**BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION,	
Complainant,	
v.	**Docket UE-19____** **Docket UG-19____**
PUGET SOUND ENERGY,	
Respondent.	

**SECOND EXHIBIT (NONCONFIDENTIAL) TO THE
PREFILED DIRECT TESTIMONY OF**

DR. CHUN K. CHANG

ON BEHALF OF PUGET SOUND ENERGY

JUNE 20, 2019

Puget Sound Energy
Load Research Report

Class Load Profiling for
January 2018 – December 2018

May 2019

Prepared by

Puget Sound Energy
Rates and Regulatory Affairs Department

Puget Sound Energy
Load Research
Class Hourly Load Profile by Rate Schedule

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Load Research

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1   INTRODUCTION

1.1 Background

The class hourly load profiles developed in this study are to support Puget Sound Energy's (PSE or the Company) electric cost-of-service (COS) study and rate design, integrated resource planning, and energy efficiency program impact evaluation. The class hourly loads were estimated on the basis of the 15-minute interval load data collected during the test-year period ending December 31, 2018. PSE collects 15-minute interval load data for the residential, commercial and industrial customers sampled for its on-going class load research program. Interval load data for all of the sampled customers are collected by the Company's automated meter reading (AMR) network. Interval load data for the whole populations of Rate Schedules 5, 35 and 40 are also collected by PSE's AMR network. In addition, interval load data for the populations of large commercial and industrial (C&I) rate classes, such as Schedules 46, 49, 449PV, 449HV, 459 and Special Contract, are compiled by the MV-90 metering system. All of the interval load data are assembled and stored in a Statistical Analysis System (SAS) data file format. The current class load research samples were established through the sample design and deployment study performed in November 2017.[1]

The class load estimates presented in this report include losses. Therefore, the sum of class load estimates amounts to the Company's official system hourly load at the generation, purchased and intertie (GPI) level. The rate classes covered in this study are listed in Table 1. In its 2019 General Rate Case (GRC) filing, PSE proposes to eliminate Rate Schedule 40 (Campus Rate) and to move 36 of 129 existing Schedule 40 metering device locations to Rate Schedules 24, 25, 26 and 31, based on their electric usage patterns. Ninety-three Schedule 40 metering device locations were switched to a special contract on April 1, 2019. The Special Contract device locations are provided with retail wheeling and distribution service by PSE.

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[1] The historical data analyzed and the statistical analyses and validation performed for 2017 sample design and selection are discussed in 2017 Class Load Research Sample Design and Deployment report, which is attached to this report, as Appendix A.

PSE System Loads	
Rate Schedule	Description
7	Residential
5	Sales for Resale
8 & 24	Small General Service <50 kW
11 & 25	Medium General Service 50-350 kW
12 & 26	Large General Service >350 kW
29	Seasonal Irrigation
10 & 31	Primary Voltage General Service
35	Primary Voltage Seasonal Irrigation
43	Primary Voltage Interruptible Service
	For Total Electric Schools
46	High Voltage Interruptible Service
49	High Voltage General Service
50-59	Street & Area Lighting
Non-System Loads	
Rate Schedule	Description
449HV	Retail Wheeling - High Voltage
449PV	Retail Wheeling - Primary Voltage
459	Back-up Generation
Special Contract	Retail Wheeling & Distribution Service

Table 1 – Rate Classes[2] Analyzed

1.2 Goals

This study is intended to yield the following load research products:

- ➢ Validated and edited 15-minute interval load dataset suitable for use in the class load estimation;

- ➢ A dataset containing class hourly load estimates for the following scenarios:
  - ▪ Class hourly loads without losses and not reconciled to hourly system load;
  - ▪ Class hourly loads with losses and not reconciled to hourly system load; and
  - ▪ Class hourly loads with losses and reconciled to hourly system load.
  - ▪ Documentation of load research expansion analysis including:
    1) General class statistics;
    2) Post-stratification statistics;
    3) Coincident and non-coincident peak statistics including kW demand, load factor, and coincident factor.

- ➢ A series of tables depicting the class contributions for specific cost-of-service studies including:
  - ▪ Monthly coincident peaks by schedule;
  - ▪ Monthly non-coincident peaks by schedule;
  - ▪ Top 12, 75 and 200 system peak hours average coincident peak demands and mid-winter month (Nov. – Feb.) system peak hour average coincident peak demand (4CP) by schedule;
  - ▪ Top 12, 75 and 200 non-coincident peaks by schedule;

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[2] Non-System loads are PSE's transportation or "Retail Wheeling" class loads.

1.3 Data

Except for the cases of some primary- or high-voltage large C&I rate classes where 15-minute load data were available for all of the customers in the class, most of the 15-minute interval load data were compiled from the samples selected for each rate class. The population characteristics of rate class loads were estimated using the load study samples, because it is not practical to collect load profile data for every customer within the class. The load study sample results were translated to class loads through a load research expansion analysis.

Some large C&I rate classes, such as 46 and 49, have load profile data for all customers. Customers in these classes tend to have large loads and their load profile data are also used for billing purposes. No expansion analysis was necessary for these customers since they form the total class population. Total class hourly loads for the lighting schedules were estimated on the basis of lighting fixture inventories and assumed number of daylight hours.

15-minute interval load data were compiled from the customers sampled for the following rate schedules:
- Residential (07);
- Small general service (08 & 24);
- Medium general service (11 & 25);
- Large general service (12 & 26);
- Seasonal irrigation and drainage pumping service (29);
- Primary voltage service (10 & 31); and
- Interruptible primary voltage service for total electric schools (43).

Hourly load data for the **total** rate class were available for the following schedules:
- Small resale (05);
- Seasonal primary voltage irrigation (35);
- High voltage interruptible service (46);
- High voltage general service (49);
- Retail wheeling – high voltage (449 HV);
- Retail wheeling – primary voltage (449 PV);
- Backup generation (459); and
- Special contract (SC).

The total class load profiles are referred to in this report as "deemed" profiles since they have already been calculated for the entire class and were not included in the load research expansion analysis. Deemed profiles include schedules 05, 35, 46, 49, non-system loads (schedules 449HV, 449PV, 459 and SC),[3] and lighting loads.

All load profile data used in this study was for the test-year period of January 1, 2018 to December 31, 2018. Fifteen-minute interval load data were aggregated to hourly loads and were used for all of the analyses performed. In addition to the interval load data, total system hourly load data were used for the final reconciliation of the estimated class hourly loads with losses.

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[3] Since the PSE system load data does not include loads for its transportation customers, those loads are called "non-system" loads in this report.

Additional data such as total monthly and annual delivered energy sales by schedule, customer counts, annual billed kWh by customer, the control area loads and scheduled losses, were used to validate the customer-level load profiles constructed from the interval load data, and to estimate monthly loss factors by service voltage and rate schedule.

1.4 Methodology

The load research expansion analysis presented in this report was done on the basis of the Mean-Per-Unit approach, which has been adopted since 2011 Class Load Research Sample Design.[4]

The following eight steps were taken to produce the class hourly load profiles and the information needed for electric cost of service studies:

1. Validated, edited and estimated (VEE) the sampled customers' 15-minute interval load data and aggregated them to create hourly load profiles,

2. Identified monthly system peak days and hours and top 12, 75 and 200 system peak hours using the PSE system hourly load data,

3. Post-stratified sampled customers' load data using their current billing data to calculate case weights for use in the expansion analysis,

4. Using the case weights, expanded the test-year load research data to estimate the class hourly load profiles without losses,

5. Applied loss factors to the load research class expansions;

6. Reconciled the loss-adjusted load research expansions with the system hourly load data,

7. Developed tables of class monthly non-coincident peaks and contribution to system peaks to be used for electric cost of service studies, and

8. Documented the process and findings of the analysis.

1.5 Total System Load

Figure 1 shows a vertical EnergyPrint, which was produced by using a load profiling and analysis software called "EnergyProbe" and illustrates energy use intensity by hour, day and month.[5] Figure 1 also presents a two-dimensional time series plot of the PSE system load during the 12-month period ending December 31, 2018. In the vertical EnergyPrint, the days are measured on the y-axis and hours of the day on the x-axis. The load is displayed using the color scale shown at the left of the plot. Figure 1 provides an overview of the system load profile. In this case, the EnergyPrint shows that the PSE system load is winter peaking with the highest demands in the early morning (e.g., 6AM to 9AM) and early evening (e.g., 5 PM to 8 PM) periods during the months of November through March. The PSE system load peaked at 4,206 MW on Friday, February 23, 2018 at 8 AM. As stated earlier, a major portion of schedule 40 energy requirements is now served under a special contract and only for retail wheeling and distribution services. Excluding the special contract customer's demand from the system demand requirement to serve, PSE system peak in 2018 would have been 4,144 MW.

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[4] The 2011 Class Load Research Sample Design and Deployment report, attached as Appendix A to PSE's load research report filed with 2017 GRC, presents discussions of the procedural efficiency and transparency, and the statistical justifications of the Mean-Per-Unit approach under PSE's current meter reading system and data processing environments.

[5] EnergyProbe is proprietary load research software developed by MiloSlick Scientific in Chico, California.
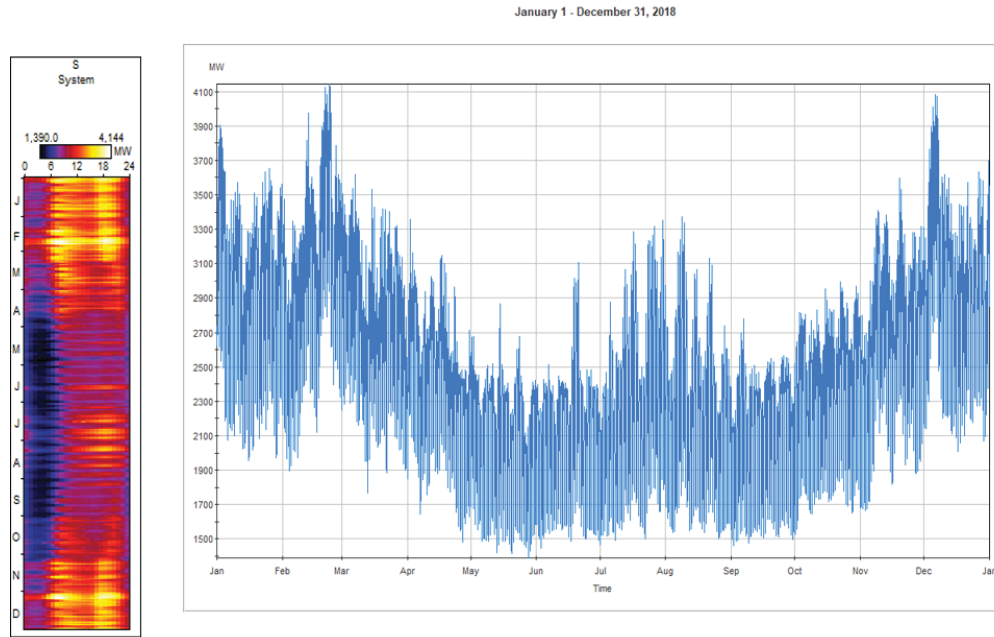
Figure 1 – PSE System Load

Table 2 summarizes the monthly statistics from the system loads for the twelve months ending December 31, 2018. The actual monthly system energy and demand figures were adjusted for the migration of schedule 40 energy sales and demand to other C&I rate schedules and a special contract. The total monthly peak demand varied from a low of 2,780 MW in September 2018 to the high of 4,144 MW in February 2018. The monthly load factor of the system varied from 66.9% to 78.1%.

Month	Monthly Energy Use (MWh)	Date of System Peak	Time of System Peak	System Peak Demand (MW)	Load Factor (%)
Jan-18	2,175,835	Tuesday, January 2, 2018	18:00	3,902	75.0%
Feb-18	2,028,194	Friday, February 23, 2018	08:00	4,144	72.8%
Mar-18	2,025,625	Wednesday, March 7, 2018	08:00	3,617	75.3%
Apr-18	1,732,735	Monday, April 2, 2018	08:00	3,358	71.7%
May-18	1,556,549	Monday, May 14, 2018	18:00	2,865	73.0%
Jun-18	1,531,896	Wednesday, June 20, 2018	18:00	3,106	68.5%
Jul-18	1,714,742	Monday, July 30, 2018	18:00	3,352	68.7%
Aug-18	1,677,031	Wednesday, August 8, 2018	18:00	3,370	66.9%
Sep-18	1,514,979	Thursday, September 6, 2018	18:00	2,780	75.7%
Oct-18	1,739,627	Monday, October 22, 2018	08:00	2,995	78.1%
Nov-18	1,906,875	Monday, November 19, 2018	08:00	3,597	73.6%
Dec-18	2,207,589	Thursday, December 6, 2018	08:00	4,082	72.7%
Annual	21,811,677	Friday, February 23, 2018		4,144	60.1%

Table 2 – Monthly System Peaks

Figure 2 presents monthly system energy requirement, peak demand and load factor in graphics.
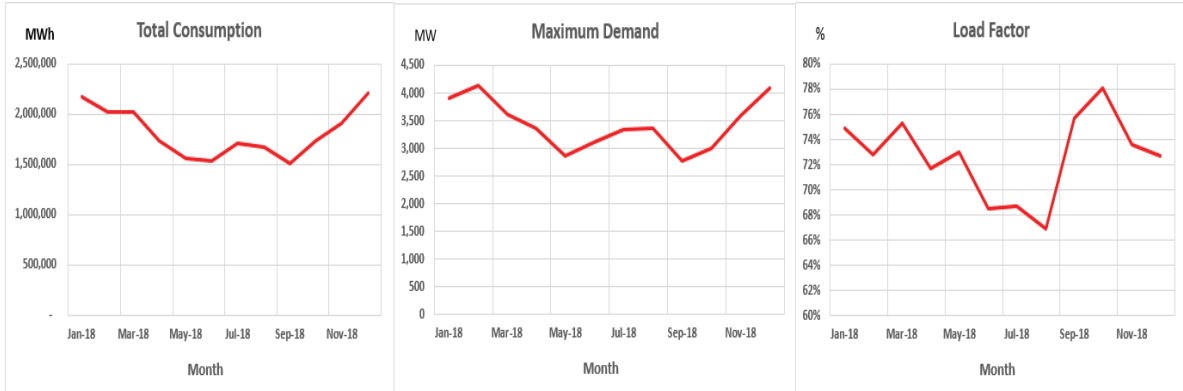
Figure 2 – Monthly System Energy, Demand and Load Factor

Figure 3 shows the 24-hour profile of the total system load on the day when PSE's system hit its annual peak load. The annual peak load day happens usually in the winter and is bi-modal with mid-morning and early evening peaks. Winter is defined as the October through May period with summer defined as June through September.
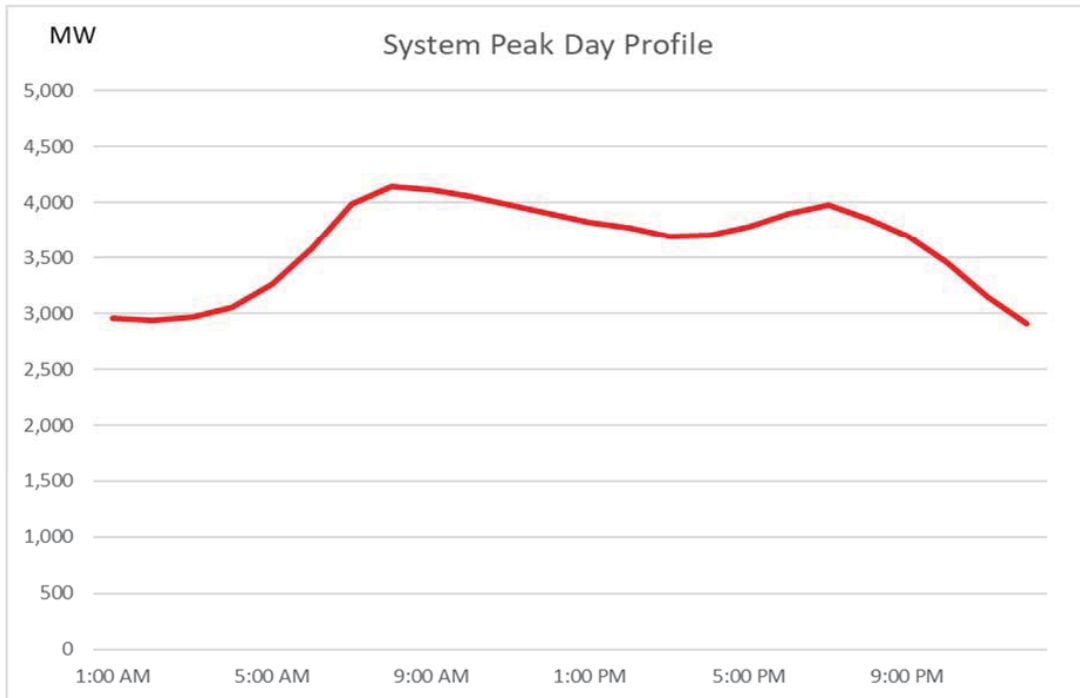
Figure 3 – Hourly Load Profile on Annual Peak Day

1.6 Annual Sales by Rate Class

Table 3 shows the number of accounts, total annual sales in kWh, and the average annual kWh sales per account in each rate class for the study period of January 2018 through December 2018.

The Residential class (Schedule 7) contains 1,010,572 accounts (87.9% of all accounts) with a total annual energy use of 10,497.4 GWh (51.5% of the total system energy use). The average annual use per residential customer is 10,388 kWh.

The Commercial and Industrial class contains the following rate schedules:
1. Schedules 8 & 24: Secondary Voltage General Service with demands of 50 kW or less,
2. Schedules 11 & 25: Secondary Voltage General Service "Small" demands between 50 kW and 350 kW,
3. Schedules 12& 26: Secondary Voltage General Service "Large" demands greater than 350 kW,
4. Schedule 29: Secondary Voltage Seasonal Irrigation & Drainage Pumping Service,
5. Schedules 10 & 31: Primary Voltage General Service,
6. Schedule 35: Primary Voltage Seasonal Irrigation & Drainage Pumping Service,
7. Schedule 43: Primary Voltage Interruptible Service for Total Electric Schools,
8. Schedule 46: High Voltage Interruptible Service, and
9. Schedule 49: High Voltage General Service.

In addition to the Commercial and Industrial customer classes, there is a sale for resale customer class (Schedule 05 – Small Resale). Also, separate class profiles were developed for Area Lighting and Street Lighting. Finally, hourly load profiles were developed for four non-system tariff classes, i.e., 449HV - Retail Wheeling High Voltage, 449PV - Retail Wheeling Primary Voltage, 459 - Back-up Generation, and Special Contract – Retail Wheeling and Distribution Service.

Rate Schedule	Description	No. of Accounts	Total Annual kWh Use	Avg. kWh Use per Account	% of Total kWh Sales
7	Residential	1,010,572	10,497,389,421	10,388	51.5%
5	Sales for Resale	8	7,084,150	885,519	0.0%
8 & 24	Small General Service	121,598	2,690,721,830	22,128	13.2%
11 & 25	Medium General Service	7,561	2,986,356,398	394,968	14.7%
12 & 26	Large General Service	842	1,946,174,476	2,311,371	9.6%
29	Seasonal Irrigation	603	16,475,530	27,323	0.1%
10 & 31	Primary Voltage General Service	487	1,408,684,085	2,892,575	6.9%
35	Primary Voltage Seasonal Irrigation	2	4,443,660	2,221,830	0.0%
43	Primary Volt. Interrupt. Total Elec. Schools	155	119,697,408	772,241	0.6%
46	High Voltage Interruptible Service	6	78,351,492	13,058,582	0.4%
49	High Voltage General Service	19	542,259,321	28,539,964	2.7%
50-59	Street & Area Lighting	7,829	69,969,105	8,937	0.3%
System Total		1,149,682	20,367,606,876	17,716	100.0%
Non-System Loads					
449HV	Retail Wheeling - High Voltage	11	1,690,248,699	153,658,973	69.6%
449PV	Retail Wheeling - Primary Voltage	2	77,694,726	38,847,363	3.2%
459	Back-Up Distribution Service	3	298,207,124	99,402,375	12.3%
Special Contract	Retail Wheeling and Distribution Services	93	361,016,477	3,881,898	14.9%
Non-System Total		109	2,427,167,026	22,267,587	100.0%

Table 3 – Population Counts[6] and Consumption[7] Data

Figure 4 shows how the total PSE system loads are composed of the class loads during the annual peak demand week. As shown in the graph, the Residential class contributes to the largest share of the system peak demand and the Small C&I class is the second largest contributor to the system peak. Figure 4 also superimposes non-system loads on top of the system loads to illustrate the total loads transmitted by PSE during its system peak week.

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[6] Number of Accounts is average schedule counts for twelve months ended December 2018.

[7] Total Annual Energy Use is calendar view energy sales for January 2018 – December 2018.
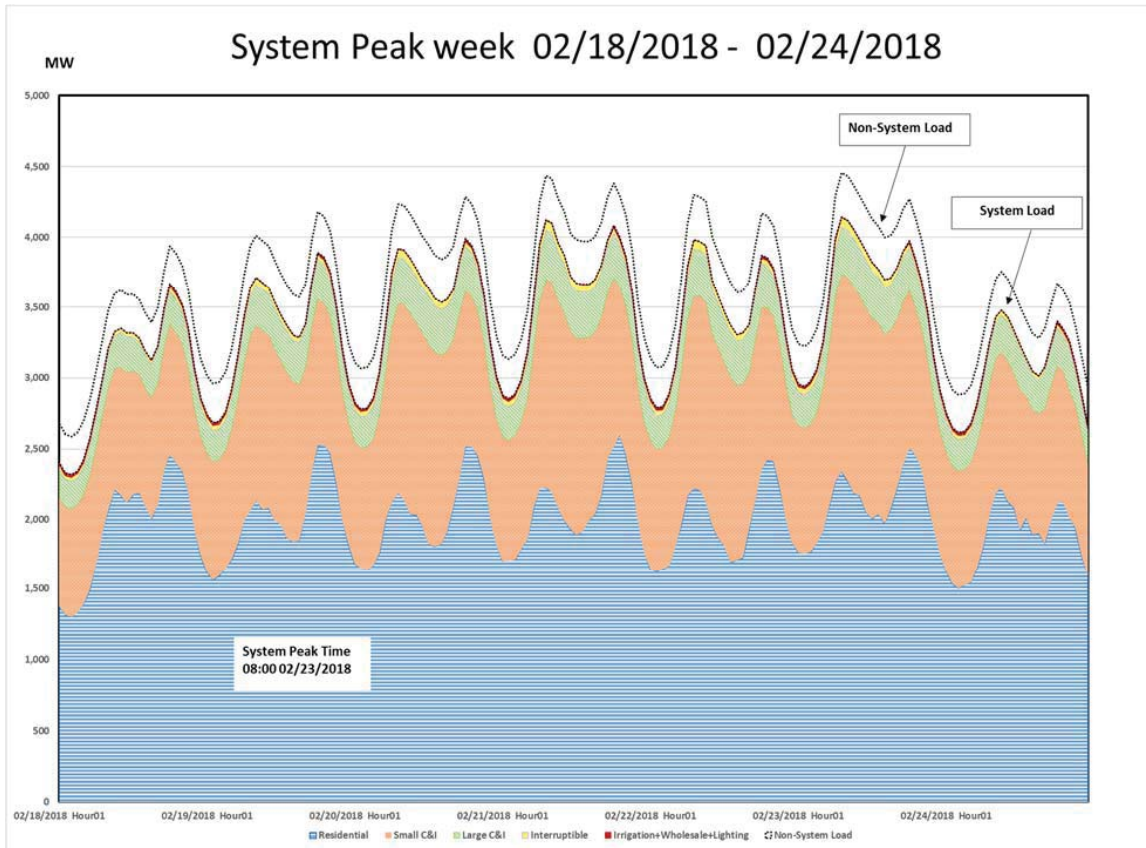
Figure 4 – Composition of System Load during Annual System Peak Week

2   VERIFICATION AND EDITING OF THE INTERVAL DATA

The first task undertaken for class load profiling was to systematically and thoroughly examine each interval load data point available from the class load research samples. While the interval load data collected through the wired MV-90 system were almost perfect, some of the data collected through the wireless AMR system involved missing observations and erroneous readings. The objective was to identify and correct anomalous points and missing data. Where appropriate, a secondary data source was used to derive an estimate to replace erroneous or missing load data.

The first step in this task was to review the interval load data collected from each site, using "iWave," a proprietary software designed to visualize and identify anomalous data points, based on the levels of error tolerance set for various possible causes of data inconsistencies to be examined and a constraint set by the corresponding customer's daily total energy use. This process screens out anomalous data points, such as power outage, meter reading failure, spikes, or changes in multipliers. The daily energy use is calculated with the daily mid-night meter readings recorded and verified by "iWave," the Meter Data Management System (MDMS) software being subscribed

by PSE.[8] Primary roles of "iWave" are to receive and audit the daily meter readings and to perform daily energy use calculations and estimations, if necessary, for customer billings.

For example, Figure 5 shows the load shape for an individual site. For a brief number of intervals, this site exhibited a spike in demand 10 times larger than the typical demand. This spike was not supported by the billing data. Accordingly, it was deemed anomalous, and eliminated from the individual customer profile. Figure 6 shows the same site with the anomalous data omitted.
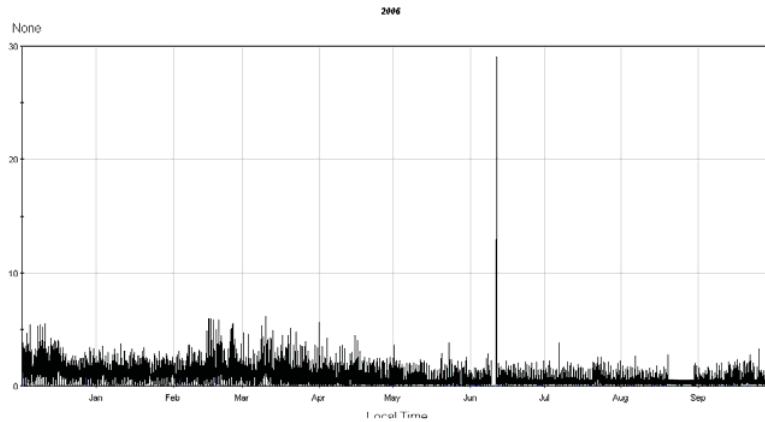
Figure 5 – Example of an Anomalous Spike
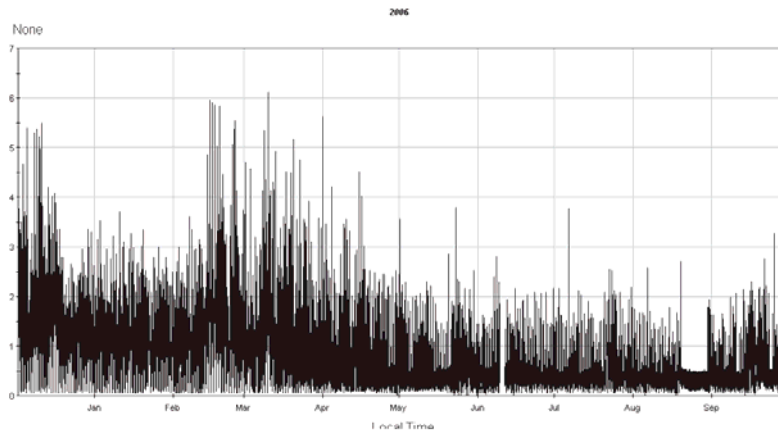
Figure 6 – Load Shape with the Spike Corrected

The second step was to correct the anomalies and fill in the missing intervals. The first attempt to estimate the missing interval loads was made through "iWave," which uses straight- or flat-line interpolation technique with the neighboring observations if only a few observations are missing or uses reference load shapes differentiated by type of day if several or more observations are missing. The same-day or like-day reference load shapes are developed from the accurate interval load readings recorded for the non-missing days prior to the missing interval. If the situations of missing or erroneous intervals are so messy or prolonged that "iWave" cannot produce a reasonable

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[8] "Wave" and iWave" are proprietary Meter Data Management System (MDMS) software developed by Ecologic Analytics, which was integrated into Landis and Gyr's Gridstream Solutions in January 2012.

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estimate to meet the pre-set criteria, then it stops the estimation effort and identifies those intervals as "Exception." [9]

The third step was to examine and produce a reasonable estimate manually for each of the erroneous or missing intervals designated as "Exception." The manual review and estimation were a time-consuming process and were performed in "iWave." If the interval load data collected from a certain sample site involve many missing and/or erroneous meter readings and are determined to be beyond repair, the data collected from that particular sample site was excluded entirely from the post-stratification and expansion analysis done for the month. In such case, the primary sample data were replaced by the interval load data collected from a back-up sample meter. In rare cases the quality of the data collected from the back-up sample was also unacceptable or no substitute meter data was available.

Table 34 shows the number of sample meters utilized to collect the interval load data by rate schedule. For the twelve months ending December 31, 2018, 1,598 sample meters were utilized for data collection. The whole populations of Rate Schedules 5 and 35 metering device locations and the pre-migration population of Rate Schedule 40 metering device locations were included in the interval load readings performed by PSE's wireless AMR network.

Rate Sch.	# of Sample Meters
7	212
8 & 24	514
11 & 25	221
12 & 26	149
29	279
10 & 31	166
43	57
Total	1,598

Table 4 – Number of Sample Meters Utilized for Class Load Profiling

The last step was to check the edited and filled interval load data against the billing data. This was to verify that the processed data was estimated accurately, and to verify that the meter multipliers were correct.

In summary, some of the interval load data were screened out by "iWave" as "Exception" and had to be edited manually. Various estimation techniques, including linear or flat-line interpolation, reference load shapes and meter multiplier correction, were used to fill the missing values or to replace anomalous observations. In extreme cases, the interval load data collected from a primary sample meter were replaced by a back-up meter reading data or were discarded. However, impact of those exception intervals on overall accuracy of the interval load data used in this study was small. As shown in Table 5, percentage of the exceptions to the total number of interval data points was 3.2% or less for all of the rate schedules. The interval load readings for Rate Schedules 5, 35 and 40 were much more reliable and the exception percentage was negligible.

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[9] If a missing interval is a result of a power outage that lasts more than 48 hours, iWave did not attempt to estimate the missing loads.

Rate Sch.	Sample Points	Total Number of Intervals to Validate	Exception Counts	% Exception
7	212	7,428,480	241,056	3.2%
8 & 24	514	18,010,560	371,712	2.1%
11 & 25	221	7,743,840	105,792	1.4%
12 & 26	149	5,220,960	77,952	1.5%
29	279	9,776,160	261,024	2.7%
10 & 31	166	5,816,640	65,184	1.1%
43	57	1,997,280	18,048	0.9%
Total	1,598	55,993,920	1,140,768	2.0%

Table 5 – Number of Exception Intervals Edited Manually

3   SYSTEM CLASS LOAD PROFILES

This section highlights the development of class load profiles.

3.1   Analysis Approach

In general, the following process was used to develop the system rate class profiles:

1. The hourly interval load data as verified and improved in Section 2-Verification and Editing of the Interval Data was organized by rate class;

2. Current billing data was used to develop a distribution of the total annual energy use for the rate class population of interest;

3. Mean-per-unit statistical sampling techniques outlined in Section 1.4 - Methodology and Appendix A of PSE's Load Research Report prepared for its 2017 GRC were used to construct a post-stratification framework for analyzing the interval load data;

4. Hourly expansions were generated for each rate class using stratified ratio estimation. These were deemed the population expansions;

5. The population expansions were used to estimate average loss factors for each delivery voltage and rate class;

6. The loss factors were applied to the class hourly load estimates to produce the class hourly load estimates with losses;

7. The hourly load estimate with loss for each rate class were summed for all of the system rate classes and compared with the actual system hourly load. This results in a residual load known as unaccounted for energy[10] (or UFE); and

8. Finally, the UFE was applied to each rate class based on the proportion of the rate class contribution to the individual hourly load yielding the reconciled class load. Hourly load profiles for Rate Schedules 5, 35, 40, 46, 49 and the lighting classes were constructed using a "deemed" profile which provides actual interval load data for the entire population of the

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[10] Unaccounted for energy (UFE) refers to the difference between the total of system rate class estimates and the actual system load data, which is resulted from sampling and estimation errors. In this report, UFE does not refer to the energy unaccounted due to theft or "lost" meters.

rate classes. Therefore, the UFE allocation was done among only the system rate classes for which the population expansions were required.

The following sections present the results of the reconciled class load for each of the system contributing loads. For the non-system rate class loads, the process concluded with step 6.

3.2 Residential Class (Schedule 7)

The historical sample data was expanded by post-stratifying the residential class. Table 6 presents the post-stratification done for sample expansion to population, using a case weighting scheme. The table shows population count, number of sample points and case weight by annual energy usage bracket. The case weight was calculated by dividing the population count by the number of sample points and adjusting the population-to-sample ratio for the percentage deviation of sample mean energy usage from population mean for each bracket.

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	W(h)	Y(h)	y(h)	Adj. %	Case Wt.
0 - 6,000*	299,411	38	7879.2	0.2947	4,122	4,038	2.1%	8,042.8
6,001 -11,000	393,374	54	7284.7	0.3872	8,250	8,457	-2.4%	7,106.9
11,001 - 17,000	207,618	31	6697.4	0.2044	13,510	13,189	2.4%	6,860.2
17,001 - 28,000	96,633	38	2543.0	0.0951	20,798	20,971	-0.8%	2,522.1
> 28,000	18,921	51	371.0	0.0186	38,522	40,375	-4.6%	354.0
Total	1,015,957	212	4792.3	1.0000	9,866	9,906	-0.4%	4,772.6

Table 6 – Residential Post-Stratification

In the second stage of analysis, the line loss factor of 7.64% estimated for the Residential class was applied to the hourly load estimated at a premise metering point. The estimated line loss factor is an annual average loss factor and was applied uniformly to all of the 8,760 hourly loads estimates. The hourly load estimates including line losses were preliminary estimates of residential class' contribution to system's hourly demand. Table 7 lists the estimated average loss factor by rate schedule.

Rate Schedule	Loss Factor
5	3.70%
7	7.64%
8 & 24	7.62%
11 & 25	7.60%
12 & 26	7.55%
29	7.36%
10 & 31	3.64%
35	3.58%
40	3.64%
43	3.70%
46	1.77%
49	1.76%
50-59	8.02%
449HV	1.69%
449PV	3.50%
459	1.69%

Table 7 – Estimated Loss Factor by Rate Schedule

Finally, the residential hourly load estimates are reconciled to the system hourly loads by allocating the unaccounted for energy (UFE) to the Residential class on the basis of preliminary percentage estimate of its contribution to the system demand for that particular hour.

Figure 7 presents the results of the reconciled hourly expansion analysis for the Residential class. The figure displays the EnergyPrint to the left of a more standard two-dimensional x-y plot. The vertical form of the EnergyPrint displays time on the x-axis, day of the year on the y-axis and the magnitude of the load on the z-axis. The magnitude of load is displayed as a color gradient with low levels of load in the black-blue spectrum and high levels of load in the yellow-white spectrum. The dominance of the winter load is clearly evident with bi-modal peaks occurring in the morning and early evening periods. The Residential class peak occurred at 7 PM on January 1, 2018 and was 2,683.9 MW.
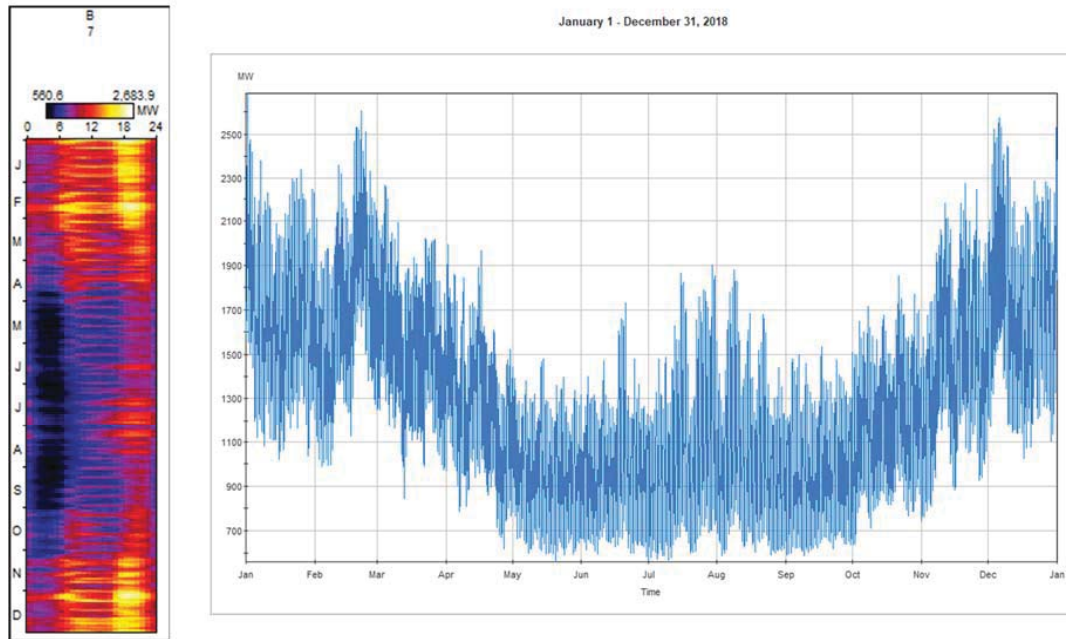
Figure 7 – Residential Class Total Load

Figure 8 presents the Residential class load during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The Residential class load at the time of the system peak was 2,343.4 MW, or 87.3% of its class peak demand of 2,683.9 MW. The system peak demand occurred at 8 AM on February 23, 2018.
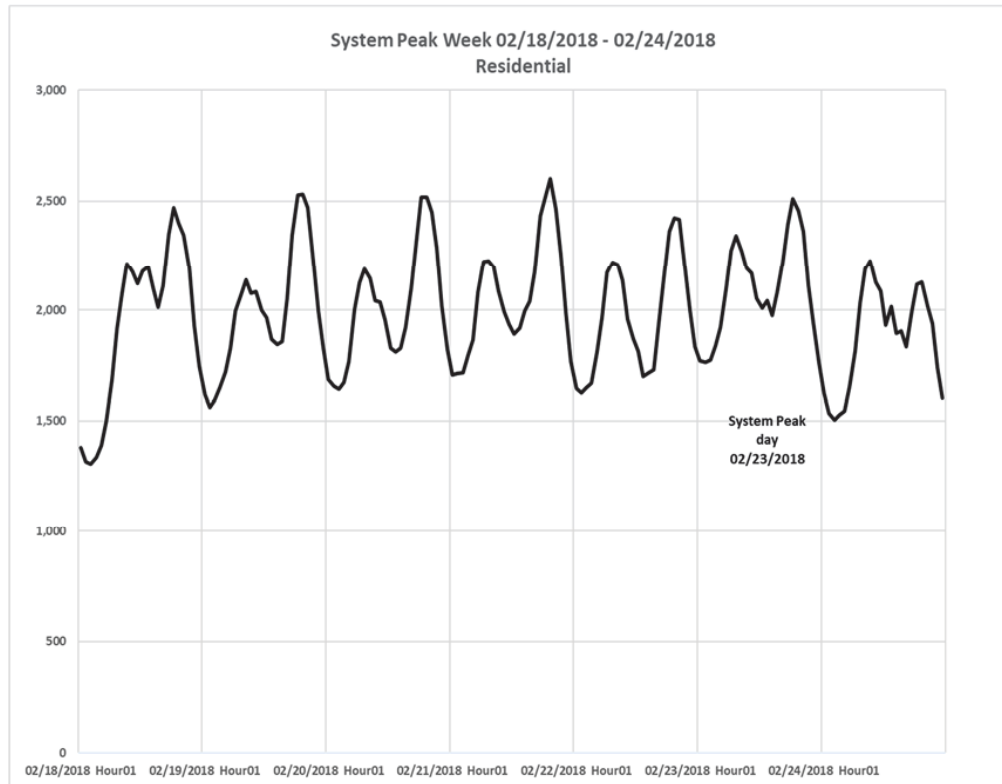
Figure 8 – Residential Class: Total Load during System Peak Week

Figure 9 presents the monthly Residential class energy consumption, peak demand and load factor in graphics.

Figure 9 – Residential Class: Monthly Energy, Demand and Load Factor

Achieved precision associated with the Residential class analysis can be evaluated in terms of the deviation of the sum of Residential class hourly loads net of losses estimated for the 12 months ending December 2018 from the total actual sales to the class in the same 12-month period. The sum of estimated Residential hourly loads net of losses is 10,445,863 MWh, 0.5% less than the actual delivered Residential energy sales of 10,497,389 MWh. The implied error percentage is significantly lower than the maximum error margin of ±10% tolerated in a typical load research practice.

Table 8 presents summary statistics for the Residential class load after applying losses and reconciliation to the system load. The table displays class totals and includes monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak (i.e., class system-coincident peak load) and coincidence factor calculated as the class coincident peak divided by the class non-coincident peak demand. In addition, the table displays other summary characteristics including:

- 12-month average coincident peak contribution;

- Average class demand associated with top 12, 75 and 200 system peak hours;

- Average class demand associated with top 12, 75 and 200 class peak hours; and

- 4 winter-month (Nov. –Feb.) average coincident peak contribution.

Residential monthly class non-coincident peak (NCP) load factors ranged from a low of 54.7% in August to a high of 67.5% in December. The Residential load coincides heavily with the system peak displaying a system peak coincidence factor of over 80% for all of the 12 months, with the minimum of 80.9% occurring in October.

| | | Class Peak Demand | | | | | Class Demand at System Peak Hour | | | |
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	1,248,864,873	Monday, January 01, 2018	19:00	2,683,905	1,678,582	62.5%	Tuesday, January 02, 2018	18:00	2,451,659	91.3%
Feb-18	1,141,355,317	Wednesday, February 21, 2018	20:00	2,603,532	1,698,445	65.2%	Friday, February 23, 2018	08:00	2,343,428	90.0%
Mar-18	1,120,043,747	Sunday, March 04, 2018	19:00	2,270,936	1,505,435	66.3%	Wednesday, March 07, 2018	08:00	2,008,111	88.4%
Apr-18	900,103,495	Sunday, April 01, 2018	21:00	1,994,799	1,250,144	62.7%	Monday, April 02, 2018	08:00	1,752,781	87.9%
May-18	712,589,488	Monday, May 14, 2018	20:00	1,478,115	957,782	64.8%	Monday, May 14, 2018	18:00	1,378,717	93.3%
Jun-18	709,016,608	Wednesday, June 20, 2018	20:00	1,730,324	984,745	56.9%	Wednesday, June 20, 2018	18:00	1,692,503	97.8%
Jul-18	792,731,486	Sunday, July 29, 2018	20:00	1,898,292	1,065,499	56.1%	Monday, July 30, 2018	18:00	1,818,838	95.8%
Aug-18	765,341,127	Wednesday, August 08, 2018	19:00	1,880,295	1,028,684	54.7%	Wednesday, August 08, 2018	18:00	1,828,728	97.3%
Sep-18	698,693,941	Sunday, September 16, 2018	21:00	1,532,673	970,408	63.3%	Thursday, September 06, 2018	18:00	1,364,998	89.1%
Oct-18	876,107,608	Sunday, October 21, 2018	20:00	1,851,191	1,177,564	63.6%	Monday, October 22, 2018	08:00	1,496,843	80.9%
Nov-18	1,052,317,676	Tuesday, November 20, 2018	19:00	2,278,766	1,461,552	64.1%	Monday, November 19, 2018	08:00	1,933,373	84.8%
Dec-18	1,292,777,765	Wednesday, December 05, 2018	20:00	2,573,781	1,737,605	67.5%	Thursday, December 06, 2018	08:00	2,217,437	86.2%
Annual	11,309,943,131	Annual Class Peak		2,683,905	1,291,089	48.1%	Annual System Peak		2,343,428	87.3%
		Average 12 Monthly NCPs		2,064,717		62.5%	Average 12 Monthly CPs		1,857,285	90.0%
		Average Top 12 NCPs		2,568,141		50.3%	Average Top 12 CPs		2,272,036	88.5%
		Average Top 75 NCPs		2,427,100		53.2%	Average Top 75 CPs		2,254,831	92.9%
		Average Top 200 NCPs		2,302,077		56.1%	Average Top 200 CPs		2,190,379	95.1%
							Average 4CPs *		2,236,474	

* Monthly CPs for November, December, January and February

Table 8 – Residential Class: Summary Statistics (Totals – kW)

Table 9 presents the data on an average-per-customer basis. The average Residential customer used 11,192 kWh during the 12 months ending December 2018 and had a peak demand of 2.67 kW in January.

Month	Monthly Energy Use (kWh)	Class Peak Demand					Class Demand at System Peak Hour			
		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	1,243	Monday, January 01, 2018	19:00	2.67	1.67	62.5%	Tuesday, January 02, 2018	18:00	2.44	91.3%
Feb-18	1,134	Wednesday, February 21, 2018	20:00	2.59	1.69	65.2%	Friday, February 23, 2018	08:00	2.33	90.0%
Mar-18	1,112	Sunday, March 04, 2018	19:00	2.26	1.50	66.3%	Wednesday, March 07, 2018	08:00	1.99	88.4%
Apr-18	893	Sunday, April 01, 2018	21:00	1.98	1.24	62.7%	Monday, April 02, 2018	08:00	1.74	87.9%
May-18	707	Monday, May 14, 2018	20:00	1.47	0.95	64.8%	Monday, May 14, 2018	18:00	1.37	93.3%
Jun-18	702	Wednesday, June 20, 2018	20:00	1.71	0.98	56.9%	Wednesday, June 20, 2018	18:00	1.68	97.8%
Jul-18	785	Sunday, July 29, 2018	20:00	1.88	1.05	56.1%	Monday, July 30, 2018	18:00	1.80	95.8%
Aug-18	757	Wednesday, August 08, 2018	19:00	1.86	1.02	54.7%	Wednesday, August 08, 2018	18:00	1.81	97.3%
Sep-18	690	Sunday, September 16, 2018	21:00	1.51	0.96	63.3%	Thursday, September 06, 2018	18:00	1.35	89.1%
Oct-18	864	Sunday, October 21, 2018	20:00	1.82	1.16	63.6%	Monday, October 22, 2018	08:00	1.48	80.9%
Nov-18	1,035	Tuesday, November 20, 2018	19:00	2.24	1.44	64.1%	Monday, November 19, 2018	08:00	1.90	84.8%
Dec-18	1,270	Wednesday, December 05, 2018	20:00	2.53	1.71	67.5%	Thursday, December 06, 2018	08:00	2.18	86.2%
Annual	11,192	Annual Class Peak		2.67	1.28	47.8%	Annual System Peak		2.33	87.2%

Table 9 – Residential Customer: Summary Statistics (Means – kW)

3.3 Schedule 05 Sales for Resale

The interval load data were collected from all of the nine resale metering device locations under Schedule 05. The interval load data were verified, edited and integrated to form an hourly load shape. Since the interval load data cover the whole population of the sales for resale customers, there is no need for sample post-stratification and expansion. In the next step, an average loss factor of 3.70% was applied to the hourly load data to produce the class hourly load profile with losses. The estimated average loss factor by rate schedule is presented in Table 7.

Figure 10 presents the total load for Schedule 05. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. The dominance of the winter load is clearly evident. The Schedule 05 class load peaked on Wednesday, February 21, 2018 at the hour ending midnight. The peak demand was 1,693 kW.
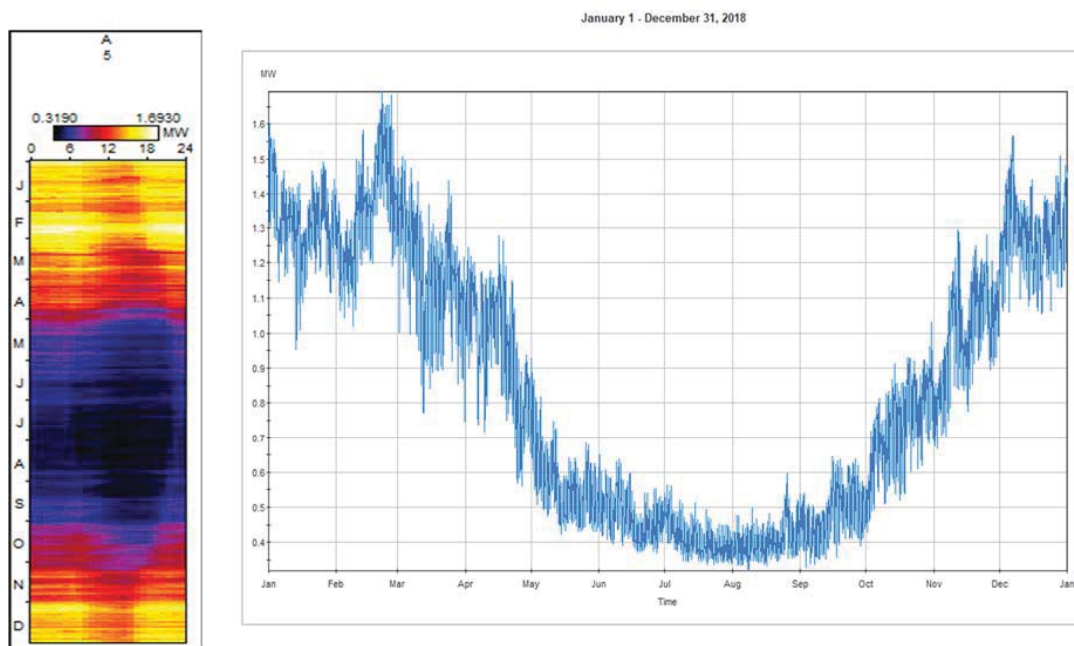
Figure 10 – Schedule 05: Class Total Load

Figure 11 presents Schedule 05 class loads during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The total Schedule 05 load at the time of the system peak was 1,590 kW.
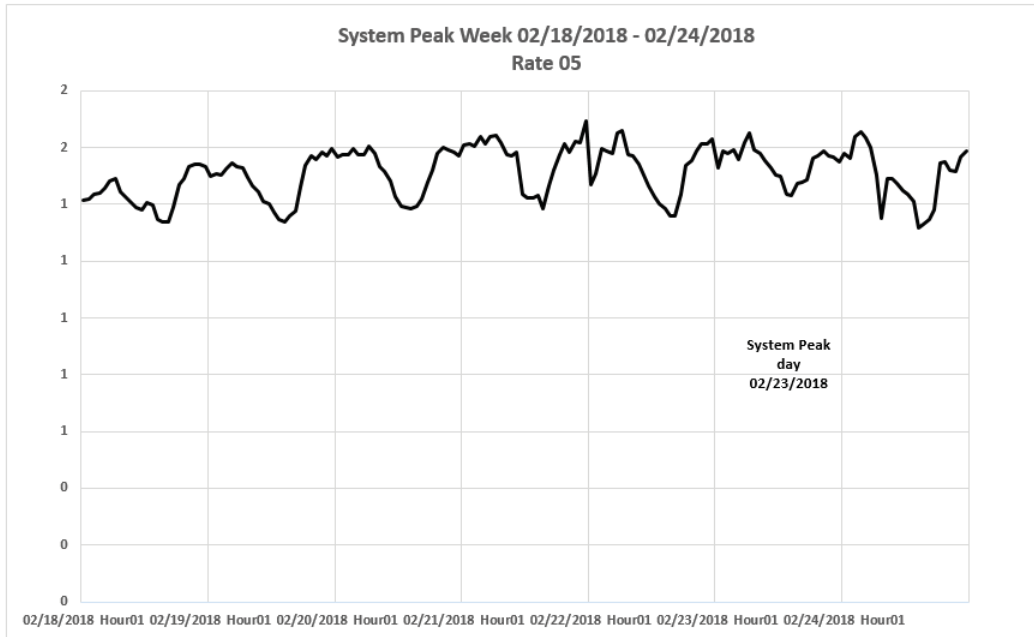
Figure 11 – Schedule 05: Total Load during System Peak Week

Figure 12 presents the monthly Sales for Resale class energy consumption, peak demand and load factor in graphics.
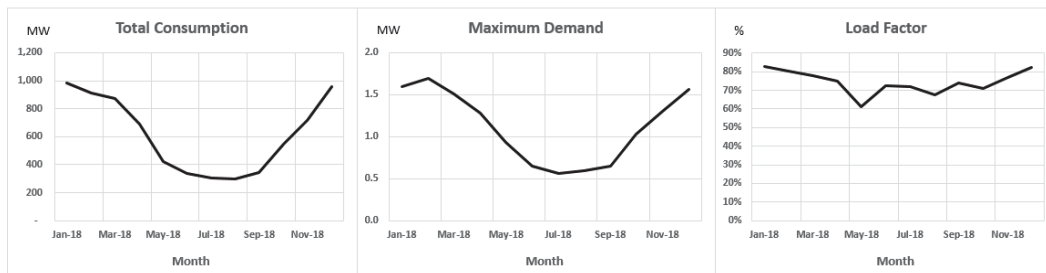
Figure 12 – Schedule 05: Class Monthly Energy, Demand and Load Factor

Achieved precision associated with the Sales for Resale class analysis can be evaluated in terms of the deviation of the sum of the class hourly loads net of losses estimated for the 12 months ending December 2018 from the total actual delivered sales to the class in the same period. The sum of estimated hourly loads net of losses was 7,111,572 kWh, only 0.4% higher than the actual Sales for Resale class sales of 7,084,150 kWh.

Table 10 presents system total summary statistics for the Schedule 05 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month average coincident peak contribution and class peaks, 4 winter-month average coincident

peak contribution, average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. Monthly NCP load factors ranged from a low of 61.1% in May, 2018 to a high of 82.7% in January 2018. The Schedule 05 load is fairly coincident with the system peak during the winter season displaying system peak coincidence factors of 89% or higher for most of the winter months.

| | Monthly Energy Use | | Class Peak Demand | | | | Class Demand at System Peak Hour | | | |
| | | | Class Peak Demand | Average Demand | Load Factor | | | Time of | Class Demand @ System Peak | Coincidence Factor |
Month	(kWh)	Date of Class Peak	Time of Class Peak	(kW)	(kW)	(%)	Date of System Peak	System Peak	(kW)	(%)
Jan-18	985,015	Monday, January 01, 2018	08:00	1,600	1,324	82.7%	Tuesday, January 02, 2018	18:00	1,470	91.8%
Feb-18	911,734	Wednesday, February 21, 2018	24:00	1,693	1,357	80.1%	Friday, February 23, 2018	08:00	1,590	93.9%
Mar-18	873,792	Saturday, March 03, 2018	04:00	1,507	1,174	77.9%	Wednesday, March 07, 2018	08:00	1,400	92.8%
Apr-18	688,688	Monday, April 16, 2018	06:00	1,277	957	74.9%	Monday, April 02, 2018	08:00	1,196	93.7%
May-18	422,135	Tuesday, May 01, 2018	06:00	929	567	61.1%	Monday, May 14, 2018	18:00	449	48.3%
Jun-18	339,070	Friday, June 01, 2018	05:00	650	471	72.5%	Wednesday, June 20, 2018	18:00	377	58.0%
Jul-18	302,563	Sunday, July 01, 2018	23:00	564	407	72.1%	Monday, July 30, 2018	18:00	388	68.7%
Aug-18	299,073	Saturday, August 25, 2018	21:00	596	402	67.5%	Wednesday, August 08, 2018	18:00	373	62.7%
Sep-18	343,256	Saturday, September 15, 2018	21:00	645	477	73.9%	Thursday, September 06, 2018	18:00	428	66.3%
Oct-18	543,457	Tuesday, October 30, 2018	21:00	1,031	730	70.9%	Monday, October 22, 2018	08:00	868	84.3%
Nov-18	719,398	Monday, November 12, 2018	06:00	1,296	999	77.1%	Monday, November 19, 2018	08:00	1,157	89.2%
Dec-18	956,630	Friday, December 07, 2018	08:00	1,565	1,286	82.1%	Thursday, December 06, 2018	08:00	1,498	95.7%
Annual	7,384,810	Annual Class Peak		1,693	843	49.8%	Annual System Peak		1,590	93.9%
		Average 12 Monthly NCPs		1,113		75.8%	Average 12 Monthly CPs		933	83.8%
		Average Top 12 NCPs		1,654		51.0%	Average Top 12 CPs		1,542	93.2%
		Average Top 75 NCPs		1,599		52.7%	Average Top 75 CPs		1,499	93.8%
		Average Top 200 NCPs		1,552		54.3%	Average Top 200 CPs		1,454	93.7%
							Average 4CPs *		1,428	

* Monthly CPs for November, December, January and February

Table 10 – Schedule 05 Class: Summary Statistics (Totals – kW)

Table 11 presents the data on an average-per-customer basis. For Schedule 05, the average annual use per account is 923,101 kWh with a peak demand of 211.65 kW.

| | Monthly Energy Use | | Class Peak Demand | | | | Class Demand at System Peak Hour | | | |
| | | | Class Peak Demand | Average Demand | Load Factor | | | Time of | Class Demand @ System Peak | Coincidence Factor |
Month	(kWh)	Date of Class Peak	Time of Class Peak	(kW)	(kW)	(%)	Timing of System Peak	System Peak	(kW)	(%)
Jan-18	123,127	Monday, January 01, 2018	08:00	200.04	165.49	82.7%	Tuesday, January 02, 2018	18:00	183.70	91.8%
Feb-18	113,967	Wednesday, February 21, 2018	24:00	211.65	169.59	80.1%	Friday, February 23, 2018	08:00	198.69	93.9%
Mar-18	109,224	Saturday, March 03, 2018	04:00	188.43	146.81	77.9%	Wednesday, March 07, 2018	08:00	174.95	92.8%
Apr-18	86,086	Monday, April 16, 2018	06:00	159.59	119.56	74.9%	Monday, April 02, 2018	08:00	149.49	93.7%
May-18	52,767	Tuesday, May 01, 2018	06:00	116.08	70.92	61.1%	Monday, May 14, 2018	18:00	56.09	48.3%
Jun-18	42,384	Friday, June 01, 2018	05:00	81.24	58.87	72.5%	Wednesday, June 20, 2018	18:00	47.08	58.0%
Jul-18	37,820	Sunday, July 01, 2018	23:00	70.54	50.83	72.1%	Monday, July 30, 2018	18:00	48.46	68.7%
Aug-18	37,384	Saturday, August 25, 2018	21:00	74.44	50.25	67.5%	Wednesday, August 08, 2018	18:00	46.65	62.7%
Sep-18	42,907	Saturday, September 15, 2018	21:00	80.68	59.59	73.9%	Thursday, September 06, 2018	18:00	53.47	66.3%
Oct-18	67,932	Tuesday, October 30, 2018	21:00	128.84	91.31	70.9%	Monday, October 22, 2018	08:00	108.55	84.3%
Nov-18	89,925	Monday, November 12, 2018	06:00	162.05	124.90	77.1%	Monday, November 19, 2018	08:00	144.59	89.2%
Dec-18	119,579	Friday, December 07, 2018	08:00	195.67	160.72	82.1%	Thursday, December 06, 2018	08:00	187.24	95.7%
Annual	923,101	Annual Class Peak		211.65	105.38	49.8%	Annual System CP		198.69	93.9%

Table 11 – Schedule 05 Customer: Summary Statistics (Means – kW)

3.4 Schedules 8 & 24 Small General Service

The historical sample data was expanded by post-stratifying the data available for Schedules 8 & 24 Small General Service class. Table 12 presents the post-stratification used in the sample expansion analysis. The table shows population count, number of sample points and the case weight by annual energy usage bracket.

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	W(h)	Y(h)	y(h)	Adj. %	Case Wt.
0 - 15,000*	80,604	142	567.6	0.6501	4,929	5,313	-7.2%	526.5
15,001 -50,000	29,462	128	230.2	0.2376	27,435	28,538	-3.9%	221.3
50,001 - 120,000	11,158	130	85.8	0.0900	74,944	77,083	-2.8%	83.4
> 120,000	2,754	114	24.2	0.0222	173,818	216,110	-19.6%	19.4
Total	123,978	514	241.2	1.0000	20,330	21,974	-7.5%	223.2

Table 12 – Schedules 8 & 24: Post-Stratification

As stated earlier, PSE proposes elimination of Rate Schedule 40 in its 2019 GRC. Among the existing 129 Schedule 40 metering device locations, eight locations are going to be served under Schedule 24. Therefore, the final estimate of Schedule 24 load shape has been produced by adding the sum of hourly loads metered at those 8 locations to the class hourly load shape estimated for the existing Schedule 8 & 24 device locations.

In the next step, the average loss factor estimated for Schedules 8 & 24 was applied to the hourly expansions to produce the class hourly load profile with losses. As shown in Table 7, the average loss factor estimated for the Small General Service class is 7.62%.

The hourly load estimates including line losses were preliminary estimates of the Small General Service class' contribution to system's hourly demand. In the final stage of the analysis, the UFE was allocated to the Schedules 8 & 24 based on preliminary percentage estimate of its contribution to the system demand for that particular hour.

Figure 13 presents the Schedules 8 & 24 class load. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. Dominance of mid-winter load is evident. The Small General Service class peak occurred on Wednesday, January 3, 2018 at 10AM. The peak demand was about 570.0 MW.

January 1 - December 31, 2018

Figure 13 – Schedules 8 & 24: Class Total Load

Figure 14 presents the Small General Service class load during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The Small General Service class load at the time of the system peak was 532.2 MW or 93.4% of its class peak demand of 570.0 MW. The system peak demand occurred at 8 AM, Friday, February 23.
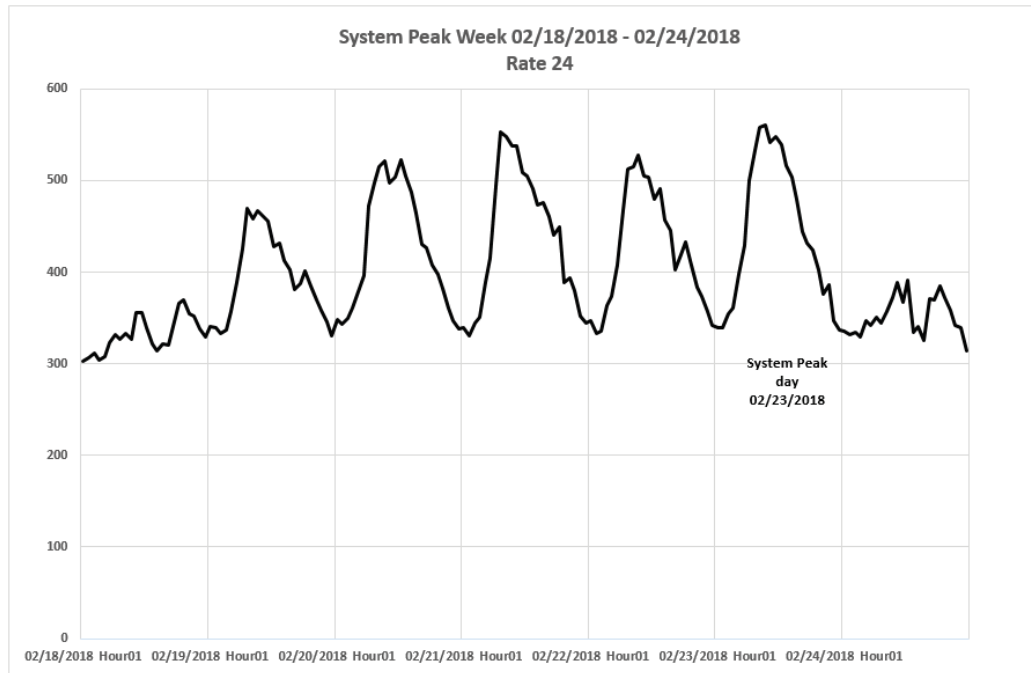
Figure 14 – Schedules 8 & 24: Total Load during System Peak Week

Figure 15 presents the monthly Small General Service class energy consumption, peak demand and load factor in graphics.
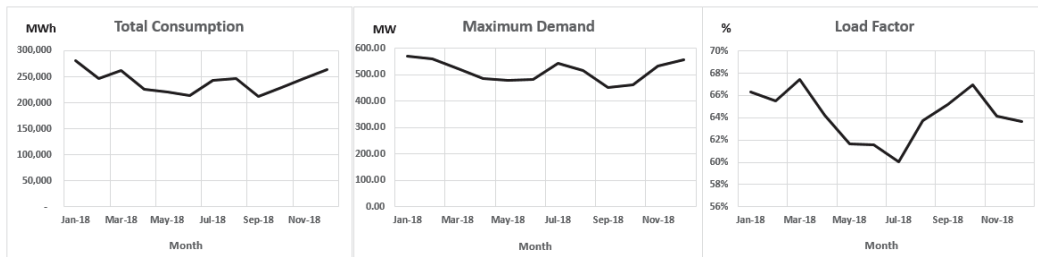
Figure 15 – Schedules 8 & 24: Class Monthly Energy, Demand and Load Factor

Achieved precision associated with the Small General Service class analysis can be evaluated in terms of the deviation of the annual sum of estimated class hourly loads net of losses from the total actual sales to the class in the same period. The sum of estimated hourly loads net of losses was 2,669,772 MWh, 0.2% higher than the actual class sales of 2,690,722 MWh.

Table 13 presents summary statistics for the Schedules 8 & 24 total class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as

12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. Monthly NCP load factors range from a low of 60.0% in July to a high of 67.5% in March. The coincidence of Schedules 8 & 24 class load to the system peak fluctuates month to month from 73.0% in June to 98.0% in December.

		Class Peak Demand					Class Demand at System Peak Hour			
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	281,173,432	Wednesday, January 3, 2018	10:00	570,046	377,921	66.3%	Tuesday, January 2, 2018	18:00	471,173	82.7%
Feb-18	246,718,910	Friday, February 23, 2018	10:00	560,664	367,141	65.5%	Friday, February 23, 2018	08:00	532,239	94.9%
Mar-18	262,009,412	Wednesday, March 7, 2018	10:00	522,045	352,163	67.5%	Wednesday, March 7, 2018	08:00	492,291	94.3%
Apr-18	225,078,459	Monday, April 2, 2018	10:00	486,516	312,609	64.3%	Monday, April 2, 2018	08:00	465,136	95.6%
May-18	220,536,492	Monday, May 14, 2018	14:00	480,775	296,420	61.7%	Monday, May 14, 2018	18:00	395,969	82.4%
Jun-18	213,263,071	Monday, June 18, 2018	14:00	481,329	296,199	61.5%	Wednesday, June 20, 2018	18:00	366,930	76.2%
Jul-18	243,006,081	Tuesday, July 17, 2018	13:00	543,985	326,621	60.0%	Monday, July 30, 2018	18:00	397,272	73.0%
Aug-18	245,969,838	Thursday, August 9, 2018	14:00	518,413	330,605	63.8%	Wednesday, August 8, 2018	18:00	420,740	81.2%
Sep-18	212,284,508	Wednesday, September 5, 2018	15:00	452,220	294,840	65.2%	Thursday, September 6, 2018	18:00	373,206	82.5%
Oct-18	229,703,255	Monday, October 29, 2018	12:00	461,107	308,741	67.0%	Monday, October 22, 2018	08:00	433,591	94.0%
Nov-18	246,913,861	Monday, November 19, 2018	10:00	534,860	342,936	64.1%	Monday, November 19, 2018	08:00	514,089	96.1%
Dec-18	263,331,586	Friday, December 7, 2018	09:00	555,844	353,940	63.7%	Thursday, December 6, 2018	08:00	545,002	98.0%
Annual	2,889,988,904	Annual Class Peak		570,046	329,907	57.9%	Annual System Peak		532,239	93.4%
		Average 12 Monthly NCPs		513,984		64.2%	Average 12 Monthly CPs		450,637	87.7%
		Average Top 12 NCPs		557,632		59.2%	Average Top 12 CPs		526,004	94.3%
		Average Top 75 NCPs		535,432		61.6%	Average Top 75 CPs		481,726	90.0%
		Average Top 200 NCPs		514,937		64.1%	Average Top 200 CPs		453,256	88.0%
							Average 4CPs *		515,626	

* Monthly CPs for November, December, January and February

Table 13 – Schedules 8 & 24 Class: Summary Statistics (Totals – kW)

Table 14 presents the data on an average-per-customer basis. For Schedules 8 & 24, the average annual use per customer is 23,769 kWh with peak demand of 4.71 kW.

		Class Peak Demand					Class Demand at System Peak Hour			
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	2,324	Wednesday, January 03, 2018	10:00	4.71	3.12	66.3%	Tuesday, January 02, 2018	18:00	3.90	82.7%
Feb-18	2,037	Friday, February 23, 2018	10:00	4.63	3.03	65.5%	Friday, February 23, 2018	08:00	4.39	94.9%
Mar-18	2,161	Wednesday, March 07, 2018	10:00	4.30	2.90	67.5%	Wednesday, March 07, 2018	08:00	4.06	94.3%
Apr-18	1,856	Monday, April 02, 2018	10:00	4.01	2.58	64.3%	Monday, April 02, 2018	08:00	3.84	95.6%
May-18	1,817	Monday, May 14, 2018	14:00	3.96	2.44	61.7%	Monday, May 14, 2018	18:00	3.26	82.4%
Jun-18	1,754	Monday, June 18, 2018	14:00	3.96	2.44	61.5%	Wednesday, June 20, 2018	18:00	3.02	76.2%
Jul-18	1,997	Tuesday, July 17, 2018	13:00	4.47	2.68	60.0%	Monday, July 30, 2018	18:00	3.26	73.0%
Aug-18	2,019	Thursday, August 09, 2018	14:00	4.25	2.71	63.8%	Wednesday, August 08, 2018	18:00	3.45	81.2%
Sep-18	1,740	Wednesday, September 05, 2018	15:00	3.71	2.42	65.2%	Thursday, September 06, 2018	18:00	3.06	82.5%
Oct-18	1,882	Monday, October 29, 2018	12:00	3.78	2.53	67.0%	Monday, October 22, 2018	08:00	3.55	94.0%
Nov-18	2,024	Monday, November 19, 2018	10:00	4.38	2.81	64.1%	Monday, November 19, 2018	08:00	4.21	96.1%
Dec-18	2,159	Friday, December 07, 2018	09:00	4.56	2.90	63.7%	Thursday, December 06, 2018	08:00	4.47	98.0%
Annual	23,769	Annual Class Peak		4.71	2.71	57.6%	Annual System CP		4.39	93.2%

Table 14 – Schedules 8 & 24 Customer: Summary Statistics (Means – kW)

3.5 Schedules 11 & 25 Medium General Service

The historical sample data was expanded by post-stratifying the data available for Schedule 11 & 25 Medium General Service class. Table 15 presents the post-stratification used in the sample expansion analysis. The table shows population count, number of sample points and the case weight by annual energy usage bracket.

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	W(h)	Y(h)	y(h)	Adj. %	Case Wt.
0 - 220,000*	3,114	59	52.8	0.3979	132,274	154,311	-14.3%	45.2
220,001 - 450,000	2,736	56	48.9	0.3496	313,994	321,663	-2.4%	47.7
450,001 - 900,000	1,436	59	24.3	0.1835	613,340	636,821	-3.7%	23.4
> 900,000	540	47	11.5	0.0690	1,265,055	1,274,839	-0.8%	11.4
Total	7,826	221	35.4	1.0000	362,238	378,671	-4.3%	33.9

Table 15 – Schedules 11 & 25: Post-Stratification

Among the existing 129 Schedule 40 metering device locations, twelve locations are going to be served under Schedule 25. The final estimate of Schedule 25 load shape has been produced by adding the sum of hourly loads metered at those 12 locations to the class hourly load shape estimated for the existing Schedule 11 & 25 device locations.

In the next step, the average loss factor estimated for the Medium General Service class was applied to the hourly expansions to produce the class hourly load profile with losses. As listed in Table 7, the estimated average loss factor for Schedules 11 & 25 is 7.60%.

In the final step, the UFE was allocated to the Schedules 11 & 25 based on preliminary percentage estimate of its contribution to the system demand for that particular hour.

Figure 16 presents the total load for Schedules 11 & 25. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. Due to space heating and cooling loads, the Schedules 11 & 25 load profile shows that its mid-winter and mid-summer loads tend to be higher than other seasonal loads. The Schedules 11 & 25 class load peaked on Thursday, December 6, 2018 at 10 AM. The class peak demand was 680.7 MW.
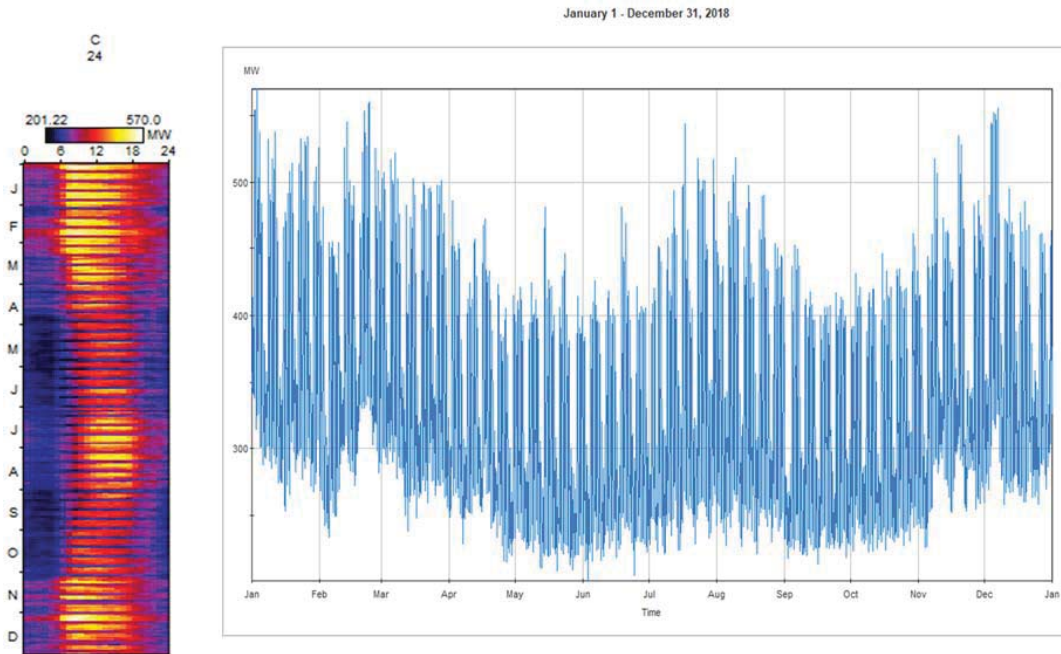
January 1 - December 31, 2018

Figure 16 – Schedules 11 & 25: Class Total Load

Figure 17 presents the Schedules 11 & 25 class load during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peaked on Friday, February 23 at hour ending 8 AM. At the system peak hour, the class demand was 577.2 MW, or 84.8% of the class peak demand of 680.7 MW.
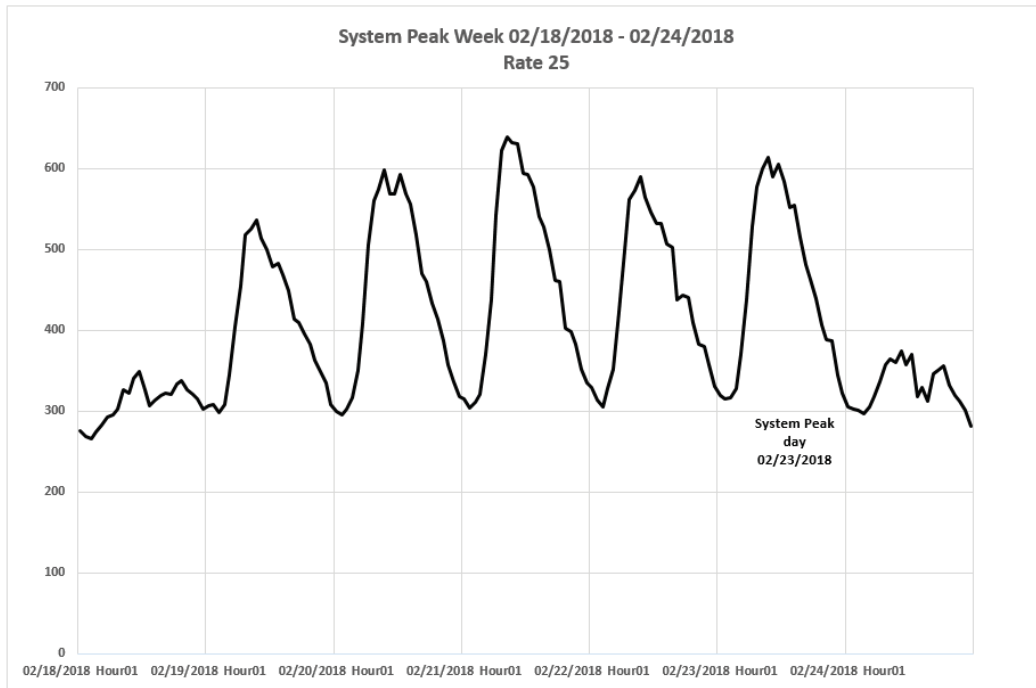
Figure 17 – Schedules 11 & 25: Total Load during System Peak Week

Figure 18 presents the monthly Medium General Service class energy consumption, peak demand and load factor in graphics. The monthly peak loads in December and July were winter and summer seasonal peak loads.
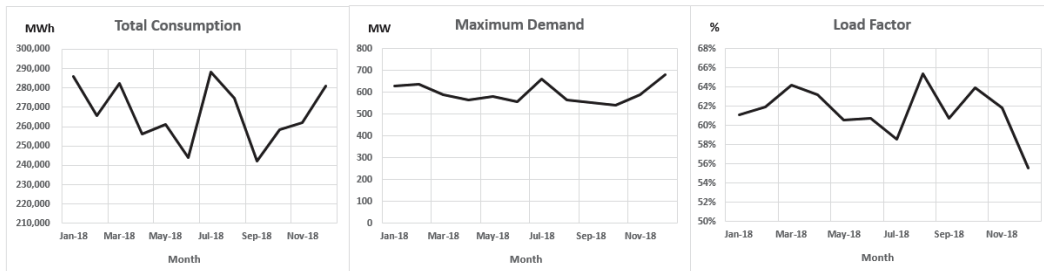
Figure 18 – Schedules 11 & 25: Class Monthly Energy, Demand and Load Factor

Achieved precision associated with the Medium General Service class analysis is evaluated in terms of the deviation of the annual sum of the class hourly loads net of losses estimated for the study period from the total actual sales to the class during the same period. The sum of estimated hourly loads net of losses was 2,959,028 MWh, 0.9% lower than the actual class sales of 2,986,356 MWh. The percentage of error is much less than the maximum error margin of ±10% tolerated in a typical load research practice.

Table 16 presents summary statistics for the Schedules 11 & 25 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. Monthly NCP load factors are relatively stable with a low of 55.5% in December to a high of 65.4% in August. Monthly system coincidence factor of Schedule 11 & 25 load fluctuates form 69.7% in January to 94.8% in December.

Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	286,050,273	Wednesday, January 17, 2018	12:00	628,833	384,476	61.1%	Tuesday, January 2, 2018	18:00	438,465	69.7%
Feb-18	265,783,246	Wednesday, February 21, 2018	09:00	638,556	395,511	61.9%	Friday, February 23, 2018	08:00	577,209	90.4%
Mar-18	282,302,084	Wednesday, March 7, 2018	10:00	590,677	379,438	64.2%	Wednesday, March 7, 2018	08:00	526,061	89.1%
Apr-18	256,384,100	Tuesday, April 17, 2018	10:00	563,558	356,089	63.2%	Monday, April 2, 2018	08:00	528,042	93.7%
May-18	261,212,572	Monday, May 14, 2018	14:00	579,931	351,092	60.5%	Monday, May 14, 2018	18:00	481,010	82.9%
Jun-18	244,135,251	Monday, June 18, 2018	13:00	558,503	339,077	60.7%	Wednesday, June 20, 2018	18:00	428,937	76.8%
Jul-18	288,049,859	Tuesday, July 17, 2018	13:00	660,827	387,164	58.6%	Monday, July 30, 2018	18:00	494,406	74.8%
Aug-18	274,779,012	Wednesday, August 8, 2018	11:00	564,771	369,327	65.4%	Wednesday, August 8, 2018	18:00	484,735	85.8%
Sep-18	241,970,287	Wednesday, September 5, 2018	14:00	553,308	336,070	60.7%	Thursday, September 6, 2018	18:00	433,344	78.3%
Oct-18	258,382,881	Monday, October 29, 2018	11:00	543,246	347,289	63.9%	Monday, October 22, 2018	08:00	475,343	87.5%
Nov-18	262,181,805	Tuesday, November 20, 2018	10:00	588,820	364,141	61.8%	Monday, November 19, 2018	08:00	544,794	92.5%
Dec-18	281,179,971	Thursday, December 6, 2018	10:00	680,657	377,930	55.5%	Thursday, December 6, 2018	08:00	645,264	94.8%
Annual	3,202,411,340	Annual Class Peak		680,657	365,572	53.7%	Annual System Peak		577,209	84.8%
		Average 12 Monthly NCPs		595,974		61.3%	Average 12 Monthly CPs		504,801	84.7%
		Average Top 12 NCPs		653,087		56.0%	Average Top 12 CPs		590,938	90.5%
		Average Top 75 NCPs		609,314		60.0%	Average Top 75 CPs		525,811	86.3%
		Average Top 200 NCPs		587,763		62.2%	Average Top 200 CPs		486,753	82.8%
							Average 4CPs *		551,433	

Table 16 – Schedules 11 & 25 Class: Summary Statistics (Totals – kW)

Table 17 presents the data on an average-per-customer basis. For Schedule 25, the average annual use per customer is 423,756 kWh with peak demand of 88.82 kW.

		Class Peak Demand					Class Demand at System Peak Hour			
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	39,206	Wednesday, January 17, 2018	12:00	86.19	52.70	61.1%	Tuesday, January 02, 2018	18:00	60.10	69.7%
Feb-18	35,931	Wednesday, February 21, 2018	09:00	86.33	53.47	61.9%	Friday, February 23, 2018	08:00	78.03	90.4%
Mar-18	37,545	Wednesday, March 07, 2018	10:00	78.56	50.46	64.2%	Wednesday, March 07, 2018	08:00	69.96	89.1%
Apr-18	33,585	Tuesday, April 17, 2018	10:00	73.82	46.65	63.2%	Monday, April 02, 2018	08:00	69.17	93.7%
May-18	33,972	Monday, May 14, 2018	14:00	75.42	45.66	60.5%	Monday, May 14, 2018	18:00	62.56	82.9%
Jun-18	32,165	Monday, June 18, 2018	13:00	73.58	44.67	60.7%	Wednesday, June 20, 2018	18:00	56.51	76.8%
Jul-18	38,102	Tuesday, July 17, 2018	13:00	87.41	51.21	58.6%	Monday, July 30, 2018	18:00	65.40	74.8%
Aug-18	36,342	Wednesday, August 08, 2018	11:00	74.70	48.85	65.4%	Wednesday, August 08, 2018	18:00	64.11	85.8%
Sep-18	31,990	Wednesday, September 05, 2018	14:00	73.15	44.43	60.7%	Thursday, September 06, 2018	18:00	57.29	78.3%
Oct-18	33,975	Monday, October 29, 2018	11:00	71.43	45.67	63.9%	Monday, October 22, 2018	08:00	62.50	87.5%
Nov-18	34,250	Tuesday, November 20, 2018	10:00	76.92	47.57	61.8%	Monday, November 19, 2018	08:00	71.17	92.5%
Dec-18	36,693	Thursday, December 06, 2018	10:00	88.82	49.32	55.5%	Thursday, December 06, 2018	08:00	84.21	94.8%
Annual	423,756	Annual Class Peak		88.82	48.37	54.5%	Annual System CP		78.03	87.9%

Table 17 – Schedules 11 & 25 Customer: Summary Statistics (Means – kW)

3.6 Schedules 12 & 26 Large General Service

The historical sample data was expanded by post-stratifying the data available for Schedules 12 & 26 Large General Service class. Table 18 presents the post-stratification used in the sample expansion analysis. The table shows population count, number of sample points and the case weight by annual energy usage bracket.

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	W(h)	Y(h)	y(h)	Adj. %	Case Wt.
0 - 2,000,000*	444	70	6.3	0.5324	1,238,963	1,286,818	-3.7%	6.1
2,000,001 -4,000,000	332	52	6.4	0.3981	2,715,198	2,915,360	-6.9%	5.9
> 4,000,000	58	27	2.1	0.0695	5,451,965	5,485,098	-0.6%	2.1
Total	834	149	5.6	1.0000	2,119,615	2,227,077	-4.8%	5.3

Table 18 – Schedules 12 & 26: Post-Stratification

Eleven of 129 existing schedule 40 metering device locations are going to be served under Schedule 26. The final estimate of load shape has been produced by adding the sum of hourly loads metered at those 11 locations to the class hourly load shape estimated for the existing Schedule 12 & 26 device locations.

In the second step, the average loss factor estimated for Schedules 12 & 26 was applied to the hourly expansions to produce the class hourly load profile with losses. As seen in Table 7, the estimated average loss factor for the Large General Service class is 7.55%.

In the final step, the UFE was allocated to the Schedules 12 & 26 based on preliminary percentage estimate of its contribution to the system demand for that particular hour.

Figure 19 presents the total load for the Schedules 12 & 26 class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. The Schedules 12 & 26 class load is fairly stable and shows little seasonality. The Large General Service class load peaked on Tuesday, July 17, 2018 at 1 PM. The class peak demand was 386.1 MW.
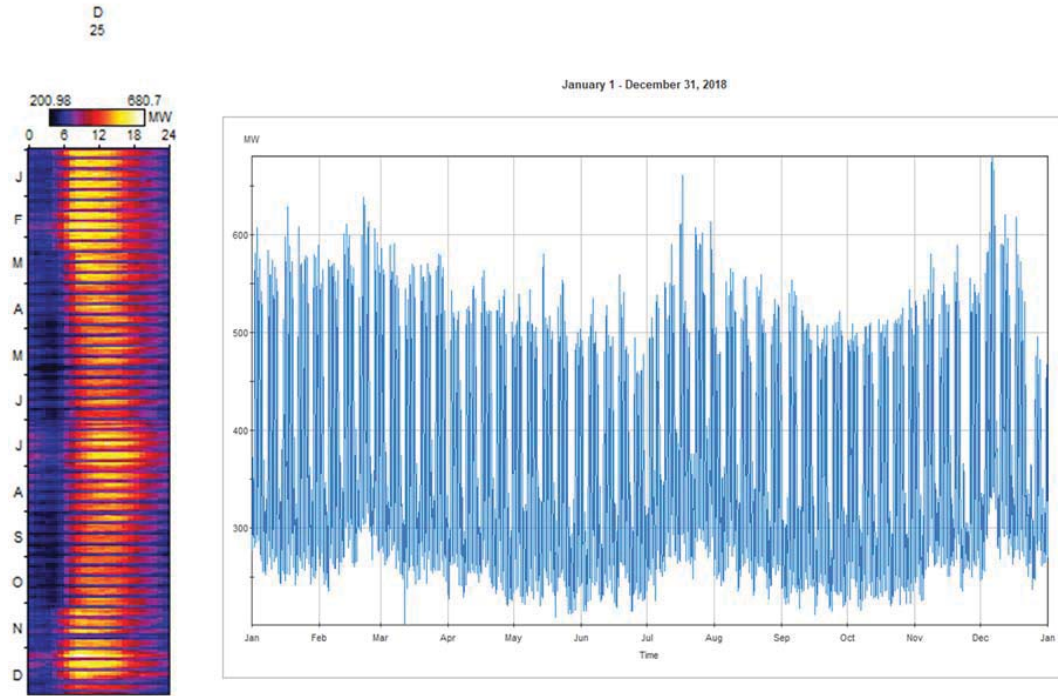
January 1 - December 31, 2018
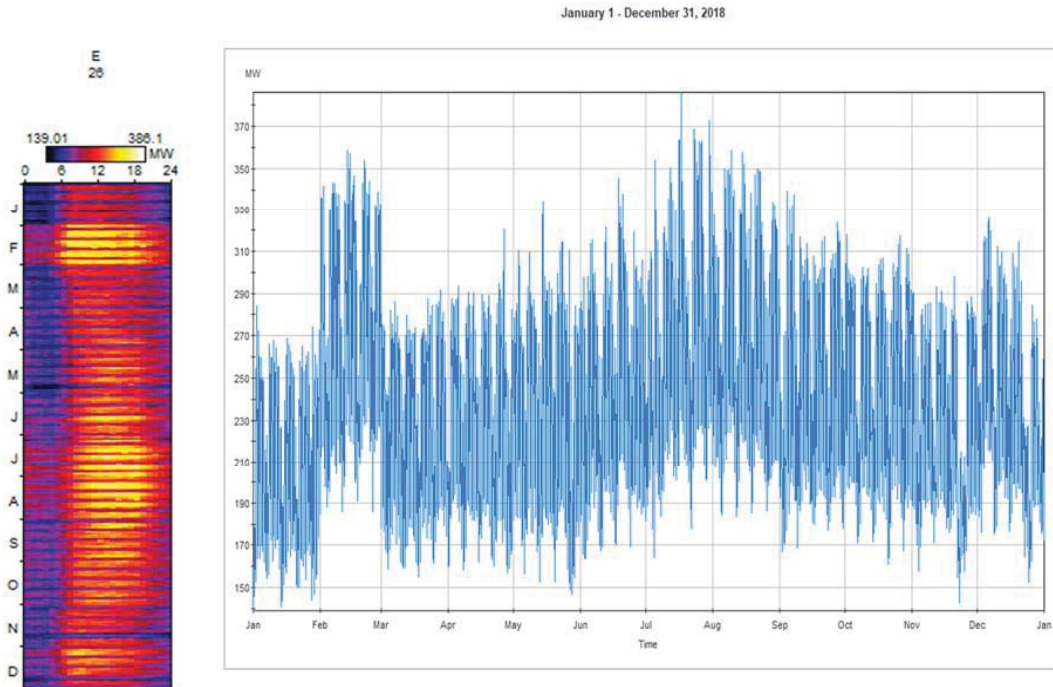
Figure 19 – Schedules 12 & 26: Class Total Load

Figure 20 presents the Schedule 12 & 26 class loads during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peaked on Friday, February 23, 2018 at hour ending 8 AM. The class had a system peak hour load of 337.6 MW or 87.4% of the July class peak demand of 386.1 MW.

Figure 20 – Schedules 12 & 26: Total Load during System Peak Week

Figure 21 presents monthly Schedules 12 & 26 class energy consumption, peak demand and load factor in graphics. Summer and winter weather sensitivities are evident with higher monthly energy consumption and maximum loads occurred in February, July, August and December.
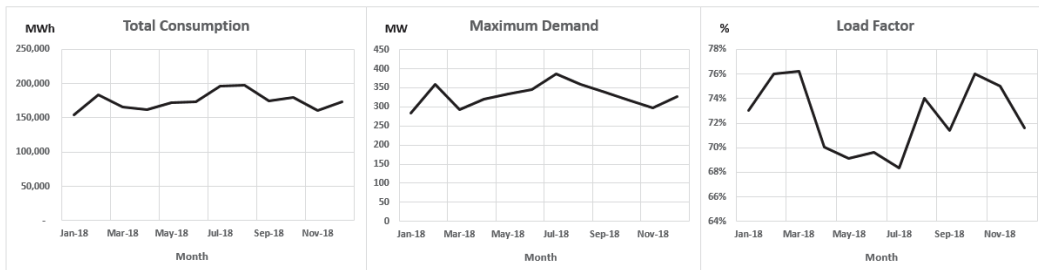
Figure 21 –Schedules 12 & 26: Class Monthly Energy, Demand and Load Factor

Achieved precision of the Large General Service class analysis is evaluated in terms of the deviation of the sum of the estimated class hourly loads net of losses from the total actual sales to the class during the 12-month study period. The sum of estimated hourly loads net of losses was 1,934,042 MWh, 0.6% lower than the actual class sales of 1,946,174 MWh. The percentage of error is much less than the maximum tolerable error margin of ±10% set for a typical load research practice.

Table 19 presents summary statistics for the Schedules 12 & 26 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at

the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. Monthly NCP load factors do not fluctuate much with a low of 68.3% in July and a high of 76.2% in March. The Schedules 12 & 26 load is fairly coincident with the system peak displaying a system peak coincidence factor of over 90% for 8 of the 12 months.

| | Monthly Energy Use (kWh) | Class Peak Demand | | | | | Class Demand at System Peak Hour | | | |
Month		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	154,288,106	Tuesday, January 2, 2018	12:00	284,095	207,376	73.0%	Tuesday, January 2, 2018	18:00	238,160	83.8%
Feb-18	183,297,427	Tuesday, February 13, 2018	08:00	358,690	272,764	76.0%	Friday, February 23, 2018	08:00	337,597	94.1%
Mar-18	165,448,609	Wednesday, March 28, 2018	09:00	291,873	222,377	76.2%	Wednesday, March 7, 2018	08:00	266,038	91.1%
Apr-18	161,703,400	Thursday, April 26, 2018	16:00	320,704	224,588	70.0%	Monday, April 2, 2018	08:00	280,935	87.6%
May-18	171,875,772	Monday, May 14, 2018	14:00	334,180	231,016	69.1%	Monday, May 14, 2018	18:00	318,700	95.4%
Jun-18	173,011,484	Monday, June 18, 2018	13:00	345,146	240,294	69.6%	Wednesday, June 20, 2018	18:00	311,833	90.3%
Jul-18	196,276,590	Tuesday, July 17, 2018	13:00	386,131	263,813	68.3%	Monday, July 30, 2018	18:00	346,921	89.8%
Aug-18	197,357,675	Thursday, August 9, 2018	14:00	358,445	265,266	74.0%	Wednesday, August 8, 2018	18:00	341,196	95.2%
Sep-18	174,328,998	Tuesday, September 4, 2018	13:00	339,155	242,124	71.4%	Thursday, September 6, 2018	18:00	305,222	90.0%
Oct-18	179,669,306	Monday, October 1, 2018	16:00	317,802	241,491	76.0%	Monday, October 22, 2018	08:00	275,861	86.8%
Nov-18	160,963,852	Tuesday, November 20, 2018	10:00	297,932	223,561	75.0%	Monday, November 19, 2018	08:00	277,230	93.1%
Dec-18	173,765,731	Thursday, December 6, 2018	10:00	326,245	233,556	71.6%	Thursday, December 6, 2018	08:00	306,913	94.1%
Annual	2,091,986,948	Annual Class Peak		386,131	238,811	61.8%	Annual System Peak		337,597	87.4%
		Average 12 Monthly NCPs		330,033		72.4%	Average 12 Monthly CPs		300,550	91.1%
		Average Top 12 NCPs		366,739		65.1%	Average Top 12 CPs		324,847	88.6%
		Average Top 75 NCPs		354,178		67.4%	Average Top 75 CPs		306,905	86.7%
		Average Top 200 NCPs		344,501		69.3%	Average Top 200 CPs		286,173	83.1%
							Average 4CPs *		289,975	

* Monthly CPs for November, December, January and February

Table 19 – Schedules 12 & 26 Class: Summary Statistics (Totals –kW)

Table 20 presents the data on an average-per-customer basis. For Schedules 12 & 26, the average annual use per customer is 2,483,172 kWh with peak demand of 443.83 kW.

| | Monthly Energy Use (kWh) | Class Peak Demand | | | | | Class Demand at System Peak Hour | | | |
Month		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	189,543	Tuesday, January 02, 2018	12:00	349.01	254.76	73.0%	Tuesday, January 02, 2018	18:00	292.58	83.8%
Feb-18	226,573	Tuesday, February 13, 2018	08:00	443.37	337.16	76.0%	Friday, February 23, 2018	08:00	417.30	94.1%
Mar-18	204,258	Wednesday, March 28, 2018	09:00	360.34	274.54	76.2%	Wednesday, March 07, 2018	08:00	328.44	91.1%
Apr-18	198,653	Thursday, April 26, 2018	16:00	393.99	275.91	70.0%	Monday, April 02, 2018	08:00	345.13	87.6%
May-18	203,886	Monday, May 14, 2018	14:00	396.42	274.04	69.1%	Monday, May 14, 2018	18:00	378.05	95.4%
Jun-18	198,408	Monday, June 18, 2018	13:00	395.81	275.57	69.6%	Wednesday, June 20, 2018	18:00	357.61	90.3%
Jul-18	225,605	Tuesday, July 17, 2018	13:00	443.83	303.23	68.3%	Monday, July 30, 2018	18:00	398.76	89.8%
Aug-18	225,810	Thursday, August 09, 2018	14:00	410.12	303.51	74.0%	Wednesday, August 08, 2018	18:00	390.38	95.2%
Sep-18	199,461	Tuesday, September 04, 2018	13:00	388.05	277.00	71.4%	Thursday, September 06, 2018	18:00	349.22	90.0%
Oct-18	208,675	Monday, October 01, 2018	16:00	369.11	280.48	76.0%	Monday, October 22, 2018	08:00	320.40	86.8%
Nov-18	193,699	Tuesday, November 20, 2018	10:00	358.52	269.03	75.0%	Monday, November 19, 2018	08:00	333.61	93.1%
Dec-18	208,602	Thursday, December 06, 2018	10:00	391.65	280.38	71.6%	Thursday, December 06, 2018	08:00	368.44	94.1%
Annual	2,483,172	Annual Class Peak		443.83	283.47	63.9%	Annual System CP		417.30	94.0%

Table 20 – Schedules 12 & 26 Customer: Summary Statistics (Means – kW)

3.7 Schedule 29 Seasonal Irrigation

The historical sample data was expanded to the population level by post-stratifying the data available for Schedule 29 Seasonal Irrigation and Pumping Service class. Table 21 presents the post-stratification used in the sample expansion analysis.

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	W(h)	Y(h)	y(h)	Adj. %	Case Wt.
0 - 35,000*	627	192	3.3	0.8207	11,432	11,962	-4.4%	3.1
> 35,000	137	87	1.6	0.1793	69,324	76,173	-9.0%	1.4
Total	764	279	2.7	1.0000	21,814	23,476	-7.1%	2.5

Table 21 – Schedule 29: Post-Stratification

In the next step, the average loss factor estimated for Schedule 29 was applied to the hourly expansions to produce the class hourly load profile. Table 7 indicates that the estimated average loss factor for the irrigation rate schedule is 7.36%.

In the final step, the UFE was allocated to the Schedule 29 in proportion to preliminary estimate of its contribution to the system demand for hour by hour.

Figure 22 presents the total load for the Seasonal Irrigation and Pumping Service class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. Dominance of the summer seasonal load is clearly evident. The Seasonal Irrigation and Pumping Service class peak occurred on Friday, July 20, 2018 at 7 PM. The class peak demand was 7.5 MW.
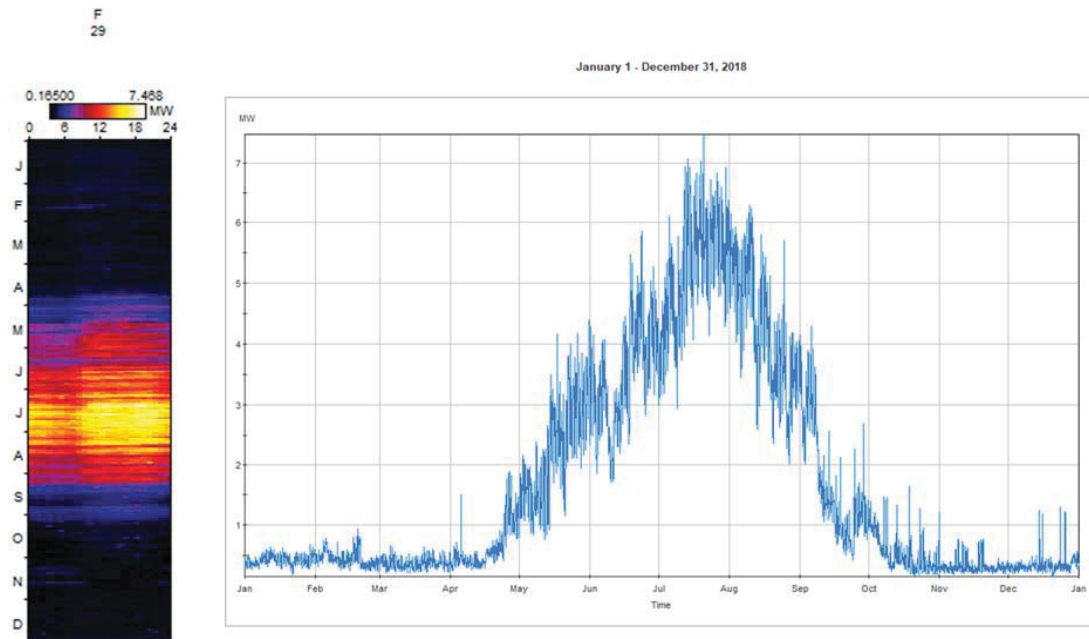
Figure 22 – Schedule 29: Class Total Load

Figure 23 presents the total Seasonal Irrigation Rate Schedule 29 loads during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peaked on Friday, February 23, 2018 at hour ending 8 AM. The class had a system peak hour load of about 382 kW or 5.1% of its July peak of 7.5 MW.
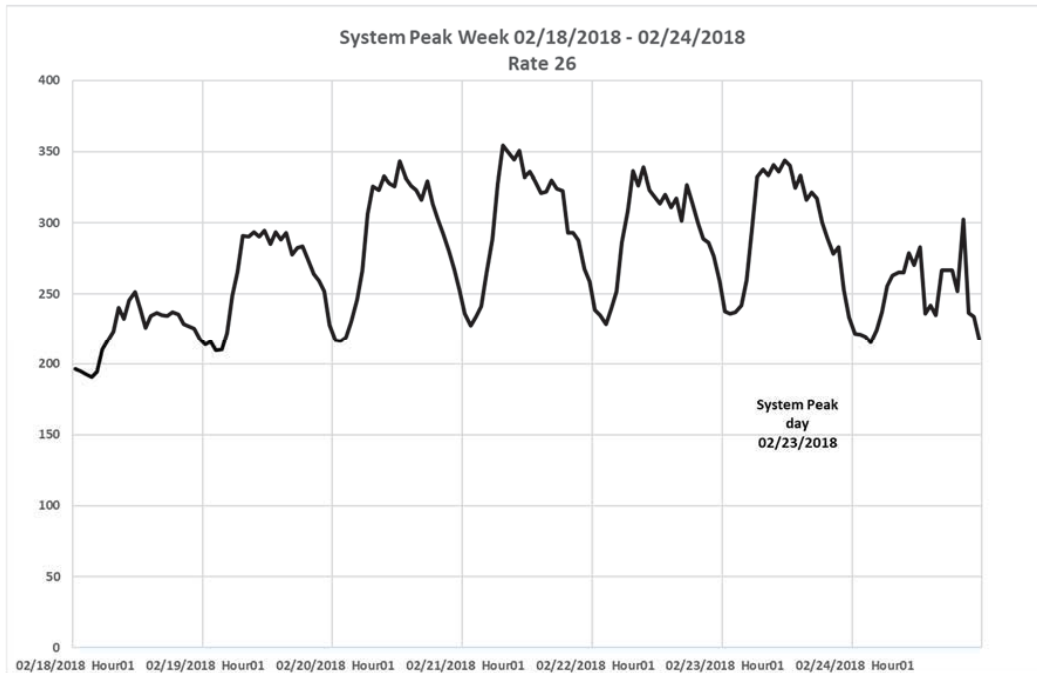

Figure 23 – Schedule 29: Total Load during System Peak Week

Figure 24 shows the monthly Schedule 29 class energy consumption, peak demand and load factor in graphics. The Seasonal Irrigation and Pumping Service load is highest during the summer months.
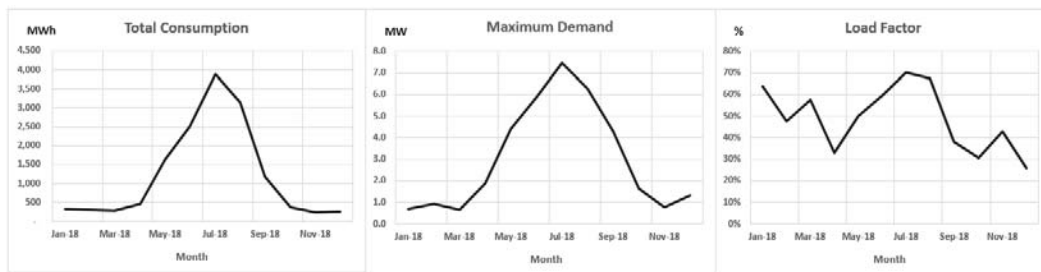
Figure 24 –Schedule 29: Class Monthly Energy, Demand and Load Factor

For Schedule 29, the sum of estimated hourly loads net of losses for the 12 months ending December 2018 was 13,513 MWh, 18.0% lower than the actual class sales of 16,476 MWh. The percentage of error is much higher than any other rate schedule's. The irrigation load is extremely volatile. There are many accounts showing no usage or inactive, even during the crop growing

season. A significant number of the irrigation service customers close their accounts during the winter months and re-open the accounts in spring or early summer months. Therefore, population expansion of the sampled hourly loads is a real challenge and error margins are expected to be higher than other rate classes'.

Table 22 presents summary statistics for the Seasonal Irrigation and Pumping Service load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. Monthly load factors are low during the winter months while being much higher in the summer months. Monthly load factors range from a low of 25.9% in December to a high of 70.1% in July. Except in the mid-summer months of July and August, the Seasonal Irrigation load is hardly coincident with the system peak displaying a system peak coincidence factor as low as 15.4% in October and 24.7% in April.

		Class Peak Demand					Class Demand at System Peak Hour			
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	320,841	Monday, January 29, 2018	14:00	675	431	63.9%	Tuesday, January 02, 2018	18:00	457	67.6%
Feb-18	301,756	Monday, February 19, 2018	10:00	942	449	47.7%	Friday, February 23, 2018	08:00	382	40.6%
Mar-18	283,075	Monday, March 05, 2018	19:00	660	380	57.7%	Wednesday, March 07, 2018	08:00	463	70.2%
Apr-18	448,627	Thursday, April 26, 2018	16:00	1,880	623	33.1%	Monday, April 02, 2018	08:00	465	24.7%
May-18	1,635,524	Thursday, May 31, 2018	15:00	4,391	2,198	50.1%	Monday, May 14, 2018	18:00	3,122	71.1%
Jun-18	2,508,500	Saturday, June 23, 2018	14:00	5,860	3,484	59.5%	Wednesday, June 20, 2018	18:00	4,240	72.4%
Jul-18	3,896,276	Friday, July 20, 2018	19:00	7,468	5,237	70.1%	Monday, July 30, 2018	18:00	6,257	83.8%
Aug-18	3,148,675	Thursday, August 09, 2018	19:00	6,276	4,232	67.4%	Wednesday, August 08, 2018	18:00	5,822	92.8%
Sep-18	1,174,834	Wednesday, September 05, 2018	20:00	4,299	1,632	38.0%	Thursday, September 06, 2018	18:00	3,722	86.6%
Oct-18	376,728	Thursday, October 18, 2018	18:00	1,648	506	30.7%	Monday, October 22, 2018	08:00	256	15.5%
Nov-18	240,085	Friday, November 09, 2018	03:00	780	333	42.8%	Monday, November 19, 2018	08:00	660	84.7%
Dec-18	251,709	Sunday, December 23, 2018	21:00	1,309	338	25.9%	Thursday, December 06, 2018	08:00	345	26.3%
Annual	14,586,630	Annual Class Peak		7,468	1,665	22.3%	Annual System Peak		382	5.1%
		Average 12 Monthly NCPs		3,016		55.2%	Average 12 Monthly CPs		2,183	72.4%
		Average Top 12 NCPs		7,017		23.7%	Average Top 12 CPs		364	5.2%
		Average Top 75 NCPs		6,618		25.2%	Average Top 75 CPs		394	6.0%
		Average Top 200 NCPs		6,313		26.4%	Average Top 200 CPs		401	6.4%
							Average 4CPs *		461	

* Monthly CPs for November, December, January and February

Table 22 – Schedule 29 Class: Summary Statistics (Totals – kW)

Table 23 presents the data on an average-per-customer basis. The average annual use per customer in Rate Schedule 29 is 22,302 kWh with annual peak demand of 10.87 kW.

Month	Monthly Energy Use (kWh)	Class Peak Demand					Class Demand at System Peak Hour			
		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	602	Monday, January 29, 2018	14:00	1.27	0.81	63.9%	Tuesday, January 02, 2018	18:00	0.86	67.6%
Feb-18	579	Monday, February 19, 2018	10:00	1.81	0.86	47.7%	Friday, February 23, 2018	08:00	0.73	40.6%
Mar-18	535	Monday, March 05, 2018	19:00	1.25	0.72	57.7%	Wednesday, March 07, 2018	08:00	0.88	70.2%
Apr-18	795	Thursday, April 26, 2018	16:00	3.33	1.10	33.1%	Monday, April 02, 2018	08:00	0.82	24.7%
May-18	2,600	Thursday, May 31, 2018	15:00	6.98	3.49	50.1%	Monday, May 14, 2018	18:00	4.96	71.1%
Jun-18	3,772	Saturday, June 23, 2018	14:00	8.81	5.24	59.5%	Wednesday, June 20, 2018	18:00	6.38	72.4%
Jul-18	5,671	Friday, July 20, 2018	19:00	10.87	7.62	70.1%	Monday, July 30, 2018	18:00	9.11	83.8%
Aug-18	4,530	Thursday, August 09, 2018	19:00	9.03	6.09	67.4%	Wednesday, August 08, 2018	18:00	8.38	92.8%
Sep-18	1,720	Wednesday, September 05, 2018	20:00	6.30	2.39	38.0%	Thursday, September 06, 2018	18:00	5.45	86.6%
Oct-18	595	Thursday, October 18, 2018	18:00	2.60	0.80	30.7%	Monday, October 22, 2018	08:00	0.40	15.5%
Nov-18	433	Friday, November 09, 2018	03:00	1.41	0.60	42.8%	Monday, November 19, 2018	08:00	1.19	84.7%
Dec-18	467	Sunday, December 23, 2018	21:00	2.43	0.63	25.9%	Thursday, December 06, 2018	08:00	0.64	26.3%
Annual	22,302	Annual Class Peak		10.87	2.55	23.4%	Annual System CP		0.73	6.8%

Table 23 – Schedule 29 Customer: Summary Statistics (Means – kW)

3.8 Schedules 10 & 31 Primary General Service

The historical sample data was expanded to the population level by post-stratifying the data available for Schedules 10 & 31 Large Primary General Service class. Table 24 presents the post-stratification used in the sample expansion analysis.

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	W(h)	Y(h)	y(h)	Adj. %	Case Wt.
0 - 2,000,000*	314	59	5.3	0.6528	641,668	780,862	-17.8%	4.4
2,000,001 - 8,000,000	133	78	1.7	0.2765	4,127,757	4,176,326	-1.2%	1.7
> 8,000,000	34	29	1.2	0.0707	13,210,931	13,194,071	0.1%	1.2
Total	481	166	2.9	1.0000	2,494,069	2,597,173	-4.0%	2.8

Table 24 – Schedules 10 & 31: Post-Stratification

Five existing Schedule 40 device locations are going to be served under Schedule 31. The final estimate of hourly load shape has been produced by adding the sum of hourly loads metered at those 5 locations to the class hourly load shape estimated for the existing Schedule 10 & 31 device locations.

In the next step, the average loss factor estimated for the primary voltage general service class was applied to the hourly expansions to produce the class hourly load profile. According to Table 7, the estimated average loss factor for Schedules 10 & 31 is 3.64%.

Finally, the UFE was allocated to the Schedules 10 & 31 in proportion to preliminary estimate of its contribution to the system demand on an hourly basis.

Figure 25 presents the total load for the Schedules 10 & 31 class. The figure displays the EnergyPrint to the left of two-dimensional x-y plot. An overall consistency of the load throughout the year is clearly visible in the EnergyPrint. The Schedules 10 & 31 class peak occurred on Wednesday, January 17, 2018 at 2 PM. The class peak demand was 289.5 MW.
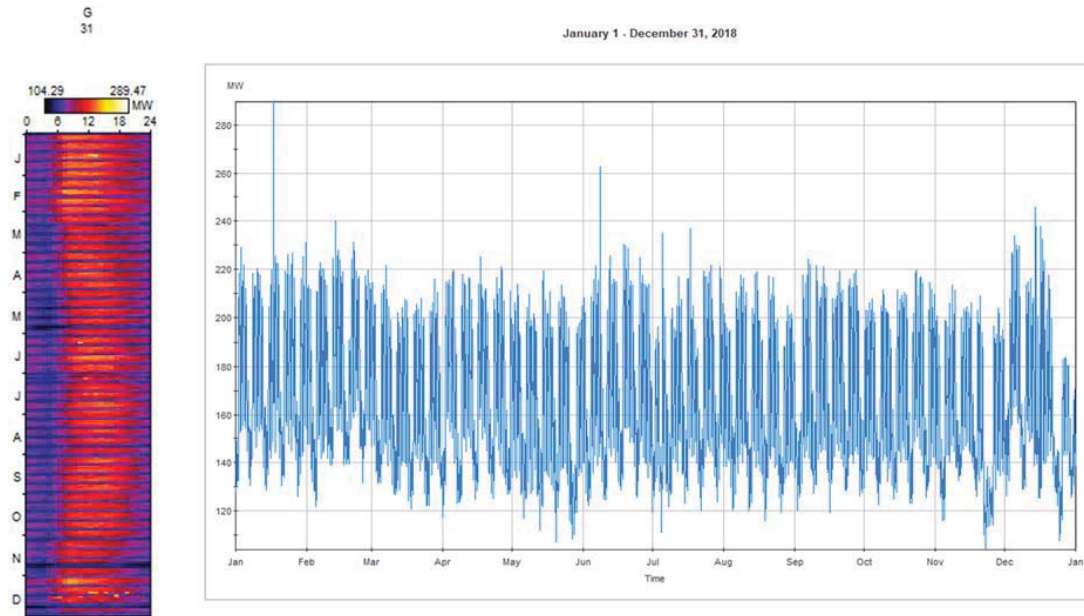
Figure 25 – Schedules 10 & 31 Class Total Load

Figure 26 presents Schedules 10 & 31 class load during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peaked on Friday, February 23, 2018 at hour ending 8 AM. The class had a system peak hour load of 214.7 MW or 74.2% of the January class peak demand of 289.5 MW.
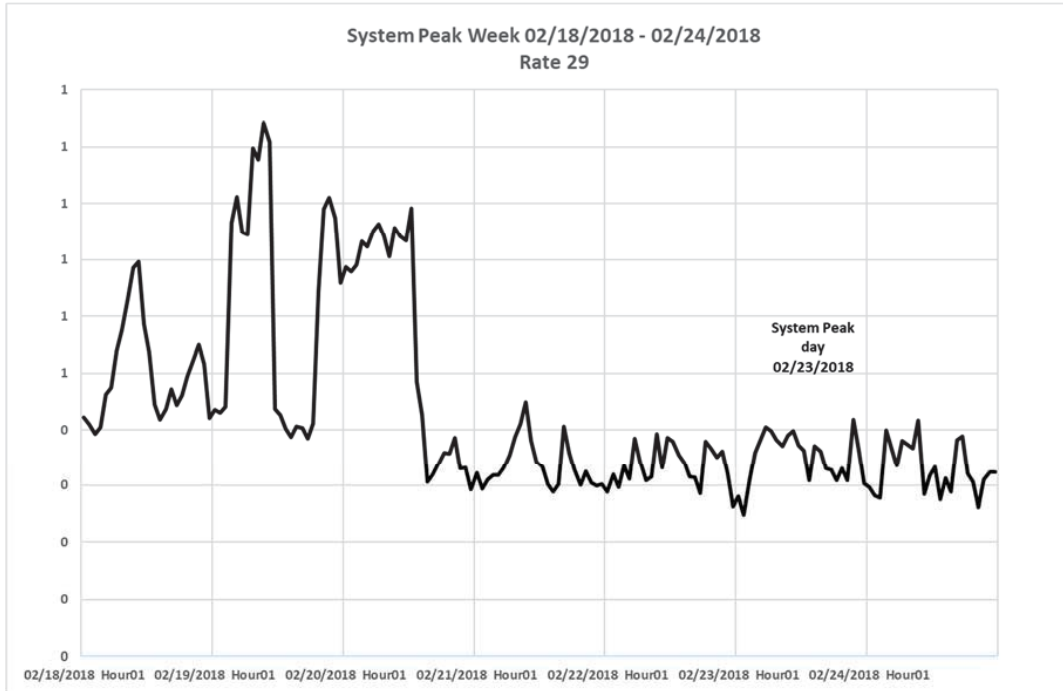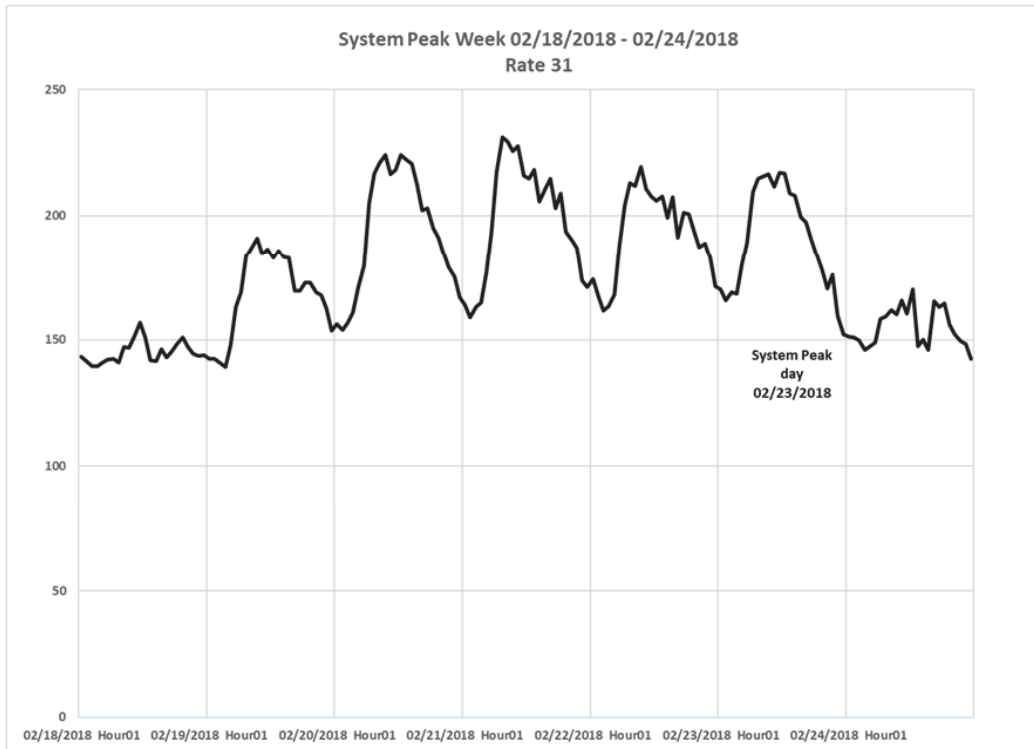
Figure 26 – Schedules 10 & 31: Total Load during System Peak Week

Figure 27 presents the monthly Schedules 10 & 31 class energy consumption, peak demand and load factor in graphics. Except the case of June 2016 when weather was abnormally warm on the annual class peak day, the class load is quite stable month to month and the ranges of fluctuations in monthly energy consumption, peak demand and load factor are fairly narrow.
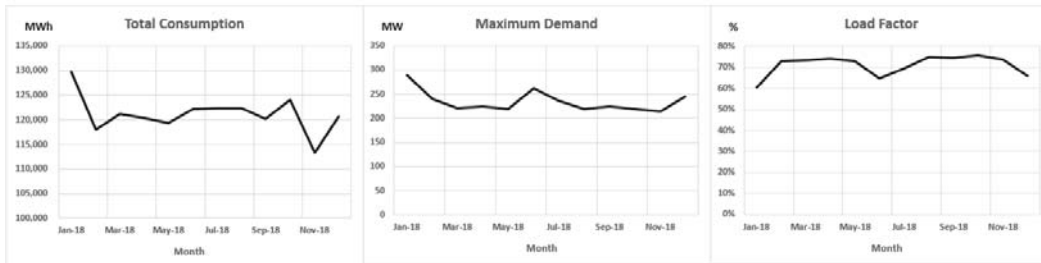
Figure 27 – Schedules 10 & 31: Class Monthly Energy, Demand and Load Factor

Achieved precision of the Large General Service class analysis is reflected in the difference between the sum of the estimated class hourly loads net of losses and the total actual sales to the class in the study period. The sum of estimated hourly loads net of losses was 1,401,225 MWh, 8.0% higher than the actual class sales of 1,297,585 MWh. The percentage of error is less than the maximum error margin of ±10% accepted in a typical load research practice.

Table 25 presents summary statistics for the Schedules 10 & 31 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. Monthly NCP load factors range from a low of 60.3% in January to a high of 75.9% in October. The Schedules 10 & 31 load is fairly coincident with the system peak displaying a system peak coincidence factor of over 80% for 10 of the 12 months.

	Monthly Energy Use	Class Peak Demand					Class Demand at System Peak Hour			
Month	(kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	129,854,121	Wednesday, January 17, 2018	14:00	289,468	174,535	60.3%	Tuesday, January 02, 2018	18:00	193,014	66.7%
Feb-18	118,003,920	Tuesday, February 13, 2018	08:00	240,007	175,601	73.2%	Friday, February 23, 2018	08:00	214,695	89.5%
Mar-18	121,143,256	Wednesday, March 07, 2018	10:00	221,571	162,827	73.5%	Wednesday, March 07, 2018	08:00	202,112	91.2%
Apr-18	120,319,257	Tuesday, April 17, 2018	10:00	225,097	167,110	74.2%	Monday, April 02, 2018	08:00	207,666	92.3%
May-18	119,410,813	Monday, May 14, 2018	14:00	219,365	160,498	73.2%	Monday, May 14, 2018	18:00	196,914	89.8%
Jun-18	122,296,597	Friday, June 08, 2018	10:00	262,544	169,856	64.7%	Wednesday, June 20, 2018	18:00	200,795	76.5%
Jul-18	122,346,319	Tuesday, July 17, 2018	13:00	236,778	164,444	69.5%	Monday, July 30, 2018	18:00	195,859	82.7%
Aug-18	122,396,631	Wednesday, August 15, 2018	14:00	219,039	164,512	75.1%	Wednesday, August 08, 2018	18:00	195,866	89.4%
Sep-18	120,241,252	Thursday, September 06, 2018	14:00	224,230	167,002	74.5%	Thursday, September 06, 2018	18:00	203,806	90.9%
Oct-18	124,124,014	Tuesday, October 23, 2018	14:00	219,775	166,833	75.9%	Monday, October 22, 2018	08:00	193,221	87.9%
Nov-18	113,283,703	Thursday, November 08, 2018	09:00	213,543	157,338	73.7%	Monday, November 19, 2018	08:00	193,183	90.5%
Dec-18	120,736,689	Friday, December 14, 2018	14:00	245,962	162,280	66.0%	Thursday, December 06, 2018	08:00	218,487	88.8%
Annual	1,454,156,572	Annual Class Peak		289,468	166,000	57.3%	Annual System Peak		214,695	74.2%
		Average 12 Monthly NCPs		234,781		70.7%	Average 12 Monthly CPs		201,301	85.7%
		Average Top 12 NCPs		245,292		67.7%	Average Top 12 CPs		218,845	89.2%
		Average Top 75 NCPs		229,270		72.4%	Average Top 75 CPs		207,465	90.5%
		Average Top 200 NCPs		222,948		74.5%	Average Top 200 CPs		197,738	88.7%
							Average 4CPs *		204,845	

* Monthly CPs for November, December, January and February

Table 25 – Schedules 10 & 31 Class: Summary Statistics (Totals – kW)

Table 26 presents the data on an average-per-customer basis. For a Schedules 10 & 31, the average use per customer is 2,986,909 kWh with a peak demand of 594.39 kW.

	Monthly Energy Use	Class Peak Demand					Class Demand at System Peak Hour			
Month	(kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	266,641	Wednesday, January 17, 2018	14:00	594.39	358.39	60.3%	Tuesday, January 02, 2018	18:00	396.33	66.7%
Feb-18	242,806	Tuesday, February 13, 2018	08:00	493.84	361.32	73.2%	Friday, February 23, 2018	08:00	441.76	89.5%
Mar-18	249,780	Wednesday, March 07, 2018	10:00	456.85	335.73	73.5%	Wednesday, March 07, 2018	08:00	416.72	91.2%
Apr-18	246,556	Tuesday, April 17, 2018	10:00	461.26	342.44	74.2%	Monday, April 02, 2018	08:00	425.55	92.3%
May-18	245,197	Monday, May 14, 2018	14:00	450.44	329.57	73.2%	Monday, May 14, 2018	18:00	404.34	89.8%
Jun-18	251,639	Friday, June 08, 2018	10:00	540.21	349.50	64.7%	Wednesday, June 20, 2018	18:00	413.16	76.5%
Jul-18	249,686	Tuesday, July 17, 2018	13:00	483.22	335.60	69.5%	Monday, July 30, 2018	18:00	399.71	82.7%
Aug-18	251,328	Wednesday, August 15, 2018	14:00	449.77	337.81	75.1%	Wednesday, August 08, 2018	18:00	402.19	89.4%
Sep-18	247,920	Thursday, September 06, 2018	14:00	462.33	344.33	74.5%	Thursday, September 06, 2018	18:00	420.22	90.9%
Oct-18	253,832	Tuesday, October 23, 2018	14:00	449.44	341.17	75.9%	Monday, October 22, 2018	08:00	395.13	87.9%
Nov-18	233,094	Thursday, November 08, 2018	09:00	439.39	323.74	73.7%	Monday, November 19, 2018	08:00	397.50	90.5%
Dec-18	248,429	Friday, December 14, 2018	14:00	506.09	333.91	66.0%	Thursday, December 06, 2018	08:00	449.56	88.8%
Annual	2,986,909	Annual Class Peak		594.39	340.97	57.4%	Annual System CP		441.76	74.3%

Table 26 – Schedules 10 & 31 Customer: Summary Statistics (Means – kW)

3.9 Schedule 35 Primary Seasonal Irrigation

Since there is only one customer in this rate class, the Schedule 35 Primary Seasonal Irrigation class hourly loads were determined on the basis of the actual 15-minute interval data collected for this customer. In the next step, the average loss factor estimated for the primary voltage seasonal irrigation service was applied to the hourly loads. The estimated average loss factor is 3.58%, according to Table 7.

Figure 28 presents the total load for the Schedule 35 class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. The dominance of the summer seasonal load is obvious. The Schedule 35 class peak occurred on Saturday, July 21, 2018 at 3 PM. The class peak demand was 1.551 MW.
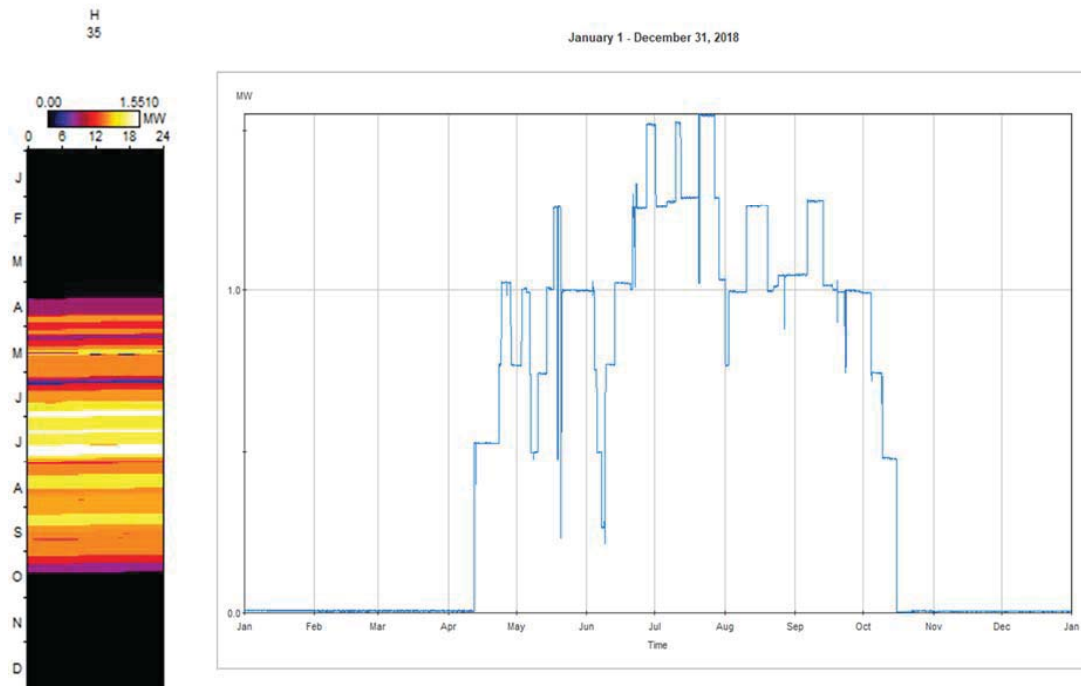
Figure 28 – Schedule 35: Class Total Load

There was almost no demand during the system peak week of February 18 – February 24, 2018.

Figure 29 presents the monthly Schedule 35 class energy consumption, peak demand and load factor in graphics. As shown in the graphs, Schedule 35 load is highly summer seasonal with virtually no load during the winter period.
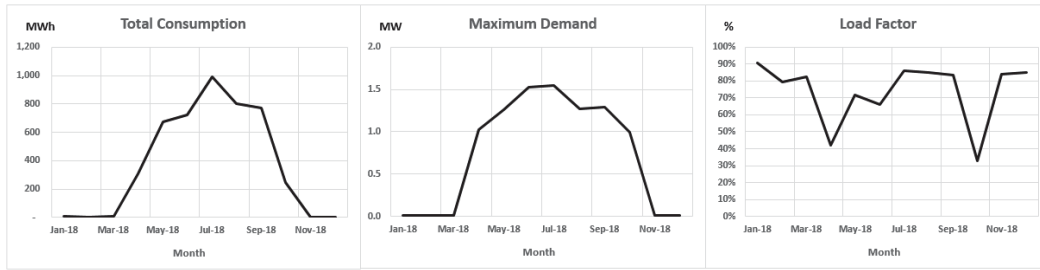
Figure 29 – Schedule 35: Class Monthly Energy, Demand and Load Factors

The achieved precision was perfect since the data for the entire Schedule 35 class was available for the full twelve-month period examined.

Table 27 presents summary statistics for the Schedule 35 class. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. The class displays virtually no load in the winter months.

Month	Monthly Energy Use (kWh)	Class Peak Demand					Class Demand at System Peak Hour			
		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	5,873	Monday, January 01, 2018	02:00	9	8	90.6%	Tuesday, January 02, 2018	18:00	8	92.9%
Feb-18	4,305	Thursday, February 01, 2018	01:00	8	6	79.2%	Friday, February 23, 2018	08:00	6	76.9%
Mar-18	4,966	Thursday, March 01, 2018	01:00	8	7	82.5%	Wednesday, March 07, 2018	08:00	7	84.6%
Apr-18	310,235	Tuesday, April 24, 2018	08:00	1,026	431	42.0%	Monday, April 02, 2018	08:00	7	0.7%
May-18	674,293	Saturday, May 19, 2018	09:00	1,262	906	71.8%	Monday, May 14, 2018	18:00	1,006	79.7%
Jun-18	721,673	Thursday, June 28, 2018	05:00	1,522	1,002	65.9%	Wednesday, June 20, 2018	18:00	1,001	65.8%
Jul-18	994,695	Saturday, July 21, 2018	03:00	1,551	1,337	86.2%	Monday, July 30, 2018	18:00	1,031	66.5%
Aug-18	803,391	Friday, August 17, 2018	04:00	1,268	1,080	85.2%	Wednesday, August 08, 2018	18:00	993	78.4%
Sep-18	773,234	Thursday, September 06, 2018	08:00	1,286	1,074	83.5%	Thursday, September 06, 2018	18:00	1,279	99.5%
Oct-18	243,728	Monday, October 01, 2018	09:00	994	328	32.9%	Monday, October 22, 2018	08:00	4	0.4%
Nov-18	4,522	Thursday, November 01, 2018	02:00	7	6	84.1%	Monday, November 19, 2018	08:00	7	91.7%
Dec-18	4,732	Sunday, December 02, 2018	03:00	7	6	85.2%	Thursday, December 06, 2018	08:00	7	91.7%
Annual	4,545,647	Annual Class Peak		1,551	519	33.5%	Annual System Peak		6	0.4%
		Average 12 Monthly NCPs		746		69.6%	Average 12 Monthly CPs		446	59.9%
		Average Top 12 NCPs		1,550		33.5%	Average Top 12 CPs		6	0.4%
		Average Top 75 NCPs		1,548		33.5%	Average Top 75 CPs		7	0.4%
		Average Top 200 NCPs		1,542		33.6%	Average Top 200 CPs		7	0.4%
							Average 4CPs *		7	

* Monthly CPs for November, December, January and February

Table 27 – Schedule 35 Class: Summary Statistics (Totals – kW)

Since only one customer is served under the Primary Seasonal Irrigation class, no summary table is presented on a per-customer basis.

3.10 Schedule 43 Interruptible Primary Service for Electric Schools

The historical sample data was expanded to the population level by post-stratifying the data available for the Schedule 43 Interruptible Primary Service for Electric Schools class. Table 28 presents the post-stratification used in the sample expansion analysis.

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	W(h)	Y(h)	y(h)	Adj. %	Case Wt.
0 - 1,000,000*	129	38	3.4	0.8377	521,965	558,141	-6.5%	3.2
> 1,000,000	25	19	1.3	0.1623	1,848,798	2,026,940	-8.8%	1.2
Total	154	57	2.7	1.0000	737,360	796,583	-7.4%	2.5

Table 28 – Schedule 43: Post-Stratification

In the second step, the average loss factor estimated for Schedule 43 was applied to the hourly expansion. As stated in Table 7, the estimated average loss factor is 3.70%.

Figure 30 presents the total load for the Schedule 43 class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. The dominance of the winter seasonal load and the summer shut-down of schools are clearly evident. The Schedule 43 class peak occurred on Monday, February 13, 2018 at 8 AM. The class peak demand was 62.7 MW.
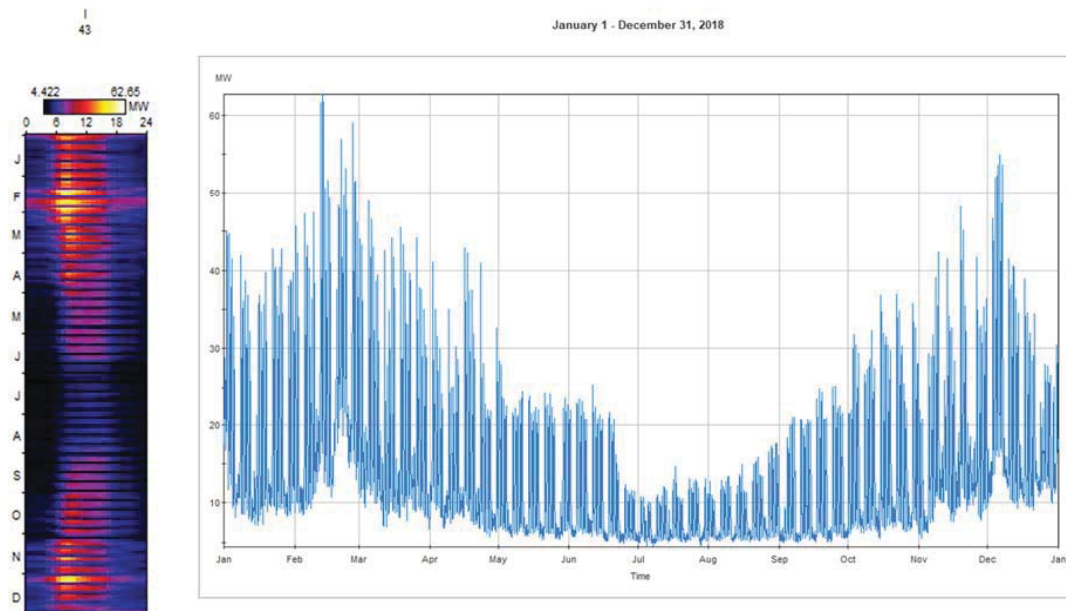
Figure 30 – Schedule 43: Class Total Load

Figure 31 presents the total Schedule 43 load during the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peak demand occurred at 8 PM on Friday, February 23, 2018. The class had a system peak hour load of 52.6 MW or 84.0% of the class peak demand of 62.7 MW occurred at 8 AM on February 13.
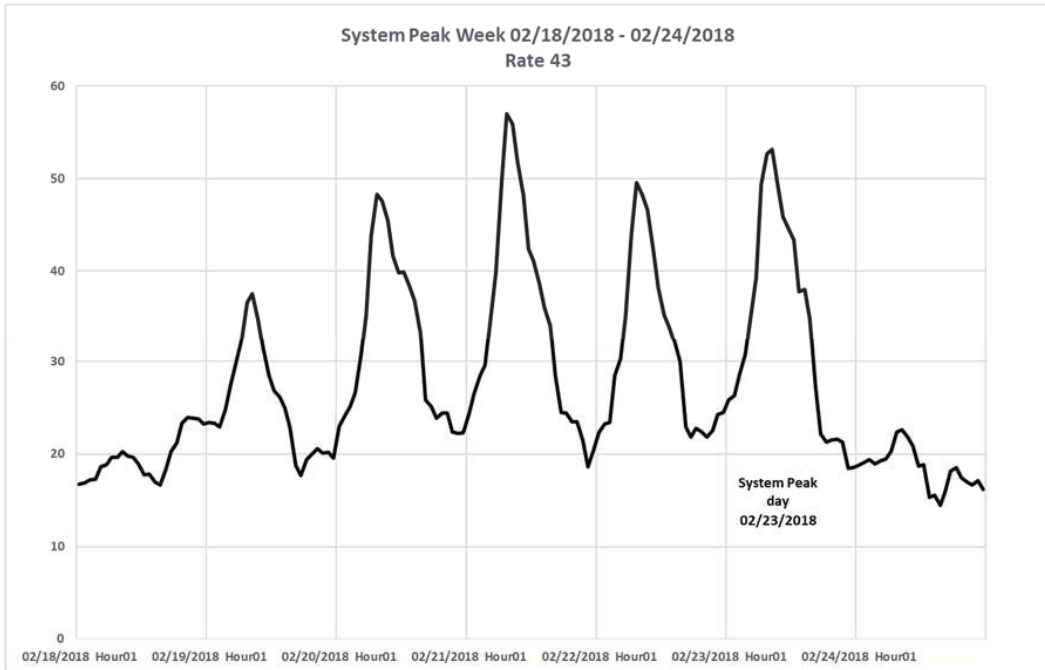
Figure 31 – Schedule 43: Total Load during System Peak Week

Figure 32 presents the monthly Schedule 43 class energy consumption, peak demand and load factor in graphics. As shown in the graphs, the Interruptible Primary Service load of all-electric schools is highly seasonal with electric space-heating load in the winter months. The loads in July and August are substantially lower, reflecting the annual summer break at schools.
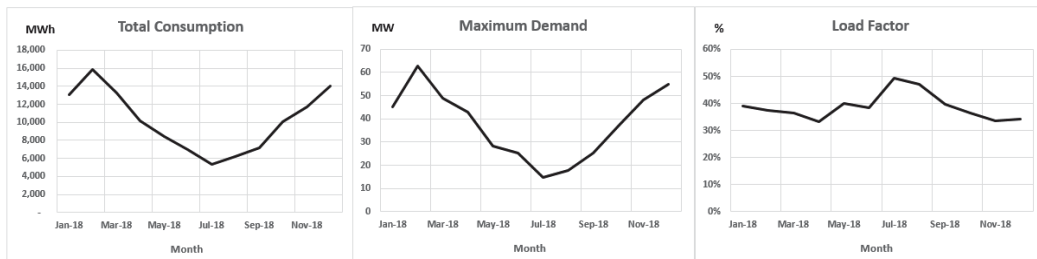
Figure 32 – Schedule 43: Class Monthly Energy, Demand and Load Factor

Achieved precision of the Interruptible Primary Service class analysis can be evaluated in terms of the difference between the sum of the estimated class hourly loads net of losses for the study period and the total actual sales to the class in the same period. The sum of estimated hourly loads net of losses was 117,821 MWh, 1.6% lower than the actual class sales of 119,697 MWh. The percentage of error is substantially lower than the maximum tolerable error margin of ±10% allowed in a typical load research practice.

Table 29 presents summary statistics for the Schedule 43 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. The monthly NCP load factor tends to be low and ranges from a low of 33.1% in April to a high of 49.4% in July. Due to summer and winter breaks at schools, the system coincidence factors fluctuate from 36.9% to 100.0%

		Class Peak Demand					Class Demand at System Peak Hour			
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	13,067,264	Tuesday, January 02, 2018	08:00	45,049	17,564	39.0%	Tuesday, January 02, 2018	18:00	19,555	43.4%
Feb-18	15,825,219	Tuesday, February 13, 2018	08:00	62,653	23,549	37.6%	Friday, February 23, 2018	08:00	52,646	84.0%
Mar-18	13,274,215	Monday, March 05, 2018	09:00	48,919	17,842	36.5%	Wednesday, March 07, 2018	08:00	42,140	86.1%
Apr-18	10,218,774	Monday, April 16, 2018	08:00	42,849	14,193	33.1%	Monday, April 02, 2018	08:00	41,019	95.7%
May-18	8,428,818	Tuesday, May 01, 2018	09:00	28,355	11,329	40.0%	Monday, May 14, 2018	18:00	11,914	42.0%
Jun-18	7,017,949	Monday, June 11, 2018	08:00	25,311	9,747	38.5%	Wednesday, June 20, 2018	18:00	9,341	36.9%
Jul-18	5,373,037	Tuesday, July 17, 2018	13:00	14,633	7,222	49.4%	Monday, July 30, 2018	18:00	8,033	54.9%
Aug-18	6,194,788	Thursday, August 30, 2018	12:00	17,623	8,326	47.2%	Wednesday, August 08, 2018	18:00	8,346	47.4%
Sep-18	7,200,873	Tuesday, September 25, 2018	09:00	25,150	10,001	39.8%	Thursday, September 06, 2018	18:00	9,627	38.3%
Oct-18	10,042,676	Monday, October 22, 2018	08:00	36,987	13,498	36.5%	Monday, October 22, 2018	08:00	36,987	100.0%
Nov-18	11,676,276	Monday, November 19, 2018	08:00	48,161	16,217	33.7%	Monday, November 19, 2018	08:00	48,161	100.0%
Dec-18	14,027,804	Thursday, December 06, 2018	09:00	54,873	18,855	34.4%	Thursday, December 06, 2018	08:00	53,323	97.2%
Annual	122,347,692	Annual Class Peak		62,653	13,967	22.3%	Annual System Peak		52,646	84.0%
		Average 12 Monthly NCPs		37,547		37.2%	Average 12 Monthly CPs		28,424	75.7%
		Average Top 12 NCPs		57,795		24.2%	Average Top 12 CPs		48,496	83.9%
		Average Top 75 NCPs		49,801		28.0%	Average Top 75 CPs		38,310	76.9%
		Average Top 200 NCPs		44,529		31.4%	Average Top 200 CPs		32,008	71.9%
							Average 4CPs *		43,421	

* Monthly CPs for November, December, January and February

Table 29 – Schedule 43 Class: Summary Statistics (Totals – kW)

Table 30 presents the data on an average-per-customer basis. The average use per customer for Schedule 43 is estimated to be 790,638 kWh with a peak demand of 401.62 kW.

		Class Peak Demand					Class Demand at System Peak Hour			
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	83,231	Tuesday, January 02, 2018	08:00	286.93	111.87	39.0%	Tuesday, January 02, 2018	18:00	124.55	43.4%
Feb-18	101,444	Tuesday, February 13, 2018	08:00	401.62	150.96	37.6%	Friday, February 23, 2018	08:00	337.47	84.0%
Mar-18	85,091	Monday, March 05, 2018	09:00	313.58	114.37	36.5%	Wednesday, March 07, 2018	08:00	270.13	86.1%
Apr-18	65,928	Monday, April 16, 2018	08:00	276.45	91.57	33.1%	Monday, April 02, 2018	08:00	264.64	95.7%
May-18	54,379	Tuesday, May 01, 2018	09:00	182.94	73.09	40.0%	Monday, May 14, 2018	18:00	76.86	42.0%
Jun-18	45,277	Monday, June 11, 2018	08:00	163.29	62.88	38.5%	Wednesday, June 20, 2018	18:00	60.26	36.9%
Jul-18	34,665	Tuesday, July 17, 2018	13:00	94.41	46.59	49.4%	Monday, July 30, 2018	18:00	51.83	54.9%
Aug-18	40,226	Thursday, August 30, 2018	12:00	114.43	54.07	47.2%	Wednesday, August 08, 2018	18:00	54.19	47.4%
Sep-18	46,759	Tuesday, September 25, 2018	09:00	163.31	64.94	39.8%	Thursday, September 06, 2018	18:00	62.51	38.3%
Oct-18	65,638	Monday, October 22, 2018	08:00	241.75	88.22	36.5%	Monday, October 22, 2018	08:00	241.75	100.0%
Nov-18	76,316	Monday, November 19, 2018	08:00	314.77	105.99	33.7%	Monday, November 19, 2018	08:00	314.77	100.0%
Dec-18	91,685	Thursday, December 06, 2018	09:00	358.65	123.23	34.4%	Thursday, December 06, 2018	08:00	348.51	97.2%
Annual	790,638	Annual Class Peak		401.62	90.26	22.5%	Annual System CP		337.47	84.0%

Table 30 – Schedule 43 Customer: Summary Statistics (Means – kW)

3.11 Schedule 46 High Voltage Interruptible Service

Since the 15-minute interval load data are available for all of the loads on Schedule 46, the Schedule 46 High Voltage Interruptible Service class hourly loads were calculated on the basis of the actual interval load data collected for population. Finally, the average loss factor estimated for the high voltage interruptible service was applied to the hourly loads. Table 7 shows that the estimated average loss factor is 1.77%.

Figure 33 presents the total load for the Schedule 46 class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. No significant seasonality is observed with this class load. The Schedule 46 class peak occurred on Friday, June 1, 2018 at 10 AM. The class peak demand was 23.5 MW.

Figure 33 – Schedule 46: Class Total Load

Figure 34 presents the total Schedule 46 class load for the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The class had a system peak hour load of 14.3 MW, or 60.8% of the June class peak demand of 23.5 MW.
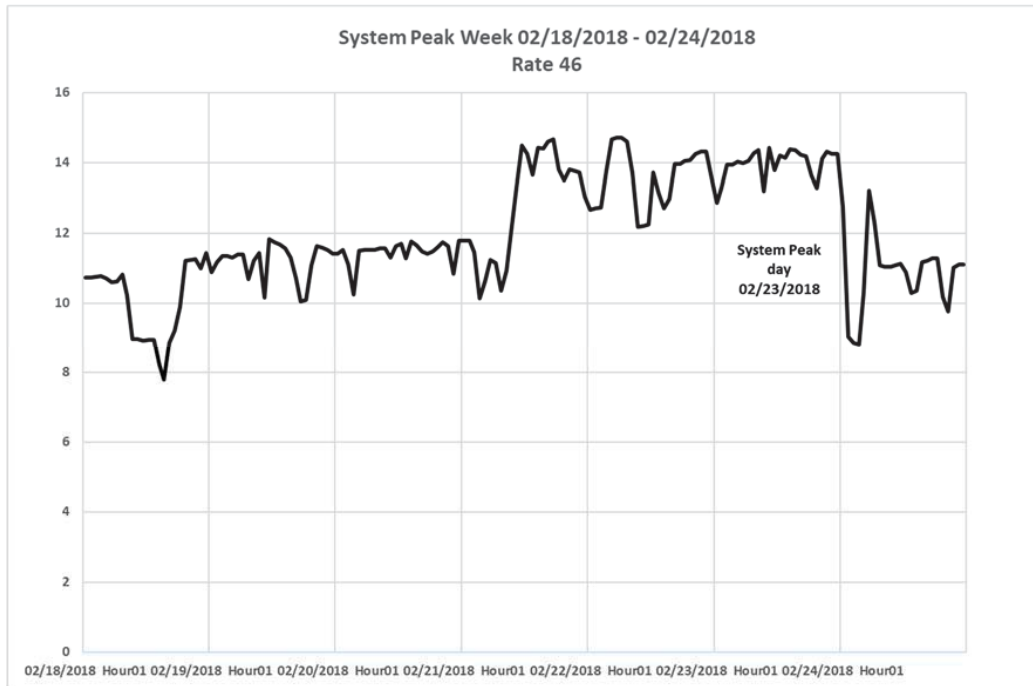
Figure 34 – Schedule 46: Total Load during System Peak Week

Figure 35 shows the monthly energy consumption, peak demand and load factor of the Schedule 46 class in graphics. As illustrated in the graphs, the interruptible high voltage service load of Schedule 46 tends to have monthly class peak demand fluctuate from 13.8 MW in April to 23.5 MW in June.
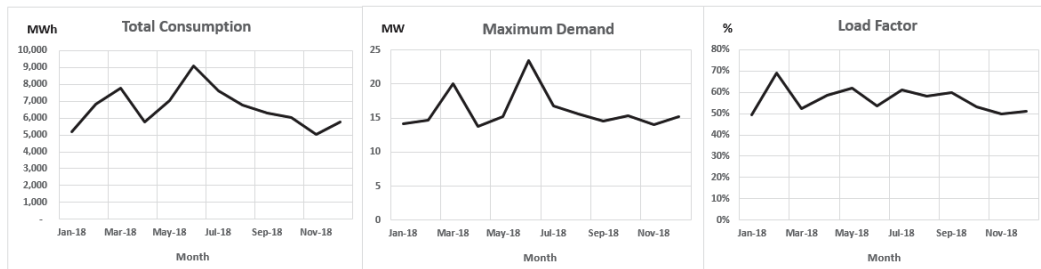
Figure 35 – Schedule 46: Class Monthly Energy, Demand and Load Factor

The achieved precision is expected to be perfect since the interval load data for all of the customers in this rate class were available for the full twelve-month period examined.

Table 31 presents summary statistics for the Schedule 46 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and

4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. The class displays some volatility in its monthly energy use and peak demand. The monthly class load factors range from a low of 49.6% in January to a high of 69.1% in February. The load is rarely coincident with the system peak with a coincidence factor over 70% for only 3 of the 12 months.

Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
				Class Peak Demand					Class Demand at System Peak Hour	
Jan-18	5,214,429	Wednesday, January 31, 2018	16:00	14,126	7,009	49.6%	Tuesday, January 02, 2018	18:00	6,440	45.6%
Feb-18	6,834,765	Thursday, February 22, 2018	07:00	14,714	10,171	69.1%	Friday, February 23, 2018	08:00	14,277	97.0%
Mar-18	7,777,853	Thursday, March 15, 2018	12:00	20,031	10,454	52.2%	Wednesday, March 07, 2018	08:00	9,619	48.0%
Apr-18	5,786,605	Saturday, April 28, 2018	01:00	13,764	8,037	58.4%	Monday, April 02, 2018	08:00	8,922	64.8%
May-18	7,016,013	Thursday, May 31, 2018	14:00	15,177	9,430	62.1%	Monday, May 14, 2018	18:00	5,104	33.6%
Jun-18	9,088,375	Friday, June 01, 2018	10:00	23,483	12,623	53.8%	Wednesday, June 20, 2018	18:00	15,966	68.0%
Jul-18	7,636,594	Thursday, July 19, 2018	02:00	16,746	10,264	61.3%	Monday, July 30, 2018	18:00	11,043	65.9%
Aug-18	6,768,867	Friday, August 24, 2018	13:00	15,625	9,098	58.2%	Wednesday, August 08, 2018	18:00	9,217	59.0%
Sep-18	6,286,494	Friday, September 07, 2018	20:00	14,578	8,731	59.9%	Thursday, September 06, 2018	18:00	13,747	94.3%
Oct-18	6,047,538	Tuesday, October 16, 2018	10:00	15,283	8,128	53.2%	Monday, October 22, 2018	08:00	5,062	33.1%
Nov-18	5,039,305	Friday, November 30, 2018	11:00	14,026	6,999	49.9%	Monday, November 19, 2018	08:00	7,442	53.1%
Dec-18	5,772,476	Saturday, December 01, 2018	03:00	15,171	7,759	51.1%	Thursday, December 06, 2018	08:00	11,430	75.3%
Annual	79,269,313	Annual Class Peak		23,483	9,049	38.5%	Annual System Peak		14,277	60.8%
		Average 12 Monthly NCPs		16,060		56.3%	Average 12 Monthly CPs		9,856	61.4%
		Average Top 12 NCPs		22,359		40.5%	Average Top 12 CPs		11,338	50.7%
		Average Top 75 NCPs		19,872		45.5%	Average Top 75 CPs		11,099	55.9%
		Average Top 200 NCPs		17,754		51.0%	Average Top 200 CPs		10,130	57.1%
							Average 4CPs *		9,897	

* Monthly CPs for November, December, January and February

Table 31 – Schedule 46 Class: Summary Statistics (Totals – kW)

Since only six customers are served under the Interruptible High Voltage Service rate, no summary table is presented on a per-customer basis.

3.12 Schedule 49 High Voltage General Service

Since all of the customers in the High Voltage General Service class are metered with interval load readings, the entire load data for the class was used for the class hourly load profiling. The average loss factor estimated for the class was applied to the hourly loads. Table 7 shows that the estimated average loss factor is 1.76%.

Figure 36 presents the results for the Schedule 49 class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. The Schedule 49 class peak occurred on Thursday, July 26, 2018 at 1 PM. The class peak demand was 83.6 MW. While mid-summer loads tend to be slightly higher than the loads in other months, no seasonality was apparent.
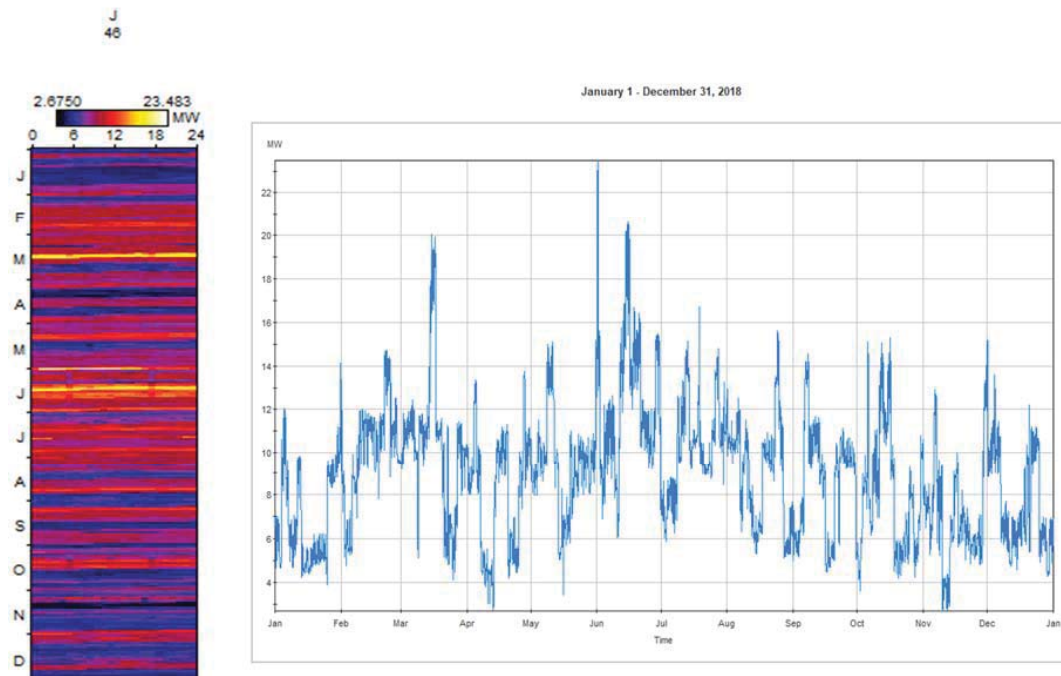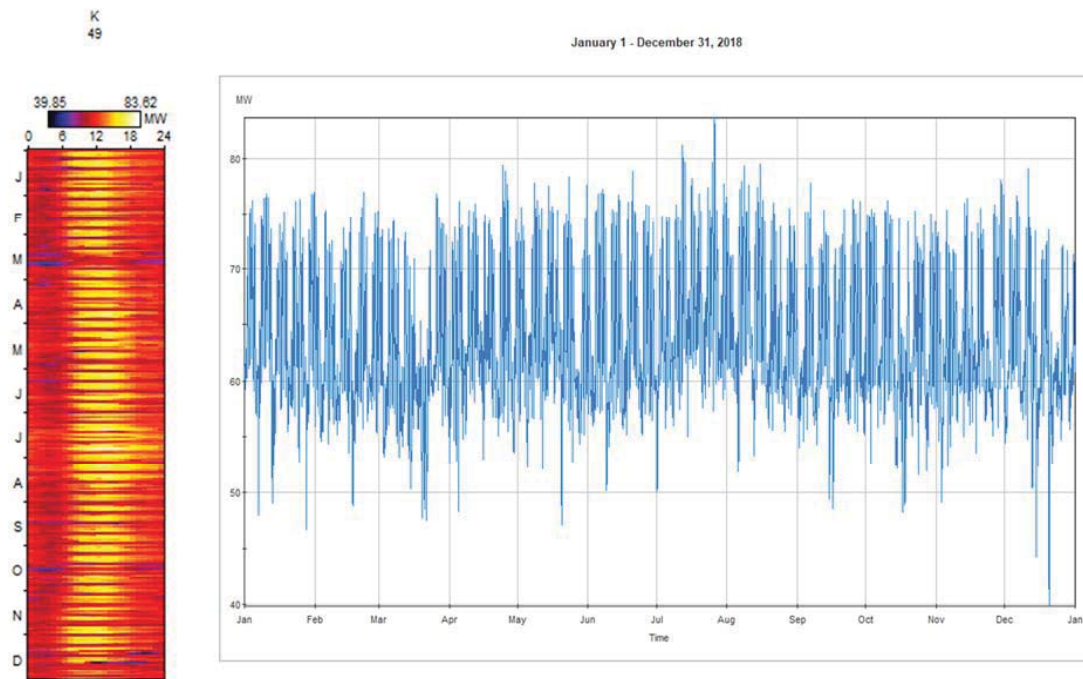

Figure 36 – Schedule 49: Class Total Load

Figure 37 presents the total Schedule 49 class load for the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The class had a system peak hour load of 69.4 MW or 83.0% of the July class peak demand of 83.6 MW.
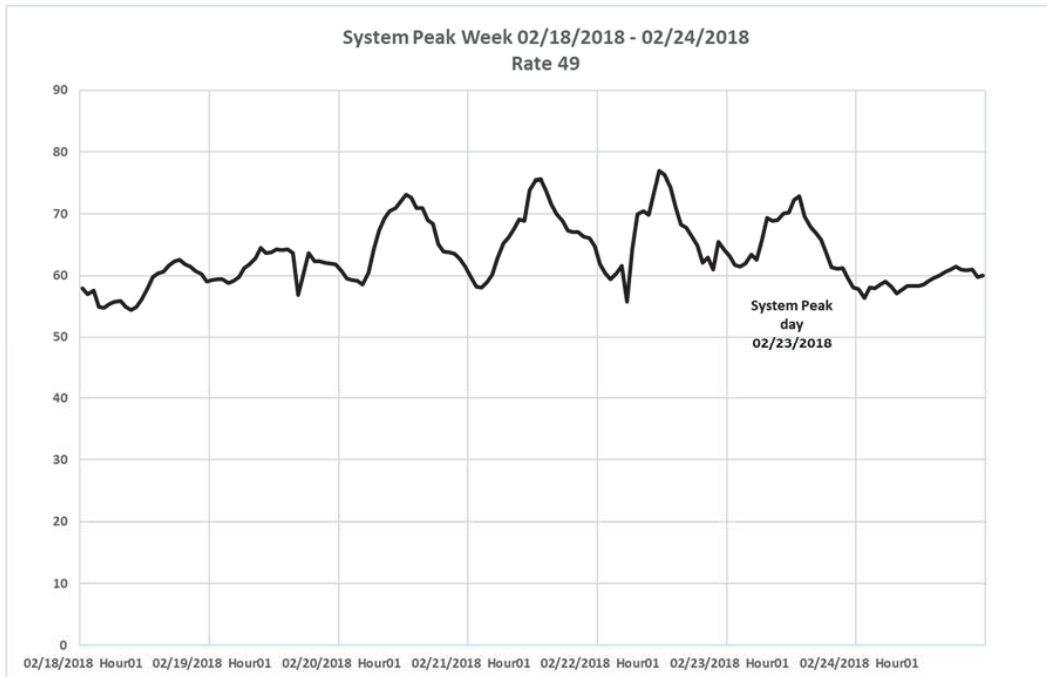
Figure 37 – Schedule 49: Total Load during System Peak Week

Figure 38 presents the monthly energy consumption, peak demand and load factors of the Schedule 49 class in charts. As shown in the charts, the High Voltage General Service loads were stable throughout the year and the percentage difference between the highest monthly peak of 83.6 MW and the lowest monthly peak load of 76.2 MW was only 8.9%.

Figure 38 – Schedule 49: Class Monthly Energy, Demand and Load Factor

The achieved precision for this class was perfect since the interval load data for all of the customers in this rate class were available for the full twelve-month period examined.

Table 32 presents summary statistics for the Schedule 49 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class

peaks and the class loads at the top 12, 75 and 200 system peak hours. The monthly class NCP load factors are high and stable, ranging from a low of 78.8% in December to a high of 83.5% in January. The load is highly coincident with the system peak with a coincidence factor over 83% for all of the 12 months.

Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	47,807,448	Wednesday, January 31, 2018	13:00	76,951	64,257	83.5%	Tuesday, January 02, 2018	18:00	64,001	83.2%
Feb-18	42,377,245	Thursday, February 22, 2018	12:00	76,956	63,061	81.9%	Friday, February 23, 2018	08:00	69,414	90.2%
Mar-18	45,844,061	Monday, March 26, 2018	12:00	76,794	61,618	80.2%	Wednesday, March 07, 2018	08:00	68,598	89.3%
Apr-18	46,152,692	Tuesday, April 24, 2018	14:00	79,357	64,101	80.8%	Monday, April 02, 2018	08:00	71,485	90.1%
May-18	47,807,303	Wednesday, May 23, 2018	14:00	78,364	64,257	82.0%	Monday, May 14, 2018	18:00	71,800	91.6%
Jun-18	46,114,461	Wednesday, June 20, 2018	11:00	78,857	64,048	81.2%	Wednesday, June 20, 2018	18:00	73,143	92.8%
Jul-18	49,395,998	Thursday, July 26, 2018	13:00	83,617	66,392	79.4%	Monday, July 30, 2018	18:00	71,784	85.8%
Aug-18	48,549,345	Wednesday, August 15, 2018	14:00	79,488	65,254	82.1%	Wednesday, August 08, 2018	18:00	73,607	92.6%
Sep-18	45,588,810	Thursday, September 06, 2018	14:00	77,754	63,318	81.4%	Thursday, September 06, 2018	18:00	70,300	90.4%
Oct-18	47,187,830	Wednesday, October 10, 2018	12:00	76,207	63,425	83.2%	Monday, October 22, 2018	08:00	68,232	89.5%
Nov-18	45,789,374	Thursday, November 29, 2018	13:00	78,040	63,596	81.5%	Monday, November 19, 2018	08:00	72,482	92.9%
Dec-18	46,351,956	Tuesday, December 11, 2018	12:00	79,089	62,301	78.8%	Thursday, December 06, 2018	08:00	72,412	91.6%
Annual	558,966,522	Annual Class Peak		83,617	63,809	76.3%	Annual System Peak		69,414	83.0%
		Average 12 Monthly NCPs		78,456		81.3%	Average 12 Monthly CPs		70,605	90.0%
		Average Top 12 NCPs		80,941		78.8%	Average Top 12 CPs		69,469	85.8%
		Average Top 75 NCPs		78,353		81.4%	Average Top 75 CPs		68,124	86.9%
		Average Top 200 NCPs		76,935		0.0%	Average Top 200 CPs		67,414	87.6%
							Average 4CPs *		69,577	

* Monthly CPs for November, December, January and February

Table 32 – Schedule 49 Class: Summary Statistics (Totals – MW)

Table 30 presents the data on an average-per-customer basis. There were 19 customers under Schedule 49 during the study period. The average use per customer in the class is estimated to be 29,419,291 kWh with a peak demand of 4,401 kW.

Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Timing of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	2,516,181	Wednesday, January 31, 2018	13:00	4,050	3,382	83.5%	Tuesday, January 02, 2018	18:00	3,368	83.2%
Feb-18	2,230,381	Thursday, February 22, 2018	12:00	4,050	3,319	81.9%	Friday, February 23, 2018	08:00	3,653	90.2%
Mar-18	2,412,845	Monday, March 26, 2018	12:00	4,042	3,243	80.2%	Wednesday, March 07, 2018	08:00	3,610	89.3%
Apr-18	2,429,089	Tuesday, April 24, 2018	14:00	4,177	3,374	80.8%	Monday, April 02, 2018	08:00	3,762	90.1%
May-18	2,516,174	Wednesday, May 23, 2018	14:00	4,124	3,382	82.0%	Monday, May 14, 2018	18:00	3,779	91.6%
Jun-18	2,427,077	Wednesday, June 20, 2018	11:00	4,150	3,371	81.2%	Wednesday, June 20, 2018	18:00	3,850	92.8%
Jul-18	2,599,789	Thursday, July 26, 2018	13:00	4,401	3,494	79.4%	Monday, July 30, 2018	18:00	3,778	85.8%
Aug-18	2,555,229	Wednesday, August 15, 2018	14:00	4,184	3,434	82.1%	Wednesday, August 08, 2018	18:00	3,874	92.6%
Sep-18	2,399,411	Thursday, September 06, 2018	14:00	4,092	3,333	81.4%	Thursday, September 06, 2018	18:00	3,700	90.4%
Oct-18	2,483,570	Wednesday, October 10, 2018	12:00	4,011	3,338	83.2%	Monday, October 22, 2018	08:00	3,591	89.5%
Nov-18	2,409,967	Thursday, November 29, 2018	13:00	4,107	3,347	81.5%	Monday, November 19, 2018	08:00	3,815	92.9%
Dec-18	2,439,577	Tuesday, December 11, 2018	12:00	4,163	3,279	78.8%	Thursday, December 06, 2018	08:00	3,811	91.6%
Annual	29,419,291	Annual Class Peak		4,401	3,358	76.3%	Annual System CP		3,653	83.0%

Table 33 – Schedule 49 Customer: Summary Statistics (Means – kW)

3.13 Schedules 50-59 Area and Street Lighting

The Area and Street Lighting hourly load profiles were produced by allocating the energy sales to those customer classes billed during the study period to each day and hour, based on the daily and hourly lighting energy requirements calculated with the lighting fixture and capacity data and the daily sunset and sunrise times. The Street Lighting class energy sales also includes the traffic lighting energy use. The portion of traffic lighting energy use was estimated with the traffic lighting fixture and wattage data for the study period. The estimated annual energy use of traffic lights was separated from the Street Lighting class energy sales and was distributed evenly to all of the hours in the study period. The Street Lighting class hourly load shape was then constructed by aggregating the street and traffic lighting hourly load estimates.

Average loss factor estimated for the Area and Street Lighting classes as combined was applied to the hourly load estimates. The estimated loss factor is 8.02%.

Figure 39 and Figure 40 present the class total load results for the two lighting classes. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. The lighting loads track the nighttime hours. Both the Area Lighting class load and the Street Lighting class load reach their peaks after the sunset and stay at the peak levels during the nighttime hours. The Area Lighting class peak was 1.6 MW, while the Street Lighting class peak was 16.0 MW.
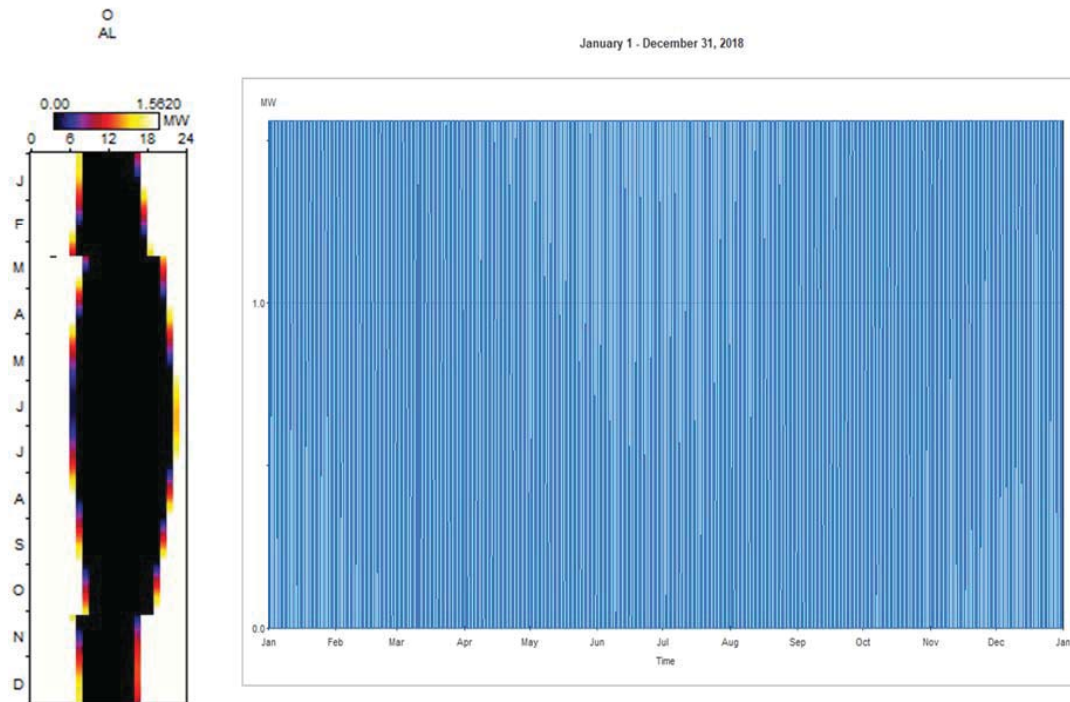
Figure 39 – Area Lighting: Class Total Load

Q
SL

0.00   15.983
                    MW
0   6   12   18   24

January 1 - December 31, 2018
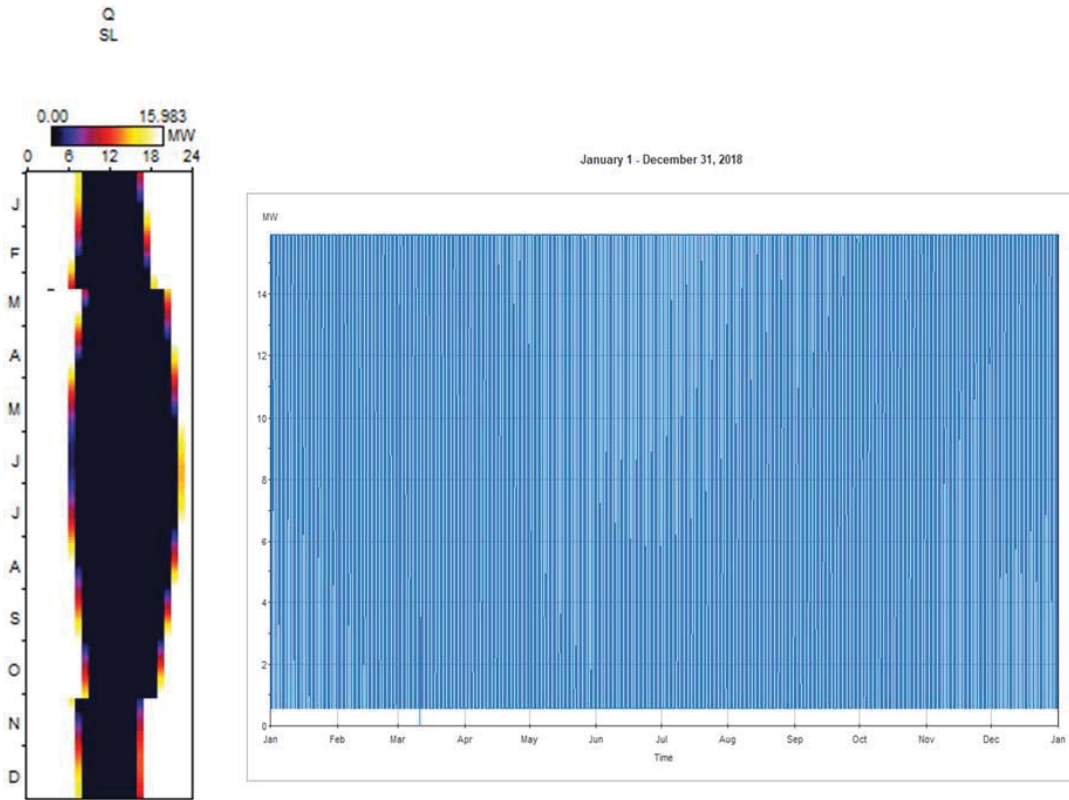
Figure 40 – Street Lighting: Class Total Load

Figure 41 and Figure 42 present the total loads of the lighting classes for the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peak occurred on Friday, February 23, 2018 at 8 AM. The Area Lighting class imposed no load at the time of the system coincident peak and the Street Lighting class reached a system-coincident peak of 556 kW.
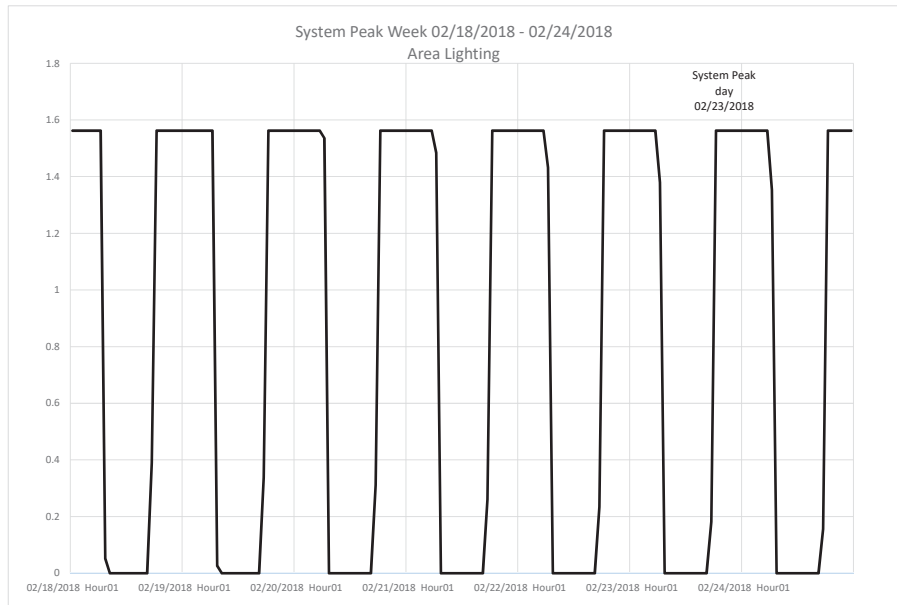
Figure 41 – Area Lighting: Total Load during System Peak Week

Figure 42 – Street Lighting: Total Load during System Peak Week

Figure 43 and Figure 44 present the monthly energy consumption, peak demand and load factors of the lighting classes in charts. As reflected in the monthly energy consumption and maximum demand charts, the lighting classes consume more electricity in the winter months due to a longer lighting period, while the maximum demand stays about the same with the number of lighting fixtures and their wattage requirements changing rarely month to month.
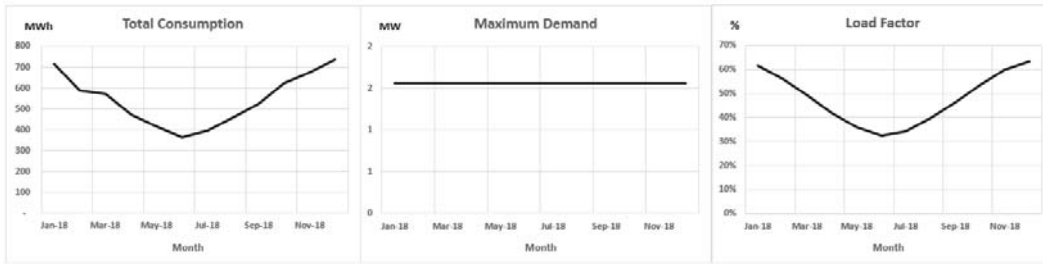
Figure 43 – Area Lighting: Class Monthly Energy, Demand and Load Factor
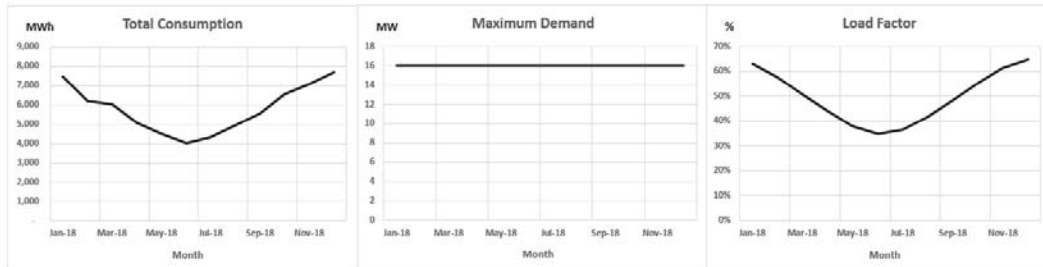
Figure 44 – Street Lighting: Class Monthly Energy, Demand and Load Factor

Table 34 and Table 35 present summary statistics for the lighting classes. Each table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. The lighting class load factors tend to be higher in the winter months reflecting more lighting hours in the winter but the monthly maximum demand staying about the same. Monthly system coincidence factors are 100% in January, over 50% in October and December, about 20% in November, and zero or close to zero for rest of the year.

| | Monthly Energy Use (kWh) | Class Peak Demand | | | | | Class Demand at System Peak Hour | | |
Month		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	716,090	Monday, January 01, 2018	01:00	1,562	962	61.6%	Tuesday, January 02, 2018	18:00	1,562	100.0%
Feb-18	588,868	Thursday, February 01, 2018	01:00	1,562	876	56.1%	Friday, February 23, 2018	08:00	-	0.0%
Mar-18	570,519	Thursday, March 01, 2018	01:00	1,562	767	49.1%	Wednesday, March 07, 2018	08:00	-	0.0%
Apr-18	472,552	Sunday, April 01, 2018	01:00	1,562	656	42.0%	Monday, April 02, 2018	08:00	-	0.0%
May-18	416,047	Tuesday, May 01, 2018	01:00	1,562	559	35.8%	Monday, May 14, 2018	18:00	-	0.0%
Jun-18	366,127	Friday, June 01, 2018	01:00	1,562	509	32.6%	Wednesday, June 20, 2018	18:00	-	0.0%
Jul-18	396,969	Sunday, July 01, 2018	01:00	1,562	534	34.2%	Monday, July 30, 2018	18:00	-	0.0%
Aug-18	460,398	Wednesday, August 01, 2018	01:00	1,562	619	39.6%	Wednesday, August 08, 2018	18:00	-	0.0%
Sep-18	523,202	Saturday, September 01, 2018	01:00	1,562	727	46.5%	Thursday, September 06, 2018	18:00	-	0.0%
Oct-18	623,667	Monday, October 01, 2018	01:00	1,562	838	53.7%	Monday, October 22, 2018	08:00	781	50.0%
Nov-18	675,149	Thursday, November 01, 2018	01:00	1,562	938	60.0%	Monday, November 19, 2018	08:00	312	20.0%
Dec-18	737,094	Saturday, December 01, 2018	01:00	1,562	991	63.4%	Thursday, December 06, 2018	08:00	885	56.7%
Annual	6,546,682	Annual Class Peak		1,562	747	47.9%	Annual System Peak		-	0.0%
		Average 12 Monthly NCPs		1,562		47.9%	Average 12 Monthly CPs		295	18.9%
		Average Top 12 NCPs		1,562		47.9%	Average Top 12 CPs		482	30.8%
		Average Top 75 NCPs		1,562		47.9%	Average Top 75 CPs		740	47.4%
		Average Top 200 NCPs		1,562		47.9%	Average Top 200 CPs		883	56.6%
							Average 4CPs *		690	

* Monthly CPs for November, December, January and February

Table 34 – Area Lighting Class: Summary Statistics (Totals – kW)

Month	Monthly Energy Use (kWh)	Class Peak Demand					Class Demand at System Peak Hour			
		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	7,487,643	Monday, January 01, 2018	01:00	15,983	10,064	63.0%	Tuesday, January 02, 2018	18:00	15,983	100.0%
Feb-18	6,190,843	Thursday, February 01, 2018	01:00	15,983	9,213	57.6%	Friday, February 23, 2018	08:00	556	3.5%
Mar-18	6,049,061	Thursday, March 01, 2018	01:00	15,983	8,130	50.9%	Wednesday, March 07, 2018	08:00	556	3.5%
Apr-18	5,068,503	Sunday, April 01, 2018	01:00	15,983	7,040	44.0%	Monday, April 02, 2018	08:00	556	3.5%
May-18	4,523,660	Tuesday, May 01, 2018	01:00	15,983	6,080	38.0%	Monday, May 14, 2018	18:00	556	3.5%
Jun-18	4,017,173	Friday, June 01, 2018	01:00	15,983	5,579	34.9%	Wednesday, June 20, 2018	18:00	556	3.5%
Jul-18	4,335,197	Sunday, July 01, 2018	01:00	15,983	5,827	36.5%	Monday, July 30, 2018	18:00	556	3.5%
Aug-18	4,961,778	Wednesday, August 01, 2018	01:00	15,983	6,669	41.7%	Wednesday, August 08, 2018	18:00	556	3.5%
Sep-18	5,568,842	Saturday, September 01, 2018	01:00	15,983	7,735	48.4%	Thursday, September 06, 2018	18:00	556	3.5%
Oct-18	6,574,640	Monday, October 01, 2018	01:00	15,983	8,837	55.3%	Monday, October 22, 2018	08:00	8,269	51.7%
Nov-18	7,069,860	Thursday, November 01, 2018	01:00	15,983	9,819	61.4%	Monday, November 19, 2018	08:00	3,641	22.8%
Dec-18	7,695,132	Saturday, December 01, 2018	01:00	15,983	10,343	64.7%	Thursday, December 06, 2018	08:00	9,298	58.2%
Annual	69,542,333	Annual Class Peak		15,983	7,939	49.7%	Annual System Peak		556	3.5%
		Average 12 Monthly NCPs		15,983		49.7%	Average 12 Monthly CPs		3,470	21.7%
		Average Top 12 NCPs		15,983		49.7%	Average Top 12 CPs		5,313	33.2%
		Average Top 75 NCPs		15,983		49.7%	Average Top 75 CPs		7,861	49.2%
		Average Top 200 NCPs		15,983		49.7%	Average Top 200 CPs		9,282	58.1%
							Average 4CPs *		7,370	

* Monthly CPs for November, December, January and February

Table 35 – Street Lighting Class: Summary Statistics (Totals – kW)

4   NON-SYSTEM CLASS LOAD PROFILES

There are four classes that are termed "non-system loads" and are included in the cost-of-service analysis. These classes are considered non-system because they are transportation customers and are not included in PSE's measurement of system load. These classes include:

- Rate 449PV – Retail Wheeling Service Primary Voltage;
- Rate 449HV – Retail Wheeling Service High Voltage;
- Rate 459 – Back-Up Generation; and
- Special Contract – Retail Wheeling and Distribution Service.

4.1 Schedule 449 Primary Voltage Retail Wheeling Service

Since all of the customers under the Schedule 449 Primary Voltage (PV) are metered with interval load readings, the class hourly load profile was constructed by integrating their interval load data. The average loss factor estimated for the class was applied to the hourly loads. As listed in Table 7, the estimated average loss factor is 3.50%.

Figure 45 presents the total load for the Schedule 449PV class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. This class displays a fairly flat load profile with a high load factor, except several cases of abrupt drop in energy usage mostly on seasonal holidays like New Year's, Thanksgiving and Christmas holidays. The Schedule 449PV class peak occurred on Wednesday, June 6, 2018 at 4 PM. The class peak demand was 11.6 MW.
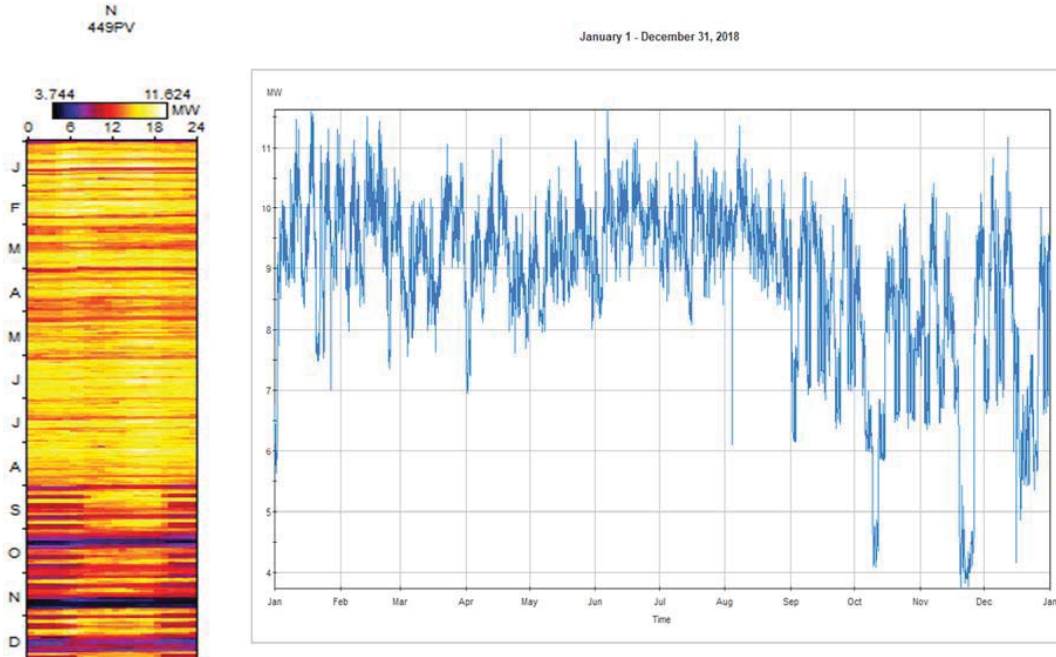
Figure 45 – Schedule 449PV: Class Total Load

Figure 46 presents the total Schedule 449PV class load for the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The class total load was about 8.7 MW at the time of the system coincident peak occurred on February 23, 2018.
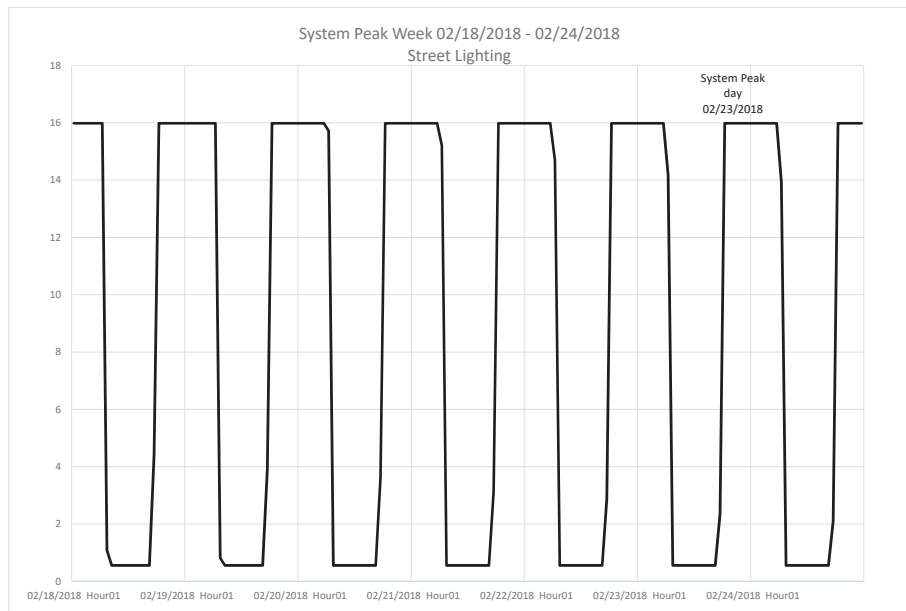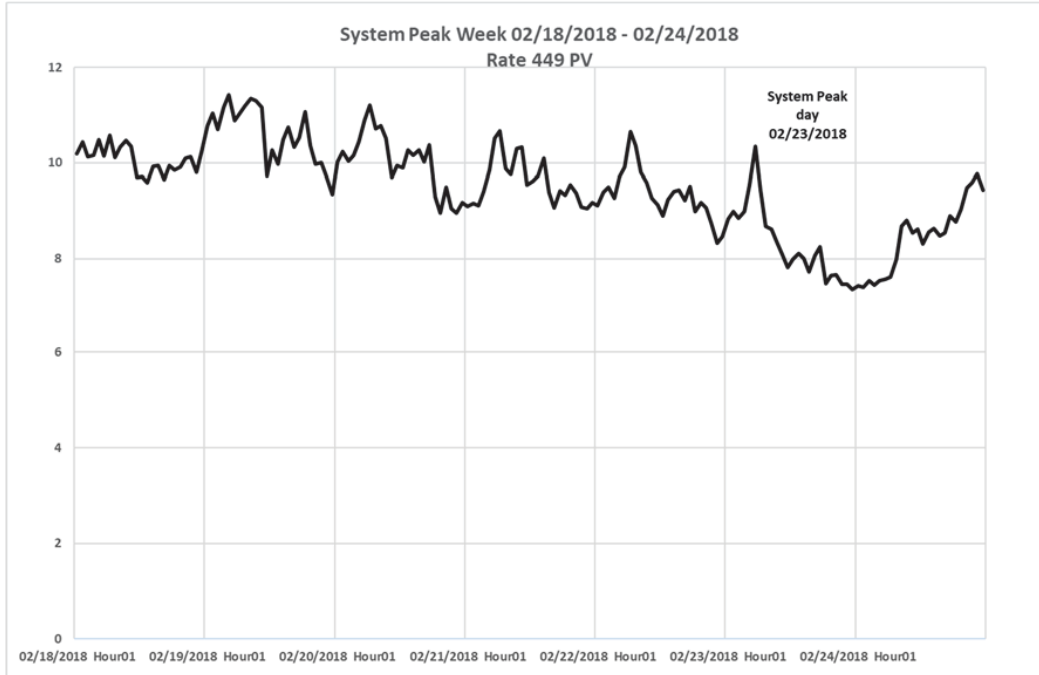

Figure 46 – Schedule 449PV: Total Load during System Peak Week

Figure 47 presents the monthly energy consumption, peak demand and load factor of the Schedule 449-PV class in charts. As reflected in the monthly energy and maximum demand charts, electric energy uses of the retail wheeling primary voltage customers has declined significantly since September 2018. This class also shows its monthly load factors above 80% for the first eight months of the test year.
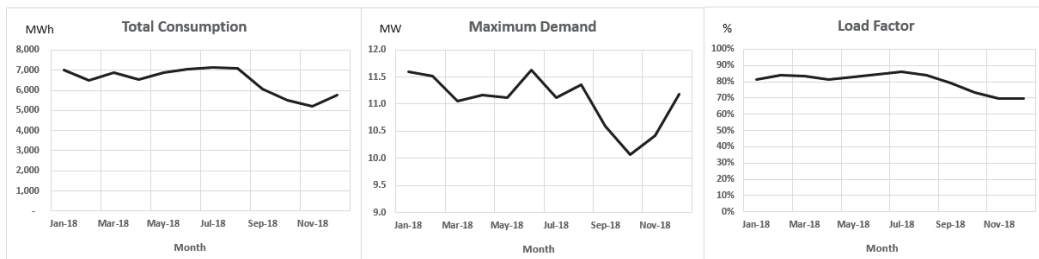
Figure 47 – Schedule 449PV: Class Monthly Energy, Demand and Load Factor

The achieved precision was perfect since the data for every customer in the class was available for the whole twelve-month period examined.

Table 36 presents summary statistics for the Schedule 449PV class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contributions, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. The monthly NCP load factor ranges from a low of 69.5% for December to a high of 86.2% in July. The load is fairly coincident with the system peak as shown by the system coincidence factors of over 80% in 8 of the 12 months in the study period.

| | Monthly | Class Peak Demand | | | | | Class Demand at System Peak Hour | | | |
Month	Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	7,004,602	Thursday, January 18, 2018	06:00	11,590	9,415	81.2%	Tuesday, January 02, 2018	18:00	8,682	74.9%
Feb-18	6,505,500	Tuesday, February 13, 2018	09:00	11,514	9,681	84.1%	Friday, February 23, 2018	08:00	8,674	75.3%
Mar-18	6,876,859	Friday, March 23, 2018	07:00	11,058	9,243	83.6%	Wednesday, March 07, 2018	08:00	10,119	91.5%
Apr-18	6,543,362	Tuesday, April 17, 2018	08:00	11,160	9,088	81.4%	Monday, April 02, 2018	08:00	8,453	75.7%
May-18	6,886,455	Tuesday, May 22, 2018	15:00	11,123	9,256	83.2%	Monday, May 14, 2018	18:00	10,431	93.8%
Jun-18	7,064,902	Wednesday, June 06, 2018	16:00	11,624	9,812	84.4%	Wednesday, June 20, 2018	18:00	11,008	94.7%
Jul-18	7,128,952	Tuesday, July 17, 2018	16:00	11,122	9,582	86.2%	Monday, July 30, 2018	18:00	9,965	89.6%
Aug-18	7,096,665	Tuesday, August 07, 2018	16:00	11,359	9,539	84.0%	Wednesday, August 08, 2018	18:00	10,032	88.3%
Sep-18	6,067,331	Friday, September 07, 2018	15:00	10,601	8,427	79.5%	Thursday, September 06, 2018	18:00	10,358	97.7%
Oct-18	5,516,496	Wednesday, October 24, 2018	14:00	10,070	7,415	73.6%	Monday, October 22, 2018	08:00	9,188	91.2%
Nov-18	5,224,732	Wednesday, November 07, 2018	06:00	10,417	7,257	69.7%	Monday, November 19, 2018	08:00	5,092	48.9%
Dec-18	5,778,871	Wednesday, December 12, 2018	07:00	11,175	7,767	69.5%	Thursday, December 06, 2018	08:00	9,166	82.0%
Annual	77,694,726	Annual Class Peak		11,624	8,869	76.3%	Annual System Peak		8,674	74.6%
		Average 12 Monthly NCPs		11,068		80.1%	Average 12 Monthly CPs		9,264	83.7%
		Average Top 12 NCPs		11,472		77.3%	Average Top 12 CPs		9,315	81.2%
		Average Top 75 NCPs		11,190		79.3%	Average Top 75 CPs		9,394	84.0%
		Average Top 200 NCPs		10,952		81.0%	Average Top 200 CPs		9,376	85.6%
							Average 4CPs *		7,903	

* Monthly CPs for November, December, January and February

Table 36 – Schedule 449PV Class: Summary Statistics (Totals – kW)

Since only two customers are served under Schedule 449PV, no summary table is presented on a per-customer basis.

4.2 Schedule 449 High Voltage Retail Wheeling Service

All of the customers under the Schedule 449 High Voltage (HV) are metered with interval load readings. Therefore, the class hourly load profile is based on the population's actual load data. The average loss factor estimated for the class was applied to the hourly loads. As shown in Table 7, the estimated average loss factor is 1.69%.

Figure 48 presents the total load for the Schedule 449HV class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. Except the sudden drops in mid-April and May, this class load profile shows a fairly stable profile like 449PV's but at much higher loads. The Schedule 449HV class peak occurred on Wednesday, July 25, 2018 at 10 AM. The class peak demand was 216.6 MW.
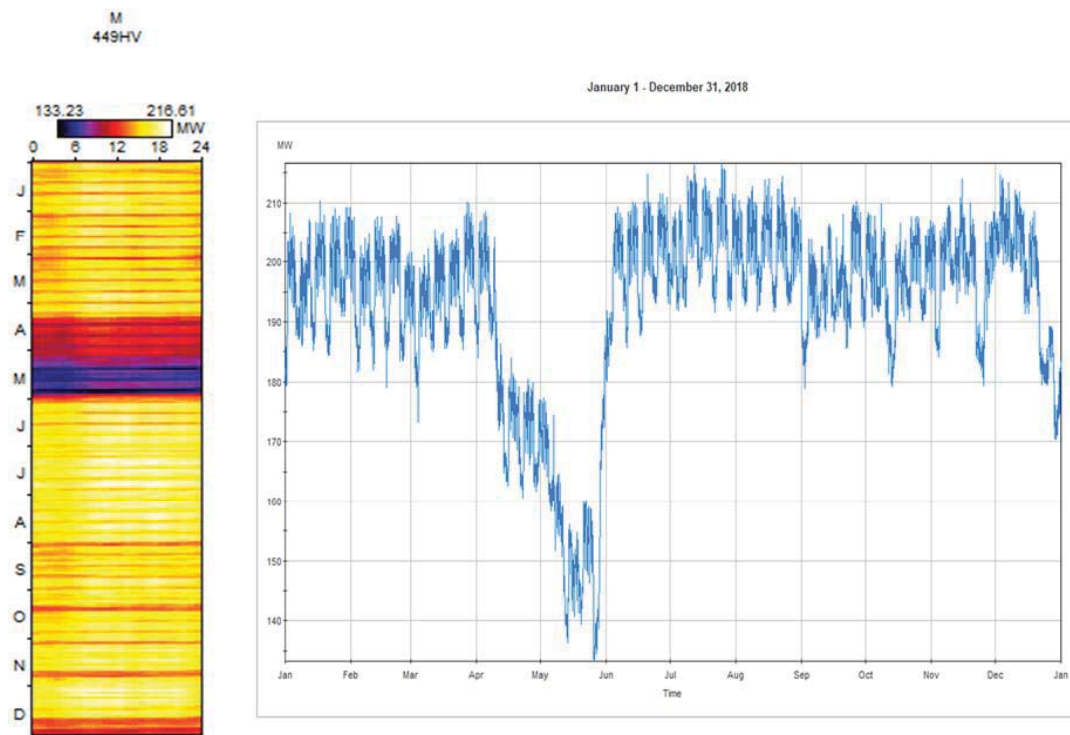
Figure 48 – Schedule 449HV: Class Total Load

Figure 49 presents the total Schedule 449HV class load for the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The total class demand was 206.2 MW at the time of the system peak.
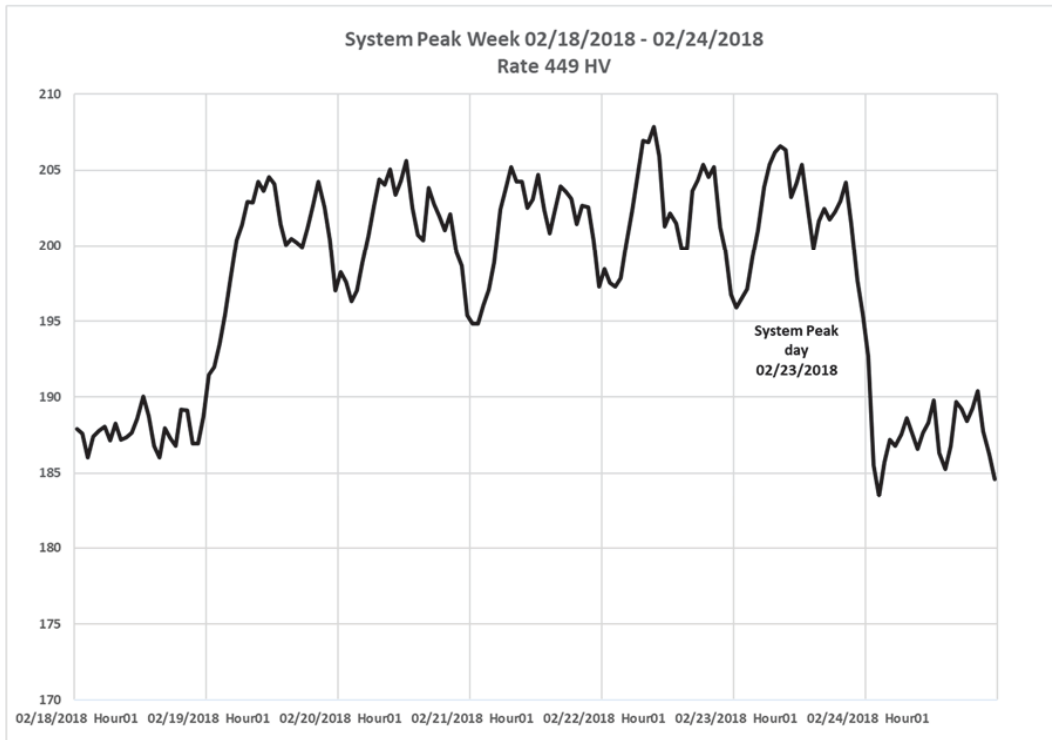
Figure 49 – Schedule 449HV: Total Load during System Peak Week

Figure 50 presents the monthly energy consumption, peak demand and load factors of the Schedule 449HV class in charts. As indicated by the monthly energy and maximum demand charts, the retail wheeling high voltage customer class load is slightly higher in the mid-summer and mid-winter months. Monthly load factors are significantly higher than the Schedule 449PV's with 90% or higher for 10 of the 12 months.
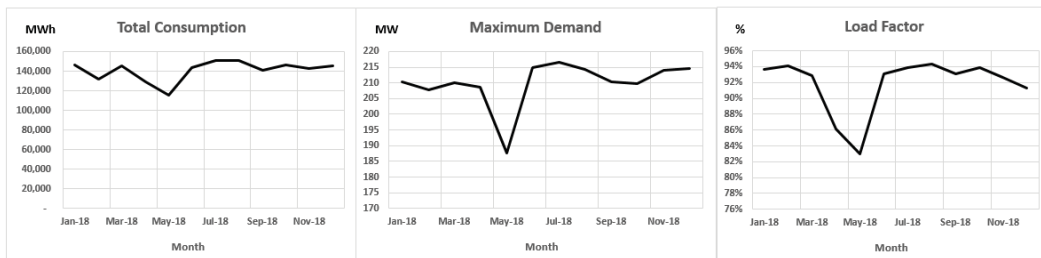
Figure 50 – Schedule 449HV: Class Monthly Energy, Demand and Load Factors

The achieved precision was perfect since the interval load data for the entire customer class was available for the full twelve-month period examined.

Table 37 presents summary statistics for the Retail Wheeling High Voltage class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand,

average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contribution, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. The class displays very high monthly NCP load factors ranging from a low of 83.0% in May to a high of 94.4% in August. The class load is highly coincident with the system peak with the monthly system coincident factors of over 95% for 11 of the 12 months in the study period.

		Class Peak Demand					Class Demand at System Peak Hour			
Month	Monthly Energy Use (kWh)	Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	146,534,868	Wednesday, January 17, 2018	09:00	210,263	196,955	93.7%	Tuesday, January 02, 2018	18:00	201,978	96.1%
Feb-18	131,469,326	Thursday, February 22, 2018	10:00	207,860	195,639	94.1%	Friday, February 23, 2018	08:00	206,183	99.2%
Mar-18	145,098,229	Tuesday, March 27, 2018	13:00	210,096	195,025	92.8%	Wednesday, March 07, 2018	08:00	200,231	95.3%
Apr-18	129,465,553	Thursday, April 05, 2018	09:00	208,628	179,813	86.2%	Monday, April 02, 2018	08:00	206,768	99.1%
May-18	115,822,821	Thursday, May 31, 2018	14:00	187,660	155,676	83.0%	Monday, May 14, 2018	18:00	155,480	82.9%
Jun-18	143,990,381	Wednesday, June 20, 2018	13:00	214,805	199,987	93.1%	Wednesday, June 20, 2018	18:00	210,154	97.8%
Jul-18	151,308,018	Wednesday, July 25, 2018	10:00	216,608	203,371	93.9%	Monday, July 30, 2018	18:00	208,754	96.4%
Aug-18	150,574,483	Wednesday, August 22, 2018	17:00	214,433	202,385	94.4%	Wednesday, August 08, 2018	18:00	210,908	98.4%
Sep-18	140,948,731	Wednesday, September 26, 2018	17:00	210,309	195,762	93.1%	Thursday, September 06, 2018	18:00	200,932	95.5%
Oct-18	146,538,320	Monday, October 08, 2018	10:00	209,802	196,960	93.9%	Monday, October 22, 2018	08:00	205,802	98.1%
Nov-18	142,789,981	Thursday, November 15, 2018	10:00	213,942	198,319	92.7%	Monday, November 19, 2018	08:00	209,961	98.1%
Dec-18	145,707,989	Monday, December 03, 2018	13:00	214,535	195,844	91.3%	Thursday, December 06, 2018	08:00	210,712	98.2%
Annual	1,690,248,699	Annual Class Peak		216,608	192,951	89.1%	Annual System Peak		206,183	95.2%
		Average 12 Monthly NCPs		209,912		91.9%	Average 12 Monthly CPs		202,322	96.4%
		Average Top 12 NCPs		215,206		89.7%	Average Top 12 CPs		207,185	96.3%
		Average Top 75 NCPs		213,297		90.5%	Average Top 75 CPs		205,707	96.4%
		Average Top 200 NCPs		211,896		91.1%	Average Top 200 CPs		202,838	95.7%
							Average 4CPs *		207,208	

* Monthly CPs for November, December, January and February

Table 37 – Schedule 449HV Class: Summary Statistics (Totals – kW)

Since only eleven customers are served under Schedule 449HV, no summary table is presented on a per-customer basis.

4.3 Schedule 459 – Back-Up Generation

Schedule 459 Back-Up Generation class hourly loads were calculated by integrating the class customers' interval load data.   There were only three customers under Schedule 459. The average loss factor estimated for the class was applied to the hourly loads. As listed in Table 7, the estimated average loss factor is 1.69%.

Figure 51 presents the total load for the Schedule 459 class. The figure displays the EnergyPrint to the left of a two-dimensional x-y plot. The class energy use tends to be a little higher in the mid-summer months and substantially low in April and May. The Schedule 459 class peak occurred on Wednesday, September 26, 2018 at 3 PM. The class peak demand was 54.6 MW.
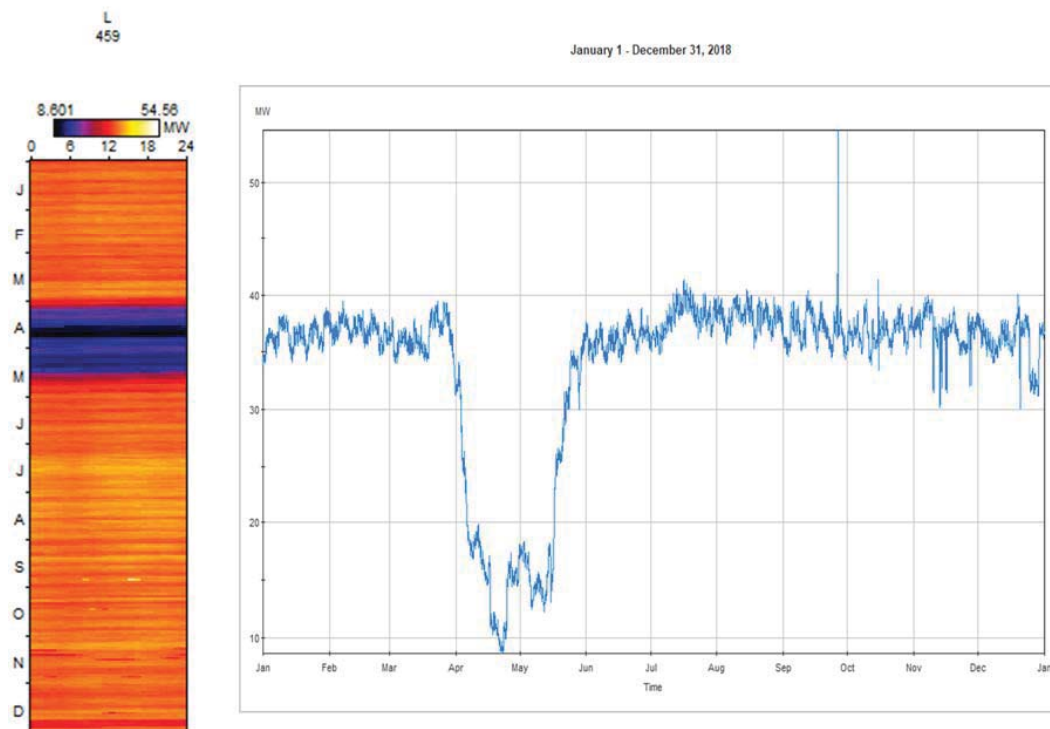
Figure 51 – Schedule 459: Class Total Load

Figure 52 presents the total Schedule 459 class load for the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peak happened on Friday, February 23, 2018 at 8 AM. The class demand was 36.4 MW at the time of the system peak.
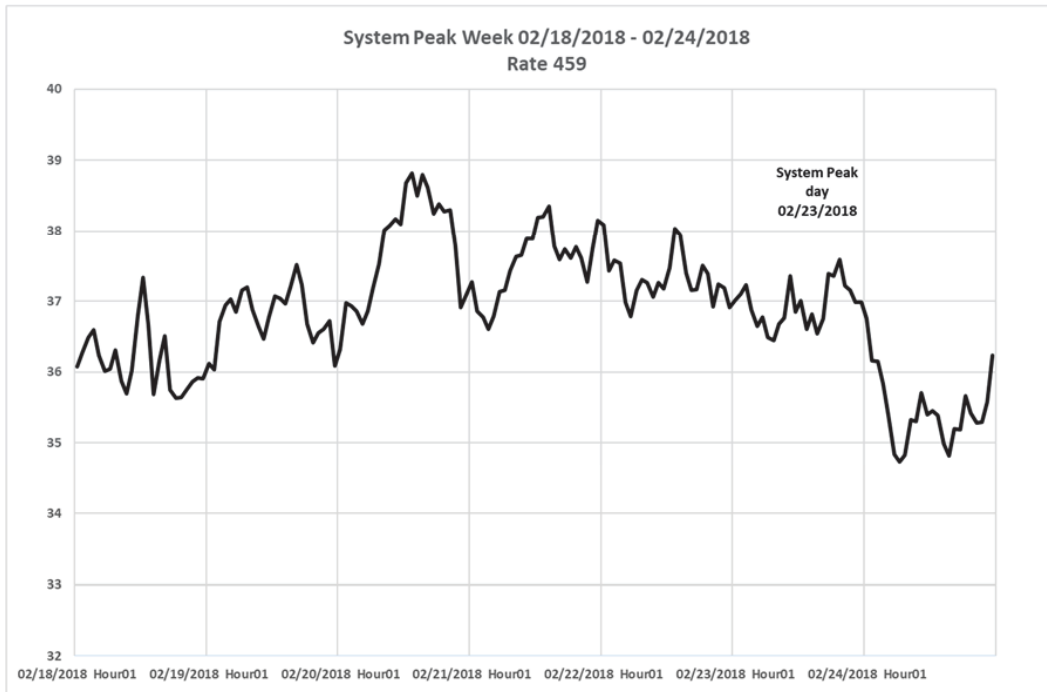
Figure 52 – Schedule 459: Total Load during System Peak Week

Figure 53 illustrates the monthly energy consumption, peak demand and load factor of the Schedule 459 class. The monthly energy consumption and demand charts show a slight summer-seasonality of the class load.
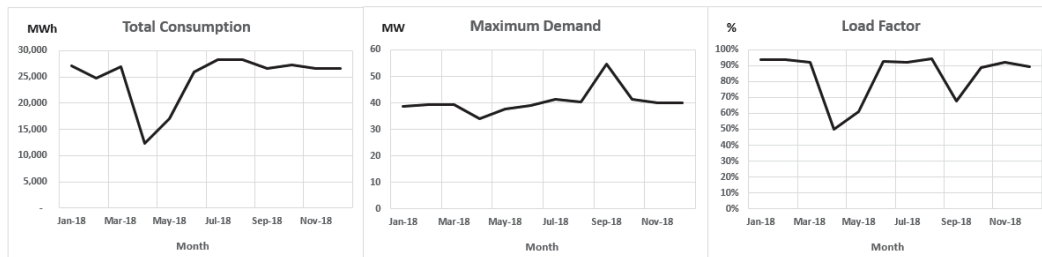
Figure 53 – Schedule 459: Class Monthly Energy, Demand and Load Factor

The achieved precision was perfect since the interval load data for all of the customers in the class were available for the full twelve-month period examined.

Table 38 presents summary statistics for the Schedule 459 class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contribution, and average values of the top 12, 75 and 200 class

peaks and the class loads at the top 12, 75 and 200 system peak hours. The monthly NCP load factors range from a low of 50.2% in April to a high of 94.2% in August. The monthly system-coincidence factors of class load are 89% or higher for 10 of 12 months in the study period.

Month	Monthly Energy Use (kWh)	Class Peak Demand					Class Demand at System Peak Hour			
		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	27,106,621	Tuesday, January 30, 2018	17:00	38,844	36,434	93.8%	Tuesday, January 02, 2018	18:00	36,321	93.5%
Feb-18	24,842,005	Wednesday, February 07, 2018	11:00	39,492	36,967	93.6%	Friday, February 23, 2018	08:00	36,446	92.3%
Mar-18	27,011,221	Friday, March 23, 2018	11:00	39,442	36,305	92.0%	Wednesday, March 07, 2018	08:00	36,031	91.4%
Apr-18	12,310,108	Monday, April 02, 2018	10:00	34,075	17,097	50.2%	Monday, April 02, 2018	08:00	33,142	97.3%
May-18	17,085,474	Thursday, May 31, 2018	23:00	37,721	22,964	60.9%	Monday, May 14, 2018	18:00	17,922	47.5%
Jun-18	25,990,901	Tuesday, June 26, 2018	16:00	38,889	36,098	92.8%	Wednesday, June 20, 2018	18:00	38,471	98.9%
Jul-18	28,320,571	Monday, July 16, 2018	15:00	41,349	38,065	92.1%	Monday, July 30, 2018	18:00	38,961	94.2%
Aug-18	28,371,821	Tuesday, August 14, 2018	23:00	40,463	38,134	94.2%	Wednesday, August 08, 2018	18:00	39,451	97.5%
Sep-18	26,609,269	Wednesday, September 26, 2018	15:00	54,564	36,957	67.7%	Thursday, September 06, 2018	18:00	38,465	70.5%
Oct-18	27,330,439	Monday, October 15, 2018	09:00	41,382	36,734	88.8%	Monday, October 22, 2018	08:00	36,769	88.9%
Nov-18	26,555,376	Wednesday, November 07, 2018	13:00	40,023	36,882	92.2%	Monday, November 19, 2018	08:00	38,272	95.6%
Dec-18	26,673,319	Wednesday, December 19, 2018	16:00	40,086	35,851	89.4%	Thursday, December 06, 2018	08:00	35,873	89.5%
Annual	298,207,124	Annual Class Peak		54,564	34,042	62.4%	Annual System Peak		36,446	66.8%
		Average 12 Monthly NCPs		40,527		84.0%	Average 12 Monthly CPs		35,510	87.6%
		Average Top 12 NCPs		42,833		79.5%	Average Top 12 CPs		36,486	85.2%
		Average Top 75 NCPs		40,626		83.8%	Average Top 75 CPs		36,762	90.5%
		Average Top 200 NCPs		40,055		85.0%	Average Top 200 CPs		36,610	91.4%
							Average 4CPs *		36,728	

* Monthly CPs for November, December, January and February

Table 38 – Schedule 459 Class: Summary Statistics (Totals – kW)

Since only three customers are served under Schedule 459, no summary table is presented on a per-customer basis.

4.4 Special Contract – Retail Wheeling and Distribution Service

Special Contract class hourly loads were calculated by integrating the interval load data collected from 93 metering device locations belonging to the Special Contract customer.[11]   Since all 93 device locations were served as Schedule 40 customers before being placed in a special contract, the average loss factor estimated for the existing Schedule 40 customers was applied to the Special Contract hourly loads. As listed in Table 7, the estimated average loss factor is 3.64%.

Figure 54 presents the total load for the Special Contract class. The figure displays the EnergyPrint to the left of two-dimensional x-y plot. The class energy use tends to be higher in the winter months but is also sensitive to summer weather. The Special Contract class peak occurred on Monday, February 12, 2018 at 9 AM. The class peak demand was 76.7 MW.
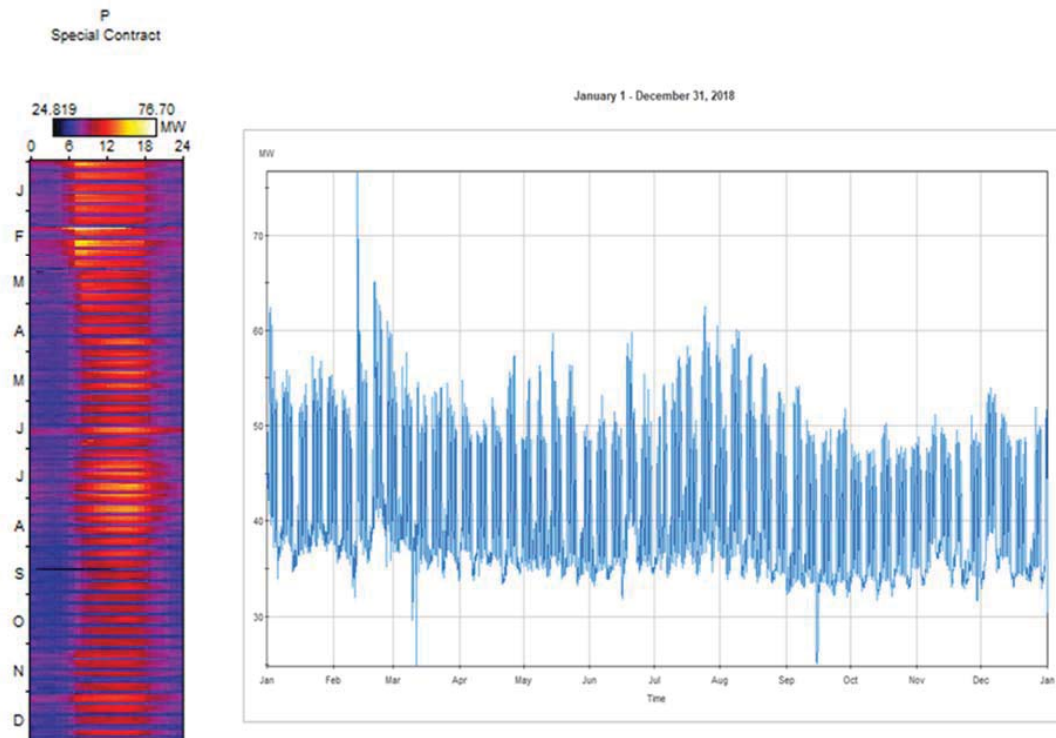
Figure 54 – Special Contract: Class Total Load

Figure 55 presents the Special Contract class load for the system peak week of Sunday, February 18, 2018 through Saturday, February 24, 2018. The system peak happened on Friday, February 23, 2018 at 8 AM. The class demand was 62.0 MW at the time of the system peak.

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[11] Only one customer is served under a special contract since April 1, 2019.
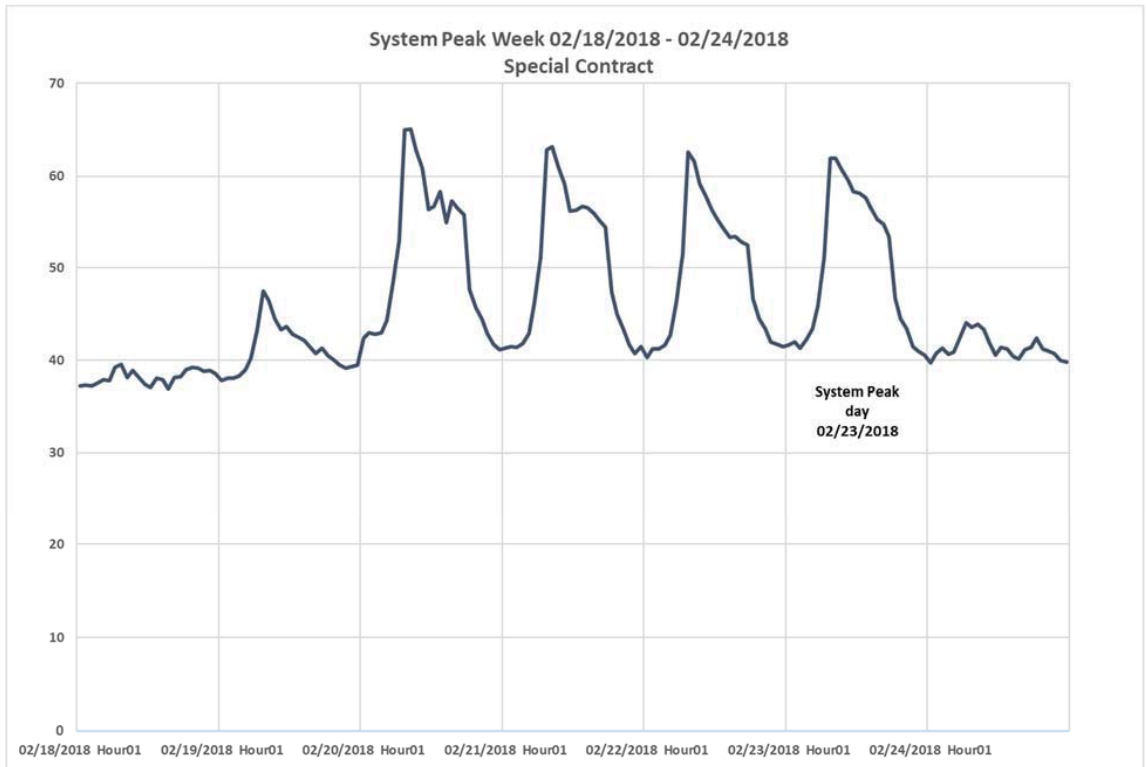
Figure 55 – Special Contract: Total Load during System Peak Week

Figure 56 illustrates the monthly energy consumption, peak demand and load factor of the Special Contract class. The monthly energy consumption and demand charts show some summer and winter seasonality of the class load.
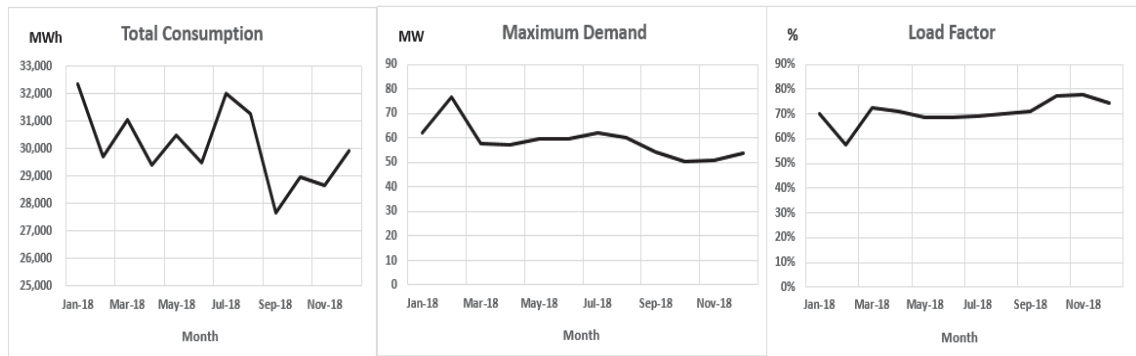
Figure 56 – Special Contract: Class Monthly Energy, Demand and Load Factor

The achieved precision was perfect since the interval load data for all of the metering device locations in the class were available for the full twelve-month period examined.

Table 389 presents summary statistics for the Special Contract class load. The table displays monthly energy use, timing of the class peak demand, magnitude of the class peak demand, average demand, load factor based on the class peak demand, timing of the system peak and class load at the time of system peak and the coincidence factor calculated as the class system-coincident load divided by the class peak. In addition, the table displays other summary characteristics, such as 12-month and 4-month average coincident peak contribution, and average values of the top 12, 75 and 200 class peaks and the class loads at the top 12, 75 and 200 system peak hours. The monthly NCP load factors range from a low of 57.6% in February to a high of 77.8% in November. The monthly system-coincidence factors of class load are high at 80% or higher for all of the 12 months in the study year.

| Month | Monthly Energy Use (kWh) | Class Peak Demand | | | | | Class Demand at System Peak Hour | | | |
		Date of Class Peak	Time of Class Peak	Class Peak Demand (kW)	Average Demand (kW)	Load Factor (%)	Date of System Peak	Time of System Peak	Class Demand @ System Peak (kW)	Coincidence Factor (%)
Jan-18	32,369,593	Tuesday, January 2, 2018	09:00	62,336	43,508	69.8%	Tuesday, January 2, 2018	18:00	52,055	83.5%
Feb-18	29,690,445	Monday, February 12, 2018	09:00	76,703	44,182	57.6%	Friday, February 23, 2018	08:00	61,962	80.8%
Mar-18	31,044,350	Wednesday, March 7, 2018	08:00	57,604	41,726	72.4%	Wednesday, March 7, 2018	08:00	57,604	100.0%
Apr-18	29,390,614	Thursday, April 26, 2018	15:00	57,344	40,820	71.2%	Monday, April 2, 2018	08:00	54,790	95.5%
May-18	30,502,071	Monday, May 14, 2018	15:00	59,687	40,997	68.7%	Monday, May 14, 2018	18:00	52,740	88.4%
Jun-18	29,482,662	Wednesday, June 20, 2018	14:00	59,729	40,948	68.6%	Wednesday, June 20, 2018	18:00	55,379	92.7%
Jul-18	32,029,337	Tuesday, July 24, 2018	15:00	62,410	43,050	69.0%	Monday, July 30, 2018	18:00	54,612	87.5%
Aug-18	31,292,404	Wednesday, August 8, 2018	15:00	60,081	42,060	70.0%	Wednesday, August 8, 2018	18:00	52,821	87.9%
Sep-18	27,671,470	Thursday, September 6, 2018	13:00	54,216	38,433	70.9%	Thursday, September 6, 2018	18:00	47,766	88.1%
Oct-18	28,981,673	Wednesday, October 17, 2018	15:00	50,352	38,954	77.4%	Monday, October 22, 2018	08:00	44,680	88.7%
Nov-18	28,657,133	Friday, November 9, 2018	12:00	51,181	39,802	77.8%	Monday, November 19, 2018	08:00	47,468	92.7%
Dec-18	29,904,725	Wednesday, December 5, 2018	14:00	53,994	40,195	74.4%	Thursday, December 6, 2018	08:00	49,700	92.0%
Annual	361,016,477	Annual Class Peak		76,703	41,212	53.7%	Annual System Peak		61,962	80.8%
		Average 12 Monthly NCPs		58,803		70.1%	Average 12 Monthly CPs		52,631	89.5%
		Average Top 12 NCPs		69,766		59.1%	Average Top 12 CPs		54,736	78.5%
		Average Top 75 NCPs		61,475		67.0%	Average Top 75 CPs		53,549	87.1%
		Average Top 200 NCPs		58,665		70.2%	Average Top 200 CPs		50,731	86.5%
							Average 4CPs *		52,796	

* Monthly CPs for November, December, January and February

Table 39 – Special Contract Class: Summary Statistics (Totals – kW)

Since only one customer is served under Special Contract, no summary table is presented on a per-customer basis.

APPENDIX A

2017 Class Load Research Sample Design and Deployment

2017 Class Load Research Sample Design and Deployment

Puget Sound Energy (PSE) selected and deployed its new class load research samples in November 2017. The new samples replaced the old samples deployed in March 2011. In total, 3,605 device locations were sampled from PSE electric service population to collect 15-minute interval load data for Residential, Small, Medium and Large Commercial and Industrial (C&I), Seasonal Irrigation, and Total-Electric Schools rate class customers.[1] Out of 3,605 sampled device locations, 1,674 device locations are "Primary" samples, 1,374 device locations are the "First Backup" samples, and 557 device locations are the "Second Backup" samples. The new Primary and Backup samples have been producing interval load data since November 11, 2017 and are being monitored regularly for their reliability. The following sections discuss the billing and interval load data analyzed for sampling, the statistical methods and analyses performed for sample design and the initial sampling results. The sample design methodology also leveraged some existing sampled meters from other studies for their statistical substitutability and interval load reading performance which is discussed below as well.

Data

The following three databases were used to analyze and evaluate the population and the old sample data and to develop a new sample design:

1. Annualized kWh use data by active location device and rate schedule at the end of December 2016;

2. 15-minute interval load data collected from the old load research samples and the energy efficiency and conservation program samples for September 2016 through February 2017; and

3. Individual sample location device and class hourly load profiles developed for the twelve months ending September 2016.

The 15-minute interval load data were collected from PSE's wireless automatic meter reading (AMR) system, which relies on Landis & Gyr's Cellnet® technology.

Statistical Methods and Analyses

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[1] _Since the sampling unit is a device location and the population billing data are compiled by device location, all of the use-per-customer calculations and the customer usage stratifications are performed on the basis of electric device locations. Therefore, the terms, "device location" and "customer" are being used interchangeably in this report._

One of the main purposes of class load research is to support the cost of service study and rate design analyses, which are included as parts of PSE's general rate case filings. In PSE's cost-of-service study, demand-related production and transmission costs are allocated on the basis of the average of class loads coincident with system monthly peaks in four mid-winter months. Distribution substation and feeder costs are allocated to each rate class based on a 12-month average of the class' contribution to the monthly peak loads of individual substations. Each class' contribution to a substation's monthly peak load is calculated by dividing an estimate of the average hourly load of the class on the substation by an estimate of the class' non-coincident peak load factor for the month.

When developing a sample design for class load research, a major problem we encounter is that actual population data is not available for class hourly loads, the target variable. In search for a surrogate variable, the correlation between annual energy use and the average of monthly system-coincident loads for four mid-winter months (4 CP) was evaluated for each rate class using the sampled customers' hourly load profiles developed for October 2015 - September2016 with the 2011 load research sample data. The correlation between annual energy use and the average of 12 monthly non-coincident peaks (12 NCP) was also analyzed for each rate class. The correlation coefficients presented in Table 1 provide a measure of how closely a customer's system-coincident peak loads (4CP) are correlated with the same customer's annual use and separately, how closely a customer's average monthly class-coincident peak load (12 NCP) is correlated with the same customer's annual energy use. Except the irrigation rate class (Schedule 29) in which number of active customers and energy sales are highly seasonal, most of the rate classes demonstrate consistently a strong positive correlation between the peak loads and the energy use, with the correlation coefficients of 0.85 or higher. Even in the case of irrigation rate class a high correlation is detected for annual energy use and average of their class non-coincident peaks (12 NCP) with a correlation coefficient higher than 0.91.

Table 1

2017 Correlation coefficient by Rate Class

Rate Class	4 CP Avg. vs. Ann. kWh Use	12 NCP Avg. vs. Ann. kWh Use
07	0.8514	0.9512
24	0.9134	0.9404
25	0.9122	0.9466
26	0.8577	0.9466
29	0.6406	0.9149
31	0.9767	0.9837
43	0.9590	0.9910

A stratified Mean per Unit (MPU) estimation approach was used for 2017 load research sample design. The MPU approach assumes a close correlation between class hourly loads and annual kWh across the customers in each rate class. Based on the correlation analysis discussed above, it is reasonable to adopt annual kWh energy use as an instrumental (or a surrogate) variable. The class load research sample design was developed by analyzing the population statistics of electric energy use and customers for a twelve month period ending December 31, 2016. The population statistics were calculated only for the active customers at the end of 2016.

By using the additional information regarding the relationship between system-coincident (or non-coincident) peaks ("Y" variable) and annual energy use ("X" variable) obtained from a no-intercept linear (ratio) model coefficients and the model's error ratio estimated with the previous load research sample data, a Model-Based Statistical Sampling (MBSS) sample design tends to require a smaller sample size than an MPU sample design to meet a given error margin and confidence limit criteria. However, complexity of the modeling and estimation procedures involved in an MBSS approach makes the monitoring and load research routines impractical. On the other hand, MPU sample design and class load estimation procedures are quite simple and easy to maintain. In an MPU approach, the analytical process and working assumptions are fairly straightforward and transparent.

An MBSS approach is also bound by its assumption of the estimation errors (residuals) of the ratio model to be positively correlated ("heteroscedastic") with the "X" variable (annual energy use). However, it is easily conceivable that this assumption of heteroscedastic residuals may be not applicable to some of the customers in the population or even to a rate class in general. On the other hand, an MPU approach uses the population statistics of actual energy use and customers and is free of the estimation bias or error. The only assumption made for this approach is a close correlation between the coincident (or non-coincident) peaks and the annual energy use, which is proven through the correlation analysis presented above. Considering that the interval-load reading cost gets lower with the wireless technology being used by PSE and in order to keep the load research process practical and manageable, a stratified MPU approach was chosen since 2011 for new sample design and load profiling over a Model-Based Statistical Sampling (MBSS) approach used for 2005 load research sample design.

To perform a stratified sampling, population data of customers and their annual kWh use by rate schedule were sorted by size of their kWh use. A frequency table was created by assigning the

customers into appropriate usage brackets. The number and ranges of usage brackets were pre-defined on the basis of population size and density of its usage distribution. The frequency table was then stratified by 2 to 5 groups by combining the usage brackets and their frequencies. For efficiency and practicality, the most popular numbers of strata being used for a stratified sampling are 2 to 5. For the number of strata set for each of the rate classes, strata boundaries were determined following the Dalenius-Hodges (DH) procedure, also known as the cumulative square root (uf) procedure where "u" denotes kWh, width of a given usage bracket and "f" stands for frequency of the usage bracket. In the DH procedure, strata boundaries are set to have each of the strata yield a similar sum of square-rooted kWh values of (uf). The Neyman Optimum Allocation formula was then used to calculate total number of sample units for each rate class and the strata sample sizes. The Neyman Allocation formula estimates total and strata sample sizes required for a given error margin and confidence limit on the basis of the population statistics of number of customers and their kWh use. For each rate class, total and strata sample sizes were determined by using the following formulae:

$$n = (\sum W_h S_h)^2/((d/t)^2 + 1/N * \sum W_h S_h^2)$$

$$n_h = n*(W_h*S_h)/\sum(W_h*S_h)$$

Where N = Total Population size

N_h = Stratum population size

n = Total sample size

n_h = Stratum sample size

$W_h = N_h/N$

S_h = Stratum standard deviation of annual kWh use

d = Tolerable error margin; and

t = t-statistic value for pre-set confidence limit

The examples presented below illustrate how the stratified sample sizes were determined for the residential rate class (RC 07) through the two-step procedure explained above. The first step was to set strata boundaries through the DH procedure. At the beginning, all of the electric usage points under the residential rate schedules were sorted by sizes of their annual energy usage, A frequency table was created by counting the number of usage points (f) sorted to each of the usage brackets ascending with an increment (u) of 1,000 kWh for the annual usage of 20,000 kWh or lower, 2,000 kWh for the annual usage of 20,001 kWh through 30,000 kWh, 5,000 kWh for 30,001 kWh to 50,000 kWh, 10,000 kWh for 50,001 kWh to 60,000 kWh, 20,000 kWh for

60,001 kWh to 100,000 kWh and 300,000 kWh for the annual usage over 100,000 kWh. The

sum of square rooted value of (uf) for all of the usage brackets was 186,068 kWh. The number of

strata set for residential sampling was 5. The strata boundaries were then determined by making

the cut-offs so that all of the five strata yield a sum of square rooted (uf) close to one fifth of

193,166 kWh (38,633 kWh). The strata boundaries set for residential sample design were 0 –

6,000 kWh for the first stratum, 6001 – 10,000 kWh for the second, 10,001 – 17,000 kWh for the

third, 17,001 – 30,000 kWh for the fourth, and all of the customers with annual usage over 30,000

kWh assigned to the fifth stratum.

Step 1

Dalenius-Hodges Procedure (Based on Annualized Sales Data for 2016)

Bracket	Frequency (f)	u	uf	sqrt(uf)	Cum sqrt(uf)		% Distribution by Stratum
0-1,000	11,561	1,000	11,561,000	3,400	3,400		
1,001-2,000	14,533	1,000	14,533,000	3,812	7,212		
2,001-3,000	29,454	1,000	29,454,000	5,427	12,640		
3,001-4,000	51,372	1,000	51,372,000	7,167	19,807		
4,001-5,000	72,482	1,000	72,482,000	8,514	28,321		
5,001-6,000	86,724	1,000	86,724,000	9,313	37,633	38,633	26.6%
6,001-7,000	90,854	1,000	90,854,000	9,532	47,165		
7,001-8,000	87,939	1,000	87,939,000	9,378	56,542		
8,001-9,000	80,463	1,000	80,463,000	8,970	65,513		
9,001-10,000	70,797	1,000	70,797,000	8,414	73,927	77,266	33.0%
10,001-11,000	60,534	1,000	60,534,000	7,780	81,707		
11,001-12,000	51,930	1,000	51,930,000	7,206	88,913		
12,001-13,000	44,298	1,000	44,298,000	6,656	95,569		
13,001-14,000	37,962	1,000	37,962,000	6,161	101,730		
14,001-15,000	32,232	1,000	32,232,000	5,677	107,408		
15,001-16,000	27,375	1,000	27,375,000	5,232	112,640		
16,001-17,000	23,228	1,000	23,228,000	4,820	117,459	115,899	27.7%
17,001-18,000	19,828	1,000	19,828,000	4,453	121,912		
18,001-19,000	16,622	1,000	16,622,000	4,077	125,989		
19,001-20,000	14,018	1,000	14,018,000	3,744	129,733		
20,001-22,000	21,689	2,000	43,378,000	6,586	136,319		
22,001-24,000	15,176	2,000	30,352,000	5,509	141,829		
24,001-26,000	10,596	2,000	21,192,000	4,603	146,432		
26,001-28,000	7,408	2,000	14,816,000	3,849	150,281		
28,001-30,000	5,374	2,000	10,748,000	3,278	153,560	154,533	11.1%
30,001-35,000	7,669	5,000	38,345,000	6,192	159,752		
35,001-40,000	3,457	5,000	17,285,000	4,158	163,910		
40,001-45,000	1,863	5,000	9,315,000	3,052	166,962		
45,001-50,000	1,105	5,000	5,525,000	2,351	169,312		
50,001-60,000	1,120	10,000	11,200,000	3,347	172,659		
60,001-80,000	974	20,000	19,480,000	4,414	177,072		
80,001-100,000	389	20,000	7,780,000	2,789	179,862		
over 100,000	590	300,000	177,000,000	13,304	193,166	193,166	1.7%
Total	1,001,616						100.0%

38,633	5 =Number of Strata
38,633	1 Stratum 1
77,266	2 Stratum 2
115,899	3 Stratum 3
154,533	4 Stratum 4
193,166	5 Stratum 5

The second step was to calculate the minimum number of samples required to meet the sample

design criteria of 3% error margin with 95% confidence limit for each residential rate schedule

and to allocate the total number of samples to each stratum. The example provided below

illustrates how the population statistics of customers and their annual energy usage were used in

the Neyman Optimum Allocation formula to determine the residential rate-schedule total and

strata sample sizes. The components of the formula calculated with the population statistics are shown in columns of the rate-schedule tables provided below. The final results for rate-schedule total and strata sample sizes are presented in column "n(h)."

Step 2

Neyman Allocation for Stratified Sampling
(Total Sample Size Required for 3% Error Margin @ 95% Confidence Limit)

RC *7*

Annual kWh Range	Max	N(h)	W(h)	Y(h)	S(h)	W(h)*S(h)	n(h)		S(h)^2	W(h)*S(h)^2
0 - 6,000*	6,000	266,125	0.2657	4,094	1,435	381	35		2,058,488	546,931
6,001 -10,000	10,000	330,052	0.3295	7,892	1,136	374	35		1,291,314	425,513
11,001 - 17,000	17,000	277,561	0.2771	12,864	1,957	542	50		3,829,260	1,061,139
17,001 - 30,000	30,000	110,710	0.1105	21,218	3,324	367	34		11,048,030	1,221,154
> 30,000	>30,000	17,168	0.0171	44,129	38,510	660	61		1,483,029,064	25,419,565
Total		1,001,616	1.0000	10,355		2,325	215			28,674,302

The accounts not active as of December 31, 2016 were excluded from the analysis.

Total sample size required =   77
(@ 5% error margin w/ 95% confidence limit)

Total sample size required =   215
(@ 3% error margin w/ 95% confidence limit)

Sample Design

As illustrated above for the case of residential rate schedules, use of the Dalenius-Hodges procedure and the Neyman Optimum Allocation method produced the following sample designs for non-residential rate classes:

RC 24C

Annual kWh Range	N(h)	n(h)
0 - 16,000*	90,438	116
16,001 -60,000	30,150	103
60,001 - 180,000	10,756	92
> 180,000	1,333	115
Total	132,677	426

RC 24I

Annual kWh Range	N(h)	n(h)
0 - 16,000*	1,676	31
16,001 -60,000	1,060	51
60,001 - 180,000	424	50
> 180,000	34	34
Total	3,194	166

RC 25C

Annual kWh Range	N(h)	n(h)
0 - 220,000*	2,605	22
220,001 - 450,000	2,578	24
450,001 - 1,000,000	1,498	32
> 1,000,000	451	25
Total	7,132	103

RC 25I

Annual kWh Range	N(h)	n(h)
0 - 220,000*	210	18
220,001 - 450,000	159	15
450,001 - 1,000,000	109	25
> 1,000,000	30	26
Total	508	84

RC 26C

Annual kWh Range	N(h)	n(h)
0 - 2,000,000*	369	39
2,000,001 -4,000,000	303	34
> 4,000,000	76	27
Total	748	100

RC 26I

Annual kWh Range	N(h)	n(h)
0 - 2,000,000*	58	24
2,000,001 -4,000,000	27	11
> 4,000,000	14	13
Total	99	48

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RC 29

Annual kWh Range	N(h)	n(h)
0 - 50,000*	639	190
> 50,000	105	105
Total	744	295

RC 31C				**RC 31I**		
Annual kWh Range	N(h)	n(h)		Annual kWh Range	N(h)	n(h)
0 - 2,000,000*	248	44		0 - 2,000,000*	71	12
2,000,001 - 8,000,000	100	63		2,000,001 - 8,000,000	42	25
> 8,000,000	19	19		> 8,000,000	17	17
Total	367	126		Total	130	54

RC 43

Annual kWh Range	N(h)	n(h)
0 - 1,000,000*	133	37
> 1,000,000	28	28
Total	161	65

The residential class (RC 07) sample size was determined to meet a 3% error margin with 95% confidence limit, while all the other rate class sample sizes were estimated to satisfy a 5% error margin with 95% confidence limit requirement. Since the variances of electric energy usage of the irrigation (RC 29) and the large C&I rate class (RC 26I, RC 31C, RC 31I and RC 43) customers were so high, it requires big sample sizes and takes up a third or even a higher portion of population to meet the criteria of 5% error margin. Total number of samples required for all of the rate classes was 1,682. Since all of the customers in the primary voltage seasonal irrigation (RC 35), the Campus Rate (RC 40), the high voltage interruptible service (RC 46) and the high voltage general service (RC 49) classes are metered with 15-minute interval load readings, no sampling was necessary for those rate classes. All of the non-system loads under the primary and high voltage retail wheeling services (RC 449PV and 449HV) and the back-up generation service (RC 459) class rates, are also metered with interval load readings.

Sample Drawing and Retention

A systematic sampling technique was used to draw the samples for each rate class stratum. The following procedures were followed to select the samples from the population list of active device locations by rate class and their annual billing data as of December 31, 2016:

1) Sort the rate class population in ascending order of annual kWh usage and stratify the sorted data by the same usage strata as was determined in the sample design.
2) Count the number of customers in each usage bracket (or stratum).
3) Calculate $K = N_h/n_h$ where N_h = population number of customers in stratum h and n_h = number of samples as required by the sample design for stratum h.

4) Draw stratum samples by taking the $(K/2)^{th}$ customer from the top of the stratum population list as the first sample and every k^{th} customer from the first and the samples drawn in sequence until the total number of samples drawn reaches the number of sampling units determined in the sample design.

5) Repeat 3) and 4) to draw the samples for the remaining strata.

To be able to replace the primary samples in case of poor metering quality or service termination/changes, two backup samples were also drawn using an approach similar to the one used for the primary samples. The numbers of the first backup and the second backup samples were set equal to the number of primary samples. The backup samples for each stratum were drawn by taking every K^{th} device location from the same population list used for the primary sampling after selecting the $(K/2-1)^{th}$ device location to be the first backup sample and the $(K/2+1)^{th}$ device location as the second backup sample . For some of the high usage brackets in the irrigation and the large C&I classes, such as RC 29, RC 31 and RC 43, the whole population was selected as the primary sample. In such cases, there is no backup sample. Taking the residential class sampling as an example, Table 2 and Table 3 illustrate how the primary, first backup and second backup samples were selected for each of the rate class strata:

Table 2
Primary Sample Selection

Annual kWh Range	N(h)	n(h)	N(h)/n(h)	1st Sample	Obs. # for 1st Sample	Obs. # for Last Sample
0 - 6,000*	266,125	35	7,604	3,802	3,802	262,323
6,001 -10,000	330,052	35	9,430	4,715	275,555	596,177
11,001 - 17,000	277,561	50	5,551	2,776	598,953	870,963
17,001 - 30,000	110,710	34	3,256	1,628	875,366	982,820
> 30,000	17,168	61	281	141	984,589	1,001,476
Total	1,001,616	215				

Table 3

2017 Load Research Sample Drawing

Primary Sample for RC 07 (P) **First Backup Sample for RC07 (FB)** **Second Backup Sample for RC07 (SB)**

Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH
1	3,802	6001675281	70	1	3,801	6001164538	70	1	3,803	6001413042	70
2	11,406	6000293318	985	2	11,405	6000343503	985	2	11,407	6000749822	986
3	19,009	6000082914	1,603	3	19,008	6001012606	1,603	3	19,010	6002051331	1,603
4	26,613	6000942730	2,025	4	26,612	6001818064	2,025	4	26,614	6001600983	2,025
5	34,216	6000425303	2,347	5	34,215	6001466089	2,347	5	34,217	6000803648	2,347
6	41,820	6000943789	2,612	6	41,819	6001481887	2,612	6	41,821	6000719061	2,612
7	49,423	6001915047	2,839	7	49,422	6000349354	2,839	7	49,424	6001982622	2,839
8	57,027	6000191623	3,037	8	57,026	6000578038	3,037	8	57,028	6001129701	3,037
9	64,631	6000959519	3,215	9	64,630	6001053869	3,215	9	64,632	6000048682	3,216
10	72,234	6001134702	3,378	10	72,233	6001412153	3,378	10	72,235	6000919383	3,378
11	79,838	6001237416	3,530	11	79,837	6000466213	3,530	11	79,839	6001567528	3,530
12	87,441	6002015711	3,671	12	87,440	6001452858	3,671	12	87,442	6001086120	3,671
13	95,045	6001742346	3,804	13	95,044	6000243136	3,804	13	95,046	6001340612	3,804
14	102,648	6000852353	3,931	14	102,647	6000853578	3,931	14	102,649	6000776693	3,931
15	110,252	6000731799	4,054	15	110,251	6000619200	4,054	15	110,253	6001906051	4,054
16	117,856	6001515525	4,168	16	117,855	6000776335	4,168	16	117,857	6000995381	4,168
17	125,459	6001025963	4,282	17	125,458	6001515981	4,282	17	125,460	6000980176	4,282
18	133,063	6001229231	4,392	18	133,062	6001148839	4,392	18	133,064	6001435959	4,392
19	140,666	6001313554	4,500	19	140,665	6000865262	4,500	19	140,667	6000667269	4,500
20	148,270	6001152572	4,603	20	148,269	6001354155	4,603	20	148,271	6000071644	4,603
21	155,873	6001937577	4,701	21	155,872	6000755985	4,701	21	155,874	6001302031	4,701
22	163,477	6001849463	4,799	22	163,476	6001594829	4,799	22	163,478	6000449876	4,799
23	171,081	6001001932	4,896	23	171,080	6001822294	4,896	23	171,082	6001478317	4,896
24	178,684	6000455082	4,991	24	178,683	6001110125	4,991	24	178,685	6000028558	4,991
25	186,288	6000709115	5,084	25	186,287	6001741734	5,084	25	186,289	6001909162	5,084
26	193,891	6000512224	5,175	26	193,890	6000722737	5,175	26	193,892	6000935160	5,175
27	201,495	6000826080	5,265	27	201,494	6000491741	5,265	27	201,496	6000389790	5,265
28	209,098	6000117423	5,355	28	209,097	6000944605	5,355	28	209,099	6000059574	5,355
29	216,702	6000125295	5,443	29	216,701	6000024332	5,443	29	216,703	6001298620	5,443
30	224,306	6001749444	5,530	30	224,305	6000696358	5,530	30	224,307	6001616883	5,530
31	231,909	6000879591	5,618	31	231,908	6001660293	5,618	31	231,910	6000647237	5,618
32	239,513	6000649420	5,704	32	239,512	6001661879	5,704	32	239,514	6001301724	5,704
33	247,116	6001306392	5,789	33	247,115	6000253227	5,789	33	247,117	6001803817	5,789
34	254,720	6000114553	5,874	34	254,719	6000336617	5,874	34	254,721	6000195242	5,874
35	262,323	6001120864	5,958	35	262,322	6001140316	5,958	35	262,324	6000798946	5,958
36	275,555	6001135520	6,105	36	275,554	6000343427	6,105	36	275,556	6000008274	6,105
37	284,985	6000414645	6,210	37	284,984	6000345238	6,210	37	284,986	6000838201	6,210
38	294,415	6000688475	6,313	38	294,414	6000637408	6,313	38	294,416	6000725737	6,313
39	303,845	6001647381	6,417	39	303,844	6001740421	6,417	39	303,846	6000393104	6,417
40	313,276	6001747532	6,520	40	313,274	6001795988	6,520	40	313,275	6001764549	6,520
41	322,705	6001812721	6,624	41	322,704	6000596946	6,624	41	322,706	6000603520	6,624
42	332,135	6000313311	6,727	42	332,134	6001954512	6,727	42	332,136	6001459264	6,727
43	341,565	6000050436	6,831	43	341,564	6001883098	6,831	43	341,566	6000825726	6,831
44	350,996	6000900439	6,934	44	350,995	6000948758	6,934	44	350,997	6000604174	6,934
45	360,426	6001351184	7,038	45	360,425	6001681141	7,038	45	360,427	6001355360	7,038
46	369,856	6001474939	7,144	46	369,855	6000316946	7,144	46	369,857	6000713599	7,144
47	379,286	6000387521	7,252	47	379,285	6001760032	7,252	47	379,287	6001997307	7,252
48	388,716	6001188994	7,357	48	388,715	6001007852	7,357	48	388,717	6001090477	7,358
49	398,146	6001032029	7,462	49	398,145	6000331934	7,462	49	398,147	6000448030	7,462
50	407,576	6000403712	7,569	50	407,575	6000305218	7,569	50	407,577	6001593316	7,569

Primary Sample for RC 07 (P)				First Backup Sample for RC07 (FB)				Second Backup Sample for RC07 (SB)			
Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH
51	417,006	6000913439	7,675	51	417,005	6000590301	7,675	51	417,007	6000741927	7,675
52	426,436	6001227437	7,785	52	426,435	6001764154	7,785	52	426,437	6001714929	7,785
53	435,866	6001870965	7,894	53	435,865	6000771050	7,894	53	435,867	6000136620	7,894
54	445,296	6001811101	8,005	54	445,295	6000168905	8,005	54	445,297	6001976064	8,005
55	454,726	6000798528	8,117	55	454,725	6000744179	8,117	55	454,727	6000331584	8,117
56	464,156	6000184434	8,229	56	464,155	6000115297	8,229	56	464,157	6000006831	8,229
57	473,586	6001507702	8,345	57	473,585	6000111094	8,345	57	473,587	6001524333	8,345
58	483,016	6000169346	8,459	58	483,015	6000007016	8,459	58	483,017	6001399748	8,459
59	492,446	6000825914	8,576	59	492,445	6000425865	8,576	59	492,447	6000949051	8,576
60	501,876	6001584061	8,694	60	501,875	6000105474	8,694	60	501,877	6000239350	8,694
61	511,306	6001481636	8,816	61	511,305	6001334666	8,816	61	511,307	6001292448	8,816
62	520,737	6000707345	8,939	62	520,736	6001821635	8,939	62	520,738	6000569887	8,939
63	530,167	6000586492	9,063	63	530,166	6001397272	9,063	63	530,168	6000355227	9,063
64	539,597	6001761082	9,191	64	539,596	6001671750	9,191	64	539,598	6000844832	9,191
65	549,027	6001335921	9,320	65	549,026	6000650658	9,320	65	549,028	6000860240	9,320
66	558,457	6001686250	9,451	66	558,456	6001216619	9,451	66	558,458	6000703980	9,451
67	567,887	6000383831	9,583	67	567,886	6000319194	9,583	67	567,888	6001592668	9,583
68	577,317	6000235850	9,719	68	577,316	6000367938	9,719	68	577,318	6000592204	9,719
69	586,747	6001371705	9,859	69	586,746	6001027625	9,859	69	586,748	6000559757	9,859
70	596,177	6000285514	10,000	70	596,176	6000077386	10,000	70	596,178	6000877294	10,000
71	598,953	6001197780	10,044	71	598,952	6000238665	10,043	71	598,954	6001643878	10,044
72	604,504	6000276929	10,129	72	604,503	6000471076	10,129	72	604,505	6000277775	10,129
73	610,055	6000151806	10,218	73	610,054	6000070340	10,218	73	610,056	6000646603	10,218
74	615,607	6001696359	10,306	74	615,606	6001253198	10,306	74	615,608	6000629261	10,306
75	621,158	6001780098	10,394	75	621,157	6000298719	10,394	75	621,159	6001631408	10,394
76	626,709	6001015284	10,483	76	626,708	6001763336	10,483	76	626,710	6001590805	10,483
77	632,260	6000861084	10,576	77	632,259	6000968116	10,576	77	632,261	6001863074	10,576
78	637,812	6000591775	10,670	78	637,811	6000634675	10,670	78	637,813	6001711413	10,670
79	643,363	6000030223	10,765	79	643,362	6000264975	10,765	79	643,364	6001547717	10,765
80	648,914	6001472143	10,863	80	648,913	6000349092	10,863	80	648,915	6000276539	10,863
81	654,465	6000813048	10,960	81	654,464	6001412584	10,960	81	654,466	6001250183	10,960
82	660,016	6000895369	11,059	82	660,015	6000251981	11,059	82	660,017	6000736163	11,059
83	665,568	6001650056	11,162	83	665,567	6001978852	11,162	83	665,569	6000748089	11,162
84	671,119	6000273434	11,264	84	671,118	6001548024	11,264	84	671,120	6001583571	11,264
85	676,670	6001674895	11,369	85	676,669	6001836621	11,369	85	676,671	6000950509	11,369
86	682,221	6000123442	11,475	86	682,220	6001193965	11,474	86	682,222	6001394726	11,475
87	687,773	6000496817	11,585	87	687,772	6000175285	11,585	87	687,774	6001074386	11,585
88	693,324	6001332931	11,693	88	693,323	6001438951	11,693	88	693,325	6001440381	11,693
89	698,875	6001085993	11,805	89	698,874	6000772355	11,805	89	698,876	6000594112	11,805
90	704,426	6001077033	11,914	90	704,425	6000701989	11,914	90	704,427	6000667665	11,914
91	709,977	6000891623	12,028	91	709,976	6000630217	12,028	91	709,978	6000818741	12,028
92	715,529	6000016818	12,145	92	715,528	6000355801	12,145	92	715,530	6001131881	12,145
93	721,080	6000281392	12,265	93	721,079	6000814603	12,265	93	721,081	6000690596	12,265
94	726,631	6001559282	12,386	94	726,630	6000885375	12,386	94	726,632	6001611393	12,386
95	732,182	6001021795	12,511	95	732,181	6000566548	12,511	95	732,183	6001572589	12,511
96	737,733	6001506802	12,636	96	737,732	6000079000	12,636	96	737,734	6001298577	12,636
97	743,285	6001131238	12,768	97	743,284	6000272136	12,767	97	743,286	6001096997	12,768
98	748,836	6001660780	12,901	98	748,835	6001457771	12,901	98	748,837	6000693440	12,901
99	754,387	6001310642	13,035	99	754,386	6000034271	13,035	99	754,388	6001126574	13,035
100	759,938	6001666247	13,173	100	759,937	6001522277	13,173	100	759,939	6001468278	13,173
101	765,490	6001014411	13,310	101	765,489	6001123817	13,310	101	765,491	6001142390	13,310
102	771,041	6001776251	13,454	102	771,040	6000424023	13,454	102	771,042	6001103024	13,454
103	776,592	6000059696	13,602	103	776,591	6000786585	13,602	103	776,593	6000694395	13,602
104	782,143	6001573923	13,755	104	782,142	6000064726	13,755	104	782,144	6001502721	13,755
105	787,694	6000430609	13,910	105	787,693	6000126657	13,910	105	787,695	6000620609	13,910
106	793,246	6000006917	14,070	106	793,245	6000837188	14,070	106	793,247	6001145625	14,070
107	798,797	6000928953	14,233	107	798,796	6000490157	14,233	107	798,798	6001508904	14,233
108	804,348	6001637318	14,402	108	804,347	6001619658	14,402	108	804,349	6001656985	14,402
109	809,899	6000009449	14,574	109	809,898	6001630249	14,574	109	809,900	6000271147	14,574
110	815,451	6001442227	14,751	110	815,450	6001604304	14,751	110	815,452	6001364941	14,751

	Primary Sample for RC 07 (P)				First Backup Sample for RC07 (FB)				Second Backup Sample for RC07 (SB)		
Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH
111	821,002	6000268274	14,929	111	821,001	6001771831	14,929	111	821,003	6001834448	14,929
112	826,553	6001954975	15,115	112	826,552	6001429329	15,115	112	826,554	6000170628	15,115
113	832,104	6000487709	15,307	113	832,103	6000298057	15,307	113	832,105	6001016720	15,307
114	837,655	6001779777	15,508	114	837,654	6000211828	15,508	114	837,656	6000352771	15,508
115	843,207	6001358619	15,715	115	843,206	6000995047	15,715	115	843,208	6001624799	15,715
116	848,758	6001553993	15,932	116	848,757	6001691770	15,932	116	848,759	6001135024	15,932
117	854,309	6001405768	16,158	117	854,308	6001327750	16,158	117	854,310	6000457433	16,158
118	859,860	6001824900	16,390	118	859,859	6000700976	16,390	118	859,861	6000139941	16,390
119	865,412	6000043883	16,624	119	865,411	6001042912	16,624	119	865,413	6001190371	16,624
120	870,963	6000797308	16,872	120	870,962	6001824338	16,872	120	870,964	6000635082	16,872
121	875,366	6001876937	17,079	121	875,365	6000726162	17,078	121	875,367	6000930642	17,079
122	878,622	6000090911	17,235	122	878,621	6000467904	17,235	122	878,623	6000321567	17,235
123	881,878	6001198571	17,395	123	881,877	6001077762	17,395	123	881,879	6001001884	17,395
124	885,135	6000985709	17,559	124	885,134	6000869973	17,559	124	885,136	6000789409	17,559
125	888,391	6000351451	17,725	125	888,390	6000760170	17,725	125	888,392	6001029538	17,725
126	891,647	6000320517	17,894	126	891,646	6001288371	17,894	126	891,648	6001628339	17,894
127	894,903	6000855995	18,077	127	894,902	6001087309	18,077	127	894,904	6000888679	18,077
128	898,159	6000341168	18,265	128	898,158	6001753584	18,265	128	898,160	6000847795	18,265
129	901,415	6000645542	18,459	129	901,414	6001697562	18,459	129	901,416	6001085341	18,459
130	904,672	6001041240	18,653	130	904,671	6001443155	18,653	130	904,673	6001275026	18,653
131	907,928	6001719366	18,855	131	907,927	6001629409	18,855	131	907,929	6001621890	18,855
132	911,184	6001223080	19,065	132	911,183	6000526635	19,065	132	911,185	6000610850	19,065
133	914,440	6000685235	19,287	133	914,439	6001110295	19,287	133	914,441	6001968988	19,287
134	917,696	6001276676	19,520	134	917,695	6001103741	19,520	134	917,697	6000527036	19,520
135	920,952	6001459617	19,759	135	920,951	6000032323	19,759	135	920,953	6001687211	19,759
136	924,209	6001401279	20,000	136	924,208	6001512946	20,000	136	924,210	6000453778	20,000
137	927,465	6001438719	20,256	137	927,464	6001100976	20,256	137	927,466	6001653377	20,256
138	930,721	6001193004	20,530	138	930,720	6000412878	20,530	138	930,722	6000060654	20,530
139	933,977	6001053297	20,820	139	933,976	6001860290	20,820	139	933,978	6000018244	20,820
140	937,233	6000254855	21,117	140	937,232	6000705407	21,117	140	937,234	6001794596	21,118
141	940,490	6000536948	21,432	141	940,489	6001176666	21,431	141	940,491	6001311083	21,432
142	943,746	6000744275	21,772	142	943,745	6001342687	21,772	142	943,747	6001302641	21,773
143	947,002	6001869085	22,124	143	947,001	6000463355	22,123	143	947,003	6000401187	22,124
144	950,258	6001763150	22,498	144	950,257	6001354954	22,498	144	950,259	6001867539	22,498
145	953,514	6000932422	22,905	145	953,513	6001109983	22,905	145	953,515	6001024573	22,905
146	956,770	6002040257	23,346	146	956,769	6001208199	23,346	146	956,771	6001454549	23,346
147	960,027	6001659363	23,835	147	960,026	6001009227	23,835	147	960,028	6000326111	23,835
148	963,283	6000608222	24,375	148	963,282	6001819958	24,375	148	963,284	6001889693	24,376
149	966,539	6001520252	24,956	149	966,538	6001013679	24,956	149	966,540	6000723722	24,957
150	969,795	6000112729	25,586	150	969,794	6001703609	25,586	150	969,796	6000534229	25,586
151	973,051	6001799826	26,321	151	973,050	6001509983	26,321	151	973,052	6001122693	26,321
152	976,307	6000726978	27,172	152	976,306	6001372642	27,171	152	976,308	6000645822	27,172
153	979,564	6000603582	28,155	153	979,563	6000545347	28,155	153	979,565	6000936383	28,156
154	982,820	6001234794	29,328	154	982,819	6001827396	29,328	154	982,821	6000004473	29,328
155	984,589	6000326601	30,069	155	984,588	6001060492	30,067	155	984,590	6001475141	30,069
156	984,870	6001043596	30,190	156	984,869	6000380928	30,189	156	984,871	6000261610	30,190
157	985,152	6001491937	30,304	157	985,151	6000148033	30,304	157	985,153	6000956895	30,305
158	985,433	6001098618	30,444	158	985,432	6001235872	30,443	158	985,434	6000364116	30,444
159	985,715	6000440051	30,592	159	985,714	6001425693	30,592	159	985,716	6000389078	30,592
160	985,996	6000983154	30,724	160	985,995	6000671094	30,723	160	985,997	6001969557	30,724
161	986,278	6000035055	30,860	161	986,277	6001390577	30,860	161	986,279	6000103157	30,860
162	986,559	6000529936	30,985	162	986,558	6000100425	30,985	162	986,560	6000146589	30,985
163	986,841	6001852897	31,147	163	986,840	6001513793	31,146	163	986,842	6000290021	31,147
164	987,122	6000186507	31,284	164	987,121	6001554903	31,284	164	987,123	6000132819	31,284
165	987,403	6000064776	31,449	165	987,402	6000490510	31,449	165	987,404	6000571801	31,450
166	987,685	6000024298	31,622	166	987,684	6001594343	31,621	166	987,686	6001211487	31,623
167	987,966	6000194343	31,775	167	987,965	6000942618	31,775	167	987,967	6001258302	31,775
168	988,248	6001504834	31,948	168	988,247	6000346962	31,948	168	988,249	6001238712	31,949
169	988,529	6000913361	32,110	169	988,528	6001053468	32,108	169	988,530	6000479238	32,111
170	988,811	6000946578	32,270	170	988,810	6000243601	32,268	170	988,812	6001240387	32,272

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Primary Sample for RC 07 (P)   **First Backup Sample for RC07 (FB)**   **Second Backup Sample for RC07 (SB)**

Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH	Sample #	Obs.	Device Location	Annualized KWH
171	989,092	6001791199	32,447	171	989,091	6001256927	32,446	171	989,093	6001294953	32,448
172	989,374	6001317832	32,644	172	989,373	6000162897	32,643	172	989,375	6001072751	32,645
173	989,655	6000100901	32,844	173	989,654	6001780870	32,844	173	989,656	6000466197	32,847
174	989,936	6001407252	33,055	174	989,935	6001632926	33,055	174	989,937	6001774656	33,055
175	990,218	6001696468	33,296	175	990,217	6000890144	33,294	175	990,219	6001477203	33,296
176	990,499	6001299277	33,520	176	990,498	6001996073	33,518	176	990,500	6001467411	33,520
177	990,781	6001767992	33,735	177	990,780	6001072054	33,735	177	990,782	6001185903	33,735
178	991,062	6000132854	33,971	178	991,061	6001898804	33,971	178	991,063	6001328136	33,972
179	991,344	6000779443	34,217	179	991,343	6000064856	34,217	179	991,345	6001471855	34,217
180	991,625	6001531238	34,488	180	991,624	6000447050	34,488	180	991,626	6000886683	34,488
181	991,907	6000946534	34,775	181	991,906	6001115788	34,773	181	991,908	6000106805	34,775
182	992,188	6001211593	35,089	182	992,187	6000728773	35,088	182	992,189	6000273700	35,089
183	992,469	6001784313	35,373	183	992,468	6001818932	35,373	183	992,470	6001816812	35,375
184	992,751	6001644291	35,692	184	992,750	6000964622	35,691	184	992,752	6000800116	35,695
185	993,032	6000482949	36,000	185	993,031	6001582501	36,000	185	993,033	6001346843	36,001
186	993,314	6001766336	36,362	186	993,313	6001649915	36,361	186	993,315	6001536058	36,363
187	993,595	6000500151	36,738	187	993,594	6000555865	36,738	187	993,596	6001254290	36,739
188	993,877	6000016899	37,106	188	993,876	6000176250	37,104	188	993,878	6000815150	37,106
189	994,158	6000788745	37,537	189	994,157	6001557052	37,535	189	994,159	6000519377	37,538
190	994,439	6000031211	37,983	190	994,438	6001804773	37,982	190	994,440	6001733879	37,983
191	994,721	6000663669	38,431	191	994,720	6001675625	38,428	191	994,722	6000362759	38,431
192	995,002	6000242577	38,909	192	995,001	6001108076	38,908	192	995,003	6000318270	38,910
193	995,284	6000048839	39,451	193	995,283	6001238213	39,450	193	995,285	6000294805	39,456
194	995,565	6001085365	39,988	194	995,564	6001051334	39,984	194	995,566	6000588391	39,988
195	995,847	6000215850	40,609	195	995,846	6000609015	40,608	195	995,848	6001756967	40,611
196	996,128	6000804143	41,205	196	996,127	6000275881	41,204	196	996,129	6001429184	41,205
197	996,410	6000944138	41,878	197	996,409	6000828140	41,877	197	996,411	6001841503	41,883
198	996,691	6000245258	42,578	198	996,690	6000144807	42,577	198	996,692	6001016098	42,582
199	996,972	6000268583	43,431	199	996,971	6000604417	43,430	199	996,973	6001328859	43,433
200	997,254	6000304826	44,345	200	997,253	6000940497	44,341	200	997,255	6000854982	44,347
201	997,535	6001138244	45,270	201	997,534	6000720849	45,266	201	997,536	6001481660	45,272
202	997,817	6001375948	46,398	202	997,816	6001536942	46,398	202	997,818	6001664394	46,398
203	998,098	6000733428	47,683	203	998,097	6000739766	47,679	203	998,099	6001230689	47,691
204	998,380	6001371810	49,130	204	998,379	6000643418	49,129	204	998,381	6001454821	49,130
205	998,661	6000005542	50,880	205	998,660	6000761894	50,873	205	998,662	6000240025	50,888
206	998,943	6001315850	52,804	206	998,942	6001801646	52,799	206	998,944	6001415689	52,808
207	999,224	6000122971	55,221	207	999,223	6001012562	55,193	207	999,225	6000325917	55,219
208	999,505	6000588958	57,781	208	999,504	6000872212	57,777	208	999,506	6000985685	57,781
209	999,787	6001219324	61,708	209	999,786	6000389048	61,697	209	999,788	6000622841	61,716
210	1,000,068	6001664677	65,953	210	1,000,067	6001774893	65,923	210	1,000,069	6000944606	65,966
211	1,000,350	6001485851	71,743	211	1,000,349	6001798484	71,733	211	1,000,351	6000723309	71,759
212	1,000,631	6002049626	79,751	212	1,000,630	6000394744	79,704	212	1,000,632	6001230689	79,770
213	1,000,913	6002017180	92,159	213	1,000,912	6001585194	92,124	213	1,000,914	6000444254	92,166
214	1,001,194	6001067513	113,963	214	1,001,193	6001905902	113,927	214	1,001,195	6000974443	114,007
215	1,001,476	6000882908	160,428	215	1,001,475	6000091994	160,033	215	1,001,477	6000845957	160,734

Reuse of the Existing Sample Meters with High Performance Records

In order to improve the performance of the sampled meters, other existing sampled metered data were evaluated. This includes existing load research sample meters, which were deployed in March 2011 and the 15-minute interval meter readings maintained by the Energy Efficiency Group for their program impact study. These existing meter data were evaluated for availability and quality of their interval load readings from September 2016 to February 2017. In total, 543 existing residential sample meters and 5,188 existing non-residential sample meters were examined. Through the meter reading performance evaluation, it was discovered that 329

residential meters and 3,757 non-residential meters have been producing accurate interval load readings for 99 or higher percent of time.

Since these meters have been verified for their high performance, we would save a good amount of time and effort spent previously for verifying, editing and estimating (VEE) the interval load readings, if we reuse those existing sample meters in place of the newly drawn samples whenever they are compatible with the new samples drawn.   For each rate class, those high performing meters were checked against the new samples for their compatibility in annual energy usage. Whenever the difference between the annual energy usage of an existing high-performance sample and a newly-drawn sample is within 5 percent, the existing sample replaced the new sample. This process resulted in a final list of primary samples made of 477 from the existing load research sample meters, 792 from the interval load meters being maintained by the Energy Efficiency Group, and 405 from the new samples drawn in accordance with the 2017 Load Research Sample Design. Since the number of interval load reading meters is limited by a budget constraint, the secondary backup samples were selected from only the existing sample meters. Table 4 below lists sources and sizes of the final primary, first backup and second backup samples by rate class:

Table 4

2017 Load Research Samples by Rate Schedule and Source

	Schedule 07				Schedule 24			
	Sources of Samples				Sources of Samples			
	Existing Samples				Existing Samples			
	L.R.	Other	New	Total	L.R.	Other	New	Total
Primary Samples	119	44	51	214	172	290	127	589
First Backup Samples	66	37	111	214	92	264	196	552
Second Backup Samples	30	15	0	45	62	218	0	280
Total	215	96	162	473	326	772	323	1421

	Schedule 25				Schedule 26			
	Sources of Samples				Sources of Samples			
	Existing Samples				Existing Samples			
	L.R.	Other	New	Total	L.R.	Other	New	Total
Primary Samples	46	102	38	186	19	107	21	147
First Backup Samples	23	96	46	165	8	75	46	129
Second Backup Samples	21	75	0	96	2	62	0	64
Total	90	273	84	447	29	244	67	340

	Schedule 29				Schedule 31			
	Sources of Samples				Sources of Samples			
	Existing Samples				Existing Samples			
	L.R.	Other	New	Total	L.R.	Other	New	Total
Primary Samples	50	137	106	293	50	79	51	180
First Backup Samples	10	66	115	191	11	42	34	87
Second Backup Samples	2	21	0	23	4	29	0	33
Total	62	224	221	507	65	150	85	300

	Schedule 43				Total			
	Sources of Samples				Sources of Samples			
	Existing Samples				Existing Samples			
	L.R.	Other	New	Total	L.R.	Other	New	Total
Primary Samples	21	33	11	65	477	792	405	1,674
First Backup Samples	8	23	5	36	218	603	553	1,374
Second Backup Samples	4	12	0	16	125	432	0	557
Total	33	68	16	117	820	1,827	958	3,605

Validation of the Final Samples

The main goal of sample design is to obtain unbiased samples to represent statistical properties of the target population within a pre-determined level of error tolerance. The maximum level of error tolerance with a 95 percent confidence limit set for the sample design was 3 percent for the residential rate class and 5 percent for all other rate classes. Validity of the samples selected for each usage bracket was evaluated comparing the mean value of the selected sample customers' annual energy usage with the population mean calculated for the rate-class usage brackets involved. There were 37 usage brackets to evaluate. As shown in Table 5 below, all the usage bracket samples selected for the "Primary" sample group perform significantly better than the

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pre-set error margin criteria, except the highest usage bracket samples selected for Rate Class 25I. Difference between the sample mean and the population mean for this rate class usage bracket is 5.1 percent, slightly over the 5 percent criteria. This usage bracket has only 30 large industrial customers with a high usage variance. Out of 24 samples required to meet the sample design criteria, 4 samples were selected from the existing Load Research Program samples and 3 samples were recruited from the current Energy Efficiency Program samples. Considering the benefit of reusing the existing samples with proven records, an error margin slightly above the 5 percent limit was deemed reasonable.

Future Plan

The interval load data to be collected from the new samples will be examined regularly for service changes and metering performance. The interval load readings will be verified, estimated and edited, and be post-stratified and expanded to develop class hourly load profiles as needed for electric cost of service study. Through the continuous monitoring and verification process, the load research meters with missing or erroneous readings for more than 5% of times will be sorted out. If a sub-performing meter is a primary sample, performance of its first backup meter will be evaluated. If the backup meter's performance rate is 95% or above, it will replace the primary meter for interval load data processing and hourly load profiling for the current and future months. If both the primary and the first backup meters fail the performance test, the second backup will be evaluated as a substitute. The large C&I customers whose interval loads are being read and stored in the MV-90 system will also be evaluated as a replacement for the failing samples. PSE plans to update its class load research sample design and selection every five years.

Table 5

Validity Test Results of the Final Primary Samples by Rate Class

RC 7

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 6,000*	0.2657	4,094	4,102	0.20%
6,001 -10,000	0.3295	7,892	7,946	0.68%
11,001 - 17,000	0.2771	12,864	12,857	-0.05%
17,001 - 30,000	0.1105	21,218	21,218	0.00%
> 30,000	0.0171	44,129	43,514	-1.40%
Total	1.0000	10,355	10,362	0.07%

Where W(h) = Usage bracket weight; Y(h) = Population Mean; y(h) = Sample Mean

RC 24C

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 16,000*	0.6816	4,666	4,664	-0.04%
16,001 -60,000	0.2272	30,999	30,921	-0.25%
60,001 - 180,000	0.0811	96,188	95,822	-0.38%
> 180,000	0.0100	303,750	297,478	-2.06%
Total	1.0000	21,075	20,963	-0.53%

RC 24I

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 16,000*	0.5247	6,433	6,441	0.13%
16,001 -60,000	0.3319	31,130	31,546	1.34%
60,001 - 180,000	0.1327	95,842	95,497	-0.36%
> 180,000	0.0106	397,576	397,576	0.00%
Total	1.0000	30,662	30,759	0.31%

RC 25C

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 220,000*	0.4134	130,478	130,368	-0.08%
220,001 - 450,000	0.3130	315,447	315,311	-0.04%
450,001 - 1,000,000	0.2146	644,594	644,371	-0.03%
> 1,000,000	0.0591	1,377,211	1,356,396	-1.51%
Total	1.0000	372,310	370,945	-0.37%

RC 25I

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 220,000*	0.4134	126,733	127,262	0.42%
220,001 - 450,000	0.3130	307,881	303,510	-1.42%
450,001 - 1,000,000	0.2146	667,491	662,662	-0.72%
> 1,000,000	0.0591	1,436,845	1,363,165	-5.13%
Total	1.0000	376,829	370,292	-1.73%

RC 26C

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 2,000,000*	0.4933	1,242,556	1,237,622	-0.40%
2,000,001 -4,000,000	0.4051	2,775,802	2,800,977	0.91%
> 4,000,000	0.1016	5,391,478	5,287,760	-1.92%
Total	1.0000	2,285,192	2,282,418	-0.12%

RC 26I

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 2,000,000*	0.5859	1,213,976	1,177,192	-3.03%
2,000,001 -4,000,000	0.2727	2,783,103	2,720,446	-2.25%
> 4,000,000	0.1414	5,340,681	5,166,295	-3.27%
Total	1.0000	2,268,889	2,207,644	-2.70%

RC 29

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 50,000*	0.8589	13,692	13,643	-0.35%
> 50,000	0.1411	91,757	91,757	0.00%
Total	1.0000	24,709	24,667	-0.17%

RC 31C

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 2,000,000*	0.6757	593,843	584,823	-1.52%
2,000,001 - 8,000,000	0.2725	3,984,168	3,939,590	-1.12%
> 8,000,000	0.0518	13,371,056	13,371,056	0.00%
Total	1.0000	2,179,128	2,160,886	-0.84%

RC 31I

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 2,000,000*	0.5462	636,363	605,158	-4.90%
2,000,001 - 8,000,000	0.3231	4,846,963	4,747,255	-2.06%
> 8,000,000	0.1308	13,829,097	13,829,097	0.00%
Total	1.0000	2,466,668	2,418,413	-1.96%

RC 43

Annual kWh Range	W(h)	Y(h)	y(h)	% Diff.
0 - 1,000,000*	0.8261	506,784	501,626	-1.02%
> 1,000,000	0.1739	1,734,804	1,734,804	0.00%
Total	1.0000	720,353	716,092	-0.59%