PUGET SOUND ENERGY
2016-17 BIENNIAL ELECTRIC CONSERVATION ACHIEVEMENT REVIEW (BECAR)
FINAL REPORT

Submitted to

PUGET SOUND ENERGY
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

Submitted by

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sbw
ENERGY + WATER + EFFICIENCY

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EXECUTIVE SUMMARY

Introduction

The Washington Utilities and Transportation Commission (WUTC or Commission) established the requirement for an independent third-party review of Puget Sound Energy's (PSE) 2016-2017 reported electric savings in Order 01, Appendix A, condition (6)(d) of Docket UE-152058. Additionally, WAC 480-109-110(1)(d) requires PSE to involve its Conservation Resource Advisory Group (CRAG) on its independent third-party evaluation of portfolio-level biennial achievements. The intent of the review is to confirm electric savings reported in compliance with RCW 19.285.040(1). PSE retained SBW Consulting. to carry out the Biennial Electric Conservation Achievement Review (BECAR) for the 2016-2017 biennium, under the direction of PSE and WUTC staff, with further input and oversight provided by the CRAG.

This is the final report for the 2016-2017 biennium. It documents the BECAR team's methodology, findings, conclusions, and recommendations, based on an examination of reported achievements for the 2016-2017 program years.

Objectives

The objectives of the 2016-2017 BECAR are threefold:

1. Assess the extent to which PSE's reported electric energy savings were achieved**.** It is limited to those existing electric conservation programs that PSE operated in 2016 and 2017 and which are the basis for the electric energy savings that PSE reports for that two-year period.
2. Offer recommendations concerning PSE's adaptive management performance in regard to implementing Evaluation Report Responses (ERR) and go-forward adjustments from the previous BECAR.
3. Offer recommendations for how to continually improve the BECAR process and reporting for future biennium.

To support the primary objective, our goal is to ensure the BECAR process is transparent, efficient, and collaborative. To this end, we have kept PSE and the stakeholders informed of which programs, measures, savings values, etc. that we are investigating--and why--through a series of interim memorandums and status meetings throughout the process.

Methodology

This review was implemented in two phases. The 2016 BECAR Interim Report dated June 22, 2017 completed the first phase. This report is the conclusion of the second phase; the final two-year report that covers the entire 2016-2017 biennium. The work in each phase is highly dependent on the savings results presented in PSE's Annual Reports of Energy Conservation Accomplishments (ACR), released on March 31, 2017 and March 31, 2018, for program years 2016 and 2017 respectively.

Key tasks include the following:

- **PSE and RTF UES Reviews**: Review deemed Unit Energy Savings (UES) values used by PSE, for reasonable consistency with the requirements of the WAC 480-109-100 and the policy on selection and application of Regional Technical Form (RTF) and non-RTF values in PSE's *Guidelines for Measure Revisions.*
- **Portfolio Savings Audit**: Determine whether reported savings match tracking system data and further investigate irregularities or discrepancies to determine causes and, if necessary, recommend adjustments to reported savings.
- **Recommendation Response Review**: Review PSE actions taken in response to recommendations from 2014-2015 BECAR. Determine reasonableness of action/response relative to the magnitude of the issue and standard industry practice, paying particular attention to findings and recommendations regarding PSE program/measure verification practices.
- **Evaluation Response Report Review**: Assess whether PSE has undertaken follow-up actions on program evaluation studies completed after the 2014-15 BECAR, based on the Evaluation Response Reports included with each completed program evaluation
- **Detailed Review (if needed)**: Review in more detail the energy savings of some programs or measures selected in consultation with PSE, Commission Staff, and the CRAG. This review may include sampling of project files, surveys, on-site inspections, modeling or engineering analysis.

This review is limited to the claimed electric savings that are included in the Total Biennial Washington Energy Independence Act (EIA) Target as defined in PSE's 2016-2017 Biennial Conservation Plan[1]. More specifically, the review includes the additional 5% savings commitment for decoupling, but excludes savings from regional efficiency programs such as the Northwest Energy Efficiency Alliance (NEEA). Additionally, PSE pilot program savings are not included in savings claims.

Findings

This review is limited to the electric conservation programs that PSE operated in 2016-2017 that are the basis for the electric energy savings that PSE has reported in their 2016 ACR and 2017 ACR[2]. The savings shown in the ACRs are substantiated by a thorough review by the BECAR team. No corrections are needed.

[1] The Total Biennial EIA Target is the sum of the Total Biennial Potential plus the legacy Home Energy Report (HER) savings minus the regional Northwest Energy Efficiency Alliance (NEEA) savings. Details of the derivation of this target can be found in WUTC Docket UE-152058, PSE 2016-17 Biennial Conservation Plan Overview, Table 1c, page 5.

[2] The reviewed 2017 ACR document did not reflect one final change in claimed Web Enabled Thermostat savings. The final savings were 2027 MWh, and this is reflected in all tables of this report. The correction will be made in the final 2016-2017 Biennial Conservation Report which will be submitted along with 2016-2017 BECAR.

Table E-1 below compares the reported (claimed) savings with savings goals by tariff group and program.

Table E-1: Summary of 2016 Findings, Claimed versus Target Savings

		2016		2017	
Tariff	Program	Claimed[3] Savings (MWh)	Goal (MWh)	Claimed Savings (MWh)	Goal (MWh)
Residential Energy Management					
E201	**Low Income Weatherization**	**1,667**	**1,560**	**2,148**	**1,836**
E214	**Single Family Existing**	**117,585**	**110,402**	**102,682**	**96,696**
	Web-Enabled Thermostats	165	848	2,027	703
	SF Existing ARRA Weatherization	64	-	-	-
	HomePrint	4,128	3,423	5,141	5,039
	SF Existing Water Heat	1,021	571	941	728
	Single Family Weatherization	2,287	3,221	1,852	2,028
	Single Family Existing Space Heat	7,802	7,284	8,030	7,731
	SF Existing Mobile Home Duct Sealing	190	2,972	-	-
	Home Appliances	5,493	10,291	6,055	6,722
	Residential Showerheads	6,483	4,776	4,939	4,273
	Residential Lighting	84,229	71,294	73,696	69,473
	Home Energy Reports	5,722	5,722	-	-
E216	**Single Family Fuel Conversion**	**1,616**	**1,897**	**2,060**	**1,950**
E217	**Multi-Family Existing**	**19,587**	**17,190**	**18,013**	**18,985**
E218	**Multi-Family New Construction**	**1,441**	**2,000**	**1,318**	**1,294**
Total Residential Energy Management		**141,896**	**133,049**	**126,221**	**120,762**
Business Energy Management					
E250	**Commercial / Industrial Retrofit**	**82,093**	**67,800**	**84,678**	**72,000**
	C/I Retrofit	16,047	20,000	10,507	19,000
	Business Lighting - Grants	58,001	40,300	67784	46,000
	Data Center Efficiency	3,447	3,000	-	-
	Industrial System Optimization	-	1,500	3,094	4,500
	Energy Smart Grocer	4,598	3,000	3,293	2,500
E251	**Commercial / Industrial New Construction**	**19,315**	**10,108**	**24,478**	**10,000**
	C/I New Construction	18,558	10,108	22,760	10,000
	ESG New Construction	757	-	1,718	0
E253	**Resource Conservation Manager**	**13,922**	**14,250**	**14,394**	**30,250**

[3] Note that claimed savings from the Annual achievements report are identical the verified savings from the portfolio tracking Data.

Tariff	Program	2016 Claimed[3] Savings (MWh)	2016 Goal (MWh)	2017 Claimed Savings (MWh)	2017 Goal (MWh)
	Urban Smart Bellevue	-	-	1,432	16,000
	Strategic Resource Management	940	1,000	-	-
	Resource Conservation Manager [CSEM in 2017]	12,982	13,250	12,962	14,250
E258	**Large Power User-Self Directed**	**6,769**	**13,146**	**14,531**	**21,474**
	High Voltage Program	653	3,548	1,968	4,246
	High Voltage Program(Non-449)	6,115	9,598	12,563	17,228
E262	**Commercial Rebates**	**21,100**	**28,265**	**33,800**	**33,031**
	Lodging Direct Install	893	3,091	4,591	5,099
	Agriculture Direct Install	33	1,083	578	2,880
	Commercial Kitchen/Laundry	440	1,011	16,374	10,448
	Commercial HVAC	1,145	2,975	515	1,113
	Small Business Direct Install	7,013	11,021	1,801	3,449
	Business Lighting Markdown	11,029	9,084	9,942	10,043
	Business Lighting Rebates	546	-	-	-
Total Business Energy Management		**143,198**	**133,570**	**171,881**	**166,755**

2017 savings correction to E214-Residential Single Family – Web Enabled Thermostats: We were informed by PSE on April 26, 2018 that an error in reported savings for this sub-program was discovered and corrected in the DSMc database. The correction added 744 MWh to bring total annual 2017 savings for this sub-program to 2,027 MWh. The savings tables for the draft version of this report were updated accordingly for this final version.

Conclusions and Recommendations

This BECAR effort has yielded a comprehensive assessment, as required by the Order, of PSE's electric efficiency portfolio claim for the 2016-17 biennium. Conclusions and recommendations for each of the objective areas—portfolio savings, PSE adaptive management, and future improvements in the BECAR process—are provided below.

Portfolio Savings

- **Claimed savings are accurate.** Savings shown in the 2016 and 2017 Annual Report of Energy Conservation Accomplishments are substantiated by a thorough review of the corresponding extracts from PSE tracking databases. No corrections are needed.
- **Unit energy savings derivations are sound for this biennium.** Reviews in 2016 and 2017 of critical UES values found no errors, and that their derivations are reasonably consistent with the requirements of WAC 480-109-100. Our UES review found several areas for adjustments to future UES methodologies and values, as noted in Section 2.3.

- **Future Home Energy Report savings will significantly increase in 2018.** The Home Energy Reports program's 2014 expansion group pilot will transition to the REM sector in 2018. In 2016, the HER expansion group's savings were about 20,000 MWh (2017 savings are not yet available), so this should boost the overall REM savings claim by about 10%+ in 2018.

Future Improvements in Savings Estimation

Below are recommendations, based on the BECAR findings, for PSE to consider for future program and portfolio improvements.

- **Continue unit energy savings and business case reviews**: UES values account for about 67% of the BEM and REM sectors' savings in 2017. Our mid-2016 UES review found some inconsistency in PSE's baseline wattage assumptions for REM LEDs, which were then modified. Four of the ERRs reviewed in Section 2.4 note occasional anomalies with using appropriate deemed values, data collection, and program data tracking; program staff report that these findings have all been addressed and corrected. Further, our observations in mid-2017 on a limited number (business case workbooks tend to be updated late in the year) of recently updated business case reviews indicate that UES business case documentation is improving markedly. However, given the magnitude of PSE portfolio savings associated with UES values and the supporting business case data, we think it is wise to continue these reviews.

  Recommendation 1*: Conduct additional review of a sample of UES measures and associated business cases in the 2018-2019 BECAR cycle. We recommend these reviews be started by July 2018, so that any modifications would be in time for the 2019 program planning cycle that begins in September 2018.*

- **Apply HVAC interaction factors to applicable Commercial Rebates Program measures**: The Commercial Rebates evaluation found that the Lodging Direct Install and the Small Business Direct Install programs are using UES values for interior LED lighting without HVAC interaction factors; this results in overstated savings.
  Recommendation 2*: Revise the UES values for interior LED lighting in the Lodging Direct Install and Small Business Direct Install programs to account for HVAC interaction factors using RTF data.*

- **Update the Lighting to Go deemed value baselines with most current RTF values.** In the 2016 BECAR Interim Report, we recommended that the Lighting to Go program consider using RTF baseline data for LED lighting when it becomes available; however, this was delayed by the RTF and therefore PSE was unable to modify the baseline for the 2018 program year.

  Recommendation 3*: When this RTF baseline data becomes available, we recommend PSE update the LED UES values accordingly.*

- **Conduct research and develop a standard baseline for BEM indoor agriculture new construction projects.** Unlike other new construction lighting measures, the Washington State Energy Code does not set a lighting power density baseline for indoor agriculture. PSE program staff determine baseline kW for these projects through interviews with growers

about the lighting technologies they would have used absent utility incentives. Indoor agriculture projects represent about 10% of the entire BEM sector savings, and this is an expanding and relatively new commercial industry now addressed by utility incentive structures. In the interest of proactive adaptive management, it would be instructive to conduct a survey of indoor horticultural growers in the region, with the goal of establishing a rigorous set of best practice savings estimation protocols to ensure an accurate accounting of savings for this significant end use.

Recommendation 4*: Conduct a survey of regional indoor agriculture operators to gain an understanding of which lighting technologies, absent utility incentives, would have been used for new horticultural operations. Similarly, do a literature search to find any studies that already may have been done on this subject. Based on the results of this research, baseline recommendations will be presented to PSE for consideration.*

Future Improvements in PSE Adaptive Management and BECARs

It is our BECAR team's opinion that the iterative changes to the BECAR process over the past four bienniums have resulted in a process that adds value to program management and is well understood by PSE managers and staff. Moreover, PSE's internal adaptive management practices are embedded in program operations and, when needed, prompt timely mid-course program adjustments occur. Because this 2016-2017 biennium has gone smoothly and without any findings requiring re-estimation of savings, we recommend staying the course with the current BECAR structure for the 2018-2019 biennium.

- ***Recommendation 5: Continue tracking BECAR report recommendation status.*** *This is standard practice in BECAR and provides continuity between BECAR biennium cycles.*
- ***Recommendation 6: Continue conducting UES and supporting documentation reviews.*** *Developing and updating UES values is a complex task and, given the magnitude of savings in the PSE portfolio, justify regular third-party review.*
- ***Recommendation 7: Continue evaluation response reviews.*** *Based on review of the ERRs and evaluations for 2016-2017, it is evident that where practical, PSE program staff quickly implement recommendations from the third-party evaluations. For recommendations that are either partially implemented or not implemented, PSE project managers put forth clear reasoning to support their decisions. While some of the evaluation findings have prompted direct actions, PSE's own internal adaptive management process also provides both impetus and solutions to a significant number of the issues raised, frequently in advance of the receipt of evaluation results.*

1. INTRODUCTION

1.1. Background

On December 17, 2015 the Washington Utilities and Transportation Commission (WUTC or Commission) established the requirement for an independent third-party review of Puget Sound Energy's (PSE's) 2016-2017 reported electric savings, in Order 01, Appendix A of Docket UE-152058, condition (6)(g). Additionally, WAC 480-109-110(1)(d) requires PSE to involve its Conservation Resource Advisory Group (CRAG) on the independent third-party evaluation of portfolio-level biennial achievement. The intent of the review is to confirm electric savings reported in compliance with RCW 19.285.040(1). The Order and WAC rule continue a review cycle established for PSE in 2010.

Condition (6)(g) in the Order is the following requirement to conduct an independent third-party review of the electric energy savings reported by PSE for the 2016-2017 biennium.

> *An independent third-party review of portfolio-level electric energy savings reported by Puget Sound Energy for the 2016-2017 biennial period, from existing conservation programs operated during that period, shall be conducted, per WAC 480-109-120(4)(b)(v). The independent third-party reviewer shall be selected through an RFP process, unless unanimously agreed by the CRAG [Conservation Resources Advisory Group]. The review will be funded by the Puget Sound Energy Electric Conservation Service Rider. The review will be managed by UTC and Puget Sound Energy staff with input on the scope, cost, RFP development, reviewer selection and ongoing oversight by the CRAG.*
>
> *A final report for the entire 2016-2017 biennium may be implemented in phases and delivered as a final product at an earlier date, as needed by Puget Sound Energy.*

PSE retained SBW Consulting, Inc. to carry out a Biennial Electric Conservation Achievement Review (BECAR) for the 2016-2017 biennium, under the direction of PSE and WUTC staff, with further input and oversight provided by the CRAG.

This is the final BECAR report for the 2016-2017 biennium. It documents the BECAR team methodology, findings, conclusions, and recommendations to date, based on an examination of reported achievements for the 2016-2017 program years.

1.2. Objectives

The primary objective of the 2016-2017 BECAR is to assess the extent to which PSE's reported electric energy savings are achieved. This final report is a review of the electric conservation programs that PSE operated in 2016-2017, which is the basis for the electric energy savings that PSE has reported in their Annual Report of Energy Conservation Accomplishments (ACR). Therefore, the primary product of our assessment are tables that show PSE claimed savings, by program, compared to verified savings as determined by the review team.

The secondary objective of the 2016-17 BECAR is to offer recommendations concerning PSE's adaptive management performance with regard to implementing Evaluation Report Responses (ERRs) and go-forward adjustments from the previous BECAR.

The third objective is to offer recommendations for how to continually improve the BECAR process and reporting for future biennium.

To support the primary objective, our goal is to ensure the BECAR process is transparent, efficient, and collaborative. To this end, we have kept PSE and the stakeholders informed of which programs, measures, savings values, etc. we are investigating--and why--through a series of interim memorandums and status meetings throughout the process.

1.3. 2016-2017 Electric Portfolio

PSE offers their customers a broad range of programs and measures across all customer classes. The WUTC approves each of PSE's tariff schedule groups and associated programs. PSE reports their progress toward achieving savings targets semi-annually, with energy savings reported and evaluated on a gross savings basis. PSE must derive electric energy savings from either the deemed savings estimates developed by the RTF (sometimes with modifications for PSE-specific factors), other methods based on impact evaluation data, or other relevant data that has verified savings levels.

Therefore, the primary product of our assessment is a table that shows the PSE claimed savings, by program, compared to verified savings as determined by the review team.

The PSE 2016 ACR claims annual electric savings of 314,500 MWh, exceeding the 2016 electric savings goal of 294,400 MWh by 7%. The PSE 2017 ACR [4]claims annual electric savings of 318,300 MWh, exceeding the 2017 electric savings goal of 309,900 MWh by 3%. Section 2.2 provides additional details of 2016 reported versus verified savings.

Table 1 lists PSE's entire electric savings portfolio. BECAR's scope covers the Residential and Business sectors; Pilots and Regional sector savings are outside of the BECAR scope and their savings are not claimed by PSE.

Table 1: PSE 2016-2017 Electric Portfolio, Claimed and Targeted Savings

	2016			2017		
	Savings (MWh)	Goal (MWh)	Savings (% of Goal)	Savings (MWh)	Goal (MWh)	Savings (% of Goal)
Residential	141,896	133,049	107%	126,221	120,762	105%
Business	143,198	133,570	107%	171,881	166,755	103%
Pilots	17,300	17,300	100%	5,300	5,300	100%

[4] The reviewed 2017 ACR document did not reflect one final change in claimed Web Enabled Thermostat savings. The final savings were 2027 MWh, and this is reflected in all tables of this report. The correction will be made in the final 2016-2017 Biennial Conservation Report which will be submitted along with 2016-2017 BECAR.

	2016			2017		
	Savings (MWh)	Goal (MWh)	Savings (% of Goal)	Savings (MWh)	Goal (MWh)	Savings (% of Goal)
Regional	12,100	10,500	115%	15,600	17,100	91%
Total	**314,494**	**294,419**	**107%**	**319,002**	**309,917**	**103%**

Table 2 and Table 3 present 2016 and 2017 program year claimed savings and target savings for the Residential Energy Management (REM) and Business Energy Management (BEM) sectors, by tariff and the programs that contribute to each tariff group.

Table 2: 2016 Residential and Business Sectors , Claimed and Targeted Savings

		2016			
Tariff	Program	Savings Claim (MWh)	Goal (MWh)	Savings (% of Goal)	Delta (Claim - Goal)
	Residential Energy Management				
E201	**Low Income Weatherization**	**1,667**	**1,560**	**107%**	**106**
E214	**Single Family Existing**	**117,585**	**110,402**	**107%**	**7,183**
	Web-Enabled Thermostats	165	848	20%	-683
	SF Existing ARRA Weatherization	64	-	-	-
	HomePrint	4,128	3,423	121%	705
	SF Existing Water Heat	1,021	571	179%	450
	Single Family Weatherization	2,287	3,221	71%	-934
	Single Family Existing Space Heat	7,802	7,284	107%	518
	SF Existing Mobile Home Duct Sealing	190	2,972	6%	-2,781
	Home Appliances	5,493	10,291	53%	-4,798
	Residential Showerheads	6,483	4,776	136%	1,707
	Residential Lighting	84,229	71,294	118%	12,935
	Home Energy Reports	5,722	5,722	100%	-
E216	**Single Family Fuel Conversion**	**1,616**	**1,897**	**85%**	**-281**
E217	**Multi-Family Existing**	**19,587**	**17,190**	**114%**	**2,396**
E218	**Multi-Family New Construction**	**1,441**	**2,000**	**72%**	**-559**
Total Residential Energy Management		**141,896**	**133,049**	**107%**	**8,847**
	Business Energy Management				
E250	**Commercial/Industrial Retrofit**	**82,093**	**67,800**	**121%**	**14,293**
	C/I Retrofit	16,047	20,000	80%	-3,953
	Business Lighting - Grants	58,001	40,300	144%	17,701
	Data Center Efficiency	3,447	3,000	115%	447
	Industrial System Optimization	-	1,500	0%	-1,500
	Energy Smart Grocer	4,598	3,000	153%	1,598

Tariff	Program	2016 Savings Claim (MWh)	2016 Goal (MWh)	2016 Savings (% of Goal)	2016 Delta (Claim - Goal)
E251	**Commercial/Industrial New Construction**	**19,315**	**10,108**	**191%**	**9,206**
	C/I New Construction	18,558	10,108	184%	8,449
	ESG New Construction	757	-		757
E253	**Resource Conservation Manager**	**13,922**	**14,250**	**98%**	**-328**
	Urban Smart Bellevue	-	-	-	-
	Strategic Resource Management	940	1,000	94%	-60
	Resource Conservation Manager [CSEM in 2017]	12,982	13,250	98%	-268
E258	**Large Power User-Self Directed**	**6,769**	**13,146**	**51%**	**-6,377**
	High Voltage Program	653	3,548	18%	-2,895
	High Voltage Program (Non-449)	6,115	9,598	64%	-3,482
E262	**Commercial Rebates**	**21,100**	**28,265**	**75%**	**-7,165**
	Lodging Direct Install	893	3,091	29%	-2,198
	Agriculture Direct Install	33	1,083	3%	-1,050
	Commercial Kitchen/Laundry	440	1,011	44%	-571
	Commercial HVAC	1,145	2,975	38%	-1,830
	Small Business Direct Install	7,013	11,021	64%	-4,008
	Business Lighting Markdown	11,029	9,084	121%	1,945
	Business Lighting Rebates	546	-	-	546
Total Business Energy Management		**143,198**	**133,570**	**107%**	**9,628**

Table 3: 2017 Residential and Business Sectors, Claimed and Targeted Savings

Tariff	Program	2017 Savings Claim (MWh)	2017 Goal (MWh)	2017 Savings (% of Goal)	2017 Delta (Claim - Goal)
	Residential Energy Management				
E201	**Low Income Weatherization**	**2,148**	**1,836**	**117%**	**312**
E214	**Single Family Existing**	**102,682**	**96,696**	**106%**	**5985**
	Web-Enabled Thermostats	2,027	703	288%	1324
	SF Existing ARRA Weatherization	-	-	-	-
	HomePrint	5,141	5,039	102%	101
	SF Existing Water Heat	941	728	129%	214
	Single Family Weatherization	1,852	2,028	91%	-175
	Single Family Existing Space Heat	8,030	7,731	104%	299
	SF Existing Mobile Home Duct Sealing	-	-	-	-
	Home Appliances	6,055	6,722	90%	-666
	Residential Showerheads	4,939	4,273	116%	667

Tariff	Program	2017 Savings Claim (MWh)	2017 Goal (MWh)	2017 Savings (% of Goal)	2017 Delta (Claim - Goal)
	Residential Lighting	73,696	69,473	106%	4,223
	Home Energy Reports	-	-	-	-
E216	**Single Family Fuel Conversion**	**2,060**	**1,950**	**106%**	**110**
E217	**Multi-Family Existing**	**18,013**	**18,985**	**95%**	**-972**
E218	**Multi-Family New Construction**	**1,318**	**1,294**	**102%**	**24**
Total Residential Energy Management		**126,221**	**120,762**	**105%**	**5,459**
	Business Energy Management				
E250	**Commercial / Industrial Retrofit**	**84,678**	**72,000**	**118%**	**12,678**
	C/I Retrofit	10,507	19,000	55%	-8,493
	Business Lighting - Grants	67,784	46,000	147%	21,784
	Data Center Efficiency	-	-	-	-
	Industrial System Optimization	3,094	4,500	69%	-1,406
	Energy Smart Grocer	3,293	2,500	132%	793
E251	**Commercial / Industrial New Construction**	**24,478**	**10,000**	**245%**	**14,478**
	C/I New Construction	22,760	10,000	228%	12,760
	ESG New Construction	1,718	0	-	1,718
E253	**Resource Conservation Manager**	**14,394**	**30,250**	**48%**	**-15,856**
	Urban Smart Bellevue	1,432	16,000	9%	-14,568
	Strategic Resource Management	-	-	-	-
	Resource Conservation Manager [CSEM in 2017]	12,962	14,250	91%	-1,288
E258	**Large Power User-Self Directed**	**14,531**	**21,474**	**68%**	**-6,943**
	High Voltage Program	1,968	4,246	46%	-2,278
	High Voltage Program (Non-449)	12,563	17,228	73%	-4,665
E262	**Commercial Rebates**	**33,800**	**33,031**	**102%**	**769**
	Lodging Direct Install	4,591	5,099	90%	-508
	Agriculture Direct Install	578	2,880	20%	-2,302
	Commercial Kitchen/Laundry	16,374	10,448	157%	5,926
	Commercial HVAC	515	1,113	46%	-598
	Small Business Direct Install	1,801	3,449	52%	-1,648
	Business Lighting Markdown	9,942	10,043	99%	-101
	Business Lighting Rebates	-	-	-	-
Total Business Energy Management		**171,881**	**166,755**	**103%**	**5,126**

1.4. Data Sources

The list below describes the various categories of data the team relied upon to perform their review:

- **2016-2017 Biennial Conservation Plan (BCP)**: Titled *2016-2017 Biennial Conservation Plan*, this PSE report, filed in Docket No. UE-152058, outlines the new and revised programs, functions, and activities PSE is putting into place to meet energy conservation targets for 2016-2017 electric and gas programs.
- **2016 Annual Report of Energy Conservation Accomplishments (ACR):** This PSE report is the primary documentation of the claimed savings from 2016 conservation activities. It presents overall and program-level expenditures and savings and cost-effectiveness ratios, as well as information about evaluation, measurement, and verification activities, programmatic activities in the residential and business sectors, regional programs and relationships, support activities, and stakeholder relationships.
- **2017 Annual Report of Energy Conservation Accomplishments**: This PSE report is the primary documentation of the claimed savings from 2017 conservation activities. It presents overall and program-level expenditures and savings and cost-effectiveness ratios, as well as information about evaluation, measurement, and verification activities, programmatic activities in the residential and business sectors, regional programs and relationships, support activities, and stakeholder relationships
- **Interviews**: During the course of the review, the review team has been in contact with PSE Energy Efficiency managers and staff to obtain information and clarification about programs, data, and evaluation activities. These contacts occurred in person, over the phone, and via e-mail, in both formal and informal contexts.
- **Tracking database extracts**: PSE provided the review team with extracts from the Residential Energy Management (REM) and Business Energy Management (BEM) sector savings tracking databases. The tracking database extracts underpin the results shown in the 2016 and 2017 Annual Conservation Report.
- **Business Cases:** PSE provided the review team with the Business Cases and supporting files which were requested by the review team. The Business Cases contain the source references, assumptions, and calculations which are the basis for PSE deemed Unit Energy Savings (UES) values.
- **2014-2015 BECAR Final Report**: Submitted to PSE in May of 2016, this report includes seven recommendations covering the BECAR process, impact evaluations, PSE deemed savings, and other PSE savings calculations.
- **Evaluation Response Reports (ERRs):** Twelve third party program evaluations were provided for this review along with accompanying report responses by the PSE program management teams.
- **LED grow light project files:** PSE provide the review team with project files for ten E251 – Commercial/Industrial New Construction LED grow light projects.

- **Evaluation Response Reports (ERRs)**: ERRs are PSE staff responses to third party program evaluation recommendations with regard to implementation of the recommendations.

2. METHODOLOGY AND FINDINGS

2.1. Overview

The BECAR review team has completed the 2016-2017 UES Reviews, Portfolio Savings Audit, Recommendation Response Reviews, and Evaluation Report Response Reviews. The methodologies used by the review team, the findings and recommendations to date, and the remaining activities are presented in the following sections.

2.2. Portfolio Savings Audit

2.2.1. Methodology

The Portfolio Savings Audit is a key component of the BECAR's primary purpose, which is *to assess the extent to which PSE's reported electric energy savings were achieved*. Under this task, there are two subtasks:

1. Compare the claimed savings shown in the Annual Report of Energy Conservation to the savings entered in the PSE tracking databases. This subtask is performed twice: once for the 2016 reported savings and again for the 2017 reported savings.
2. For each program year we do a comparison to determine if there are any significant changes between the reported savings, the planned (PSE 2016-2017 Biennial Conservation Plan) savings, and the 2016-2017 reported savings. This comparison may indicate programs or sub-programs that warrant further investigation under one of the other BECAR tasks. We will also look for 'emerging' savers: programs and/or measures with unanticipated savings compared to the planned and/or past biennium savings.

In order to accomplish the first subtask, the review team received a draft of the 2016 and 2017 ACRs[5] from PSE, along with PSE Exhibit 1_2016-2017 Savings and Budgets and PSE Exhibit 5_2016-2017 Prescriptive Measures. PSE then provided the BECAR review team with extracts from their 2016-2017 savings tracking databases. The extracts (in MS Excel format) contain all the individual savings records that comprise the 2016-2017 REM and BEM claimed savings.

The BEM savings claim files contain 12,003 and 16,688 individual records in 2016 and 2017 respectively; with individual records covering five tariff groups: E250, E251, E253, E258, and E262. There are no E261-Energy Efficient Technology Evaluation reported savings in 2016. The REM savings claim contains 174,797 and 438,995 individual records in 2016 and 2017 respectively; which cover five tariff groups: E201, E214, E216, E217, and E218.

The PSE tracking databases contain multiple fields for each record. The BECAR review team requested an abbreviated set of fields in the extracts from PSE, since gas savings are not required for this review nor are incentive amounts or other cost data. PSE also provided the

[5] Energy Efficiency Annual Report of Energy Conservation Accomplishments

following summary tables to assist in the review team in our analysis: (1) BusinessSavings_ByTariffGroup_R.pdf, and (2) ResidentialSavings_ByTariffGroup_R.pdf.

The BECAR review team verified that the savings reported in the 2016 ACR and 2017 ACR [6]accurately reflect the savings claimed in the PSE tracking databases, both on a high-level REM and BEM sector basis, as well as a program-level basis. The review team also checked to ensure that entries reflect measure savings claimed in 2016-2017, and that UES values were consistent with those reported in PSE's Exhibit 5 from the 2016 ACR and 2017 ACR.

2.2.2. Sector Findings

The BECAR review did not find any calculation or data errors in either the REM or the BEM sector data sets. We carefully examined program data fully and have verified its accuracy. Below we describe in more detail our assessment of the REM and BEM accomplishment reporting, intended to identify larger-scale anomalies that could have indicated the presence of data issues.

2.2.2.1. Residential Energy Management

The PSE *2016 ACR* and *2017 ACR* reports biennial electric savings of 268,117 MWh for Residential Energy Management (REM), exceeding the combined biennial electric savings target of 253,811 MWh by 6%. Table 4 shows 2016-2017 claimed savings alongside target savings.

Table 4: 2016-2017 REM Sector Savings versus Target

		2016		2017		2016-2017 Combined
Tariff	Program	Claimed Savings (MWh)	Target (MWh)	Claimed Savings (MWh)	Target (MWh)	% of Target Achieved
Residential Energy Management						
E201	**Low Income Weatherization**	**1,667**	**1,560**	**2,148**	**1,836**	**112%**
E214	**Single Family Existing**	**117,585**	**110,402**	**102,682**	**96,696**	**106%**
	Web-Enabled Thermostats	165	848	2,027	703	141%
	SF Existing ARRA Weatherization	64				
	HomePrint	4,128	3,423	5,141	5,039	110%
	SF Existing Water Heat	1,021	571	941	728	151%
	Single Family Weatherization	2,287	3,221	1,852	2,028	79%
	Single Family Existing Space Heat	7,802	7,284	8,030	7,731	105%
	SF Existing Mobile Home Duct Sealing	190	2,972			6%

[6] The reviewed 2017 ACR document did not reflect one final change in claimed Web Enabled Thermostat savings. The final savings were 2027 MWh, and this is reflected in all tables of this report. The correction will be made in the final 2016-2017 Biennial Conservation Report which will be submitted along with 2016-2017 BECAR.

		2016		2017		2016-2017 Combined
Tariff	Program	Claimed Savings (MWh)	Target (MWh)	Claimed Savings (MWh)	Target (MWh)	% of Target Achieved
	Home Appliances	5,493	10,291	6,055	6,722	68%
	Residential Showerheads	6,483	4,776	4,939	4,273	126%
	Residential Lighting	84,229	71,294	73,696	69,473	112%
	Home Energy Reports	5,722	5,722			100%
E216	**Single Family Fuel Conversion**	**1,616**	**1,897**	**2,060**	**1,950**	**96%**
E217	**Multi-Family Existing**	**19,587**	**17,190**	**18,013**	**18,985**	**104%**
E218	**Multi-Family New Construction**	**1,441**	**2,000**	**1,318**	**1,294**	**84%**
Total Residential Energy Management		**141,896**	**133,049**	**126,221**	**120,762**	**106%**

Figure 1 shows the 4 year trend in achieved savings for each of the five tariff groups. E214 – Single family existing is by far the largest tariff group, accounting for 82% of REM savings, distantly followed by E217 – Multi-family Existing with 14%. The remaining tariffs each account for about 1% of the total REM portfolio.

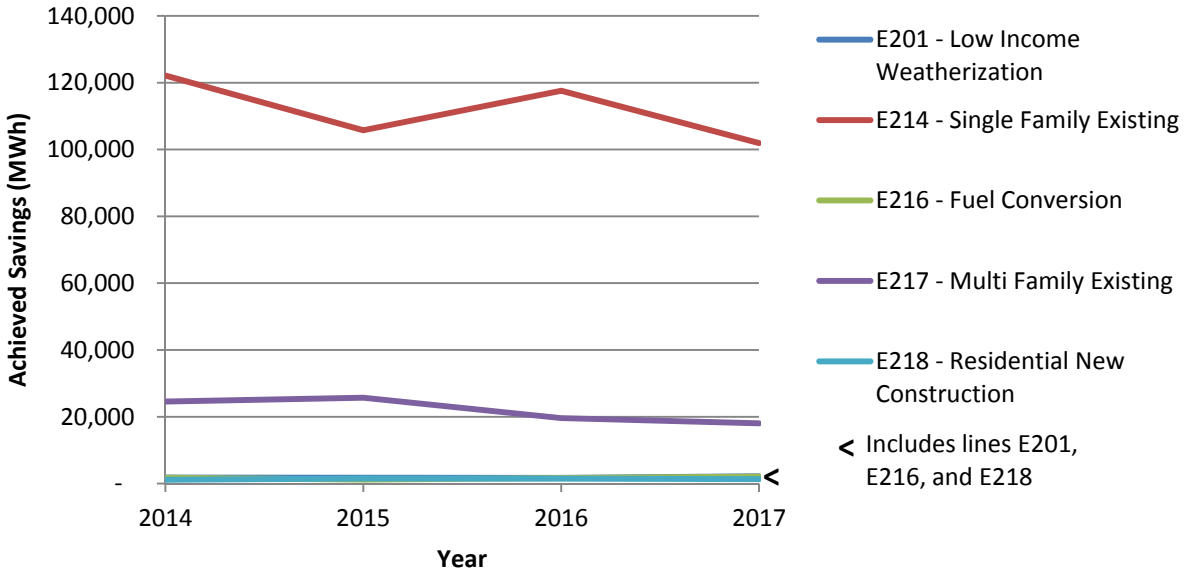

Figure 1: 2014-2017 REM Tariff Achievements Summary

Table 5 shows the percent savings contributions of the programs that comprise the Residential Sector savings. Residential Lighting, which is a program in tariff E214-Single Family Existing, contributes 59% of the entire Residential Sector savings.

Table 5: 2016-17 Residential (REM) Sector Lamp Quantities Receiving Rebates

	2016	2017	2016-2017
	Claimed Savings (MWh)	Claimed Savings (MWh)	Combined savings (MWh)
Residential Lighting	**84,229**	**73,696**	**157,926**
RETL: Lamp - LED - A Lamp	25,456	25,691	51,147
RETL: Lamp - LED - Candelabra	5,524	6,162	11,686
RETL: Lamp - LED - Globe	1,060	1,413	2,472
RETL: Fixture - LED - Indoor	2,146	1,063	3,209
RETL: Lamp - LED - MR16	498	411	908
RETL: Fixture - LED - Outdoor	631	144	775
RETL: Lamp - LED - Reflector	29,242	28,973	58,214
RETL: Fixture - LED - Retrofit Kit	6,107	6,525	12,632
RETL: Lamp - CFL - Specialty	1,708	404	2,112
RETL: Lamp - CFL - Standard	11,565	789	12,354
RETL: Fixture - LED - T8 Retrofit	125	545	670
RETL: Fixture - LED - T8	170	811	981
RETL: String Lighting - LED - Outdoor	0	766	766

REM Observations and Findings

Key observations about the REM savings claim include the following:

- **The overall REM sector surpassed its biennial target** by 6%. E201- Low Income Weatherization, E214- Single Family Existing, and E217- Multi-Family Existing exceeded their combined targets. E216-Single Family Fuel Conversion and E218- Multi-Family New Construction did not achieve their combined targets.
- **Lighting is the main savings contributor**: 94,591 MWh or 65% of the REM savings portfolio, is from various lighting measures. Aside from the lighting measures under E214 Residential Lighting, 84,229 MWh and 73,696 MWh in 2016-2017 respectively; there is also 6,258 MWh and 7,234 MWh in 2016 and 2017, respectively, of lighting savings under E217 Multi-Family Existing. In 2014, LEDs accounted for 50 percent of the residential lighting savings for the year. In 2016 LEDs accounted for 84 percent of the savings. The increased adoption of LED technology is in large part due to better technology and lower prices as manufacturing processes gain efficiency. In 2017 the Residential Lighting program exceeded its savings goal by 6%. This accomplishment was aided by changing market conditions in which the overall cost of LED technology declined and the customer adoption rate of residential LEDs increased. The decrease in cost for LED technology, coupled with the overall growth in customer adoption rate of LEDs, caused a decline in sales for CFLs over 2014-2015.

- **E214**: **Home Energy Reports**: This program continues to produce reliable savings, with 5.7 MWh claimed in 2016. The 2017 savings will not be available until mid-2018 and therefore are not included in this report. HER's 2014 expansion group has just completed its third year as a pilot program; pilot program savings are not claimed. PSE has informed us that the expansion group savings will be claimed for the 2018 program year and will add roughly 20,000 MWh to REM sector savings.
- **E214: Single Family Existing**: Duct sealing is no longer listed with an annual goal, although it is still listed as a zero savings measure in the 2017 ACR. This comes off the back of extreme under-performance (6% of goal) in 2016.
- **E214-Home Appliances** underperformed (i.e., claimed savings less than goal) in both 2016 and 2017. The target for 2016 was similar to the target for the 2014-2015 biennium. 2016 saw a significant decrease in clothes washer measures claimed. This resulted in the achievement coming in 47% below target. This overall trend of decreased participation was noted in the 2014-2015 biennial report. Starting in 2015, Energy Star specifications changed for both refrigerators and clothes washers; making Energy Star appliances much more efficient. As a result, many appliances were removed from the Energy Star qualified list, and this significantly limited the quantity of Energy Star products available for customer purchase. This, combined with overall market saturation, contributed to declining potential for these measures. The overall appliance savings and budget result was below its forecast and spending goals for the year. It is worth noting that the targets for spending and savings were adjusted in 2017, and these adjustments better reflect the overall trend for these programs.
- **E214-Residential Showerheads** exceeded their targets for the biennium. This is a significant increase in the claimed savings over the 2014-2015 Biennium. Significant progress was made in 2015 for expanding the reach and recognition of PSE's retail showerhead program, as PSE's electric and natural gas savings goals were high. The program fell short of achieving its forecasted savings goal. This was due to lower than anticipated customer interest in showerheads. Expectations were adjusted appropriately for 2016 and 2017 with an overachievement and improvement in claimed savings for 2016. 2017 saw a decrease from 2016 savings achieved.
- **E216-Fuel Conversion** underperformed in 2016, and slightly over-performed in 2017. Underperformance was due to difficulty in marketing to a very specific customer demographic. The slight over-performance was primarily driven by relatively easy to install dryer conversions.
- **E217-MF Existing** accounts for 37,600 MWh, or 14% of the total 2016-2017 REM sector. Savings exceeded its goal in 2016 and fell just short of its goal in 2017. Overall, the program exceeded savings targets by 14%.
- **E214-Residential Single Family – Web Enabled Thermostats 2017 Savings Change:** We were informed by PSE on April 26, 2018 that an error in reported savings for this sub-program was discovered and corrected in the DSMc database. The correction added 744

MWh to bring total annual 2017 savings for this sub-program to 2,027 MWh. The savings tables for the draft version of this report were updated accordingly for this final version.

2.2.2.2. Business Energy Management

The PSE *2016* ACR claims annual electric savings of 143,198 MWh for BEM, exceeding the 2016 electric savings target of 133,470 MWh by 7%. Table 6 shows 2016 claimed savings and target savings.

Table 6: 2016- 2017 BEM Sector Electric Savings vs Target

		2016		2017		2016-2017 Combined
Tariff	Program	Claimed Savings (MWh)	Target (MWh)	Claimed Savings (MWh)	Target (MWh)	% of Target Achieved
Business Energy Management						
E250	**Commercial / Industrial Retrofit**	**82,093**	**67,800**	**84,678**	**72,000**	**119%**
	C/I Retrofit	16,047	20,000	10,507	19,000	68%
	Business Lighting - Grants	58,001	40,300	67,784	46,000	146%
	Data Center Efficiency	3,447	3,000			115%
	Industrial System Optimization		1,500	3,094	4,500	52%
	Energy Smart Grocer	4,598	3,000	3,293	2,500	143%
E251	**Commercial / Industrial New Construction**	**19,315**	**10,108**	**24,478**	**10,000**	**218%**
	C/I New Construction	18,558	10,108	22,760	10,000	205%
	ESG New Construction	757		1,718		
E253	**Resource Conservation Manager**	**13,922**	**14,250**	**14,394**	**30,250**	**64%**
	Urban Smart Bellevue			1,432	16,000	9%
	Strategic Resource Management	940	1,000			94%
	Resource Conservation Manager [CSEM in 2017]	12,982	13,250	12,962	14,250	94%
E258	**Large Power User-Self Directed**	**6,769**	**13,146**	**14,531**	**21,474**	**62%**
	High Voltage Program	653	3,548	1,968	4,246	34%
	High Voltage Program(Non-449)	6,115	9,598	12,563	17,228	70%
E262	**Commercial Rebates**	**21,100**	**28,265**	**33,800**	**33,031**	**90%**
	Lodging Direct Install	893	3,091	4,591	5,099	67%
	Agriculture Direct Install	33	1,083	578	2,880	15%
	Commercial Kitchen/Laundry	440	1,011	16,374	10,448	147%
	Commercial HVAC	1,145	2,975	515	1,113	41%
	Small Business Direct Install	7,013	11,021	1,801	3,449	61%
	Business Lighting Markdown	11,029	9,084	9,942	10,043	110%
	Business Lighting Rebates	546				
Total Business Energy Management		**143,198**	**133,570**	**171,881**	**166,755**	**105%**

Figure 2 shows the four year trends in achieved savings for the BEM portfolio from 2014-2017. For this four year period, E250 – Commercial/Industrial Retrofit accounted for most of the savings in the BEM sector.

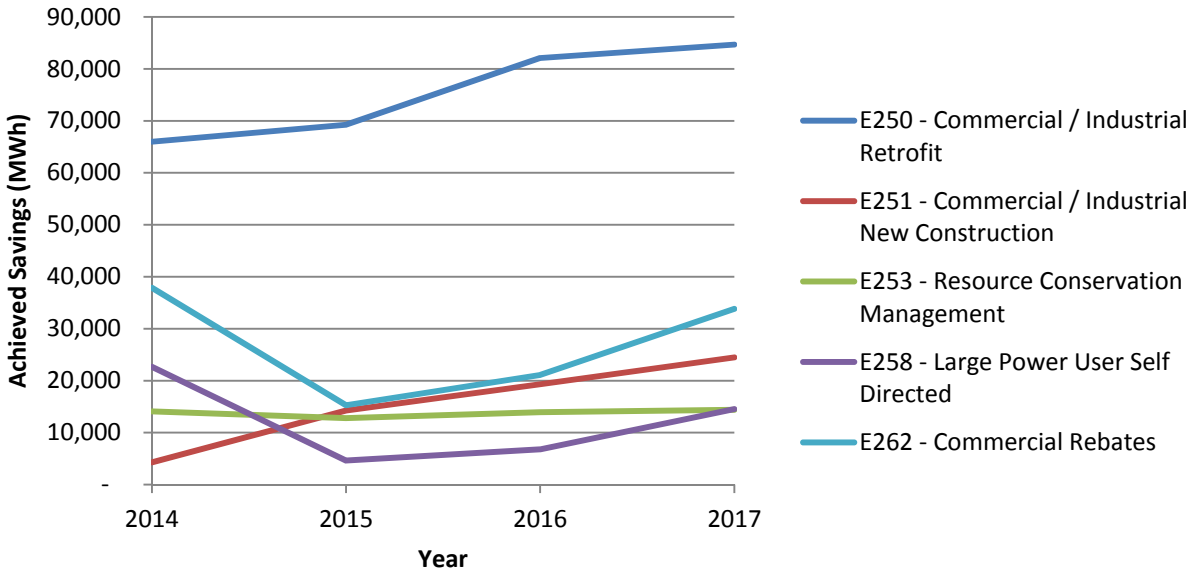

Figure 2: 2014-2017 BEM Tariff Achievements Summary

Key observations about portions of the BEM savings claims include the following:

- **The BEM sector** as a whole exceeded the biennial savings target by 5%. E250-Commercial/Industrial Retrofit and E251-Commercial/Industrial New Construction exceeded their targets. E253-Resource Conservation Manager, E258-Large Power User-Self Directed, and E262-Commercial Rebates all missed their combined biennial targets. Outside of the two most successful tariff groups, only Commercial Kitchen Laundries and Business Lighting Markdown programs met or exceeded their combined targets.
- **All BEM lighting** (LED grow lights, other LEDs, LED street lighting, etc.): 96,242 MWh of savings in 2016 and 127,231 MWh of savings in 2017 (71% of the BEM savings portfolio) is from various lighting measures included in all BEM tariff groups.
- **E250-Commercial/Industrial Retrofit**: Business Enhanced Lighting and Business Standard Lighting (part of E250-Commercial/Industrial Retrofit) realized large increases in savings in 2016-2017 over the previous biennium. This tariff group represents 53% of the combined savings for the biennium. There was a 2,585 MWh increase in savings between 2016 and 2017. The combined savings exceeded the targets by 19%.
- **E-251-C/I New Construction** saw a 5,163 MWh increase in savings in 2017 compared to 2016 with the biennial savings years 117% above target. These increases and over-achievements are primarily due to indoor cannabis farms installing LED lighting. 10% of the BEM sector savings, and 70% of E251 – C/I New Construction savings, are from indoor

agriculture lighting. A total of 37 Indoor horticulture lighting projects were completed in 2016 and 45 projects in 2017 (14,383 MWh and 16,274 MWh in 2016 and 2017 respectively). This end use trend began in 2015 with nearly 11,000 MWh of savings. The 2016 ACR noted that *PSE continued to engage Cannabis Producers as they entered the market, providing incentives for lighting. Additional savings are being calculated in lighting projects due to the lower internal heat load of more efficient lighting*. Because this is a significant end use with increasing savings and the 2014-2015 BECAR recommended adjustments in the savings calculation methodology for this end use, we reviewed savings calculations for 10 of the 37 grow light sites in 2016. Please refer to Section 2.4 for additional information about these particular custom lighting projects.

- **E253- Resource Conservation Management** did not achieve its target in 2016 and significantly under-achieved in 2017 by 48%. This was attributed primarily to the "*The savings target developed during program design was not representative of achieved savings"* for Urban Smart Bellevue program (2017 ACR). This program may have been further impacted by two RCM team members taking extended leave.
- **E258-Large Power User** saw a 7,762 MWh increase in savings in 2017 compared to 2016. The Large Power User, Self-Directed program entered the third year of the 2015-2018 program cycle in 2017. The program underperformed in both 2016 and 2017. Fewer projects were completed than anticipated, though his is consistent with the typical four-year cycle with most projects being completed in the last year.
- **E262-Commercial Rebates** saw a savings increase of 12,700 MWh in 2017 compared to 2016. The program did not meet its goal in 2016. The shortfall in 2016 was primarily due to direct install and Commercial HVAC programs. In 2017, the underperforming programs improved their savings performance with the exception of the Commercial HVAC and Small Business Direct Install programs.

2.3. PSE & RTF UES Reviews

The BECAR team undertook the review of a large group of REM and BEM UES values from July through September 2016.

2.3.1. Methodology

On July 15, 2016, PSE hosted a kickoff meeting for the PSE deemed UES review portion of this task. On July 19, SBW sent a list of the PSE deemed UES values that we selected for detailed review along with a request for the associated Business Cases to PSE. PSE then provided the requested Business Cases and supporting files. From late July through mid-August, SBW reviewed the Business Cases, as well as supporting files, and checked for:

- Any mathematical errors in the derivation of the UES, and
- Reasonable consistency with the requirements of WAC 480-109-100.

Beginning in July 2016, SBW and PSE exchanged several rounds of emailed questions and responses during the review process. PSE hosted a teleconference focused on the issue of baseline wattages for E262 (Commercial Rebates) integral LEDs. There was also a follow-up teleconference on this same topic in early September.

On September 20, SBW issued their deemed UES review summary to PSE, a copy of this memorandum is located in Appendix A.2. This review included both REM measures in Table 7 below and BEM measures in Table 8.

The detailed calculations and documentation that we developed during the course of this review were provided to PSE[7]. Below, the findings and recommendations are presented that emerged from our review.

2.3.2. Findings

2.3.2.1. Residential Energy Management

Table 7 shows the REM deemed UES values selected for detailed review. We selected these ten measures because combined they account for 54% of the overall total REM planned savings shown in the 2016-2017 Biennial Conservation Plan (BCP)[8]. Table 7 also lists the associated Business Cases provided by PSE for this review.

All of the measures listed below are from the E214-Single Family Existing program. Documentation indicated that CFLs were intended to be discontinued in 2017. Although some savings were tracked for CFLs in 2017, these measures were all installed in late 2016. No CFL savings were tracked past the first quarter of 2017.

Table 7: REM PSE Deemed UES Values Selected for Detailed Review

	2016-2017 Planned Savings*			
Subprogram / Measure Name	MWh	% of Total REM Sector	Business Case	UES kWh/yr.
Residential lighting				
A-Lamp LED	40,900	15.6%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	11
Candelabra LED	6,790	2.6%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	22
Globe LED	4,404	1.7%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	13
Outdoor LED Fixture	3,985	1.5%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	6
Reflector LED	43,248	16.5%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	28

[7] PSE Deemed UES Review_9.20.16.xlsx

[8] The UES values listed in the Business Cases are not necessarily the same as those used in the BCP. PSE adds new measures and measure revisions to the Source of Savings database when they are approved and active. Quite often, especially in the case of PSE Deemed measures that require the analyses of an Energy Management Engineer, the final savings value (noted in the Business Cases) are calculated subsequent to the filing of the BCP.

Subprogram / Measure Name	2016-2017 Planned Savings* MWh	% of Total REM Sector	Business Case	UES kWh/yr.
Specialty CFL	12,690	4.8%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	19
Standard CFL	18,373	7.0%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	14
Space heat				
Forced-Air Furnace to HP Conversion (>= 8.5 HSPF, 14 SEER)	3,528	1.3%	Source of Savings - FAF to HP Conversion_2016-17.doc	3,528
Mobile Home Duct Sealing				
MH Air Source Heat Pump	3,593	1.4%	n/a (PSE decided not to implement this measure)	n/a
Showerheads				
Showerhead – Retail C - Any WH - 1.50 gpm and less (E)	4,087	1.6%	Source of Savings - Showerhead-2014_2015.doc	132

*Based on 2016-17 BCP

RESIDENTIAL SECTOR UES FINDINGS

- We found no errors that require correction.
- The derivations are consistent with the requirements of WAC 480-109-100, Washington's administrative code governing energy efficiency activities for investor-owned utilities.

2.3.2.2. Business Energy Management

Table 8 shows the measure types with PSE deemed UES values from the Business Energy Management (BEM) sector selected for review. We selected these particular measure types because combined they account for 11% of the overall total BEM planned savings shown in the 2016-2017 BCP. Table 8 also lists the associated Business Cases provided by PSE for this review.

All of the measures types listed below are from the E262-Commercial Rebates program.

Table 8: BEM PSE Deemed UES Measure Types Selected for Detailed Review

Subprogram/ Measure Type	2016-2017 Planned Savings* MWh	% of Total BEM Sector	Business Case
Lighting To Go			
Integral LEDs	19,388	6.5%	Integral LED Business Case Update (final)_updatedLodgingGuestroomMeasures.docx
Tubular LEDs	597	0.2%	Final_Retrofit to TLED Business Case 2016_Signed - ML.pdf
SBDI			
Tubular LEDs	2,346	0.8%	Final SBDI Retrofit to TLED Business Case 2016_signed.pdf

	2016-2017 Planned Savings*		
Subprogram/ Measure Type	MWh	% of Total BEM Sector	Business Case
Screw-in LEDs	2,424	0.8%	Integral LED Business Case Update (final)_updatedLodgingGuestroomMeasures.docx
Refrigerator Case LEDs	2,193	0.7%	LED Ref Vertical Case Ltg_2016 Business Case_v2_signed.pdf
T8s	7,329	2.4%	Retrofit to T8_2016 Business Case_v3.pdf

*From the 2016-17 BCP

The actual UES values are not listed in Table 8 because there are multiple measures or permutations for each measure type. For example, there are seven measures in the Lighting To Go Integral LEDs measure type, such as MR16, PAR20, decorative, etc. and 30 measures in the Small Business Direct Install (SBDI) Refrigerator Case LEDs measure type, such as 5 ft. Open Case Lights - High Power LED from T8, 6-ft Reach-in Case Lighting: T12 to LED (Retrofit) Low Temp Case, etc.

BUSINESS SECTOR UES FINDINGS

- We found no errors that require correction.
- The derivations are reasonably consistent with the requirements of WAC 480-109-100, Washington's administrative code governing energy efficiency activities for investor-owned utilities.

2.3.3. Recommendations

Below are the recommendations, all pertinent to UES savings, from the 2016-2017 BECAR Interim Report released in June 2017. The recommendations are presented as written in the interim report, with current recommendation status updates for each.

General Recommendations

There is some overlap between these general recommendations and the program-specific recommendations that follow. Our UES research was specific to the two programs cited in Specific Recommendations in the following sections; however, we felt that the two recommendations in this section pertaining to Business Case documentation should apply to all PSE programs with UES deemed savings.

1. **Perform additional lighting UES reviews in mid-2017**: More than 60% of the residential and business energy management portfolio savings consist of lighting measure savings, with LED technology accounting for most of those savings. Given their importance, PSE and SBW are planning for additional reviews of lighting UES values in the second half of 2017. We are in agreement that savings factors such as the storage rate for upstream LEDs (10% for residential lamps, 20% for commercial lamps) and baseline wattages in general could benefit from continued examination.

Recommendation status: Completed. In September 2017, a second round of UES reviews were done for the four business case workbooks that were updated since the 2016 UES review. Our reviewer noted that overall business case documentation was good, although were some minor issues with lack of transparency with RTF values modified for PSE's service area. No recommendations came from our review and we accepted the published values as valid.

2. **Improve matching Business Cases to savings values**: PSE could improve their UES tracking system by creating a way to quickly map Business Cases to the UES values published in the BCP. UES values are listed in Exhibit 1 and Exhibit 5 of the BCP, but there is not a clear way to tie the listed measures back to a specific Business Case. We understand that work is underway within PSE to improve energy savings documentation in the Business Cases.

   Recommendation status: Pending. We haven't done broad review UES review since September 2016, but understand from ERR discussions with program staff that business cases in general have improved documentation practices. This would be a good follow up item for the 2018-2019 BECAR cycle.

3. **Identify Business Case authors and reviewers:** We recommend that PSE institute a clear system for identifying the author, the QC person, and the final approval authority in the savings section in the Business Case workbooks. Additionally, tracking approval dates will improve the documentation process. This would emulate the RTF measure savings documentation process and would help bring PSE into line with the regional best practice.

   Recommendation status: Resolved. For the four business cases/UES reviews completed in mid-2017, all authors were identified and digital signatures applied for the program manager, QC person, manager, and director.

Specific Recommendations for the Single Family Existing Program (E214)

4. **Clearly note all PSE savings calculation assumptions**. Some energy savings parameters are assigned a value of 0.0 (or 1.0, depending on how the parameter is defined) evidently because a better assumption is not available at the time the energy savings is derived. We recommend that PSE clearly note that such values are PSE assumptions. A clarifying note would save outside reviewers the time of searching for the source, but also make it clear which parameters are in need of further explanation, compared to other parameters that already have good source data. The storage and removal rate of LED bulbs is a good example of a parameter set to 0%, for which it is not clear why 0% is a PSE-assumed value.

   Recommendation status: Resolved. In our mid-2017 review of recently updated business cases, we did not encounter instances with savings calculating factors as described above.

5. **Clarify intent of "conservative."** We recommend that PSE revisit and clarify their policy in regard to the inclusion of factors of conservatism in their derivation of UES values. WAC

480-109-100 (5)(a)9 makes no mention on applying conservatism in savings factors. The Regional Technical Forum (RTF) Guidelines, in discussion of significant differences in savings, interaction factors, and bias, do not favor erring on the side of conservatism (e.g. Interaction is significant if the RTF determines that it could change a measure's savings estimate by more than ± 10%). At the May 31, 2017 CRAG meeting, the subject of conservatism was discussed. The CRAG advised PSE that broad, systemic bias towards conservative savings values was not warranted, but that making conservative assumptions for limited, specific instances when better information was unavailable was acceptable.

Recommendation status: Resolved.

Specific Recommendations for the Commercial Rebates Program (E262)

6. **Revise baseline wattages**. For Lighting To Go Integral LEDs and SBDI Screw-In LEDs, PSE derived the incandescent portion of the blended (CFL and incandescent) baseline from manufacturer's recommended incandescent equivalent wattages; these are pre-EISA wattages. Based on the EISA effective dates and the average life of incandescent bulbs, we believe that post-EISA wattages should be used when establishing baseline incandescent wattages. This issue was discussed at length during the August 16 and September 8 teleconferences. Participants in those calls agreed that without further research, PSE did not have the necessary market data to update the baselines accurately. In 2017, PSE is tracking current baseline fixture field data for the SBDI program and will apply that information for the 2018 program year LED UES savings assumptions. The Lighting To Go program may use baseline data currently under development by the RTF that should be available by September 2017 for inclusion in the 2018 program year UES values. When the RTF data becomes available, PSE will review the data for applicability to PSE's customer base. This approach was presented to the CRAG on May 31 and accepted as reasonable. The BECAR team will follow this process.

   Recommendation status: Pending for Lighting to Go, resolved for SBDI. The field data collected by the SBDI program was incorporated into program UES baselines for the 2018 program year. For the Lighting To Go program, the original plan was to update the baseline data for 2018 with RTF data under development by the RTF in 2017. That process at the RTF was delayed and therefore was not available in time for PSE's annual review and updates in September 2017 for the 2018 program year. When the RTF data becomes available, PSE will review the data for applicability to PSE's customer base.

7. **Reassess conservative reduction factor.** Integral LED savings values in the Lighting To Go program have been reduced by 20% to account for potential non-qualifying purchases. On this topic, PSE states that because we don't exactly know, we chose a conservative 20% savings reduction for all lamp purchases for 2016 and will assess the question as part of a robust savings evaluation. This approach, similar to the point made in the REM

[9] WAC 480-109-100 (5) **Energy savings**. A utility must use unit energy saving values and standard protocols approved by the regional technical forum, unless a unit energy savings value or standard protocol is: (a) Based on generally accepted methods, impact evaluation data, or other reliable and relevant data that includes verified savings levels.

recommendation, again raises the question of the applicability and appropriateness of "conservative" factors from a policy standpoint.

Recommendation status: Pending. As mentioned above in Recommendation 5, CRAG's direction in its May 31, 2017 meeting that that broad, systemic bias towards conservative savings values was not warranted, but that making conservative assumptions for limited, specific instances when better information was unavailable was acceptable. The situation cited above, appears to fall into the former category with regard to conservatism. When revised business case(s) for Lighting To Go becomes available, we recommend a 2018-2019 BECAR follow-up review.

8. **Show parameters clearly.** We recommend that all parameters that are used in a derivation be shown in the mathematical equation(s) in the Savings Analysis section of the Business Case. The 20% savings reduction factor for Lighting To Go Integral LEDs is placed in text below a table in the Measure Data Summary. All factors, particularly substantial assumptive values such as this, should be included in the equations in the Savings Analysis section.

   Recommendation status: Pending. Our mid-2017 business case review was limited to four business cases, the only ones revised since our earlier review in mid-2016. The business cases cited above were not available for our 2017 review, but our engineer doing this review observed that most, but not all, factors were transparent. An example of factors lacking transparency were those taken from the RTF and modified for PSE's service territory's building type mix. We recommend a follow-up in the 2018-2019 BECAR cycle.

In summary, there has been good progress on these recommendations from the 2016 Interim Report and indications, from our review of a limited set of revised business cases in 2017, are that PSE is working diligently to improve business case documentation. Follow-up reviews in the 2018-2019 BECAR cycle should confirm that this trend continues.

2.4. 2014-2015 BECAR Recommendation Response Review

We revisited the conclusions and recommendations from the 2014-2015 BECAR, issued in May 2016, to assess how these recommendations have been applied to the to the 2016-2017 biennium. PSE's direction for this task, from the BECAR RFP reads:

> *Review PSE actions taken in response to recommendations from 2014-2015 BECAR. Determine reasonableness of action/response relative to the magnitude of the issue and standard industry practice, paying particular attention to findings and recommendations regarding PSE program/measure verification practices.*

Methodology

Our process for evaluating PSE's response to the previous BECAR's recommendation includes the following:

- **PSE staff review of BECAR recommendation findings.** A draft of the interim memorandum (located in Appendix A.3) for this task was circulated to key PSE staff for comment on recommendations relevant to their areas of responsibility. When additional information was needed to clarify PSE actions on recommendations, we had discussions with PSE program staff to discuss the recommendation in detail.
- **Compare PSE response to industry best practices.** Once information on PSE responses was collected, we assess how well the outcomes of these activities address the issues raised in the earlier BECAR recommendations. If needed, we then identify programs in other areas that provide an appropriate comparison to the PSE program and the Pacific Northwest context.
- **Provide additional recommendations for areas not adequately addressed.** If there are areas where additional work is needed to address an earlier recommendation, we identified these issues and provide actionable recommendation as to how PSE can address these areas moving forward.

Below, each of the seven 2014-2015 BECAR recommendations is presented as written (in *italics*) in the May 2016 Final Report, followed by the status of the recommendation as of the writing of this final report.

2.4.1. Future Improvements in Savings Estimation

All four of the recommendations from the 2014-2015 BECAR discussed below have been resolved to the BECAR team's satisfaction.

1. **Revise UES values highlighted in BECAR.** The review team found several instances where PSE should examine and make appropriate adjustments to their bases for savings for the 2017 program year and beyond; most notably all UES values for residential and commercial LEDs should be based on federal minimum efficacy standards for the incandescent portion of the baseline wattage.

   Recommendation status: Resolved. UES values for a number of measures were reviewed in mid-2016 for the 2017 program year as an early part of this 2016-2017 BECAR review and, in some cases, modified for the 2017 program year. We also conducted a survey in mid-2017 of business cases modified by PSE engineers since the previous 2016 review and found the workbooks were clearly laid out and used accepted and established metrics to estimate savings and cost effectiveness. Not all calculations that adjust data taken from the RTF were transparent; however, we are familiar with these programs and accepted the published savings values as reasonable.

   PSE collected detailed SBDI baseline fixture field data and applied that information for the 2018 program year's LED UES savings assumptions.

   For the Lighting To Go program, the original plan was to update the baseline data for 2018 with RTF data under development by the RTF in 2017. That process at the RTF was delayed and therefore was not available in time for PSE's annual review and updates in September 2017 for the 2018 program year. When the RTF data becomes available, PSE

will review the data for applicability to PSE's customer base. Overall, the significant magnitude of LED savings in PSE's energy conservation portfolio justifies continued UES review. For the upcoming BECAR UES review process in the summer of 2017, we recommend additional review of LED UES values.

PSE made the case that there is a substantial amount of outdated lighting, for instance T12 fluorescent tubes and 100 watt incandescent A-lamps, remaining in their service territory and this obsolete lighting technology is still available for retail purchase. Moreover, claiming full baseline value of these lamps is an incentive for customers to upgrade to higher efficacy lighting equipment. The BECAR team now supports this position to continue to use existing lighting equipment wattage for baseline values.

2. **Revise Lighting Calculator values and assumptions.** The review team recommends PSE update their lighting calculator to include the federal minimum efficacy standards for the incandescent portion of the baseline wattage. Also, savings should incorporate HVAC interactive factors.

   Recommendation status: Resolved. The Business Lighting program's lighting calculator has Energy Independence and Security Act (EISA) compliant baseline wattages for incandescent lighting. However, PSE continues to use existing wattages for baseline because both EISA-compliant and non-compliant lamps are available for purchase as replacement lamps. As mentioned above for the UES values recommendation, The BECAR team supports this position to continue to use existing lighting equipment wattage for baseline values.

   PSE's BEM lighting calculator previously had a limited number of HVAC interaction factors and we recommend bringing PSE's interaction factors into alignment with those of the RTF, successfully resolved in late 2017 with the modification of the calculator's HVAC factors to line up with the regional values recommended by the RTF.

3. **Make improvements to assumptions for LED grow light savings**. For cannabis grow farm lighting projects, PSE should consider adopting a uniform method for calculating operating hours, which would ideally be built into the PSE calculator. Also, for farms with mechanical cooling, PSE should implement an HVAC interaction factor into their savings calculation.

   Recommendation status: Resolved. The HVAC interaction factor recommended for mechanically cooled grow areas in the previous BECAR has been implemented. The BECAR team continues to reason that a uniform methodology in savings calculations for indoor horticultural projects would impose consistency on the process of calculating hours of operation that will remove ambiguity about the basis for selecting annual operating hours.

4. **Work with WUTC and CRAG** to develop an appropriate review timeline so that adjusted UES values can be incorporated into future program plans in a timelier manner.

   Recommendation status: Resolved. This recommendation has been successfully incorporated into the BECAR process for the 2016-2017 biennium with the first round of UES reviews being completed in September 2016 for incorporation into the 2017

program cycle. The second round of UES reviews was completed in September 2017; no recommendations came from our review and we accepted the published values as valid.

2.4.2. Future Improvements in PSE Adaptive Management and BECARs

5. **Continue the BECAR recommendations and ERR reviews**, which provide ongoing assurance that continuous improvement in critical areas occurs. PSE is doing a good job implementing recommendation and keeping track of responses.

   Recommendation status: Resolved. This is standard operating procedure in this BECAR cycle, and the Recommendation Responses and the Evaluation Report Response reviews demonstrate the successful continuation of this recommendation.

6. **Provide more details in the text of the ACRs**. Future BECAR efforts would benefit from ACRs that included more detailed explanations and insights on accomplishments vis a vis the savings targets. This would aid the BECAR review team in more readily identify programs and/or measures of interest and therefore allow more time and resources for focused verification.

   Recommendation status: Resolved. Comparison of the 2016 ACR with the 2015 ACR shows some variance on the level of detail provided on programs with respect to accomplishments. Overall, given that PSE has worked closely with the Commission staff and the CRAG to determine the appropriate level of detail to include in ACRs, the BECAR team believes the level of detail in the 2016 and 2017 ACRs is acceptable.

7. **Document interview findings.** To avoid misunderstandings, following a BECAR interview with PSE staff, the interviewer should provide a transcribed copy of their interview notes to the interviewee for review, correction if necessary, and eventual mutual concurrence.

   Recommendation status: Resolved. This is now standard operating procedure and is working well by providing vetted reports for all discussions with PSE program staff. There were several ERR interviews in the latter part of this BECAR cycle where, at the time of the interview, all recommendations had been accepted and quickly implemented by program staff, hence the interviews were brief and no follow-up interview summary was necessary. We think this is indicative of the maturing of the ERR procedures and PSE program staff understanding of the process.

2.5. Evaluation Response Report Review

This section provides the BECAR team's interim findings for the Evaluation Response Report (ERR) reviews. The purpose of the ERR review is to assess whether PSE has undertaken follow-up actions on program evaluation studies completed since the completion of the 2014-2015 BECAR. When a program evaluation is submitted to PSE, program managers write a response to the third-party evaluator's conclusions and recommendations on how they intend to implement the evaluator's recommendations. The current BECAR's Work Plan defines our task:

For this task we will study a particular evaluation report and then interview relevant PSE program and evaluation staff to ensure that we have a full understanding of evaluation results and any changes that occurred to the programs after the evaluation was completed. The key question is: were the programmatic action items described in the PSE internal evaluation report response implemented, particularly those that could potentially affect future savings values?

2.5.1. Methodology

For this task we studied a particular evaluation report and then interviewed relevant PSE program and evaluation staff to ensure that we have a full understanding of evaluation results and any changes that occurred to the programs after the evaluation was completed. The key question was: Were the programmatic action items described in the PSE internal ERR implemented, particularly those that could have potentially affected future savings values?

2.5.2. Findings

Based on review of the ERRs and evaluations below, it is evident that where practical, PSE follows the recommendations made by the evaluations. In some cases, particularly recommendations that include the revision of program business case workbooks and unit energy savings (UES) values, the program managers accept the recommendations but may elect to delay recommendation implementation until the latter part of the program year when program adjustments are typically made prior to the beginning of the next program year. While some of the evaluation findings have prompted direct actions, PSE's own internal adaptive management process also provides both impetus and solutions to a significant number of the issues raised, frequently in advance of the receipt of evaluation results.

Over the 2016-2017 biennium, we received the 12 ERRs and associated evaluation reports for review and discussions with the PSE program and evaluation teams. The following EERs have been completed to date with notes on our conclusion for each review:

- **2015 Home Energy Reports Impact Evaluation**: This program continues to achieve considerable savings by promoting residential customer behavioral changes and participation in other PSE programs. The adoption of a different customer characteristics profile for selecting the 2015 refill group appears to be paying off in higher savings.
- **2012-2013 Multifamily Retrofit Program Impact and Process Evaluation:** Discussions with PSE staff members indicate they are using the appropriate deemed measures, cited in the evaluator's recommendations that are tailored to multifamily direct install programs and applying the corresponding RTF savings values. The data tracking system has been updated to address the shortcomings cited in report recommendation #3.
- **2012-2013 Commercial HVAC Program Impact and Process Evaluation:** The evaluation report's five recommendations have either been corrected through PSE's internal improvement practices and database upgrades (#2, 3, and 4), or the PM states that they are

doing the best job possible in accounting for future or current facility operations factors (#1 and 5).

- **2012-2013 Commercial Data Center Program Impact and Process Evaluation:** The third-party contractor operated Data Center Retrofit Program has been discontinued and then merged into BEM's Custom Program. The evaluation report's recommendations have been addressed because current practices in the Custom Program comply with all of the evaluator's recommendations.
- **2016 Multifamily Air Sealing Program Evaluation Update**: The program has complied with, or is in the process of implementing, the evaluation recommendations pertaining to electrical savings. This is a program with a continuous refinement loop process where performance data is collected, then rolled back into the savings estimates going forward. Their QA/QC contractor communication protocols have gone beyond the evaluation recommendations and reflect good adaptive management practices.
- **2012-2015 Industrial System Optimization Program**: The ISOP implemented recommendation #1 on improving the quality of third-party M&V calculations. The ISOP team declined to implement recommendation #2 to institute a standard 90 day M&V period for all measures. The BECAR team agreed with this decision to permit more program flexibility and allow engineer discretion; ISOP currently has an average measure M&V period exceeding 60 days.
- **2014-2015 Direct-to-Consumer (Residential Retail) Impact and Process Evaluation**: The evaluation report was delivered in August 2017 and, with the exception of the two discontinued programs (appliance replacement and advanced power strips), the program staff responded quickly to make program adjustments to line up with all non-process report recommendations for the 2018 program year.
- **2013-2015 Low Income Weatherization**: The LIW program has incorporated the recommendation for updating UES values with current RTF values into their current business case workbook.
- **2016-2017 Commercial and Industrial New Construction**: The evaluation report suggestions all addressed PSE's engineering calculations pertaining to LED lighting for indoor agricultural projects, an end use that has increased substantially in recent years. The program implemented recommendation #2 to cap baseline power density, but did not implement recommendation 1, baseline multiplier values, or recommendation 3, data collection practices, for reasons we believe are valid.
- **2016-2017 Commercial Rebates**: In recommendation #1, PSE proactively addressed the evaluation's concern about data collection and tracking practices. The evaluation's recommendation #2 to use longer annual operating hours for outdoor photocell-controlled lighting was not implemented because PSE's justification for using a small portion of pre-sunrise and post-sunset hours has a sound engineering basis for the shorter annual hours. Recommendation #3 concerning using HVAC interaction factors for indoor lighting measures was not implemented, but should be corrected for the 2019 program year.

- **2013-2015 Single Family Dealer Channel**: The program accepted and implemented the recommendation to update their business case UES values and documentation many of the measures offered through this program.
- **2016 Home Energy Reports Impact Evaluation**: As with the 2015 HER ERR review above, this unique and successful behavioral program continues to produce reliable savings for both the HER program (behavior) and referrals to other PSE residential programs.

Please refer to Appendix A.4 for the ERR memos in their entirety.

2.6. Detailed Review

BECAR reviews may include detailed reviews of energy savings of some programs or measures selected in consultation with PSE, Commission staff, and the CRAG. Reviews may include sampling of project files, surveys, on-site inspections, modeling, or other engineering analysis. No programs or measures were identified during the 2016-2017 biennium for detailed reviews.

3. CONCLUSIONS AND RECOMMENDATIONS

This BECAR effort has yielded a comprehensive assessment, as required by the Order, of PSE's electric efficiency portfolio claim for the 2016-17 biennium. Conclusions and recommendations for each of the objective areas—portfolio savings, PSE adaptive management, and future improvements in the BECAR process—are provided below.

Portfolio Savings

- **Claimed savings are accurate.** Savings shown in the 2016 and 2017 Annual Report of Energy Conservation Accomplishments are substantiated by a thorough review of the corresponding extracts from PSE tracking databases. No corrections are needed.
- **Unit energy savings derivations are sound for this biennium.** Reviews in 2016 and 2017 of critical UES values found no errors, and that their derivations are reasonably consistent with the requirements of WAC 480-109-100. Our UES review found several areas for adjustments to future UES methodologies and values, as noted in Section 2.3.
- **Future Home Energy Report savings will significantly increase in 2018.** The Home Energy Reports program's 2014 expansion group pilot will transition to the REM sector in 2018. In 2016, the HER expansion group's savings were about 20,000 MWh (2017 savings are not yet available), so this should boost the overall REM savings claim by about 10%+ in 2018.

Future Improvements in Savings Estimation

Below are recommendations, based on the BECAR findings, for PSE to consider for future program and portfolio improvements.

- **Continue unit energy savings and business case reviews**: UES values account for about 67% of the BEM and REM sectors' savings in 2017. Our mid-2016 UES review found some inconsistency in PSE's baseline wattage assumptions for REM LEDs, which were then modified. Four of the ERRs reviewed in Section 2.4 note occasional anomalies with using appropriate deemed values, data collection, and program data tracking; program staff report that these findings have all been addressed and corrected. Further, our observations in mid-2017 on a limited number (business case workbooks tend to be updated late in the year) of recently updated business case reviews indicate that UES business case documentation is improving markedly. However, given the magnitude of PSE portfolio savings associated with UES values and the supporting business case data, we think it is wise to continue these reviews.

  Recommendation 1*: Conduct additional review of a sample of UES measures and associated business cases in the 2018-2019 BECAR cycle. We recommend these reviews be started by July 2018, so that any modifications would be in time for the 2019 program planning cycle that begins in September 2018.*

- **Apply HVAC interaction factors to applicable Commercial Rebates Program measures**: The Commercial Rebates evaluation found that the Lodging Direct Install and the Small Business Direct Install programs are using UES values for interior LED lighting without HVAC interaction factors; this results in overstated savings.

***Recommendation 2**: Revise the UES values for interior LED lighting in the Lodging Direct Install and Small Business Direct Install programs to account for HVAC interaction factors using RTF data.*

- **Update the Lighting to Go deemed value baselines with most current RTF values.** In the 2016 BECAR Interim Report, we recommended that the Lighting to Go program consider using RTF baseline data for LED lighting when it becomes available; however, this was delayed by the RTF and therefore PSE was unable to modify the baseline for the 2018 program year.

  ***Recommendation 3**: When this RTF baseline data becomes available, we recommend PSE update the LED UES values accordingly.*

- **Conduct research and develop a standard baseline for BEM indoor agriculture new construction projects.** Unlike other new construction lighting measures, the Washington State Energy Code does not set a lighting power density baseline for indoor agriculture. PSE program staff determine baseline kW for these projects through interviews with growers about the lighting technologies they would have used absent utility incentives. Indoor agriculture projects represent about 10% of the entire BEM sector savings, and this is an expanding and relatively new commercial industry now addressed by utility incentive structures. In the interest of proactive adaptive management, it would be instructive to conduct a survey of indoor horticultural growers in the region, with the goal of establishing a rigorous set of best practice savings estimation protocols to ensure an accurate accounting of savings for this significant end use.

  ***Recommendation 4**: Conduct a survey of regional indoor agriculture operators to gain an understanding of which lighting technologies, absent utility incentives, would have been used for new horticultural operations. Similarly, do a literature search to find any studies that already may have been done on this subject. Based on the results of this research, baseline recommendations will be presented to PSE for consideration.*

Future Improvements in PSE Adaptive Management and BECARs

It is our BECAR team's opinion that the iterative changes to the BECAR process over the past four bienniums have resulted in a process that adds value to program management and is well understood by PSE managers and staff. Moreover, PSE's internal adaptive management practices are embedded in program operations and, when needed, prompt timely mid-course program adjustments occur. Because this 2016-2017 biennium has gone smoothly and without any findings requiring re-estimation of savings, we recommend staying the course with the current BECAR structure for the 2018-2019 biennium.

- ***Recommendation 5: Continue tracking BECAR report recommendation status.** This is standard practice in BECAR and provides continuity between BECAR biennium cycles.*
- ***Recommendation 6: Continue conducting UES and supporting documentation reviews.** Developing and updating UES values is a complex task and, given the magnitude of savings in the PSE portfolio, justify regular third-party review.*

- ***Recommendation 7: Continue evaluation response reviews.*** *Based on review of the ERRs and evaluations for 2016-2017, it is evident that where practical, PSE program staff quickly implement recommendations from the third-party evaluations. For recommendations that are either partially implemented or not implemented, PSE project managers put forth clear reasoning to support their decisions. While some of the evaluation findings have prompted direct actions, PSE's own internal adaptive management process also provides both impetus and solutions to a significant number of the issues raised, frequently in advance of the receipt of evaluation results.*

A. APPENDICES

A.1. Glossary

The alphabetical listing of acronyms and terms below appear in the report or are otherwise relevant to the review.

ACR – Energy Efficiency Annual Report of Energy Conservation Accomplishments

Adjustment – Update to a savings value on a go-forward basis, usually implemented in January of the following calendar year.

BCP – Biennial Conservation Plan

BECAR – Biennial Electric Conservation Achievement Review

Best Practice –This term will be defined in any/all BECAR document(s) in which it appears. Depending on the BECAR Task to which it is applied and the context in which it is used, guidance from the CRAG may be solicited in developing the definition. This term is not to be confused with "Industry Standard Practice," which will have its own BECAR definition.

Business Case – The PSE documentation called out in Source of Savings that provides the basis for a PSE deemed savings value; also called the Source of Savings.

CFL – Compact fluorescent lamps.

Commission – Washington Utilities and Transportation Commission (WUTC or UTC).

Conditions – Requirements established by the Commission through orders in various dockets. The 2016-17 Biennium is governed by the conditions established in Docket No. UE-152058, Order 01, Appendix A, Proposed Conditions for 20164-2017 PSE Electric Conservation.

Correction – Change to the PSE savings claim made at the time of error discovery and retroactively to the month in which the error first occurred—up to January of the year in which the discovery was made. A correction is required for mathematical errors, selection of the incorrect measure type, or measure savings claims made without complete validation in Source of Savings.

CRAG – Conservation Resource Advisory Group

Council – Northwest Power and Conservation Council

Custom Savings – This savings type applies to conservation projects where a PSE EME performs specific evaluation and review of a unique customer site to determine savings values—therms or kWh—that apply only for that site.

EIA –The Washington Energy Independence Act, is a Washington state law established by Ballot Initiative No. 937, passed by Washington voters in 2006 and codified as RCW 19.285. It is a clean energy initiative that requires large utilities to pursue all available cost-effective electricity conservation and obtain 15% of their electricity from new renewable resources by 2020.

EISA – Energy Independence and Security Act, is federal legislation pertaining to energy efficiency that includes requirements for minimum lighting efficiency.

ERR – Evaluation Report Response. A form used by PSE to document an evaluation study's resultant actions.

Industry Standard Practice - This term will be defined in any/all BECAR document(s) in which it appears. Depending on the BECAR Task to which it is applied and the context in which it is used, guidance from the CRAG may be solicited in developing the definition. This term is not to be confused with "Best Practice," which will have its own BECAR definition.

LED – Light Emitting Diode (lamp type).

Source of Savings – PSE's database for tracking current and retired deemed measures in each program, and corresponding energy savings, incentive, and measure cost information.

NEEA – Northwest Energy Efficiency Alliance

PSE Deemed – Relative to measure savings types (Custom, Calculated, PSE Deemed or RTF Deemed), these measures are supported by PSE engineering calculations or evaluation studies, in compliance with Settlement Agreement condition K(6)(c). This term is used in the Savings Type field in Appendix B, List of Measures.

RTF – Regional Technical Forum, an advisory committee and a part of the Northwest Power and Conservation Council. The RTF develops region wide unit energy savings values, as well as standardized protocols for verifying and evaluating conservation.

RTF Deemed – Former reference to the RTF's UES (Unit Energy Savings). Relative to PSE savings types (Custom, Calculated, PSE Deemed or RTF Deemed), supported by RTF analyses, in compliance with Settlement Agreement condition (6)(b).

Source of Savings – The PSE documentation called out in *Source of Savings* that provides the basis for a PSE deemed savings value; also called the Business Case.

Settlement – Refers to a 2010 Washington Utilities and Transportation Commission order that adopted a settlement agreement between Puget Sound Energy and various stakeholder parties. The settlement included conditions for approving PSE's ten-year electric conservation potential and biennial electric energy savings target, in compliance with the electric energy conservation portfolio standard required by I-937.

UES – Unit Energy Savings, or deemed measure energy savings per unit. The UES method is appropriate for measures whose unitized savings, e.g., savings per lamp or motor, is stable (both the mean and variance) and can be reliably estimated throughout the period from RTF approval to the measure's sunset date

V-team – PSE's internal Verification Team, which helps ensure high energy efficiency programs through independent verification of installed equipment and assessment of program participant satisfaction.

WUTC – Washington Utilities and Transportation Commission; also called the Commission.

A.2. LED Unit Energy Savings Memorandums

Following are two memorandums summarizing LED UES research conducted by SBW as part of this BECAR cycle.

sbw
ENERGY + WATER + EFFICIENCY

Memorandum

FROM: Kathrine Clarke

TO: Bill Hopkins, Jennifer Snyder

DATE: September 20, 2016

RE: PSE 2016-17 BECAR – PSE Deemed UES Reviews

CC: Bing Tso, Bob Tingleff

The purpose of this memorandum is to inform PSE and WUTC staff of our findings and recommendations from work to date on PSE deemed unit energy savings (UES) reviews, completed as part of the first task of the 2016-2017 Biennial Electric Conservation Achievement Review (BECAR).

This first task is described as follows in PSE's Request for Proposal (RFP):

> *Review deemed Unit Energy Savings (UES) values used by PSE, for reasonable consistency with the requirements of WAC 480-109-100 in Attachment B[1] and the policy on application of RTF and non-RTF values (see Attachment D[2]). Determine if PSE's application of deemed savings values are consistent with the requirement as applied to the:*
>
> - *Selection and application of RTF UES values.*
> - *Derivation and application of non-RTF UES values.*
> - *If necessary, recommend adjustments to UES methodologies or values.*

This memorandum focuses on the second and third bullets above[3].

On July 15, 2016, PSE hosted a kickoff meeting for the PSE deemed UES review portion of this task. On July 19, SBW sent a list of the PSE deemed UES values that we selected for detailed review along with a request for the associated Business Cases to PSE. On July 20-22, PSE uploaded the requested Business Cases and supporting files to SBW's shared server. From late July through mid-August, SBW reviewed the Business Cases, as well as supporting files, and checked for:

- Any mathematical errors in the derivation of the UES, and
- Reasonable consistency with the requirements of WAC 480-109-100.

[1] AMENDATORY SECTION (Amending WSR 07-24-012, filed 11/27/07, effective 12/28/07)
[2] Measure Revision Guidelines_Ver6.50_05072015
[3] Non-RTF UES values will be called "PSE deemed" UES values henceforth.

SBW and PSE exchanged several rounds of e-mailed questions and responses during the review process. On August 16, PSE hosted a teleconference focused on the issue of baseline wattages for E262 (Commercial Rebates) integral LEDs. There was also a follow-up teleconference on this same topic on September 8. Most recently, on September 14, PSE sent SBW the 2017 Business Case for Residential LED lighting and requesting feedback on the UES derivations therein. This memorandum does not cover this latest Res LED lighting Business Case.

When the PSE claimed savings becomes available in March of 2017, and again in 2018, we will verify the PSE tracking databases (2016, and again for 2017) correctly apply the PSE deemed UES values. Also, we will calculate the percentage of the total electric portfolio savings that are attributable to PSE deemed UES values to see if any values not covered in this review warrant investigation.

The detailed calculations and documentation that we developed during the course of this review are contained in the embedded Excel workbook. Below we provide the findings and recommendations that emerged from our review. We hope these will prove useful to PSE for improving their deemed UES derivations and documentation, as well as the overall BECAR review process.

PSE Deemed UES Review_9.20.16.xlsx

Residential Energy Management

Table 1 shows the Residential Energy Management (REM) PSE deemed UES values selected for detailed review. We selected these ten measures because combined they account for 54.1% of the overall total REM planned savings shown in the 2016-2017 Biennial Conservation Plan (BCP)[1]. Table 1 also lists the associated Business Cases provided by PSE for this review.

All of the measures listed below are from the **E214-Single Family Existing** program.

[1] The UES values listed in the Business Cases are not necessarily the same as those used in the BCP. PSE adds new measures and measure revisions to the Source of Savings database when they are approved and active. Quite often, especially in the case of PSE Deemed measures that require the analyses of an Energy Management Engineer, the final savings value (noted in the Business Cases) are calculated subsequent to the filing of the BCP.

Table 1: REM PSE Deemed UES Values Selected for Detailed Review

	2016 -2017 Planned Savings*			
Subprogram / Measure Name	MWh	% of Total REM Sector	Business Case	UES kWh/year
Residential lighting				
A-Lamp LED	40,900	15.6%	2016-17_D2C_Channel_Program_Case_2016_03_17.doc	24.09
Candelabra LED	6,790	2.6%	" "	30.95
Globe LED	4,404	1.7%	" "	21.19
Outdoor LED Fixture	3,985	1.5%	" "	58.03
Reflector LED	43,248	16.5%	" "	38.80
Specialty CFL	12,690	4.8%	" "	19.13
Standard CFL	18,373	7.0%	" "	14.13
Space heat				
Forced-Air Funace to HP Conversion (>= 8.5 HSPF, 14 SEER)	3,528	1.3%	Source of Savings - FAF to HP Conversion_2016-17.doc	3528
Mobile Home Duct Sealing				
MH Air Source Heat Pump	3,593	1.4%	*n/a* (PSE decided not to implement this measure)	*n/a*
Showerheads				
Showerhead - Retail_C - Any WH - 1.50 gpm and less (E)	4,087	1.6%	Source of Savings - Showerhead-2014_2015.doc	122

* Based on 2016-17 BCP

FINDINGS

- We found no errors that require correction.
- The derivations are reasonably consistent with the requirements of WAC 480-109-100.

RECOMMENDATIONS

- **Clearly note PSE assumptions.** For energy savings parameters that are assigned a value of 0.0 (or 1.0, depending on how the parameter is defined) because a better assumption is not available at the time the energy savings is derived, it would be helpful if PSE would clearly note that the value is a PSE assumption. A clarifying note would save outside reviewers the time of searching for the source, but also make it clear which parameters are in need of firming up (compared to other parameters which already have good source data). The storage and removal rate of LED bulbs is a good example of a parameter set to 0%, for which it is not clear that 0% is a PSE-assumed value.
- **Create adjustment factor**. For the HVAC Interaction factors used in the Residential Lighting UES derivations, PSE added together values for the HVAC kWh Interaction Factor and the HVAC Therms Interaction Factor. By definition, these are not additive values; one is expressed in units of kWh, and the other is a ratio of therms to kWh. PSE explained that they "took a conservative approach by adding these values together. By adding these values together, it decreases the kWh UES values." SBW recommends that rather than

adding Therms/kWh to kWh, PSE should create a simple adjustment factor that moves the value upwards or downwards, and call it such.

- **Clarify intent of "conservative."** We recommend that PSE revisit and clarify their policy in regards to the inclusion of factors of conservatism in their derivation of UES values. WAC 480-109-100 (5)(a)[1] makes no mention of the application of conservative factors. The Regional Technical Forum (RTF) Guidelines, in discussion of significant differences in savings, interaction factors, and bias, do not favor erring on the side of conservatism (e.g. Interaction is significant if the RTF determines that it could change a measure's savings estimate by more than ± 10%).

Business Energy Management

Table 2 shows the measure types with PSE deemed UES values from the Business Energy Management (BEM) sector selected for detailed review. We selected these particular measure types because combined they account for 11.4% of the overall total BEM planned savings shown in the 2016-2017 BCP. Table 2 also lists the associated Business Cases provided by PSE for this review.

All of the measures types listed below are from the **E262-Commercial Rebates** program.

Table 2: BEM PSE Deemed UES Measure Types Selected for Detailed Review

	2016 -2017 Planned Savings*		
Subprogram / Measure Type	MWh	% of Total BEM	Business Case
Lighting To Go			
Integral LEDs	19,388	6.5%	Integral LED Business Case Update (final)_updatedLodgingGuestroomMeasures.docx
Tubular LEDs	597	0.2%	Final_Retrofit to TLED Business Case 2016_Signed - ML.pdf
SBDI			
Tubular LEDs	2,346	0.8%	Final SBDI Retrofit to TLED Business Case 2016_signed.pdf
Screw-in LEDs	2,424	0.8%	Integral LED Business Case Update (final)_updatedLodgingGuestroomMeasures.docx
Refrigerator Case LEDs	2,193	0.7%	LED Ref Verticle Case Ltg_2016 Business Case_v2_signed.pdf
T8s	7,329	2.4%	Retrofit to T8_2016 Business Case_v3.pdf

* Based on 2016-17 BCP

The actual UES values are not listed in Table 2 because there are multiple measures for each measure type. For example, there are seven measures in the Lighting To Go Integral LEDs

[1] WAC 480-109-100 (5) **Energy savings**. A utility must use unit energy saving values and standard protocols approved by the regional technical forum, unless a unit energy savings value or standard protocol is: (a) Based on generally accepted methods, impact evaluation data, or other reliable and relevant data that includes verified savings levels.

measure type (such as MR16, PAR20, decorative, etc.) and 30 measures in the Small Business Direct Install (SBDI) Refrigerator Case LEDs measure type (such as 5-ft Open Case Lights - High Power LED from T8, 6-ft Reach-in Case Lighting: T12 to LED (Retrofit)_Low Temp Case, etc.)

FINDINGS

- We found no errors that require correction.
- The derivations are reasonably consistent with the requirements of WAC 480-109-100.

RECOMMENDATIONS

- **Revise baseline wattages.** For Lighting To Go Integral LEDs and SBDI Screw-In LEDs, PSE derived the incandescent portion of the blended (CFL and incandescent) baseline from manufacturer's recommended incandescent equivalent wattages; these are pre-EISA wattages. Based on the EISA effective dates and the average life of incandescent bulbs, SBW believes post-EISA wattages should be used when establishing baseline incandescent wattages. This issue was discussed at length during the August 16 and September 8 teleconferences. Participants in those calls agreed that without further research, PSE did not have the necessary market data to update the baselines accurately. During the 2017 program year, PSE proposes to conduct market research that will inform baseline replacement bulb wattages. PSE will then use this data to accurately inform the baseline for 2018-19 savings.
- **Reassess conservative reduction factor.** Integral LED savings values in the Lighting to Go program have been reduced by 20% to account for potential non-qualifying purchases. On this topic, PSE states "because we don't exactly know, we chose a conservative 20% savings reduction for all lamp purchases for 2016 and will assess the question as part of a robust savings evaluation." This approach, similar to the point made in the REM recommendation, again raises the question of the applicability and appropriateness of "conservative" factors from a policy standpoint.
- **Show parameters clearly.** We recommend that all parameters that are used in a derivation be shown in the mathematical equation(s) in the Savings Analysis section of the Business Case. The 20% savings reduction factor for Lighting To Go Integral LEDs is placed in text below a table in the Measure Data Summary. All factors – particularly substantial assumptive values such as this—should be included in the equations in the Savings Analysis section.

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Memorandum

FROM: Kathrine Clarke

TO: Bill Hopkins

DATE: September 26, 2016

RE: PSE 2016-17 BECAR –PSE Deemed UES Reviews, Residential LED Lighting

CC: Bing Tso, Bob Tingleff

The purpose of this memorandum is to inform PSE of our findings in regards to our review of PSE's proposed 2017 UES values for residential LED lighting[1]. In particular, review of the 2017 UES values has raised concern regarding the 2016 residential LED lighting UES values[2] which we reviewed last month and reported on in our September 20 memorandum.

We see an inconsistency in PSE's baseline wattage assumptions in going from 2016 to 2017. At first pass, an increase in baseline wattages in 2016 (compared to 2014/2015) seemed plausible because PSE updated their 2016 calculations to use the latest baseline data set from the RTF. But then seeing the 2017 baseline wattages decrease -- while using the same data set as 2016 -- caused us to take a more in-depth look at both the 2016 and 2017 assumptions.

Here's some context regarding the residential LED UES values. Table 1 shows the PSE Deemed UES values for selected LED lighting measures from 2014 through 2017 along with the parameters which are the basis for deriving the UES values.

[1] PSE LED Workbook v08.xlsx, via September 14 email from Bill Hopkins (PSE)

[2] PSEDeemed_Residential Lighting_vActive.xlsx, via July 20 Sharefile upload from Lance Rottger (PSE)

Table 1: Residential LED PSE Deemed UES Values for Selected E214 Measures

2014	Measure Wattage	Baseline Wattage	Delta Watts	Hours per Day	HVAC Interaction Factor	Storage and Removal	UES (kWh/yr)
A-Lamp LED	9.4	**32.8**	23.4	1.88	-0.16	0.00	13.48
Candelabra LED	3.7	**37.4**	33.7	1.75	-0.17	0.00	17.76
Globe LED	5.3	**38.9**	33.6	1.58	-0.19	0.00	15.71
Reflector LED	12.8	**48.9**	36.1	2.20	-0.16	0.00	24.45
Outdoor LED Fixture	9.7	**51.8**	42.2	3.80	0.00	0.00	58.47
2015	Measure Wattage	**Baseline Wattage**	Delta Watts	Hours per Day	HVAC Interaction Factor	Storage and Removal	UES (kWh/yr)
A-Lamp LED	9.4	**32.8**	23.4	2.23	-0.16	0.00	16.02
Candelabra LED	3.7	**37.4**	33.7	1.75	-0.17	0.00	17.76
Globe LED	5.3	**38.9**	33.6	1.58	-0.19	0.00	15.71
Reflector LED	12.8	**48.9**	36.1	2.54	-0.16	0.00	28.23
Outdoor LED Fixture	9.7	**51.8**	42.2	3.80	0.00	0.00	58.47
2016	Measure Wattage	**Baseline Wattage**	Delta Watts	Hours per Day	HVAC Interaction Factor	Storage and Removal	UES (kWh/yr)
A-Lamp LED	9.7	**41.9**	32.2	2.37	-0.13	0.00	24.09
Candelabra LED	4.8	**47.8**	43.1	2.31	-0.15	0.00	30.95
Globe LED	7.7	**38.8**	31.1	2.21	-0.16	0.00	21.19
Reflector LED	11.9	**52.4**	40.5	3.03	-0.13	0.00	38.80
Outdoor LED Fixture	12.2	**51.8**	39.7	4.01	0.00	0.00	58.03
2017	Measure Wattage	**Baseline Wattage**	Delta Watts	Hours per Day	HVAC Interaction Factor	Storage and Removal	UES (kWh/yr)
A-Lamp LED	8.7	**25.1**	16.4	2.33	-0.08	-0.12	11.32
Candelabra LED	4.2	**34.4**	30.2	2.51	-0.08	-0.12	22.49
Globe LED	6.0	**29.4**	23.5	1.87	-0.08	-0.12	12.93
Reflector LED	11.1	**42.7**	31.7	2.97	-0.07	-0.12	28.05
Outdoor LED Fixture	15.1	**20.3**	5.2	3.17	0.00	-0.02	5.91

Beginning in 2014, PSE worked with Ryan Firestone at the RTF to derive baseline wattages from RTF assumptions; they developed a spreadsheet that would aggregate the lumen bins and RTF assumptions based on the Residential Building Stock Assessment (RBSA)[1]. The baseline

[1] ResLEDLighting_v3_0 v03.xlsm, see "PSE Results" tab, which pulls from "RBSA Dataset" tab

wattages pulled from RBSA Dataset are from column V, **Adjusted Wattage**, captioned "Minimum of the actual wattage and federal standard maximum wattage."

In 2015, PSE continued to use the same baseline wattages as 2014.

In 2016 PSE updated their baseline wattages data set to stay current with the RTF[1]. But, in transcribing the RTF data, PSE used the actual lamp wattages instead of the minimum of the actual wattages and federal standard max wattages[2].

For the proposed 2017 UES values, PSE is using the 2016 baseline wattages data set, but now they are going back to being consistent with 2014/2015 and using the minimum of the actual wattage and federal standard max wattage.

The other significant change affecting the 2017 baseline wattages (compared to 2016) is the portion of market share by lamp type. For 2017, in anticipation of increasing LED market share, PSE is assuming 30% LED market share for all lamp types.

Table 2 shows the step-by-step progression of the baseline wattage for A-Lamp LEDs in going from 2016 to 2017.

Table 2: Residential A-Lamp LED Baseline Wattages and Market Share

	2016		Wattages Capped at Federal Maximums		2017 Revised Market Shares		
Lamp Type	Average Watts	Market Share	Average Watts	Market Share	Average Watts	Market Share	
CFL	16.1	26.0%	14.8	26.6%	14.8	26.6%	
Halogen	48.3	34.1%	38.2	35.2%	38.2	35.2%	
Incandescent	54.6	38.6%	30.4	36.9%	30.4	8.2%	
LED	7.7	1.3%	7.6	1.3%	7.6	30.0%	
Weighted Watts	**41.9**		**28.7**		**22.2**	x (782 lumens / 691 lumens)	= **25.1**

- Capping the baseline wattages at the federal maximum decreased the baseline wattage from 41.9 watts to 28.7 watts.
- Updating the LED market share to 30% further decreased the baseline wattage from 28.7 watts to 22.2 watts.
- Normalizing for PSE lumens (782) compared to market lumens (691) increased the baseline wattage from 22.2 watts to 25.1 watts.

Although we find no mathematical errors in either the 2016 or 2017 UES derivations, we think it's necessary to bring forward to PSE the inconsistency in 2016 vs 2017 (and 2014/2015) baseline wattages.

[1] See "RTF Sales Baseline" tab in PSEDeemed_Residential Lighting_vActive.xlsx

[2] http://rtf.nwcouncil.org/measures/res/ResLighting_Bulbs_v4_2.xlsm, sheet LampCharacteristicsAndMktShare, columns AG-AJ (vs columns AT-AW)

A.3. Task 4 Interim Memorandum

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Memorandum

FROM: John Roberts

TO: Bill Hopkins (PSE), Jennifer Snyder (WUTC)

DATE: June 19, 2017

RE: PSE 2016-17 BECAR – Interim Task 4 Recommendation Response Reviews

CC: Bing Tso

INTRODUCTION

The purpose of this memorandum is to inform PSE and the WUTC about the Biennial Electric Conservation Achievement Review (BECAR) team's interim findings from our work to date on Task 4 Recommendation Response Reviews. This task reviews the actions taken by PSE in response to recommendations from the previous BECAR for the 2014-2015 biennium.

The conclusions and recommendations for the 2014-2015 BECAR, issued in May 2016, are revisited in this task to assess how these recommendations have been applied to the 2017 program year.

Below, each of the seven 2014-2015 BECAR recommendations is presented as written (in *italics*) in the May 2016 Final Report, followed by the status of the recommendation as of the writing of this memorandum in June 2017, as part of the PSE review of the draft of this report, the PSE evaluation team asked program staff to review recommendation responses pertaining to their area of responsibility. These staff responses resulted in updates to the recommends by the BECAR team and, in some cases, those responses are included in this memo.

Additional work may remain to be done on our assessment of the recommendations; this task will be finalized in the 2016-2017 BECAR Final Report, to be issued in the second quarter of 2018.

2014-2015 BECAR CONCLUSIONS AND RECOMMENDATIONS

Our recommendations fall into two categories, future improvements in savings estimation and future improvements in PSE adaptive management and the BECAR process.

Future Improvements in Savings Estimation

- ***Revise UES values highlighted in BECAR.*** *The review team found several instances where PSE should examine and make appropriate adjustments to their bases for savings for the 2017 program year and beyond; most notably all UES values for residential and commercial*

LEDs should be based on federal minimum efficacy standards for the incandescent portion of the baseline wattage.

Recommendation status: UES values for a number of measures were reviewed in mid-2016 for the 2017 program year as an early part of this 2016-2017 BECAR review and, in some cases, modified for the 2017 program year. Another round of UES value reviews will occur as part of this BECAR cycle in mid-2017 for the 2018 program year. We have reviewed the recently released 2016 Energy Accomplishments Report and note that LED lighting savings continue to be a substantial part of REM and BEM energy savings.

- **E214 Single Family Existing**: The 2016 ACR reports that the Residential Lighting program achieved 118% of its goal and 72 % of total savings for this tariff group, the primary savings driver being the increased sales in LED lighting.

  The mid-2016 BECAR review of UES LED residential baseline assumptions resulted in adjusted values for 2017; these revised baseline values were applied retroactively to 2016.

- **E262 Commercial Rebates**: In the Commercial Rebates tariff group, the largest program, Lighting to Go (also known as Business Lighting Markdowns), achieved 121% of the 2016 program goal and 52% of the total savings for the tariff group, largely due to LED lamp sales. The next largest savings in the Commercial Rebates group is the Small Business Direct Install (SMBDI) program, which achieved 64% of its goal and accounted for 33% of the total Commercial Rebates savings.

PSE is tracking current baseline fixture field data for the SBDI program and will apply that information for the 2018 program year LED UES savings assumptions. The Lighting to Go program may use baseline data currently under development by the RTF that should be available by September 2017 for inclusion in the 2018 program year UES values. When the RTF data becomes available, PSE will review the data for applicability to PSE's customer base.

Overall, the magnitude of LED savings in PSE's energy conservation portfolio justifies continued UES review. For the upcoming BECAR UES review process in the summer of 2017, we recommend additional review of LED UES values.

- ***Revise Lighting Calculator values and assumptions.*** *The review team recommends PSE update their lighting calculator to include the federal minimum efficacy standards for the incandescent portion of the baseline wattage. Also, savings should incorporate HVAC interactive factors.*

  Recommendation status: The Business Lighting program's lighting calculator has added incandescent lighting wattage equivalents to Energy Independence and Security Act (EISA) baseline wattages for incandescent lighting. However, PSE continues to use existing wattages for baseline because both EISA-compliant and non-compliant lamps are available for purchase as replacement lamps. PSE's lighting calculator continues to have a limited number of HVAC interaction factors.

- **Baseline kW**: The option to use EISA equivalent wattage for incandescent lamps was added to the 2016 Lighting Calculator and remains in the current lighting calculator. The baseline for calculating savings continues to be the existing installed wattage of EISA and non-EISA lamps, since both types of product are available in the marketplace. The PSE CRAG has assented to this approach. PSE's quality control process is rigorous: all calculator inputs receive a QC review prior to approval and PSE conducts pre and post-installation inspections on 50% of projects under 25,000 KWh savings and 100% of projects over 25,000 KWh savings.
- **HVAC interaction factors**: While the PSE lighting calculator has several HVAC interaction factors, the RTF's more comprehensive list of HVAC interaction factors provides, we believe, more rigorous lighting savings estimates. In response to this recommendation, PSE points out that the RTF HVAC factors are based on whole building simulation models by building type and therefore are prototypical buildings that do not necessarily match the space distribution of an actual individual building that may have different types of conditioned spaces. PSE's HVAC Interaction factors are based on conditioned space types. The BECAR team's observation is that PSE's interaction factors are usually either 0.90 for electrically-heated spaces or 1.0 for other spaces (the exceptions being that refrigerated spaces and indoor agriculture have different factors).

  Additionally, the BECAR team observed that PSE does not claim the HVAC system savings for mechanically cooled buildings. For gas-heated buildings with air conditioning (the norm for the Business Lighting's buildings in the PSE service territory), incorporating the nine RTF building type cooling interaction factors has the potential to add about 8% in additional kWh savings that could be claimed by PSE. We recommend including cooling in PSE's interaction factors and continue to recommend adopting the RTF interaction values that provide a more detailed selection of interaction factors that include cooling savings.

- ***Make improvements to assumptions for LED grow light savings***. *For cannabis grow farm lighting projects, PSE should consider adopting a uniform method for calculating operating hours, which would ideally be built into the PSE calculator. Also, for farms with mechanical cooling, PSE should implement an HVAC interaction factor into their savings calculation*.

  Recommendation status: This recommendation has been partially implemented.

  LED grow lights for indoor agriculture provide about 10% of the savings for the 2016 BEM portfolio and 74% of the E251 tariff group savings for C/I New Construction. LED indoor agricultural savings increased in 2016 by 130% over the 2015 program year.

  This recommendation suggests that a *uniform method* be developed for calculating hours of operation. We looked at a sample of ten 2016 BEM projects for indoor agriculture lighting to review how the program was calculating savings. Below are our observations on the 2016 PSE savings calculations in the context of the above recommendation.

- **Operating hours**: We found that across the sampled projects, the PSE engineer selected annual operating hours/days in consultation with the customer. After installation, projects with savings greater than 300,000 kWh require metering, per PSE's M&V protocol. The differences between site operating hours among projects in our sample were not large; however, a uniform methodology would impose more rigor on the process and maintain consistency across projects. We recommend adding a calculator input field where downtime days are explicitly listed, so that they may be subtracted from the annual schedule. This would remove ambiguity about the basis for selecting annual operating hours.

  Example:

  Annual hours = [Daily hours][365-(days or fractions of days not in production)]*

  Vegetative Area: 8,592 hours/year = [24 hours/day][365 days – 7]*

  Flower Area: 4,296 hours/year = [12 hours/day][365 days – 7]*

  PSE's response to this recommendation is as follows:

  > *Producers' growing techniques, and consequently their operation schedules, vary considerably. Lighting hours are one component that varies from grower to grower. PSE engineers already document lighting hours in the Custom Grant project Lighting Hours Rationale section based on information gathered from each grower, including daily lighting hours for each growth phase and annual down time, similar to the example SBW provides above.*

  As stated above, the program could benefit from a uniform method for calculating hours for indoor agriculture projects. One of the grow light projects (ID No. 102-3704) that we reviewed used a methodology that had a small math error resulting in an estimate of 378 production days per year, and incentive overpayment of $852. We believe that a standard operating hour calculation would make calculations more simple and straightforward, and easier for technical staff and additionally would improve the consistency of savings estimates and incentive payments.

- **The HVAC interaction factor** of 1.1 that we recommended has been used by PSE since March 28, 2016 for grow areas with mechanical cooling.

- **Baseline fixtures**: There were minor differences in baseline fixture wattages observed in the review of the 10 projects but the differences are small (± 2%) and we consider PSE's approach to baseline wattage for this end use to be acceptable.

In summary, the 10 LED grow light projects that we reviewed are reasonable in their savings. We understand that this measure type is processed as a custom project and, as such, can accommodate the individual engineer's judgement. However, these projects are technically straightforward and use the BEM lighting calculator. With this end use representing a significant portion of the BEM savings portfolio, we think a consistent treatment of the operating hours' factor is warranted and could be easily resolved by modifying the BEM calculator with formula validation or a data validation list to ensure a uniform methodology.

- *Work with WUTC and CRAG to develop an appropriate review timeline so that adjusted UES values can be incorporated into future program plans in a timelier manner.*

  Recommendation status: This recommendation has been successfully incorporated into the BECAR process. This BECAR cycle, the request for proposals and subsequent work plan, calls for UES reviews to be completed as early as possible (September 2016 in this case) for incorporation into the 2017 program cycle. In a similar vein, PSE and the BECAR team are planning to review key 2018-2019 UES values in the third quarter of 2017, so that any adjustments can be made in time to inform the 2018-2019 Biennial Conservation Plan.

Future Improvements in PSE Adaptive Management and BECARs

- ***Continue the BECAR recommendations and ERR reviews**, which provide ongoing assurance that continuous improvement in critical areas occurs. PSE is doing a good job implementing recommendation and keeping track of responses.*

  Recommendation status: This is standard operating procedure in the current BECAR cycle, and this Task 4 memo, along with the corresponding memo for Task 5 (ERR Reviews) demonstrate the successful continuation of this recommendation.

- ***Provide more details in the text of the ACRs**. Future BECAR efforts would benefit from ACRs that included more detailed explanations and insights on accomplishments vis a vis the savings targets. This would aid the BECAR review team in more readily identify programs and/or measures of interest and therefore allow more time and resources for focused verification.*

  Recommendation status: Comparison of the 2016 ACR with the 2015 ACR shows some variance on the level of detail provided on programs with respect to accomplishments. Overall, given that PSE has worked closely with the Commission staff and the CRAG to determine the appropriate level of detail to include in ACRs, we think the level of detail in the 2016 ACR is acceptable.

- ***Document interview findings.** To avoid misunderstandings, following a BECAR interview with PSE staff, the interviewer should provide a transcribed copy of their interview notes to the interviewee for review, correction if necessary, and eventual mutual concurrence.*

  Recommendation status: This is now standard operating procedure and is working well by providing vetted reports for all discussions with PSE program staff. For example, five BECAR Task 5 Evaluation Response Report interviews have been completed so far in this cycle where transcribed accounts of the PSE program manager interviews by SBW have been submitted to the PMs for review. Consequently, some interview details were corrected by the PMs, thereby ensuring that the evaluation responses are accurate for inclusion in BECAR report.

A.4. Task 5 Interim Memorandums

The interim ERR review memo is immediately below, followed by the final 2018 memo.

M e m o r a n d u m

FROM: John Roberts

TO: Bill Hopkins, Jim Perich-Anderson

DATE: April 11, 2017

RE: PSE 2016-17 BECAR – Interim Task 5 ERR Reviews

CC: Bing Tso, Kathrine Clarke

INTRODUCTION

The purpose of this memorandum is to inform PSE staff of the Biennial Electric Conservation Achievement Review (BECAR) team's interim findings from our work to date on the Task 5 Evaluation Response Report (ERR) reviews. This memorandum begins with a summary of our findings, then provides background information regarding this particular BECAR task, and finally offers a summary of each review performed thus far.

OVERALL SUMMARY

In February 2017, we received four 2016 ERRs and associated evaluations for review. This memo addresses the four ERRs listed below. Before the end of 2017 and the end of the current program biennium, up to 11 additional program EERs and evaluations may be reviewed as they become available. The EERs in this first group are:

- 2015 Home Energy Reports Impact Evaluation
- 2012-2013 Multifamily Retrofit Program Impact and Process Evaluation
- 2012-2013 Commercial HVAC Program Impact and Process Evaluation
- 2012-2013 Commercial Data Center Program Impact and Process Evaluation

Based on review of the above ERRs and evaluations, it is evident that PSE has sought to follow the recommendations made by the evaluations. While some of the evaluation findings have spurred direct actions, PSE's own internal process improvements have provided both impetus and solutions to a significant number of the issues raised in the evaluations.

BACKGROUND

The primary BECAR objective for SBW as the independent third-party *reviewer is to assess the extent to which PSE's reported electric energy savings were achieved*. To accomplish this objective, the 2016-2017 BECAR includes seven separate tasks. This memorandum addresses Task 5 (ERR Reviews), which encompasses the following:

> *Assess whether PSE has undertaken follow-up actions on program evaluation studies completed after the 2015-15 BECAR, based on the Evaluation Response Reports included with each completed program evaluation.*

In our work plan for the 2016-2017 BECAR, we state:

> *For this task we will study a particular evaluation report and then interview relevant PSE program and evaluation staff to ensure that we have a full understanding of evaluation results and any changes that occurred to the programs after the evaluation was completed. The key question is: Were the programmatic action items described in the PSE internal evaluation report response (ERR) implemented, particularly those that could have potentially affected future savings values.*

This memorandum presents our assessment of the extent to which the programmatic action items described in the ERRs were implemented, particularly those that could affect future savings values.

One enhancement to the Task 5 interview process for this BECAR cycle is that SBW provides a transcribed copy of our interview notes to the PSE staff participating in the interview for their review, so that we can reach agreement that the notes accurately represent their interview comments. Those transcribed notes formed the basis for the program manager interview notes in the following section.

ERR REVIEW SUMMARIES

2015 Home Energy Reports Impact Evaluation

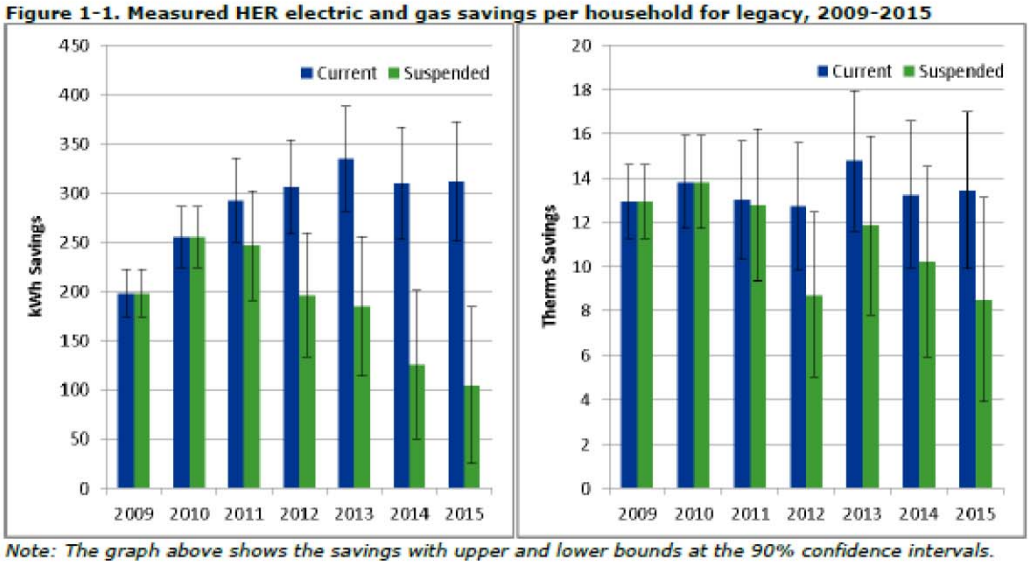
Evaluation Summary

DNV GL conducted this impact evaluation of the Home Energy Report Program and issued its report in October 2016. The program is operated by a third-party contractor. The 2015 savings reported below are the final ex post savings and are free of joint savings due to participation in other PSE programs. The results below are consistent with previous program years.

Table 1-1. Total credited electric savings for 2015 HER programs

HER treatment group	Electric (kWh)				
	Per household	No. of treatment	Total savings	Lower limit 90% CI	Upper limit 90% CI
Legacy - Current	305.4	14,629	4,467,083	3,583,981	5,350,184
Legacy - Suspended	103.3	7,300	753,795	172,996	1,334,593
Expansion - Electric only	180.9	22,291	4,033,099	2,249,369	5,816,828
Expansion - High relative user	224.3	21,924	4,917,213	3,183,842	6,650,584
Expansion – Non-urban	119.3	31,241	3,725,527	2,122,766	5,328,288
ALL	183.8	97,385	17,896,717	14,603,328	21,190,106

Figure 1-1. Measured HER electric and gas savings per household for legacy, 2009-2015



Note: The graph above shows the savings with upper and lower bounds at the 90% confidence intervals.

Program Manager Interview

There were no actionable recommendations in the 2015 HER evaluation report. Therefore, the subject of our ERR conversation with the program manager (PM) focused on observed trends in HER treatment groups that could indicate an influence on future program savings.

The PM said that they added about 25,000 refill customers in April 2015 to replace participants who had moved out their homes (HER does not track participants after closing their PSE account). Even though this refill customer group became program participants in mid-2015, they were not counted in the 2015 savings, and they will instead be counted in subsequent years. This refill group were mixed-fuel homes with characteristics that the HER contractor hypothesized would produce greater electrical savings. As it turns out, the refill population is performing well, with an accelerated ramp-up, relative to the three other expansion populations based on contractor projections and not on an independent evaluation. We do not yet know exactly why this group is outperforming the other expansion sub-groups in savings.

The PM mentioned that move-out attrition continues to be monitored and another refill group may be assembled in the future.

Action Plan

The ERR action plan was to adopt the key findings as the ex post savings for the program, and to have program management continue tracking the savings performance of the suspended households group to track the persistence of this measure. The DNV-GL report shows a steady decay in savings for suspended households in the legacy group, yet the table above shows that this group is still providing savings with about one-third of the legacy group still active in the program.

Conclusions

Established in 2008, this program is achieving considerable savings by promoting residential customer behavioral changes and participation in other PSE programs. The adoption of a different customer characteristics profile for selecting the 2015 refill group appears to be paying off in higher savings. It will be interesting to follow this and possible later refill groups in future HER impact evaluations.

2012-2013 Multifamily Retrofit Program Impact and Process Evaluation

Evaluation Summary

DNV GL performed an impact and process evaluation to verify multifamily direct-install measure installations, determine a program-level realization rate for energy savings, and provide recommendations aimed at improving program delivery. The results of the impact evaluation are presented in the table below. The study found somewhat lower than expected savings for both electric and natural gas fuels.

Table 1: 2012-13 program reported and evaluated energy savings

	Program Reported Savings[6]	Realization Rate	Evaluated Savings	Precision at 90% Confidence	Evaluated Savings Range at 90% Confidence		Evaluated Savings Range (%) at 90% Confidence	
					Low	High	Low	High
Electric (kWh)	44,208,769	86%	37,900,908	15%	32,215,772	43,586,044	73%	99%
Gas (therms)	155,082	77%	118,664	22%	92,558	144,770	60%	93%

Table 17: DI measure-level observed installation rate

Measure	Number of Sites with Measure Installed	Total Measure Expected	Total Measure Observed	Observed Measure Installation Rate
Advanced Power Strip (IR) - Direct Install	1	16	2	13%
Clothes Washer Replacement Electric Water Heat/Electric Dryer	9	13	9	69%
Energy Star CFL - Direct Install	30	4,527	2,936	65%
LED - A-Lamp - Direct Install	14	198	129	65%
LED - Candelabra - Direct Install	10	114	83	73%
Refrigerator Replacement	33	77	66	86%
Showerhead - Max 1.5 gallons per minute (GPM) EWH - Direct Install	26	312	217	70%
Showerhead - Max 1.5 GPM Gas Water Heat - Direct Install	7	72	62	86%
Showerhead (CWA) - Max 1.5 GPM Electric Water Heat - Direct Install	2	32	24	75%
Smart Power Strip - Direct Install	9	150	20	13%

Evaluation Recommendations and Program Manager Interview

There were three recommendations in the impact evaluation part of the DNV GL report. Those recommendations and the PM responses are detailed below. Note that this ERR review follows up on a previous BECAR review issued in March 2016, and provides the perspectives of a new program management team.

1. *Direct installation and leave-behind measures do not have 100% persistence. For planning purposes, including cost-effectiveness analysis, the program should assume that a portion of measures directly installed by the program either fail or are removed by tenants before the end of their useful lives.*

   ERR discussion: The program uses the RTF deemed measure savings for the direct install (DI) measures that are specific to the multifamily direct install sector and include derating factors to account for persistence issues.

   Installers' contact rate with multifamily residents is about 50%. Program representatives offer to help guide the installation of advanced power strips, and if it is a leave-behind (without being able to guide the installation), they leave detailed instructions and a manufacturer's customer hotline to call with any questions on proper installation of the devices. When meeting with the customer, they discuss the energy savings benefits with them to help reinforce the behavioral component associated with the savings.

2. *Assume an appropriate attrition rate for "plug" measures such as power strips. Appliance and water fixture measures generally are left in place in tenant units, while measures that are plugged in can be easily removed by the property owner or tenant. The program may be*

able to use follow-up communications to address the issue where measures were left to the property manager and were never installed.

ERR discussion: The program recently switched to a Bluetooth-enabled Tier 2 smart strip. Bluetooth smart strip devices can provide data for PSE on: (1) whether the device is installed and synced via Bluetooth with the mobile application and (2) the aggregate load on the strip over time. Residents with the Bluetooth functionality can observe their demand and can shut the strip down remotely. This device allows the collection of data with individual and aggregate results in reports to PSE.

The PSE evaluation analyst present for the discussion mentioned that this data, in aggregate, will eventually provide the upper and lower bounds for the device savings, thereby greatly increasing the accuracy of the evaluators' savings estimates for the program. These devices have the potential to provide energy use data remotely via Bluetooth. However, actual customer interest in using the Bluetooth capability may be limited, thus limiting the data acquisition capability of the devices. These units can still function as designed and result in energy savings without the need to sync with a mobile app via Bluetooth.

PSE does not leave strips, or any direct install items, unless they get access to the unit to make sure the unit qualifies for the DI program.

3. *Combine program tracking database and project file data. The program tracking data from the 2012-13 program was done at the site level while the project details, including where (i.e. tenant units) the measures are installed, are kept in separate disconnected files. Expanding the tracking database to include all of the relevant project level info would provide additional sample points for evaluations, allow for more reporting options, and ultimately help PSE better understand their program. Upon receipt of the draft report, PSE informed DNV GL that this issue is being addressed with the implementation of energy Orbit operations platform.*

   ERR discussion: The PM said they now have a robust data tracking platform that provides customer data at the property management portfolio level, property level, building level, and unit level by measure. Multiple data points are collected during the audit, including detailed data pertinent to air sealing for later modeling, all collected data points reside in the database.

Conclusions

Discussions with PSE staff members indicate they are using the appropriate deemed measures that are tailored to multifamily direct install programs, and applying the corresponding RTF savings values. The data tracking system has been updated to address the shortcomings cited in report recommendation #3.

2012-2013 Commercial HVAC Program Impact and Process Evaluation

Evaluation Summary

This Navigant impact and process study on PSE's custom commercial HVAC program was released in April 2016. This evaluation report presents the results of the impact and process evaluations of the PSE 2012-2013 Commercial HVAC Program. The program provides incentives for cost-effective energy efficient HVAC measures in existing commercial buildings.

The study's goals were to verify measure installations, quantify program level energy savings, collect feedback from trade allies, and present best practices for similar programs.

The impact evaluation reported an overall realization rate of 98%.

Table 1: Total Savings by Stratum

Stratum	Total Projects	Final Sample of Projects	*Ex-Ante* Savings (Electric - kWh, Gas - Therms)	Realization Rate	*Ex-Post* Savings (Electric - kWh, Gas - Therms)
HVAC Upgrades – Electric	82	15	3,485,728	97%	3,365,623
HVAC Controls – Electric	138	18	4,090,032	103%	4,225,677
Total Electric	**219**	**33**	**7,575,760**	**100%**	**7,591,299**
HVAC Upgrades – Gas	89	15	190,148	99%	188,806
HVAC Controls – Gas	151	17	137,748	92%	126,939
Total Gas	**239**	**32**	**327,896**	**96%**	**315,745**
Overall	460	65		98%	

Source: Navigant and Tierra analysis of M&V data

Evaluation Recommendations and Program Manager Interview

The Navigant report had five impact evaluation recommendations for the program to consider:

1. *Require program participants to provide estimates of building occupancy and/or operational changes over time. Currently, building occupancy and/or equipment operational changes are only tracked in the time frame between the initial project QC and final incentive payment. However, approximately 30% of the evaluated projects in the Impact Evaluation sample required adjustments to the baseline in the ex-post analysis due to occupancy and equipment operational changes that occurred after this period. Going forward, consider tracking whether the participants foresee any changes in occupancy, product demand, measure operating characteristics, etc., This will allow PSE to more accurately calculate ex-ante savings, or at the very least, keep an eye on projects that have a uncertainty surrounding their savings..*

   ERR discussion: The PM discussed the uncertainty associated with future commercial building operations, schedules and occupancy in particular. Their practice is that if there is a known change in occupancy or scheduling coming up in the future, they will factor that into

the energy savings calculations, but it is common in the commercial sector to have unanticipated changes in facility operation. An example of an anticipated future change would be a new data center where they factor in a load ramp-up rate into the savings calculations.

2. *Track line-item-level program data in the tracking database. Currently, PSE only tracks data aggregated by project and measure category, although Microsoft Excel® workbooks containing detailed data are submitted for HVAC measures as part of the program documentation. Maintaining additional line-item-level data in the detailed program tracking database would allow PSE to more readily check for errors in the submitted project data, while streamlining future evaluation efforts. .*

   ERR discussion: The PM said that PSE's standard procedure is to enter rolled-up measure savings into their tracking system. It is impractical to itemize savings for each project. Moreover, the detailed information the evaluators need is present, but it simply require that an analyst extract it from the electronic files.

   An evaluation analyst participating in the discussion observed that this recommendation is coming from an evaluator's perspective and that their DSM tracking system is a good for what is does, but it is not feasible to provide this level of granularity in the database system at this time.

3. *Ensure project and analysis files are maintained in a Spreadsheet format. Although many of the project files received from PSE were quite detailed, many spanned multiple projects and required additional time to identify the final project savings values, and align the ex-ante calculators with the program tracking databases. In some cases, HVAC project files needed to be manually translated from a .PDF format into a spreadsheet format so that the data could be analyzed and used during the site visits. Future evaluation efforts will be streamlined and effective if PSE maintains all analysis files in a spreadsheet format.*

   ERR discussion: PSE's internal process improvement practices addressed this several years back and functioning Excel spreadsheets are now archived in their system. Further, simulation models using a proprietary program such as Trace must have all files associated with the model in the PSE electronic project file.

4. *Track specific program project milestones and completion dates. Currently, estimated project completion dates are being tracked in the project documentation but specific dates pertaining to project completion and commissioning are not adequately documented. Consider implementing database fields which document specific project milestones, project commissioning, and project completion.*

   ERR discussion: The current database does have fields for a variety of benchmark dates. The PM provided an example for benchmark tracking within a single project file, with the ability of the database to track multiple commissioning completion dates for multiple measures in a single project.

5. *Ensure that any suggested changes in savings methodology are accounted for before final payment is issued. In reviewing the sampled projects, it was discovered that a small subset*

of sites had notes in the payments file regarding occupational or operational profiles which had changed since the projects were initially proposed. Ensure all comments are reviewed and accounted for in the savings and grant amounts before the numbers are finalized into CSY.

ERR discussion: The PM indicated that they do true up the final savings to reflect any known changes affecting original project savings estimates prior to payment.

Conclusions

The evaluation report's five recommendations have either been corrected through PSE's internal improvement practices and database upgrades (#2, 3, and 4), or the PM states that they do the best job possible in accounting for future or current facility operations factors (#1 and 5).

2012-2013 Commercial Data Center Program Impact and Process Evaluation

Evaluation Summary

Navigant's study of the Commercial Data Center program was released in March 2016. The ex post saving realization rate fell in 2013, although the program management team contends the realization rate should have been higher (see Recommendation 6 below). Since its inception in 2012, this program has been operated by a third-party contractor to target the small and medium data center market. The Navigant study recommends that PSE discontinue the third party operation of the program and bring it into PSE's BEM Custom Program.

Table 1. Summary of PSE's C&I Data Center Retrofit Programs Performance, 2012-2013

Program Year	# of Projects	Total Grants ($)	*Ex-Ante* Savings (kWh)
2012	2	$533,479	2,052,723
2013	7	$1,088,202	9,098,080
Total	9	$1,621,681	11,150,803

Source: Navigant analysis of PSE tracking database.

Table 5. Total Program Savings by Program Year

Program Year	*Ex-Ante* Savings (kWh)	Realization Rate	*Ex-Post* Savings (kWh)
2012	2,052,723	91%	1,875,923
2013	9,098,080	52%	9,098,080
2012-13	**11,150,803**	**59%**	**11,150,803**

Source: Navigant analysis of M&V data

As the number of Data Center Retrofit Program projects dropped off significantly in recent years, PSE could not justify the costs for administrating this as a third-party program and

discontinued it in August 2016. Consequently, energy efficiency projects that previously went through the Data Center program are now processed through the BEM Custom Program. The following discussion with the BEM custom project management team reflects the current practices in the Custom Program.

Evaluation Recommendations and Program Manager Interview

1. *Require customers or contractors to submit all calculation files and location data for installed equipment. Most of the project files included details of installed equipment and savings calculations, but some were vaguer about unit numbers and locations as well as algorithms, providing difficulties in verification.*

   ERR discussion: The current practices in the Custom Program should provide clear equipment itemization and well documented savings calculations.

2. *Confirm that database and project files contain the same ex-ante savings values. Although most of the project files examined as part of this evaluation contained consistent savings values with the program database, one contained values that deviated significantly from those reported in the program database, resulting in a low realization rate*

   ERR discussion: The program management team confirmed the program QC requirements ratchet up with large savings projects and, while it is possible that an error of this nature could happen with a small savings project, it would be a rare occurrence.

3. *Keep electronic copies of all calculation spreadsheet data. Although many of the project files included detailed calculations files, some had only scanned copies of data showing installation locations, calculations, or raw data. This significantly increases the difficulty of verification and evaluation.*

   ERR discussion: All program files are now in electronic format.

4. *Confirm baseline conditions for ex-ante calculations. Some of the variability in the evaluated realization rates could be mitigated by confirming baseline loading and conditions used for ex-ante calculations, particularly loading of fans and HVAC equipment.*

5. *Include adequate post-installation verification data in ex-ante calculations. Some of the projects used post-installation data in determining the efficient case ex-ante usage, but other projects appeared to have obtained only very limited trend or other operational data post-installation, which limits the ex-ante savings accuracy and precision.*

   ERR discussion: [*these remarks apply to both 4 and 5*] Both comments above relate to M&V practices. This is also true of recommendation 6 below, but that is specific to one project.

   In the Custom Program, the savings determine the appropriate M&V protocol; savings greater than 300,000 kWh trigger more rigorous M&V guidelines (this is consistent with many C/I DSM programs). Thus, utility engineering time and expense is proportional to the acquired savings.

   A program supervisor made the point that IPMVP Option C (whole facility measurement) requires a long timeline and is impractical with regard to providing incentives to customers in a timely manner.

Looking ahead, an evaluation analyst present mentioned that the internal evaluation team is considering a pilot for a M&V 2.0 approach for large savings projects where continuous billing analysis provides ongoing feedback to program engineers and the evaluators on facility energy use that is , in a sense, real-time evaluation.

6. *Apply extra scrutiny to very large projects. The largest project in 2013 made up over 60% of that year's ex-ante savings but had only a 37% realization rate. The low realization rate was driven both by unrealistically high savings for fan usage and by increased chiller use due to facility cooling requirements. While the latter might not have been easy to anticipate, review of ex-ante assumptions could have prevented the former overestimate of savings. For projects as large as this Navigant recommends that PSE apply extra scrutiny to savings assumptions and calculations, and possibly delay full incentive payments until longer term data can be collected for measures with weather or production variability, to reduce the discrepancies in ex-ante and ex-post savings values, particularly for the largest projects. The problem with the baseline in the largest project was apparent from reviewing facility bills and comparing them to the baseline load used in the calculations.*

   ERR discussion: For this particular project, by far the largest savings project in the evaluation period, the evaluator used IPMVP C (whole facility measurement) for the impact evaluation, whereas the program applied IPMVP A (key parameter measurement), which the evaluators conceded was the only viable option at the time. There was a 51% difference between the two ex post savings calculations methods and they could not be reconciled. The program management team stands by their assertion that the IPMVP A methodology is the appropriate methodology for this site.

Conclusions

The Data Center Retrofit Program has been discontinued. By dint of the fact that data center projects are now handled through the Custom Program, however, the evaluation report recommendations have been addressed indirectly. Current practices in the Custom Program comply with all of the above recommendations.

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Memorandum

FROM: John Roberts

TO: Bill Hopkins, Jim Perich-Anderson, Michael Noreika

DATE: April 18, 2018

RE: PSE 2016-17 BECAR – Task 5 Final ERR Reviews

CC: Bing Tso

INTRODUCTION

The purpose of this memorandum is to inform PSE staff of the Biennial Electric Conservation Achievement Review (BECAR) team's findings on our work for the Task 5 Evaluation Response Report (ERR) reviews since the Interim Task 5 review memorandum dated April 11, 2017. This memorandum contains a summary of our findings, background information on this particular BECAR task, and a summary of each ERR review performed since the April 2017.

SUMMARY

Listed below is the second group of evaluations and associated ERRs reviewed for this memo:

1. 2016 Multifamily Air Sealing Program Evaluation Update
2. 2012-2015 Industrial System Optimization Program
3. 2014-2015 Direct-to-Consumer Impact and Process Evaluation
4. 2013-2015 Low Income Weatherization
5. 2016-2017 Commercial and Industrial New Construction
6. 2016-2017 Commercial Rebates
7. 2013-2015 Single Family Dealer Channel
8. 2016 Home Energy Reports Impact Evaluation

Based on our review of the above ERRs, it is apparent that where practical, PSE follows the recommendations made in the evaluations. In some cases, particularly recommendations that include the revision of business case workbooks and unit energy savings (UES) values, PSE program managers accept the recommendations but frequently elect to delay implementation until the latter part of the program year when program adjustments are typically made before the next program year. While most of the evaluation findings prompt direct actions, PSE's own

internal adaptive management process also provides both impetus and solutions to a significant number of the issues raised, frequently in advance of the receipt of evaluation results.

Background

The primary BECAR objective for SBW as an independent third-party reviewer is to assess the extent to which PSE's reported electric energy savings were achieved. To accomplish this objective, the 2016-2017 BECAR includes seven separate tasks. This memorandum addresses Task 5 ERR Reviews, which comprises the following:

> *Assess whether PSE has undertaken follow-up actions on program evaluation studies completed after the 2014-15 BECAR cycle, based on the Evaluation Response Reports included with each completed program evaluation.*

In our work plan for the 2016-2017 BECAR, we state:

> *For this task we will study a particular evaluation report and then interview relevant PSE program and evaluation staff to ensure that we have a full understanding of evaluation results and any changes that occurred to the programs after the evaluation was completed. The key question is: Were the programmatic action items described in the PSE internal evaluation report response (ERR) implemented, particularly those that could have potentially affected future savings values?*

The BECAR review scope is limited to electrical energy savings. Program evaluations often present results that are outside of our charge to investigate electrical energy savings, such as program process findings, non-energy benefits, and natural gas savings. This memo presents our assessment of the extent to which the programmatic action items described in the ERRs were implemented, particularly those that could affect future electric savings values.

ERR Review Summaries

1. Multifamily Air Sealing Savings Evaluation Update

The Multifamily Air Sealing Pilot Program (MFAS) reduces energy use in multifamily apartments through pressure testing and sealing of electrically-heated multifamily apartments by third-party contractors to reduce outside air infiltration.

Evaluation Overview

The purpose of the evaluation conducted by DNV GL was to "*1) identify savings resulting from the PSE Puget Sound Energy Multifamily Air Sealing Pilot Program; and 2) determine whether energy savings data supports the use of a deemed savings value for multifamily air seal projects.*"

One particular driver for this evaluation was to further refine deemed savings values from previous studies. Another study task was to upgrade the air sealing calculator with the latest field data results.

Evaluation Recommendations

Below are the recommendations from the DNV GL evaluation report:

Deemed savings:

- Use deemed savings of 612 kWh / tenant unit and require sample based test-in and test-out. This deemed savings value is based on slightly below average test-in and slightly below average reduction values.
- Do not include additional evaluation sample from pre-February 2016 in additional analysis. Based on discussions with program implementers, they will likely not represent the current program well.
- Obtain post-billing data and campus building characteristics to model as many post February 2016 buildings as possible.
- Consider additional modeling quarterly to confirm program performance, as more completed buildings reach the point of providing a full year of post retrofit data. Almost all 2016 participants will have "post winter" retrofit data in Q2 2017.
- Develop a deemed savings estimate for large buildings based on modeling. Compare leakage reduction per unit to small building distribution prior to modeling, to determine if and how quickly a sampling approach for large building testing can be applied.

Using QA/QC data to inform EM&V and savings updates:

- Compare results periodically to the data from the initial pilot as a goal to achieve and track improvements above the 2015 projects that triggered re-training.
- Continue to scale savings based on total building usage. Data should be available for any participant regardless of blower door test requirements.
- Modify the calculator if QA/QC tests reveal very leaky buildings or large reductions.
- For buildings larger than 20 units, but less than four-stories, use TREAT modeling process consistent with the low-income weatherization (LIW) program and require testing for at least the first few buildings. Recommend not using the calculator for larger buildings (four-stories or greater) since per tenant unit average savings may change based on building features, especially common areas and elevators. Also recommend excluding mixed-use (commercial tenants on first floor) buildings and recommend using commercial modeling software (e.g. EnergyPlus).
- Begin sampling approach to test-in and test-out, focused on more frequent testing for new contractors as a QA/QC method.
- Reduce costs (proportionally) by moving from testing every unit to site-level sampling. Currently, every unit at every site undergoes a test-in, test-out procedure. We recommend 25% test-in, test-out for new contractors and 15% for more established contractors.
- Consider within campus sampling since the current MFAS participant population and PSE multifamily existing program population are primarily made up of campuses. Recommend requirement of 50% testing of buildings on a campus on a new contractor's first job. The criteria can then relax to 25% and 15% after proven performance. Added benefits include:

- The evaluation can construct a model for each campus, and can utilize QA/QC data, billing data, and audit data.
- Continuous expansion of savings data set to continuously improve precision and look for new trends as the sample of buildings grows.

- Continue to track where the QA/QC sample maps to the distribution of leakage reductions. The recommended QA/QC testing should lead to achieving 90/10 precision within the next evaluation year.
  - Explore whether leakage reduction values are below overall average and train contractors to correct as needed. Use pilot average leakages as another indicator of "good".
  - Examine best practices from leakage reduction values above average, especially at or above pilot averages.
  - Monitor and consider corrective actions (change in project targeting, re-training) for the lowest quartile of leakage reductions.

MFAS Program Manager Discussion

Many of the recommendations above are addressed below in this summary of our conversation with the MFAS project manager.

Data Collection - The MFAS program manager reports that with the shift to using the new deemed savings value, the calculator now serves as the data collection file for purposes of evaluation and quality control. It provides detailed documentation on the installation details for each unit and building. When applicable, the calculator file contains field inspection and blower door test results. Other documentation includes changes in the scope of work that determines the final incentive payment.

Deemed Savings – Following this evaluation, the program manager sent pre/post data for 155 multifamily buildings completed after the evaluation study period to the third party evaluator for processing and additional modeling of program savings. PSE's senior market analyst present for the discussion explained that pre/post data on project performance will be provided on an ongoing basis to shrink the confidence interval around program savings by increasing sample size. The confidence interval may also be reduced if the increased QA/QC efforts also reduce the variability of savings.

Blower Door Testing – Previously, 100% of participants received two blower door tests, pre and post air sealing or test-in/test-out. Now QC testing and post-installation field inspections are applied strategically at a rate of 15% to 25% of program participants. The air seal program has become more data-driven, thus reducing program costs by doing less blower door testing and instead relying on post installation data processing and modeling by evaluators for a periodic true-up of the per/unit kWh deemed savings. Moreover, along with increased cost effectiveness, reduced testing is much less intrusive for the customers. Depending on the outcome of the data processing/modeling, a bigger sample may be needed to achieve the desired confidence interval. The data is used to continuously improve the model for the

deemed savings – this is, in a sense, a hybrid deemed savings methodology because there is an active, ongoing process to recalibrate the model and produce revised deemed values over time.

Quality assurance and quality control: An improvement in the QA program, in addition to recommendations made in the evaluation report, is the establishment of mandatory pre-construction meetings that are proving to be an effective way to communicate PSE's expectations to the contractors and property managers. PSE's field implementation team presents clear guidelines and checklists that all participants agree to before proceeding with the installation. This improves transparency is working well to reinforce PSE's QA expectations. Another recently implemented QC improvement, also additional to evaluation recommendations, is for PSE to do random and unannounced site inspections. In the past, when QC inspections were scheduled, the contractors would typically assign their most experienced installer teams to be present for the PSE field inspection. Thus, this procedural change emphasizes best installation practices with a broader group of installer crews.

Individual TREAT (a proprietary residential simulation program) models are used for both the <20 units/per building group, and will also be used for the >20 units/building group. Because larger buildings have different characteristics than <20 unit buildings, such as larger common areas and construction types, deemed savings values for >20 unit buildings will be developed separately. To date, there have been few larger buildings participating in the program.

BECAR Conclusion

The program has complied with, or is in the process of implementing, the evaluation recommendations pertaining to electrical savings. This is a program with a continuous refinement loop process where performance data is collected, then rolled back into the savings estimates going forward. Their QA/QC contractor communication protocols have gone beyond the evaluation recommendations and reflect good adaptive management practices.

2. Industrial Systems Optimization Program Evaluation

Through ISOP, participating PSE industrial customers receive financial and technical assistance to help them to identify and implement low-cost or no-cost operations and maintenance improvements and procedural adjustments. The program focuses on energy-intensive systems such as refrigeration, compressed air, pumps, fans, and blowers. This report is the first evaluation of this program and covers the 2012-13 and 2014-15 program bienniums.

O&M measure energy savings are estimated through custom analysis on an individual project or site basis. Incentives are based on actual savings achieved. Customers agree to continue monitoring and verification following implementation to assure persistence of the savings.

Evaluation Summary

DNV GL's objective for the impact evaluation portion of the study was to independently verify program energy savings and to identify recommendations for program improvements that have the potential to increase ISOP's energy savings. Specific objectives of the impact evaluation are reporting realization rates for the evaluated energy savings, evaluating measure life, and risks to the persistence of savings.

ISOP Team Discussion

Following are the recommendations from the DNV GL report pertaining to energy savings, PSE's response in the ERR, and a synopsis of the ERR interview discussion.

Recommendation 1: Reform calculation methods. The team recommends the program select model variables and relationships that are consistent with the energy consumption of the operations and to avoid use of calculated variables unless there is a demonstrable reason why the variable drives energy consumption. While the overall realization rate was high, the team found that site-level realization rates varied considerably. This variability could be due to incorrectly estimating savings based on factors with a high correlation to usage for the performance period even though those factors were not drivers of energy consumption.

> **PSE Response**: The third-party implementer develops the energy consumption model using the best available data for each project. All models are validated for statistical validity by the third party and PSE staff.
>
> Beginning immediately upon receiving the evaluation report recommendation, PSE set additional requirements for the third-party implementer to thoroughly document all variables and assumptions as well as detailed explanations for the final included and excluded variables. Additionally, PSE staff review energy models prior to project completion.
>
> **ERR Discussion**: The ISOP contractor now consistently and precisely defines how each analysis/modeling variable contributes to the improved accuracy of energy savings estimation. As a final step in the quality control process, PSE engineers conduct a thorough review of each ISOP site model.

Recommendation 2: Extend the minimum performance period. The current 60-day minimum is very brief and the evaluation team believes that this brevity reduces the accuracy of the savings estimates. The evaluation team recommends a period of 90 days for facilities with consistent plant loads with even longer periods for inconsistent or seasonal plant loads. The length of the periods sufficient to capture seasonality should be assessed on a case-by-case basis for facilities considering the site-specific seasonal loads. The goal of the longer periods is to capture a more representative of the annual range of conditions, thereby improving savings accuracy.

> **PSE Response**: PSE acknowledges this recommendation. However, both the mean and the median overall length of project engagement times are over 60 days. While an additional 30 days or more of M&V could improve the accuracy of the savings estimates, the additional time could also unduly burden the program participants by extending the overall project engagement time. At this time, PSE does not agree with the recommendation because of the potential negative effects of a longer engagement time. PSE will consider extending the M&V period for projects with statistically unpredictable energy consumption on a case-by-case basis.
>
> **ERR Discussion**: The program staff report that each project monitoring and verification performance period is tailored to individual site circumstances and reflects a reasonable timeframe for gathering sufficient data without placing undue burden on the participant's

time. Some projects require a brief M&V period, while others require M&V of more than 60 days. The PSE evaluation staff is investigating ways that M&V could be extended where necessary.

In addition to the two evaluation recommendations above, the DNV GL evaluation team offered several suggestions for the PSE program and evaluation team to consider for future program improvements.

Suggestion 1: Expand the program to address a wider range of industries within PSE's service territory. The program has addressed cold storage and food processing, but not many other sectors. The program can bring in deep expertise in a wider range of industrial systems to increase savings and provide ISOP services to a broader range of PSE industrial customers. PSE can achieve this by identifying and contracting with industry specific experts for specific sites.

ERR Discussion: The project management team is expanding ISOP's reach to other types of industrial facilities. For the 2018-2019 biennium, wastewater treatment facilities have been identified as an industrial sector with high savings potential, and so they are working with the third-party contractor to provide engineering expertise to support this new program direction.

Suggestion 2: Incorporate action items that facilitate ongoing maintenance practices to increase savings retention. Maintaining maintenance practices and optimal settings can be challenging, especially when routines are not established or personnel change. The research team identified multiple approaches used by similar programs to address this risk, such as: training facility personnel, requiring new practices to be added to the facility standard operating procedures or similar document, continuous monitoring, and delaying incentives.

ERR Discussion: The ISOP contractor's Strategic Energy Management (SEM) process (a systematic O&M optimization process) addresses long-term optimization of facility systems to sustain improved site energy performance. An example of this is the Kaizen process, which begins with an intensive on-site systems tune up and continues with ongoing technical support for the following year.

Suggestion 3: Offer higher incentives for completing implementation steps within a specified timeframe. Two of the comparison programs were successful in using financial incentives to accelerate project completion. The program could use this approach to accelerate the customer commitments to an optimization event and to accelerate implementation. Providing incentives for rapid commitment to an optimization event may also reduce the number of scoping studies needed to meet program goals.

ERR Discussion: Beginning in 2018, PSE's ISOP project management team is testing a new program practice to encourage faster customer project implementation by reimbursing 100% of customer-incurred costs if they act on ISOP recommendations within four months; thereafter the reimbursement drops to 50% of customer implementation costs.

BECAR Conclusion

Below we summarize our conclusions regarding the two evaluation report recommendations and the three report suggestions:

- *Recommendation 1*: Improved savings calculation methods by the third party contractor have been implemented to more precisely map savings model variables to energy consumption drivers. Additionally, the program has instituted a formal quality control M&V model review by PSE engineers near the completion of a project.
- *Recommendation 2*: We agree with the ISOP team on the practicality of maintaining some flexibility on measure M&V periods, as opposed to the recommendation of a fixed 90-day M&V period for each measure. As mentioned in ISOP's response, their average M&V period is over 60 days, depending on the nature of the measure.

Our discussion with the ISOP team on the evaluation report's *Suggestions for Future Consideration* demonstrates they are actively pursuing program refinements that should result in increased future program savings. Moreover, the discussion indicates that PSE's ISOP team practices forward-looking adaptive management practices.

- *Suggestion 1*: Expanding the types of facilities that ISOP serves has been addressed and in 2018 the program has broadened its reach to include wastewater treatment facilities.
- *Suggestion 2*: Developing actions to improve the longevity of maintenance practices at participant facilities is being accomplished though ISOP's SEM practices that include their ISOP contractor's Kaizen process.
- *Suggestion 3*: In 2018, the ISOP team has increased monetary incentives to participants to motivate faster site recommendation implementation by reimbursing participants for 100% of their implementation costs if they act on those recommendations within four months of receiving their ISOP action plan.

3. Direct to Consumer Impact and Process Evaluation

The Direct to Consumer (DTC) program works through multiple delivery channels with consumers, retailers, and manufacturers to deliver the following products and services to PSE residential customers: residential lighting rebates, advanced power strip rebates, appliance commissioning, appliance replacement, appliance rebates, and residential showerheads.

Evaluation Overview

This evaluation covers the 2014-2015 program years and was delivered to PSE in August 2017. This evaluation conducted a comprehensive impact and process review for each of the program elements listed above.

DTC Program Managers' Interview

Below are findings and recommendations from the Itron study that are pertinent to the BECAR review process. Recommedation numbers used below correspond to those in the evaluation report and the ERR.

Finding Lighting (L) 1: The tracking data review completed for PSE's Residential Lighting program found that the tracking data files were missing several key measure variables needed to accurately characterize program sales and accurately calculate savings. These missing variables included: measure wattage, lumen output, baseline wattage equivalent, bulb

description (such as reflector type, specialty bulb type, and fixture type), and retailer where the program measure was sold.

> **Recommendation L1:** PSE has reported that it has begun working with program vendors to ensure these variables are included in the program tracking data going forward. The evaluation team recommends PSE audit these changes to ensure they are consistently reported for all measures sold through the program.
>
> **PSE Response:** PSE's program vendors now include the new measure variables (wattage, lumens per watt, bulb description, and retailer) in their sales data submissions to PSE. PSE has begun work to upload these additional data fields into DSMc, the system for tracking incentives and energy savings.
>
> **ERR Discussion**: The DTC program manager reports that this process has been fully integrated into program operations.

Finding L2: An issue was identified in the assignment of the 2015 deemed UES for Indoor LED fixtures and LED retrofit k its. Both measures were mistakenly assigned the 2014 UES value rather than the 2015 value. This resulted in measure level realization rates of 90% and 99% respectively.

> **Recommendation L2**: The evaluation team recommends that PSE review its QA/QC steps to ensure there is an audit step in place to confirm the deemed UES estimates have been assigned correctly.
>
> **PSE Response:** PSE has moved to a new system for tracking incentives and energy savings, DSMc. This new system includes a new QA/QC process for confirming that deemed UES estimates have been assigned correctly.
>
> **ERR Discussion**: The project manager verified the QC/QA processes as described above continue to operate well and as intended.

Finding L3: During Stage 2 of this evaluation a number of parameters in the lighting UES algorithm were updated using program sales data and data collected from program participants in order to estimate ex-post savings.

> **Recommendation L3:** The evaluation team recommends that PSE review each of these parameter updates, in light of additional changes that have occurred to the savings algorithms since 2015, to determine if updates to the deemed parameters are warranted.
>
> **PSE Response:** In Q4 2016 PSE worked with a third party vendor to review and update the deemed savings values. Our current savings values and measure life are a well-researched and documented blend of the RTF methodology, PSE's sales data, and NEEA shelf studies.
>
> **ERR Discussion**: The DTC manager confirmed that all business cases and associated lighting UES factors are reviewed annually and include the research and sales data cited above in the PSE response. The program's 2017 savings were derived from these updated UES values.

Finding Advanced Power Strips (APS) 1: PSE sells rebated Tier 2 APS units through their ShopPSE website, but has not been able to expand the program delivery to retail stores as retailers are currently carrying them. In 2016, PSE started to sell these units through their Pop-up Retail channel. At this point in time, consumers are unlikely to demand this product primarily due to very limited product awareness (72% of general population respondents reported they were not at all familiar or unsure about Tier 2 APS). Additionally, even APS purchasers who are aware of the technology, are in need of additional education on where to use them and how to appropriately install and program the units to maximize energy savings and satisfaction with the units.

> **Recommendation APS1:** Currently it is unclear how PSE customers will learn about these units, be educated on how to properly install them, and ultimately increase their demand for this product. If PSE decides to scale this effort, the theory behind this component should be explored further.
>
> **PSE Response:** This evaluation focuses on the APS measures deployed through a customer-install (vs. direct or coached install) delivery during the 2014-2015 impact evaluation period. APS program is being revised based on feedback from the Itron evaluation. PSE is currently considering removing the measure from ShopPSE and focusing on the multifamily program with coached installs when possible to increase customer awareness of and satisfaction of their installed APS unit.
>
> **ERR Discussion**: The APS program operated through December 2017; however, the program was discontinued in all delivery channels for the 2018-2019 biennium.

Finding 3 Appliance Decommissioning (AD): The evaluation team found that the 2015 tracking data for the Appliance Decommissioning Program were fairly comprehensive, though they did not contain all variables needed to evaluate the program using the recommended methods outlined in the Uniform Method Project (UMP) protocols. Many of these missing variables were being collected by the program implementers, but were not being retained in the tracking database.

> **Recommendation AD3:** The evaluation team recommends that the following variables be added to the tracking database regarding the unit recycled: door configuration, size, age, installation location, and house type. Also, retaining the account number and email address for all participants would allow for web-based follow up with customers as well as a better assessment of cross-program participation.
>
> **PSE Response:** PSE's program vendor now includes the new measure variables (door configuration, size, age, installation location, house type, and email) in their reporting data submissions to PSE. PSE has begun work to upload these additional data fields into DSMc.
>
> **ERR Discussion**: The program manager reports that this recommendation was fully implemented in 2017.

Finding 1 Appliance Replacement (AR): The evaluation team found that the 2015 tracking data for the Clothes Washer Replacement Program were fairly comprehensive, though adding some

additional variables to the database would improve the ease and accuracy of evaluation efforts. Some of the parameters used in the UES algorithm can be estimated based on the characteristics of the replacement units offered. Make and model lookups of the four units offered in 2015, provided the evaluation team with the average MEF, capacity, and Rated UEC of the actual 2015 replacement units, which were then used to calculate the UES of a replacement clothes washer.

> **Recommendation AR1:** Add the following variables to the tracking database regarding the clothes washer being recycled: age, door configuration, and size in cubic feet; as well as details on the new replacement unit: door configuration, capacity in cubic feet, installation location, MEF, water factor, and Rated UEC; and house type. If the replacement units being offered for the upcoming program year are known by September 1, the UES can be updated based on an expected distribution of the actual replacement units. If the units are not known by this time, the previous year's units could be used as a proxy for the deemed estimate for the subsequent program year.
>
> **PSE Response**: PSE's program vendor now includes the new measure variables (door configuration, size, age, installation location, house type, and email) in their reporting data submissions to PSE. PSE began work in 2017 to upload the additional data fields into DSMc.
>
> **ERR Discussion**: Due to low program cost effectiveness and a high market saturation of efficient appliances, the Appliance Replacement program was discontinued at the end of 2017.

BECAR Conclusion

The DTC evaluation report was delivered in August 2017 and, with the exception of the two discontinued programs (appliance replacement and advanced power strips), the program staff responded quickly to make program adjustments to line up with all non-process report recommendations for the 2018 program year.

4. Low Income Weatherization

PSE's Low Income Weatherization (LIW) program mission is to reduce energy costs to lower income customers through improving residences' energy efficiency and consumer education. PSE works with a variety of community-based organizations to deliver these services.

Evaluation Overview

The Cadmus evaluation of LIW program consisted of both an impact and process evaluations and a process evaluation. Ex post electrical savings were determined by two methods: measure-level savings were determined for floor insulation and ductless heat pumps and billing analysis was used for all other program impact savings.

Conclusions and recommendations (condensed) from the report, pertinent to BECAR's scope follow:

- The LIW program is achieving its overall objectives. LIW met its goal of reducing the energy cost burden of low-income customers by improving the energy efficiency of their residences

and by educating them on ways to reduce energy use. As a result of the program, participants consumed, on average, 18% less electricity as a result of LIW program participation.

- Average per household electric energy savings were lower than reported savings in 2013 and 2014 but were high relative to benchmarked low income programs (the BECAR team notes that in 2017 LIW achieved 117% of its goal, which was higher than the 2014-2016 program years).
- Frequent and open communication between the implementing agencies and PSE is key to program success.

LIW Program Manager Interview

Below are two evaluation report conclusions, recommendations, PSE responses, and ERR discussion summaries:

Conclusion: PSE's savings estimation methods and input data are reasonably accurate; however, several measures have outdated planning assumptions, and opportunities exist to improve the accuracy of savings estimates. A detailed savings review revealed that unit energy savings (UES) values for shell and duct measures relied on outdated Regional Technical Forum (RTF) sources, and refrigerator replacement and pipe insulation measures contained incomplete documentation of savings sources. In addition, Cadmus identified an opportunity to improve the accuracy of the savings calculation approach for DHP and heating system replacement measures.

> **Recommendation**: Update UES values for shell and duct measures and revisit RTF-deemed savings estimates annually for revisions. Given frequently updated energy-saving source documentation, PSE should revisit RTF-deemed savings estimates annually for any changes that may be relevant to delivery or design adjustments. Specifically, for shell measures (including insulation, air sealing, and windows) and duct sealing and insulation, PSE should revise current UES savings estimates to account for recent updates to the RTF weatherization UES workbooks.
>
> **PSE Response**: PSE has updated UES values for the 2018-19 program period. The program also reviews RTF updates on an ongoing basis. PSE is not obligated to adopt any RTF updates that occur after September 1 of each calendar year. Thus, there may be time periods when PSE is not using the most current RTF UES for certain measures.
>
> **ERR Discussion**: The program manager reports that all UES measures are reviewed annually and updated with the most current RTF values.

Conclusion: Billing analysis may provide PSE with more accurate savings estimates than the current engineering analysis-based approach. Billing analysis is industry best practice for evaluating energy savings of whole-house energy efficiency programs like LIW. This method has the advantage of capturing measure interactive effects, energy education, behavioral changes, and other factors that directly contribute to program impacts. The current evaluation produced whole-house savings estimates at ±13% and ±11% precision for electric and gas, respectively, in

contrast with engineering-based approaches which typically cannot quantify a level of uncertainty associated with the variety of measures installed.

> **Recommendation**: None. Evidently, evaluators discussed this with PSE, and concluded that PSE was unlikely to implement a billing analysis recommendation.
>
> **ERR Discussion**: The PSE senior evaluation analyst participating in the interview indicated that while utilizing a billing analysis methodology is a great idea, it is not practical from an operational or program cost effectiveness standpoint. LIW works with numerous agencies who implement the weatherization work and increasing the data collection requirements for these agencies to support billing analysis would be a challenge. Additionally, switching from UES values to billing analysis would increase program costs.

BECAR Conclusion

The LIW program has incorporated the recommendation for updating UES values with current RTF values into their current business case workbook.

5. Commercial and Industrial New Construction

PSE's BEM new construction program encourages the construction of buildings that are more energy efficient than required by Washington energy code. A new construction application that has become a significant program element in recent years is the advent of LED lighting for indoor agriculture.

Evaluation Overview

Navigant's savings impact and process evaluation of PSE's new construction program for 2016-2017 and was released in December 2017.

All of Navigant's recommendations address the indoor agriculture lighting projects within the new construction program. Indoor agriculture projects account for a substantial portion of the BEM new construction program's projects; in 2017, 72% of the new construction program's energy savings were associated with indoor agricultural lighting. The Washington State Energy Code does not include lighting power density baselines for indoor agriculture, so baseline energy use is determined by PSE engineering judgement, not to exceed a fixed maximum lighting power density, of what the customer would have done without PSE program intervention.

BEM New Construction Team Interview

Below are summaries of the three new construction program recommendations.

Recommendation 1: Use the 1.8 (multiplication) baseline factor for both flowering and non-flowering spaces. PSE's 3.3 baseline factor for non-flowering spaces assumes that these spaces require as much light as flowering spaces in the base case, which can be provided by much lower wattage efficient lamps than is possible for flowering rooms, resulting in a larger delta watts. The evaluation activities indicate that non-flowering rooms require whiter more "broad spectrum" lights, instead of the spectrally selective fixtures common in flowering rooms, and

that the baseline fixture wattage for these spaces should be lower, closer to 600-800W per fixture. As such, the team recommends using the same baseline multiplier, 1.8, in both the non-flowering and flowering spaces.

> **PSE Response**: PSE uses the 3.3 factor for non-flowering and vegetative spaces. Although the 1.8 baseline factor reflects what indoor horticulture operations could do, it is PSE's experience that more often than not the operations use the same lights in the flowering and non-flowering spaces for operation and maintenance reasons (i.e., they find it easier to stock one lamp type than multiple lamp types). As such, PSE will consider this recommendation in the future, but for now will continue to use the 3.3 factor in our calculations.
>
> **ERR Discussion**:
>
> The PSE BEM new construction team reports that they currently use a baseline factor of 3.3 for vegetative growth spaces and 1.8 for flowering spaces. This is consistent with the differing needs of each area.

Recommendation 2: Limit the canopy lighting power density to 68.75 watt/ft^2. Instead of assuming a 1:1 lamp replacement, the current industry standard assumes one 1,000W fixture per 4' x 4' square foot of canopy space. This cap helps correct for the excessively high lighting power densities that result from using baseline factors, and which program participants and industry experts confirm are unrealistic. Without limiting the baseline LPD, four of the eight projects evaluated were calculated to have LPDs exceeding 70 watt/ft^2, with the highest being 96.8 watt/ft^2.

> **PSE Response**: PSE has implemented this recommendation for the 2018-19 program cycle.
>
> **ERR Discussion**: We asked for a clarification on whether this lighting power density applies to both vegetative and flowering spaces. The BEM team replied that this cap does apply to both spaces and does not conflict with the baseline factors from Recommendation 1.

Recommendation 3: Develop a uniform method for determining operating hours for indoor horticulture projects.

Option 1. Update project application to collect lighting operating hours and area by space type. The evaluation team recommends that PSE collect customer-reported lighting operating hour estimates by space type for three general space types; flowering, non-flowering (including all vegetative, mothering and cloning spaces) and all other spaces (including all non-grow spaces such as offices, corridors, restrooms, etc.) Collecting the respective floor space and canopy space for each of these space types would also improve the certainty in lighting savings estimate allowing for a more informed baseline lamp quantity and wattage assumption.

Option 2. Update ex-ante assumptions and/or model calculations to include lighting operating hours and floor space by space type. In lieu of updating the application, the evaluation team recommends that PSE expand current program assumptions to include lighting operating hours for the same three space types defined in Option 1 (flowering, non-flowering, all other).

PSE Response: PSE already implements Option 1 for non-grow spaces. Those spaces are incentivized through the Commercial Lighting path of the New Construction program, not under the Indoor Horticulture path.

BECAR Discussion: Navigant's Option 1 recommendation is that different application forms may be used for one site, specifically grow and non-grow spaces, and that a single application form is desirable. The BEM team, as noted in their response above, said it is their policy for production spaces to go through the indoor horticulture track and non-production spaces through the standard commercial lighting track. So, there could be two applications for one project, although this seldom, if ever, occurs according to PSE program staff.

BECAR Conclusion

PSE implemented Recommendation 2, but did not implement Recommendations 1 and 3 for reasons we believe are valid.

Recommendation 1: The BEM team's continued use of a 3.3 baseline factor for vegetative spaces and a 1.8 baseline factor for flowering spaces is a reasonable assumption for now. As the savings from this end use represent significant savings in the BEM portfolio, at a later date it would be helpful to conduct a survey of indoor horticultural cannabis growers in the region to verify baseline common practice assumptions for lighting power densities in flowering and vegetative spaces.

Recommendation 2: The recommendation to have a maximum lighting power density for grow space canopy lighting of 68.75 watt/ft^2 has been implemented for the 2018 program year.

Recommendation 3: PSE currently collects horticultural lighting data for hours of operation and canopy area by space use type (e.g., flowering and vegetative). The evaluator's recommendation to record floor area would duplicate (or nearly) the currently collected canopy area; the BECAR team does not believe there is added value to also collecting floor area. PSE has a policy of treating horticultural lighting and non-horticultural (such as offices) in separate program tracks, which we find acceptable. We conclude that PSE's current system for recording and calculating lighting savings in horticultural production areas represents appropriate engineering practice.

6. Commercial Rebates

PSE's Commercial Rebate program consists of eight related but distinct sub-programs:

- Small Business Direct Install (SBDI)
- Lodging Direct Install (LDI)
- Agriculture Direct Install (ADI)
- Premium HVAC
- Commercial HVAC
- Hospitality Management

- Kitchens & Laundry – (two sub-programs)

The Small Business Direct Install, Lodging Direct Install, and Agriculture Direct Install sub-programs are designed to provide low and no-cost direct install measures to small business customers. The Premium HVAC sub-program provides incentives for maintenance and service of HVAC systems leading to energy efficiency savings, while the Commercial HVAC, Hospitality and Kitchens & Laundry sub-programs provide customers with rebates on qualifying efficient HVAC, kitchen and laundry equipment.

Commercial Rebate Team Interview

Below are the three recommendations from Navigant's impact evaluation for the Commercial Rebate program, the PSE responses from the ERR, and a summary of our discussion with the Commercial Rebate team.

Recommendation 1: Make tracking data structure streamlined and consistent across sub-programs. The data we received differed significantly between sub-programs within the Commercial Rebate program, both in terms of formatting and field names, as well as the completeness and quality of data captured. Many datasets we received were missing the majority of key fields such as contractor name, contractor email address and contractor phone. The evaluation team recommends PSE streamline the tracking data system for all programs, perhaps using the DI program tracking data as the model for all sub-programs

> **PSE Response:** PSE has recently migrated all project tracking to a new system (DSMc). The inconsistencies were likely a result of some projects in 2016 coming from the old system, and some projects in 2017 coming from the new system. PSE does not expect this to be a concern going forward now that the migration is completed.
>
> **ERR Discussion:** As with many other PSE programs that use deemed savings, this concern has been addressed and corrected through implementation of the DSMc.

Recommendation 2: Update annual hours of use (HOU) assumptions for exterior lights. PSE's current deemed annual HOU estimate for exterior lighting photo cell projects is 4,200. The evaluators estimated operating hours for photocell-controlled fixtures at 4,656 annual HOU, derived from astrological sunrise-sunset data for the PSE service territory.

> **PSE Response**: PSE will consider changing the HOU for exterior lighting. Any change will need to be aligned with PSE's Commercial Lighting program.
>
> **ERR Discussion**: PSE program staff said that the BEM senior lighting engineer provides guidance for lighting savings calculations for their program. We contacted this individual regarding PSE's assumptions supporting operating hours for photocell-controlled exterior lighting and he responded via email:
>
> *The 4200 hours was developed using the US Naval Observatory data on both Sunrise/Sunset and Civil Twilight. The reason we used both was due to the last sentence in their definition of Civil Twilight (In the morning before the beginning of civil twilight and in the evening after the end of civil twilight, artificial illumination is normally required to carry on ordinary outdoor activities). One could infer that after beginning of civil twilight but*

before sunrise, and after sunset but before the end of civil twilight that artificial illumination may not be required.

The PSE engineer also provided additional definitional detail to support this practice, including an Excel workbook with PSE's calculations for 4,200 annual operating hours for photocell-controlled exterior lighting.

Recommendation 3: Consider applying HVAC interactive effects for lighting projects. Currently, PSE's business cases for lighting measures do not include the interactive effects of efficient lighting on HVAC energy consumption. We recommend PSE expand current lighting savings values to incorporate the interactive effects currently used in the RTF lighting unit energy savings assumptions

PSE Response: PSE will consider this recommendation in the context of small to medium commercial and large commercial lighting projects. PSE currently uses an evidence-based methodology in large commercial lighting projects that differs from that of the RTF.

ERR Discussion: The commercial rebates program generally follows the lead of the BEM large commercial lighting program; although the commercial retail team noted that no HVAC interaction factors are used in the SBDI and LDI business case UES values. We noted that the 2018 BEM large commercial lighting calculator was updated with revised HVAC interaction factors for space use types that largely map to the RTF factors that are based on building use types. The BECAR team recommends that the commercial rebates group update the business cases for these two programs with HVAC interaction factors for the 2019 program year.

BECAR Conclusion

PSE has implemented recommendation 1, elected to not implement 2, and will probably implement recommendation 3 at a later date. Our conclusions for each of the three recommendations follow:

- *Recommendation 1*: PSE has proactively addressed the evaluation's concern about data collection and tracking practices.
- *Recommendation 2*: PSE provided detailed engineering data to support their decision to continue to use 4,200 annual operating hours for photocell-controlled exterior lighting. PSE's decision to claim fewer operating hours for photocell-controlled fixtures than the standard practice of sunset-to-sunrise hours used by many utilities demonstrates their commitment to best practice engineering principles.
- *Recommendation 3*: The evaluation finding that HVAC interaction factors are not applied to deemed savings for lighting measures in the SBDI and LDI programs savings calculations came too late in 2017 for the program to change for the 2018 program year. We confirmed that the current business cases for SBDI and LDI still omit HVAC interaction factors and we recommend the program correct this for the 2019 program year with interaction factors based on RTF values, similar to what the BEM large commercial lighting program did in 2017.

7. Residential Single Family Dealer Channel

This program provides high energy efficiency equipment to PSE customers, mainly through contractors, although customers can directly submit rebate applications to PSE. The program provides rebates for the following measure categories and equipment:

- Weatherization – air sealing, insulation, windows, and duct insulation and sealing
- Space Heat – heat pumps, ductless heat pumps, fireplaces, and heating system replacements
- Hot Water – water heaters

Evaluation Overview

This was both an impact and process evaluation, released in October 2017. The impact evaluation covered the 2013-2015 program years and used billing analysis and review of the savings algorithms and assumptions as the means to evaluate measure and program energy savings.

Single Family Dealer Channel Discussion

Below are conclusions and recommendation from the Cadmus evaluation report, PSE responses from the ERR, and a summary of our discussion with the program team. Just one conclusion and recommendation related the BECAR's scope of electrical energy savings.

Conclusion: PSE's savings estimation methods and input data are reasonably accurate; however, several measures have outdated planning assumptions, and opportunities exist to improve the accuracy of the savings estimates. A detailed savings review revealed that unit energy savings (UES) values for shell, duct, heat pump water heater, and lockout controls measures relied on outdated RTF sources, and the fireplace measure contained incomplete documentation of savings sources. In addition, Cadmus identified an opportunity to improve the accuracy of the savings calculation approach for DHP, ground source heat pump (GSHP), furnace replacement, and fireplace measures.

Recommendation: Update UES values for several measures and revisit RTF- deemed savings estimates annually for revisions. Given RTF frequently updates energy- saving source documentation, PSE should revisit RTF-deemed savings estimates annually for any changes that may be relevant to delivery or design adjustments. Specifically, PSE should revise current UES savings estimates for: all shell measures (e.g., insulation, air sealing, and windows), duct sealing and insulation, HPWHs, GSHPs, and heat pump sizing and lockout control measures.

> **PSE Response**: PSE has updated UES values for the 2018-19 program period. The program also reviews RTF updates on an ongoing basis. PSE is not obligated to adopt any RTF updates that occur after September 1 of each calendar year. Thus, there may be time periods when PSE is not using the most current RTF UES for certain measures.
>
> **ERR Discussion**: As stated above, the program updated UES values for the current biennium.

BECAR Conclusion

The program accepted and implemented the recommendation to update their business case UES values for the measure categories cited above.

8. Home Energy Reports Impact Evaluation

Beginning in 2008, PSE, through a third party contractor, delivers customized reports to participating households that compare their home's energy consumption to that of similar homes in the area, provide energy savings recommendations based on the home's energy use profile, and information on other PSE energy efficiency programs. The HER program evaluation by DVN GL explains how the program is designed:

> *PSE structured the program as a randomized controlled trial (RCT). The RCT experimental design randomly assigns a population of interest to control and treatment groups. Due to this random assignment, the only differentiating factor between the two groups is the receipt of the Home Energy Reports. Thus, the approach produces an unbiased estimate of the change in consumption with a high level of statistical precision due to the treatment. Program energy savings are established by an independent evaluation, based on differences in energy use between these two groups.*

Evaluation Overview

DNV GL conducted its annual impact evaluation of the HER program and issued their report in November 2017. The 2016 impact savings in the report are the final savings for the treatment groups with the subtraction of savings attributable to participation in other PSE programs. In addition to providing impact savings, the report presents information on research design and data collection, details on the statistical methodologies used, and conclusions on the performance of the individual treatment groups.

Program Managers Interview

We discussed the recommendations with the incoming and outgoing HER program managers:

Recommendation 1: *Legacy – current group*: Savings for the legacy program have decreased year over year due to customer move-outs. This kind of attrition is expected. As the new expansion groups get up to speed, these groups are expected to compensate for the dwindling total savings from the legacy group. The report states that '*From these conclusions, we recommend PSE continues the HER program for the legacy current group, recognizing that overall legacy current savings will likely continue to diminish over time due to attrition.*'

PSE Response: PSE has continued to offer the program to the legacy – current group in 2017, and based on the report findings and recommendations, PSE will also continue offering the program to the legacy – current group in 2018.

ERR Discussion: While there is a slow degradation in the legacy – current group savings, this group continues to receive reports and achieves significant savings. They will continue to offer the HER program to the 2008 legacy participant group into 2018.

Recommendation 2: *Legacy – suspended group*: In the sixth year of evaluating the legacy suspended treatment group, this is the first evaluation in which the legacy suspended electric savings were not significantly different from the control group. The report states that '*From these conclusions, we recommend that future evaluations continue to track the decrease in suspended electric and gas savings. We also note that while the suspended group stopped receiving reports after two years, the energy savings ramp for this group continued through the fifth year of the program*.'

PSE Response: PSE has continued to offer the program to the legacy – suspended group in 2017, and based on the report findings and recommendations, PSE will also continue offering the program to the legacy – suspended group in 2018.

ERR Discussion: Legacy-suspended continues to be a valid control group, so they will continue to track this group as a basis for comparison with the legacy-current group.

Recommendation 3: *Unmatched group*: In previous study years, savings from a subgroup of treatment households had been excluded because a control (comparison) group had not been developed for that subgroup. To include the savings during the 2016 program period, the evaluator conducted a propensity matching analysis for these unmatched households and found evidence that the unmatched treatment households achieved savings equal to or higher than the legacy current treatment group. Based on this finding, the evaluators applied the average savings value (3.2%) from the legacy current treatment group. The report notes that '*However, due to the prevalence of unusual data points, and the potential to further refine the matching analysis by including additional constraint criteria, we advise further research to justify the higher-level of per-household savings among the unmatched group. In this analysis, we applied the legacy current treatment group's household savings, considering it the most conservative estimate of savings.*'

PSE Response: Based on the results of the initial analysis of the unmatched group, we support further research into energy consumption and energy saving behaviors of the unmatched group. For the upcoming evaluation of the 2017 HER program, PSE has provided additional energy consumption data for the unmatched group as requested by the evaluator, and will provide additional data as requested by the evaluator.

ERR Discussion: As indicated above, more control matching research will be performed by the contractor to refine their understanding on how households within certain zip codes achieve substantial savings.

BECAR Conclusions

This unique and successful behavioral program is achieving considerable savings. Recommendations 1 and 2 aren't particularly actionable; these recommendations are to maintain the status quo, which is fine. Recommendation 3 recommends continued research into data anomalies in the unmatched group; we also think this is an excellent area for further inquiry.

One item of interest regarding future HER savings is that the 2016 savings are based on about 18,000 participant households. In 2014, approximately 100,000 households were added in an

expansion group comprised of four subgroups: electric only, high relative user, non-urban, and refill. This expansion group is considered to be a pilot program and, as such, the savings are not claimed. In 2016 (as of April 2018, the most recent program year with reported savings), the claimed savings for the E214 Residential Single Family tariff for HER's legacy and unmatched groups was 5.7 MWh; the expansion group's total 2016 savings were estimated to be about 20 MWh. Had this been claimed, the expansion group would account for approximately 12% of the savings for the entire residential energy management portfolio. The HER expansion group has completed its third year of operation (program year 2017), which will be the final year as a pilot program. In the 2018 program year, the expansion group will move to the REM program portfolio in the E214 tariff category.