

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

California Public Utilities Commission

Date: 4/1/16

CALMAC Study ID: CPU0132.01





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Table of contents

1	EXECUTIVE SUMMARY	1
1.1	Evaluation activities	1
1.2	Gross impacts	1
1.3	Net impacts	3
1.4	Conclusions and recommendations	4
2	INTRODUCTION.....	6
2.1	Objectives	6
2.2	Claimed savings	7
3	METHODS	8
3.1	Gross impact evaluation	8
3.1.1	Sample design	8
3.1.2	Expansion of sample results to the population	10
3.1.3	Data collection	10
3.1.4	Gross savings analysis	12
3.2	Net impact evaluation	18
3.2.1	Participant survey objectives	18
3.2.2	Participant survey implementation	18
3.2.3	NTG analysis	19
4	FINDINGS.....	23
4.1	Gross savings results	23
4.1.1	SDG&E workpaper assumptions	23
4.1.2	Unit-level gross energy savings	23
4.1.3	Site-level gross demand savings	26
4.1.4	Program-level gross energy savings	27
4.1.5	Program-level gross demand savings	28
4.2	Net savings results	28
4.2.1	NTG ratio	28
4.2.2	Program-level net energy savings	30
4.2.3	Program-level net demand savings	30
4.3	Load shape	31
5	CONCLUSIONS AND RECOMMENDATIONS.....	33
Appendix AA.	Standardized High Level Savings	AA-1
Appendix AB.	Standardized Per Unit Savings	AB-1
Appendix AC.	Recommendations	AC-1
APPENDIX B.	ON-SITE DATA COLLECTION FORM	B-1
APPENDIX C.	PARTICIPANT SURVEY	C-1
APPENDIX D.	Installation Contractor Survey Questions	D-1
APPENDIX E.	Participant survey responses	E-1
APPENDIX F.	Site and Equipment Characteristics	F-1

List of figures

Figure 1.	Typical VSD pool pump operation scheme	13
Figure 2.	Ex post site-level coincident demand reduction distribution.....	27
Figure 3.	Ex ante and ex post pool pump load profiles	31
Figure 4.	Ex ante and ex post seasonally adjusted pool pump load profiles.....	32

List of tables

Table 1. Unit-level gross energy savings summary	2
Table 2. Program-level gross energy savings by program year	2
Table 3. Site-level gross coincident demand savings summary	3
Table 4. Program-level gross demand savings by program year	3
Table 5. Program-level net energy savings by program year	3
Table 6. Program-level net demand savings by program year	4
Table 7. 2013-14 Claimed VSD pool pump program savings	7
Table 8. Achieved sample	9
Table 9. Comparison of planned sample and achieved sample	9
Table 10. Summary of collected data	11
Table 11. Field data collection equipment	11
Table 12. Daily pumped volume	15
Table 13. Ex ante and ex post baseline pump run time logic	15
Table 14. Ex ante TOU load shape for residential pool pumps used by SDG&E	17
Table 15. NTG assignment decision based on response to NTG3	20
Table 16. NTG assignment decision based on response to NTG4	20
Table 17. NTG assignment decision based on response to NTG1	21
Table 18. NTG assignment decision based on response to NTG2	21
Table 19. NTG assignment decision based on response to M4	22
Table 20. NTG assignment decision based on response to M2	22
Table 21. Ex Ante comparison of two-speed and variable-speed pool pump	23
Table 22. Ex post energy consumption and savings of two-speed and VSD pool pumps on year-round operating schedules (n=35)	24
Table 23. Ex post energy consumption and savings of two-speed and VSD pool pumps on summer operating schedules (n=14)	25
Table 24. Ex post energy consumption and savings of two-speed and VSD pool pumps on winter operating schedules (n=14)	25
Table 25. Ex post gross energy savings per season, schedule, and annual	26
Table 26. Ex post unit-level gross energy savings summary	26
Table 27. Ex post site-level ex post coincident demand reduction	26
Table 28. Ex post site-level gross coincident demand savings summary	27
Table 29. Program-level ex post gross energy savings by program year	28
Table 30. Program-level ex post gross demand savings by program year	28
Table 31. Importance of rebate in participants' decision to install the VSD pump (NTG1)	29
Table 32. Type of pool pump equipment participants would have installed without the VSD rebate program (NTG3)	29
Table 33. NTG ratio summary	30
Table 34. Program-level ex post net energy savings by program year	30
Table 35. Program-level ex post net demand savings by program year	30
Table 36. Prior pool pump equipment type (PE1)	E-1
Table 37. Prior pool pump equipment age (PE2)	E-1
Table 38. Prior pool pump equipment condition (PE3)	E-1
Table 39. VSD pump installation verification (M1)	E-1
Table 40. How participants heard about VSD pump rebate (M2)	E-2
Table 41. Primary reason for purchasing VSD pump (M3)	E-2
Table 42. Importance of contractor's recommendation on decision to install VSD pump (M4)	E-2
Table 43. Importance of rebate on decision to install VSD pump (NTG1)	E-3
Table 44. Awareness of different pool pump efficiency levels (NTG2)	E-3
Table 45. What participants would have installed without the pool pump rebate program (NTG3)	E-3
Table 46. When participants would have installed the VSD pump without the pool pump rebate program (NTG4)	E-3
Table 47. [For respondents that answered "later" for NTG4] Number of months later (NTG4a)	E-4
Table 48. Who applied for the rebate (SATISO)	E-4

Table 49. Participant satisfaction with program paperwork (SATIS1.1)	E-4
Table 50. Participant satisfaction with rebate application (SATIS1.2)	E-5
Table 51. Participant satisfaction with rebate timeliness (SATIS1.3)	E-5
Table 52. Participant satisfaction with pool pump contractor (SATIS1.4)	E-5
Table 53. Participant satisfaction with VSD pool pump (SATIS1.5)	E-6
Table 54. Participant satisfaction with overall experience (SATIS1.6).....	E-6
Table 55. Change in electric bill since installation of VSD pool pump (SATIS3)	E-6
Table 56. Previously installed pool pump equipment type.....	F-1
Table 57. Size of installed VSD pump	F-1
Table 58. Condition of previously installed pumped	F-1
Table 59. Sites with heated pools.....	F-2
Table 60. Sites with supplemental cleaning equipment	F-2
Table 61. Pool size	F-2

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.¹

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.²

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

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

² 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	2,869,590	105%
2014	1,169	1,230	2,433	2,844,177	2,992,590	
Total (2013-2014)	1,169	1,230	4,766	5,571,454	5,862,180	

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

³ 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	273%
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	1,056	273%
2014	0.166	0.453	2,433	404	1,101	
Total (2013-2014)	0.166	0.453	4,766	791	2,157	

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	1,750,450	117%
2014	2,844,177	0.55	1,564,297	2,992,590	0.61	1,825,480	
Total (2013-2014)	5,571,454	0.55	3,064,300	5,862,180	0.61	3,575,930	

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	644	302%
2014	404	0.55	222	903	0.61	672	
Total (2013-2014)	791	0.55	435	1,768	0.61	1,316	

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.