightforward, because the sampling strategy and strata boundaries implemented for the 2013 evaluation were also used in the 2014 and 2015 evaluations. The memo then estimates the fuel-specific GRRs and NTGRs by analyzing the 2013-2015 electric and gas populations and sample completes separately from each other, by PA.

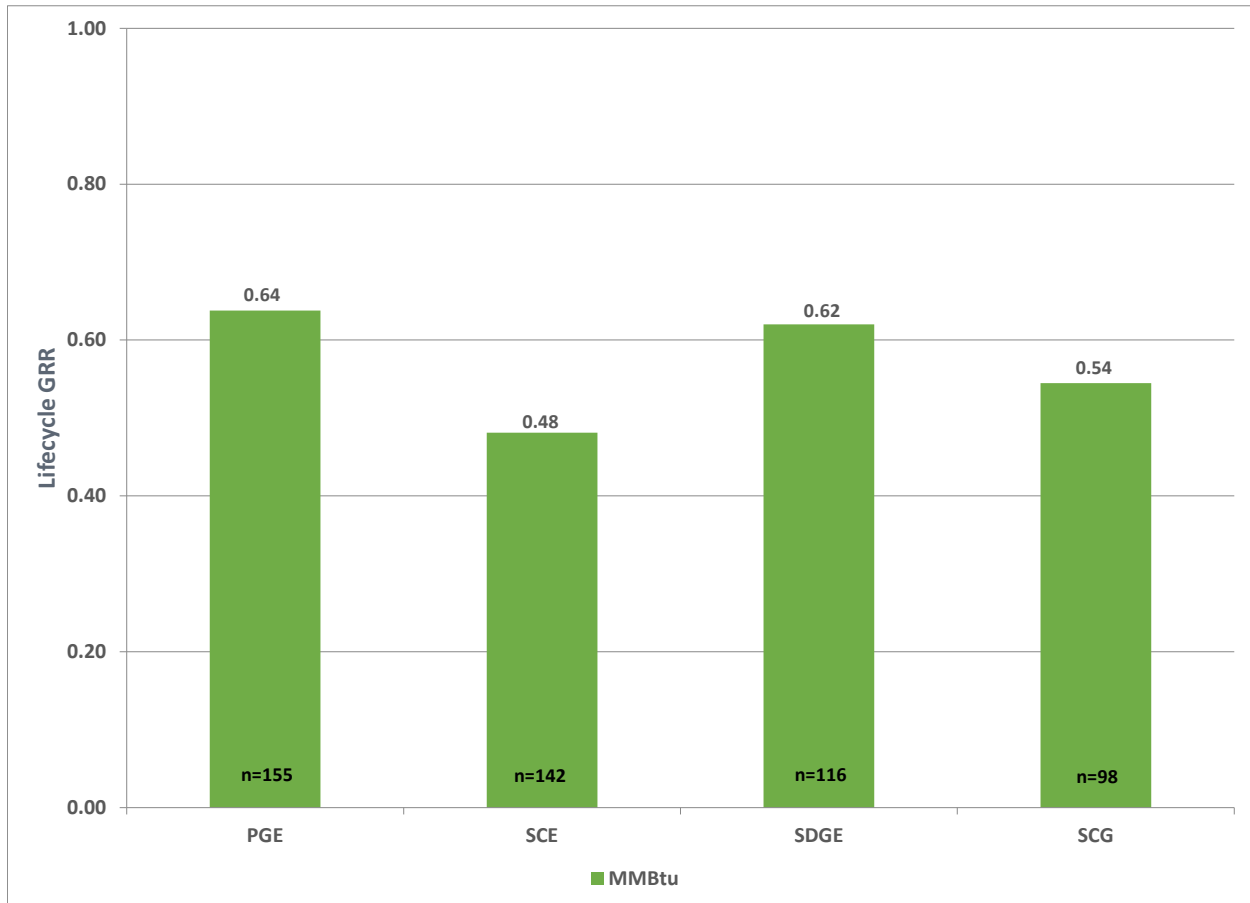
2013-2015 Combined MMBtu Gross Realization Rate and Net-to-Gross Results

Lifecycle weighted MMBtu gross realization rates by PA for the 2013-2015 program cycle are presented graphically in Figure 1.

⁴ Conversion rates obtained from "2001 Energy Efficiency Standards for Residential and Non-residential Buildings, California Energy Commission," June 2001: 1 kWh = 10,239 Btu source energy; 1 Therm = 100,000 Btu source energy. 1 MMBtu = 1,000,000 Btu.



FIGURE 1: LIFECYCLE GROSS REALIZATION RATE RESULTS BY PA FOR COMBINED ELECTRIC AND GAS SAVINGS (MMBTU) FOR THE 2013-2015 PROGRAM CYCLE



Combined 2013-2015 weighted average GRRs by PA at the 90 percent confidence level range between 0.40 and 0.75 for both lifecycle (LC) and first year (FY) GRR results, as shown in Table 1 below.

TABLE 1: WEIGHTED PROJECT LIFECYCLE AND FIRST YEAR GROSS REALIZATION RATES BY PA FOR COMBINED ELECTRIC AND GAS SAVINGS (MMBTU) FOR THE 2013-2015 PROGRAM CYCLE

PA	Population Count	Sample Count	% of Savings Sampled	LC Mean GRR	ER	LC 90% Confidence Interval	FY Mean GRR	FY 90% Confidence Interval
PGE	3,891	155	30%	0.64	0.70	0.58 to 0.70	0.68	0.62 to 0.74
SCE	2,940	142	33%	0.48	1.03	0.41 to 0.55	0.57	0.50 to 0.64
SDGE	609	116	50%	0.62	0.76	0.56 to 0.69	0.68	0.63 to 0.74
SCG	591	98	67%	0.54	0.93	0.47 to 0.62	0.64	0.58 to 0.71



Net-to-gross ratios (NTGR) by PA for the 2013-2015 program cycle are presented graphically in Figure 2 and Table 2.

FIGURE 2: NET-TO-GROSS RATIOS BY PA FOR COMBINED ELECTRIC AND GAS SAVINGS (MMBTU) FOR THE 2013-2015 PROGRAM CYCLE

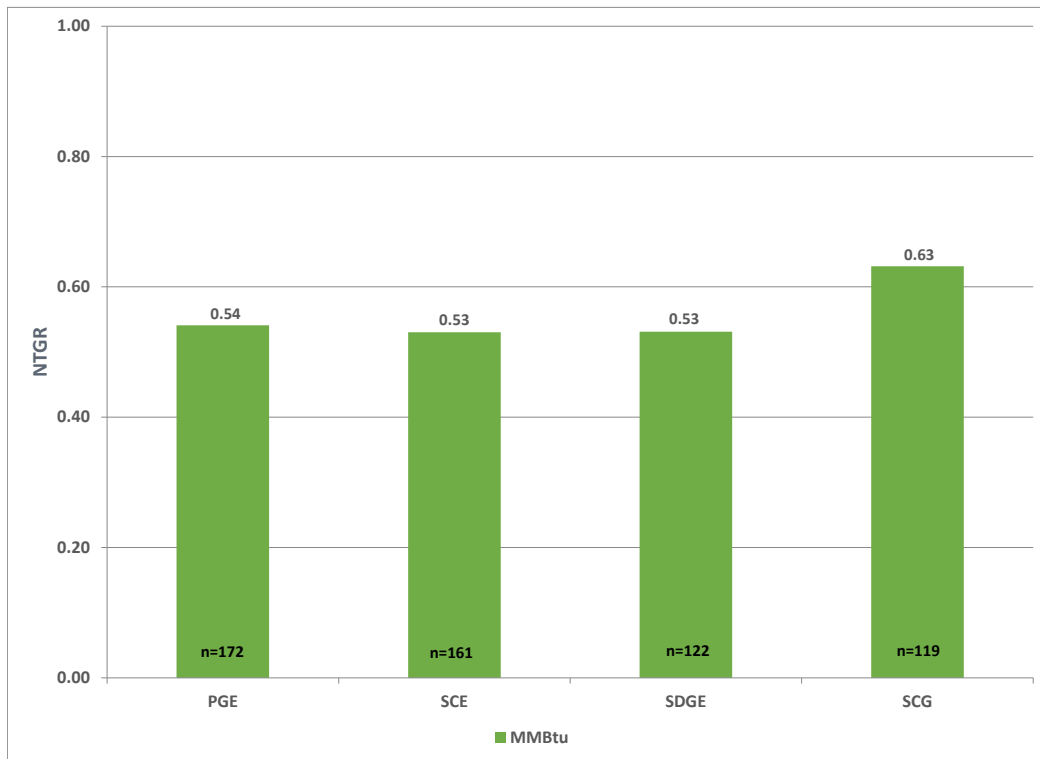


TABLE 2: NET-TO-GROSS RATIOS BY PA FOR COMBINED ELECTRIC AND GAS SAVINGS (MMBTU) FOR THE 2013-2015 PROGRAM CYCLE

Results	Weighted Average Net-to-Gross Ratios			
	PGE	SCE	SDG&E	SCG
Weighted NTGR	0.54	0.53	0.53	0.63
90 Percent Confidence Interval	0.52 to 0.56	0.51 to 0.55	0.50 to 0.56	0.60 to 0.66
Relative Precision	0.04	0.04	0.06	0.04
n NTGR Completes	172	161	122	119
N Sampling Units	3,891	2,940	609	591
Error ratio (ER)	0.35	0.35	0.43	0.32
Percent of Savings Sampled	33%	32%	46%	52%



The overall lifecycle net evaluation realization rates (the ratio of net lifecycle evaluated savings to program estimated gross lifecycle savings) for combined electric and gas savings (MMBtu) are presented in Figure 3 and Table 3. The lifecycle net realization rates for nonresidential custom projects during the 2013-2015 program cycle vary between 0.26 and 0.34.

FIGURE 3: LIFECYCLE NET REALIZATION RATE RESULTS BY PA FOR COMBINED ELECTRIC AND GAS SAVINGS (MMBTU) FOR THE 2013-2015 PROGRAM CYCLE

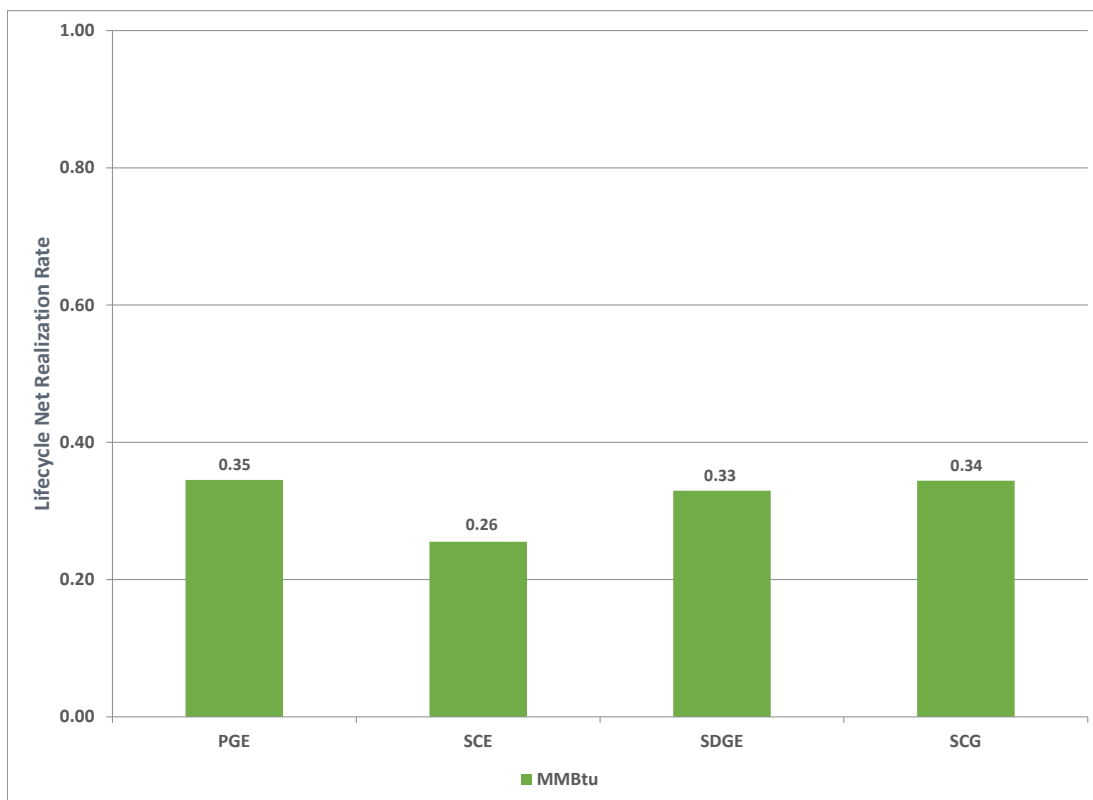


TABLE 3: NET REALIZATION RATES BY PA FOR COMBINED ELECTRIC AND GAS SAVINGS (MMBTU) FOR THE 2013-2015 PROGRAM CYCLE

Results	Lifecycle Net Realization Rate			
	PGE	SCE	SDG&E	SCG
Net Realization Rate	0.35	0.26	0.33	0.34
90 Percent Confidence Interval	0.31 to 0.38	0.21 to 0.30	0.29 to 0.37	0.29 to 0.39
Relative Precision	0.06	0.07	0.07	0.08



2013-2015 Fuel-Specific Results

Even though the IALC evaluation had limited sample sizes that could not support annual fuel-specific results, the substantial number of M&V projects and NTG interviews completed over the 2013-2015 cycle can be analyzed together to estimate fuel-specific realization rates (GRRs) and free ridership rates (NTGRs). It is important to note that, because the data analyzed (M&V and NTG completes) were obtained following MMBtu-based sample design and sample selection, this analysis is not completely equivalent to fuel-specific evaluation. In other words: had the evaluation conducted a fuel-specific study rather than a combined electric and gas (MMBtu)-based evaluation, the sample selection and resulting representation of each fuel would have been different.

The evaluation defined the sampling unit as an individual project (from one or more records) installed by a specific PA program at a specific site. MMBtu-based evaluation converted both the electric (kWh) and the gas (Therms) portions of savings into one project-specific total energy (MMBtu) savings number, and analyzed all projects together, on the basis of total energy savings. In fuel-specific evaluation a kWh-only project contributes only to the electric analysis; a Therms-only project contributes only to the gas analysis; and a dual-fuel project contributes both to the electric and the gas analyses. This is true for both the population of projects and the sampled (completed) projects.

After separating the electric and gas components of each project (where necessary) the 3-year population data for each PA-fuel domain (PGE electric, PGE gas, SCE electric, SDGE electric, SDGE gas, SCG gas) were used to stratify projects into five strata, with each stratum containing approximately 20% of the total PA savings. Note that only positive kWh and Therm savings were included when setting strata boundaries. Table 4 shows the electric strata boundaries by PA, and Table 5 shows the gas strata boundaries by PA.

TABLE 4: 2013-2015 ELECTRIC STRATA BOUNDARIES BY PA

Stratum	PGE		SCE		SDGE	
	Lower Bound (kWh)	Upper Bound (kWh)	Lower Bound (kWh)	Upper Bound (kWh)	Lower Bound (kWh)	Upper Bound (kWh)
1	1,874,214	∞	3,787,272	∞	1,922,789	∞
2	848,700	1,874,214	1,240,374	3,787,272	874,271	1,922,789
3	463,955	848,700	570,657	1,240,374	491,302	874,271
4	188,679	463,955	209,056	570,657	211,663	491,302
5	0	188,679	0	209,056	0	211,663



TABLE 5: 2013-2015 GAS STRATA BOUNDARIES BY PA

Stratum	PGE		SDGE		SCG	
	Lower Bound (Therms)	Upper Bound (Therms)	Lower Bound (Therms)	Upper Bound (Therms)	Lower Bound (Therms)	Upper Bound (Therms)
1	1,055,525	∞	179,116	∞	1,209,716	∞
2	494,323	1,055,525	116,699	179,116	784,537	1,209,716
3	294,267	494,323	42,706	116,699	281,759	784,537
4	80,081	294,267	19,643	42,706	90,331	281,759
5	0	80,081	0	19,643	0	90,331

Please note that even though SCE claimed mostly electric projects in 2013-2015, the combined electric and gas evaluation also included the limited gas savings that were claimed by SCE. However, for the fuel-specific analysis it was found that the gas domain for SCE has very few projects, and there are very few completes among the M&V and NTG samples; a fuel-specific gas analysis is not possible for SCE. Due to the re-stratification of projects into five equal electric strata, and the omission of gas savings, the electric results presented below for SCE will be somewhat different than the corresponding MMBtu-based results.

Once the strata boundaries were defined, M&V and NTGR completed projects were placed in strata, and GRR and NTGR analysis was conducted on a fuel-specific basis following the methodology described for the IALC evaluation. Since sample design and selection were based on MMBtu strata definitions, the resulting distribution of completes into the electric and gas strata was somewhat uneven. Lifecycle GRRs by PA and fuel are presented in Figure 4 and Table 6. MMBtu Lifecycle GRRs are also included in Figure 4 for comparison purposes.



FIGURE 4: LIFECYCLE GROSS REALIZATION RATE RESULTS BY PA AND FUEL FOR THE 2013-2015 PROGRAM CYCLE

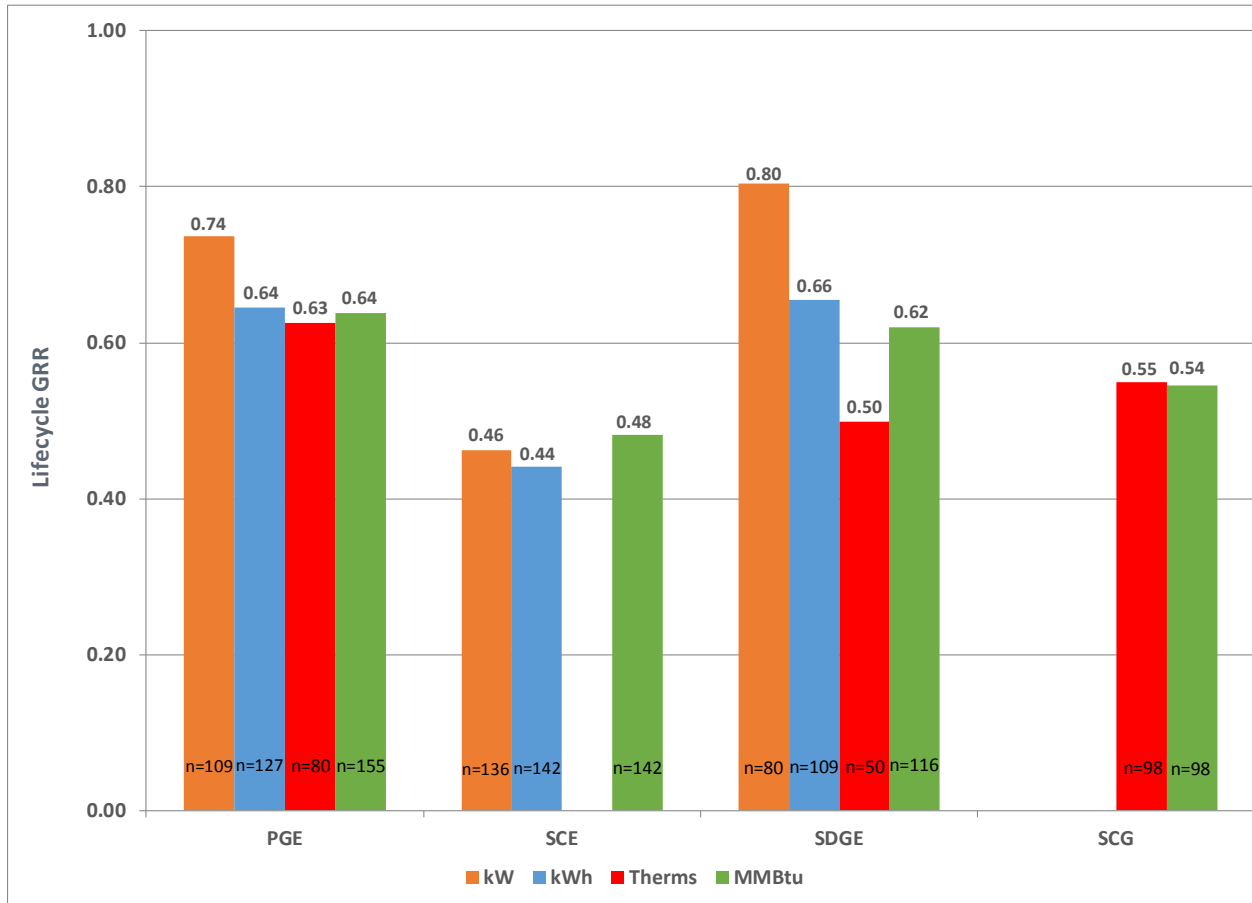




TABLE 6: WEIGHTED PROJECT LIFECYCLE AND FIRST YEAR GROSS REALIZATION RATES BY PA AND FUEL FOR THE 2013-2015 PROGRAM CYCLE

Metric	Population Count	Sample Count	% of Savings Sampled	LC Mean GRR	ER	LC 90% Confidence Interval	FY Mean GRR	FY 90% Confidence Interval
PG&E								
kWh	3,511	127	19%	0.64	0.97	0.56 to 0.73	0.68	0.61 to 0.76
kW	2,982	109	16%	0.74	2.58	0.44 to 1.03	0.75	0.53 to 0.97
Therms	1,002	80	46%	0.63	0.54	0.57 to 0.69	0.64	0.58 to 0.70
SCE								
kWh	2,928	142	33%	0.44	0.98	0.38 to 0.50	0.53	0.47 to 0.59
kW	2,659	136	27%	0.46	1.56	0.37 to 0.56	0.54	0.44 to 0.63
SDGE								
kWh	557	109	47%	0.66	0.87	0.58 to 0.74	0.71	0.65 to 0.78
kW	375	80	35%	0.80	1.17	0.65 to 0.96	0.79	0.68 to 0.91
Therms	206	50	58%	0.50	1.31	0.37 to 0.63	0.60	0.49 to 0.70
SCG								
Therms	591	98	67%	0.55	0.92	0.47 to 0.63	0.65	0.59 to 0.72

A comparison with the combined electric and gas (MMBtu) GRRs shown in Table 1 indicates the following:

- For PGE the lifecycle kWh and Therm GRRs (0.64 and 0.63) are very similar to the MMBtu GRR (0.64). PGE lifecycle energy savings are 56% electric and 44% gas.
- For SCE the lifecycle kWh GRR (0.44) is somewhat lower than the MMBtu GRR (0.48). Since the SCE lifecycle energy savings are 99% electric and 1% gas, this result is mostly attributed to the re-stratification of the 2013-2015 electric savings into five equal strata for kWh analysis purposes, rather than to the exclusion of Therm savings from this analysis.
- For SDGE the lifecycle kWh GRR (0.66) is somewhat higher and the Therm GRR (0.50) is somewhat lower than the MMBTU GRR (0.62). SDGE lifecycle energy savings are 78% electric and 22% gas.
- For SCG the lifecycle Therm GRR (0.55) is very slightly higher than the MMBtu GRR (0.54). Since SCG savings are 100% gas, this is also due to the re-stratification of the 2013-2015 savings into five equal strata for Therm analysis purposes.

Net-to-gross ratios by PA and fuel are presented in Figure 5 and Table 7.



FIGURE 5: NET-TO-GROSS RATIOS BY PA AND FUEL FOR THE 2013-2015 PROGRAM CYCLE

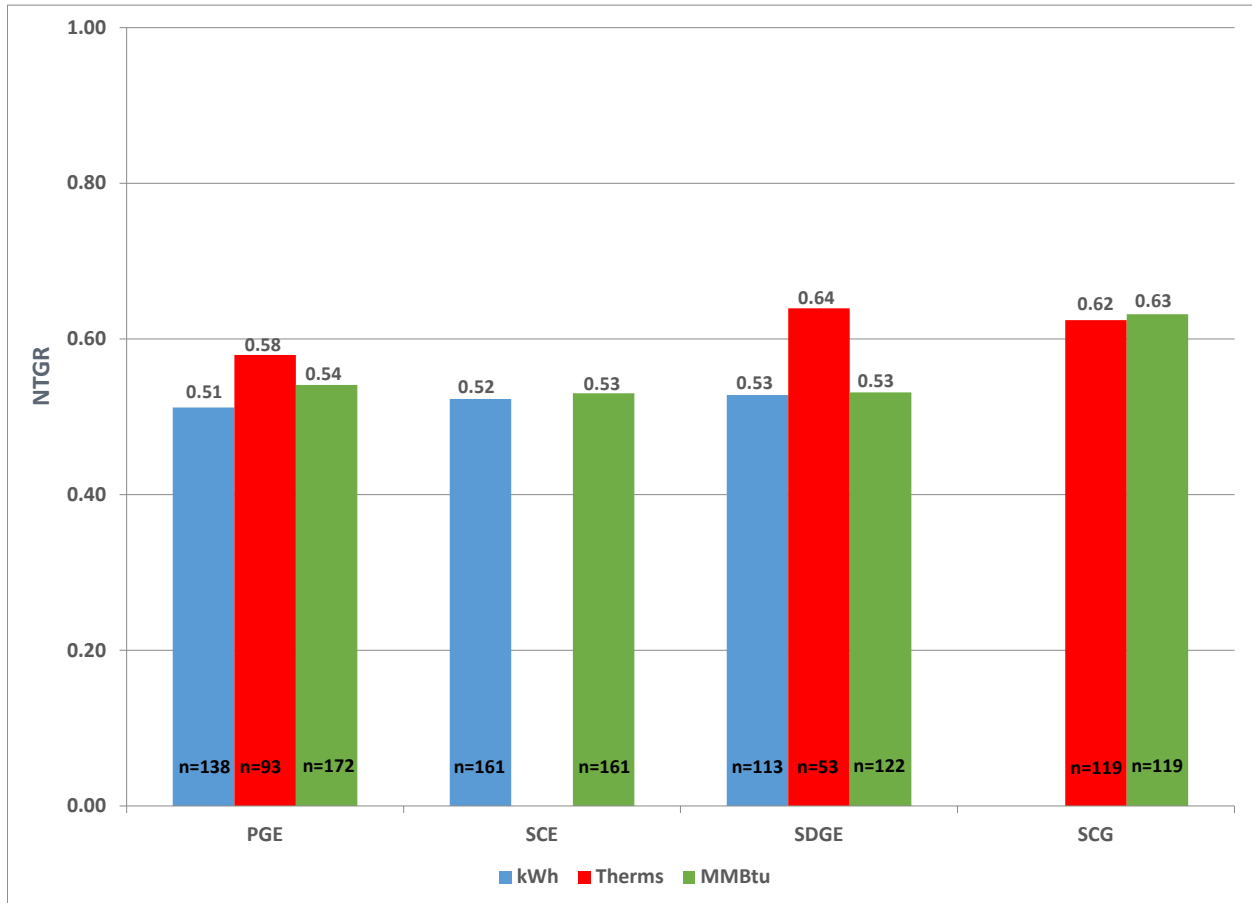




TABLE 7: NET-TO-GROSS RATIOS BY PA AND FUEL FOR THE 2013-2015 PROGRAM CYCLE

Results	Weighted Average Net-to-Gross Ratios			
	PGE	SCE	SDG&E	SCG
kWh				
Weighted NTGR	0.51	0.52	0.53	-
90 Percent Confidence Interval	0.48 to 0.54	0.50 to 0.55	0.50 to 0.56	-
Relative Precision	0.06	0.04	0.06	-
n NTGR Completes	138	161	113	-
N Sampling Units	3,511	2,928	557	-
Error ratio (ER)	0.41	0.35	0.45	-
Percent of Savings Sampled	19%	32%	46%	-
Therms				
Weighted NTGR	0.58	-	0.64	0.62
90 Percent Confidence Interval	0.56 to 0.60	-	0.58 to 0.70	0.60 to 0.65
Relative Precision	0.04	-	0.09	0.04
n NTGR Completes	93	-	53	119
N Sampling Units	1,002	-	206	591
Error ratio (ER)	0.23	-	0.48	0.26
Percent of Savings Sampled	51%	-	46%	52%

A comparison with the combined electric and gas (MMBtu) NTGRs shown in Table 2 indicates the following:

- For PGE the kWh NTGR (0.51) is slightly lower and the Therm NTGR (0.58) is slightly higher than the MMBtu NTGR (0.54).
- For SCE the kWh NTGR (0.52) is slightly lower than the MMBtu NTGR (0.53). Again, this result is mostly attributed to the re-stratification of the 2013-2015 electric savings into five equal strata for kWh analysis purposes.
- For SDGE the kWh NTGR (0.53) is equal to, and the Therm NTGR (0.64) is somewhat higher than the MMBtu NTGR (0.53). Since there were only seven gas-only completes in the sample, all with average NTGRs, the electric NTGR is very similar to the MMBtu NTGR. The dual-fuel projects that contribute to the Therm NTGR have slightly higher NTGRs than average, which causes the Therm NTGR to be higher than the MMBtu NTGR.
- For SCG the Therm NTGR (0.62) is slightly lower than the MMBtu NTGR (0.63). This is again due to the re-stratification of the 2013-2015 savings into five equal strata for Therm analysis purposes.



The overall lifecycle net evaluation realization rates (the ratio of net lifecycle evaluated savings to program estimated gross lifecycle savings) by fuel are presented in Figure 6 and Table 8. The lifecycle net realization rates for nonresidential custom projects during the 2013-2015 program cycle vary between 0.23 and 0.42. The combined electric and gas results from Table 3 are included in Table 8 for comparison purposes.

FIGURE 6: LIFECYCLE NET REALIZATION RATE RESULTS BY PA AND FUEL FOR THE 2013-2015 PROGRAM CYCLE

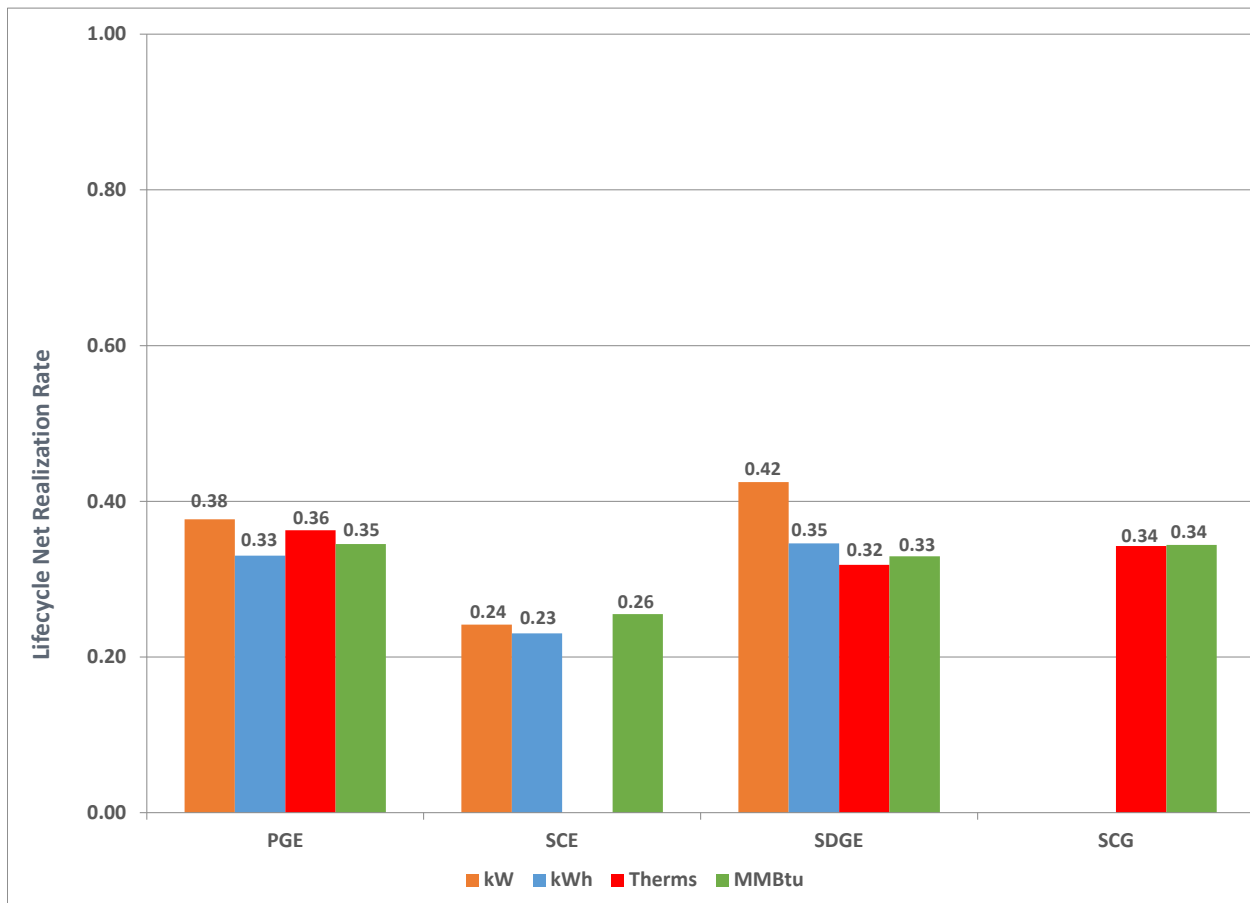




TABLE 8: NET REALIZATION RATES BY PA AND FUEL FOR THE 2013-2015 PROGRAM CYCLE

Results	Lifecycle Net Realization Rate			
	PGE	SCE	SDG&E	SCG
kWh				
Net Realization Rate	0.33	0.23	0.35	-
90 Percent Confidence Interval	0.27 to 0.39	0.19 to 0.27	0.29 to 0.40	-
Relative Precision	0.09	0.06	0.09	-
kW				
Net Realization Rate	0.38	0.24	0.42	-
90 Percent Confidence Interval	0.20 to 0.56	0.18 to 0.30	0.330 to 0.52	-
Relative Precision	0.29	0.10	0.16	-
Therms				
Net Realization Rate	0.36	-	0.32	0.34
90 Percent Confidence Interval	0.32 to 0.40	-	0.23 to 0.41	0.29 to 0.39
Relative Precision	0.06	-	0.15	0.08
MMBtu				
Net Realization Rate	0.35	0.26	0.33	0.34
90 Percent Confidence Interval	0.31 to 0.38	0.21 to 0.30	0.29 to 0.37	0.29 to 0.39
Relative Precision	0.06	0.07	0.07	0.08

Fuel-specific net realization rates are very similar to MMBtu net realization rates.

- For PGE the lifecycle kWh net realization rate (0.33) is slightly lower, and the Therm net realization rate (0.36) is slightly higher than the MMBtu net realization rate (0.35).
- For SCE the lifecycle kWh net realization rate (0.23) is slightly lower than then MMBtu net realization rate (0.26).
- For SDGE the lifecycle kWh net realization rate (0.35) is slightly higher, and the Therm net realization rate (0.32) is slightly lower than the MMBtu net realization rate (0.33).
- For SCG the lifecycle Therm net realization rate is identical to the lifecycle MMBtu net realization rate (0.34).

The differences noted above are not statistically significant.



Itron Consulting & Analysis

1111 Broadway
Suite 1800
Oakland, CA 94607

phone (510) 844-2800
fax (510) 844-2900
www.itron.com/consulting

Both MMBtu and fuel-based net realization rates for kWh and Therm metrics satisfy the 90% confidence and 10% precision criteria, with the exception of the SDGE gas net realization rate, which is 90/15. MMBtu results are based on larger numbers of completes than individual fuel-based results, and are therefore more precise than fuel-based results. Program kW savings are not reported consistently for all electric projects, and have much higher variability than energy savings; kW results are always less precise than kWh, Therm or MMBtu results.