


# Impact Evaluation of 2013-2014 SDG&E Residential VSD Pool Pump Program

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# 1 EXECUTIVE SUMMARY

This report presents DNV GL's energy impact evaluation of San Diego Gas & Electric's (SDG&E) 2013-14 Variable-Speed Drive (VSD) Pool Pump Program. The California Public Utilities Commission (CPUC) determined that the expected (ex ante) savings from VSD pool pumps were uncertain and required an evaluation under the 2014 Efficiency Savings and Performance Initiative (ESPI) review. DNV GL focused its evaluation on metering VSD pool pumps and surveying the customers who received rebates. The evaluation estimated the energy and demand impacts of rebated VSD pool pumps in SDG&E single-family homes only. Other territories and multifamily installations were not included in this evaluation. This evaluation is also part of the CPUC 2013-14 Residential Research Roadmap, which is part of the 2013-14 Energy Efficiency Evaluation, Measurement, and Verification (EM&V) Plan.<sup>1</sup>

The primary objectives of this evaluation were to first determine the ex post gross and net savings impacts for both energy (kWh) and demand (kW) achieved from the 2013-14 SDG&E VSD Pool Pump Program. While gross savings estimate the difference between the incentivized VSD pool pump and a minimally code-compliant two-speed pump, net energy savings consider the difference between the incentivized equipment and the equipment efficiency level that would have been installed in the absence of the program. The evaluation also sought to update key parameter assumptions SDG&E used in their workpaper that documented their methodology and calculations for expected savings. Key parameters DNV GL highlighted in the 2013 ESPI review as having a high degree of uncertainty, included run time and power draw in different power mode settings. Lastly, a third objective for the evaluation was to establish a more appropriate load shape for pool pumps.<sup>2</sup>

## 1.1 Evaluation activities

To achieve the primary evaluation objective of determining ex post gross and net savings impacts for both energy and demand, DNV GL performed the following evaluation activities:

- Review SDG&E's VSD pool pump workpaper to document the key parameters and assumptions used to estimate ex ante savings – Completed for 2013 ESPI
- Review program participation tracking records from SDG&E
- Conduct on-site data collection to document site and measure characteristics
- Conduct end-use metering to analyze the typical energy consumption and load shape of installed VSD pool pumps
- Estimate the baseline energy consumption using data collected during on-site surveys and end-use metering
- Conduct participant phone survey to assess program influence, attribution, and ultimately update the net-to-gross (NTG) ratio.

## 1.2 Gross impacts

As mentioned above, the primary goal of the evaluation was to determine gross and net savings impacts for both energy and demand for the SDG&E VSD Pool Pump Program during the 2013-14 cycle. To estimate

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<sup>1</sup> CPUC. 2013-2014 Energy Efficiency EM&V Plan. <http://www.energydataweb.com/cpuc>

<sup>2</sup> SDG&E workpaper used the load shaped associated with residential central air conditioning as the closest available load shape as a load shape specific to residential pool pumps was not available in the PG&E E3 calculator.

gross savings, the evaluation team used both on-site survey and end-use metering to gather data on VSD pool pump energy usage. The SDG&E workpaper assumed savings are achieved by the VSD pump running at a lower wattage for a longer time period compared to a standard pump with two speeds. The workpaper also assumed the entire volume of the pool runs through the filter daily. The evaluation's metering effort suggests that on average, 152% of the entire pool volume is filtered daily. The metering effort also suggests that the average power draw of VSD pumps in high speed mode is much less than assumed in the workpaper and that the pump runs in both high and low speed modes for longer than assumed. These findings produced ex post energy savings that were very close to the ex ante estimates, but ex post demand savings that were much higher than the ex ante estimate.

The gross realization rate is the ratio of the ex post (achieved) gross savings relative to the ex ante (expected savings) estimates from the workpaper. DNV GL established population-level gross savings estimates by extrapolating the sample level results to the population.

Table 1 shows VSD Pool Pump unit-level (i.e. per pump) expected and achieved gross energy savings. The evaluation successfully sampled 49 sites and achieved a 15.9% relative precision at 90% confidence. As indicated, the average annual unit-level gross savings was 1,230 kWh/year. This estimate indicates a 105% gross savings realization rate compared to the expected savings estimate.

**Table 1. Unit-level gross energy savings summary**

Ex ante energy savings (kWh/ yr)	Ex post energy savings (kWh/ yr), N=49	Energy savings realization rate	Ex post energy savings standard deviation	Ex post energy savings standard error	Ex post energy savings error bound (90% CI)	Ex post energy savings relative precision (90% CI)
1,169	1,230	105%	830	119	±195	±15.9%

Program-level gross expected and achieved energy savings estimates are shown in Table 2. As shown, the VSD Pool Pump Program achieved a gross energy savings realization rate of 105% across all program years. In 2013 and 2014, the program achieved gross energy savings of 2.87 million kWh/year and 2.99 million kWh/year, respectively.

**Table 2. Program-level gross energy savings by program year**

Program year	Ex ante UES (kWh/yr)	Ex post UES (kWh/yr)	Measure quantity	Ex ante gross savings (kWh/yr)	Ex post gross savings (kWh/yr)	Gross savings realization rate
2013	1,169	1,230	2,333	2,727,277	<b>2,869,590</b>	<b>105%</b>
2014	1,169	1,230	2,433	2,844,177	<b>2,992,590</b>	
Total (2013-2014)	1,169	1,230	4,766	5,571,454	<b>5,862,180</b>	

Table 3 shows site-level ex post gross coincident demand savings.<sup>3</sup> The evaluation found that coincidence of

<sup>3</sup> Gross coincident demand reduction was calculated as the average of demand reduction across all sites during the evaluation defined peak window time period within the logging period. Since the logging period did not include the DEER-defined peak periods for the climate zones within the geographical area of the study, the evaluation developed a peak window time period for the logging period that utilized the DEER peak period definitions. The evaluation peak window constraints are as follows: afternoon hours from 2-5 PM on the three hottest consecutive weekdays within the logging period for which all sites had a logger deployed.

operation is slightly lower than the expected estimate, while the measured delta watts per mode is greater than the expected estimate. The achieved gross coincident demand reduction was more than twice as much as the expected estimate, resulting in a gross demand realization rate of 273%.

**Table 3. Site-level gross coincident demand savings summary**

Source	Coincident demand reduction (kW)	Demand savings realization rate
Ex-ante	0.166	<b>273%</b>
Ex-post, n=49	0.453	

Table 4 shows the program-level gross ex post demand savings by program year. Overall, the evaluation found annual demand savings of 1,056 kW/year in 2013 and 1,101 kW/year in 2014, or 273% of the annual ex ante demand savings estimates.

**Table 4. Program-level gross demand savings by program year**

Program year	Ex ante UES (kW/yr)	Ex post UES (kW/yr)	Measure quantity	Ex ante gross savings (kW/yr)	Ex post gross savings (kW/yr)	Gross savings realization rate
2013	0.166	0.453	2,333	387	<b>1,056</b>	<b>273%</b>
2014	0.166	0.453	2,433	404	<b>1,101</b>	
Total (2013-2014)	0.166	0.453	4,766	791	<b>2,157</b>	

### 1.3 Net impacts

In their work paper, SDG&E used the CPUC Database for Energy Efficient Resources (DEER) default NTG value of 0.55 in the net savings calculations, since an impact evaluation of VSD pool pumps had not been undertaken in California before this study. To inform the NTG ratio and consequently the estimate of net savings impacts, DNV GL conducted a phone survey with participants to determine what they would have done in absence of the program as well as the pool contractor's influence on their installation decision.

As shown in Table 5, the results of the participant survey and NTG analysis yielded an achieved NTG ratio of 0.61. This resulted in a net energy savings realization rate of 117%. Overall, the 2013-14 VSD Pool Pump Program achieved energy savings of over 3.5 million kWh/year on a net basis.

**Table 5. Program-level net energy savings by program year**

Program Year	Ex Ante Gross Savings (kWh/yr)	Ex Ante NTG Ratio	Ex Ante Net Savings (kWh/yr)	Ex Post Gross Savings (kWh/yr)	Ex Post NTG Ratio	Ex Post Net Savings (kWh/yr)	Net Savings Realization Rate
2013	2,727,277	0.55	1,500,002	2,869,590	0.61	<b>1,750,450</b>	<b>117%</b>
2014	2,844,177	0.55	1,564,297	2,992,590	0.61	<b>1,825,480</b>	
Total (2013-2014)	5,571,454	0.55	3,064,300	5,862,180	0.61	<b>3,575,930</b>	



Table 6 shows the program-level achieved net demand savings using the evaluated NTG ratio of 0.61. As shown, the VSD Pool Pump Program had a net demand savings realization rate of 253% compared to the ex ante net demand savings estimate. Overall, the 2013-14 program achieved 1,100 kW/year of demand savings.

**Table 6. Program-level net demand savings by program year**

Program Year	Ex Ante Gross Savings (kW/yr)	Ex Ante NTG Ratio	Ex Ante Net Savings (kW/yr)	Ex Post Gross Savings (kW/yr)	Ex Post NTG Ratio	Ex Post Net Savings (kW/yr)	Net Savings Realization Rate
2013	387	0.55	213	866	0.61	<b>644</b>	<b>302%</b>
2014	404	0.55	222	903	0.61	<b>672</b>	
Total (2013-2014)	791	0.55	435	1,768	0.61	<b>1,316</b>	


## 1.4 Conclusions and recommendations

After completing the evaluation of SDG&E's 2013-14 VSD Pool Pump Program, DNV GL's conclusions and recommendations are as follows:

**Energy savings.** The ex post gross and net energy savings found by DNV GL's evaluation were very close to the ex ante estimates used in SDG&E's ESPI workpaper, with 105% gross savings realization rate and 117% net realization rate. While the program achieved high realization rates, the evaluation suggests that updates to the workpaper assumptions for high-speed power draw, daily pool turnover, and run time in both high and low-speed are warranted. The high realization rates found by this evaluation should help alleviate some of the uncertainty that was initially associated with VSD pool pump savings estimates.

**Demand savings.** The ex post demand savings, both gross and net, were more than double the ex ante estimates for demand savings. The workpaper simply averaged the demand reduction in high and low speed (which assumed equal time in both modes); whereas the evaluation found that during peak times VSD pumps do not run in both modes equally. DNV GL used the actual run time in each mode to calculate average site-level demand. Additionally, DNV GL believes that there is an opportunity to achieve additional demand savings with a program or outreach initiative focused on encouraging customers to shift their programmed VSD pump schedule to operate off-peak.

**Customer education.** Anecdotally, through talking with on-site contacts, DNV GL field staff found that the majority of program participants were not well informed about their pool pump operation, schedule, or how to maintain the pump to achieve the expected energy savings. While the program already provides training to contractors and program marketing materials to participants, there is an opportunity to further educate program participants through a simple flyer or leave behind provided by the pool pump contractor focused on pump operation and maintenance that could help participants and the program achieve the desired level of energy savings.



**Future evaluation.** To improve on the precision achieved by this evaluation and further reduce the uncertainty around VSD pool pump energy and demand savings, DNV GL recommends a larger and more robust evaluation of VSD pool pumps in the future. DNV GL recommends that any future evaluation should attempt to measure consumption of non-participants or code-compliant two-speed pool pumps in order to improve the baseline estimate. Additionally, DNG GL recommends a larger sample for future evaluations, which is necessary to improve precision given the large degree of variability of savings on a site by site basis. Lastly, DNV GL recommends a much longer monitoring period to better capture seasonal changes and timing across sites.