Rocky Mountain Power
Exhibit RMP___(RMM-2)
Docket No. 16-035-36
Witness: Robert M. Meredith

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF UTAH

ROCKY MOUNTAIN POWER

Exhibit Accompanying Direct Testimony of Robert M. Meredith

Load Research Sampling Procedures

January 2017

Draft Proposed Sampling Plans, Procedures and Selections for the Profile Metering Sample of

Utah Electric Vehicle Time of Use
2016

Prepared by the Load Research Group
December 2016

Executive Summary

This sample design will be prepared in support of the Load Research Company Cost-of-Service commitment, with the intent of installing a load study on the Company's Utah Residential Electric Vehicle Owner Customer Class. All sample designs will be prepared in accordance with PURPA standards and, as such, are expected to provide estimates of system peak demand that achieve, at a minimum, ± 10% at the 90% confidence level.

Draft Utah Electric Vehicle Time of Use (2016)
Load Recorder Study
Proposed Sampling Procedures

This paper describes the procedures to be used in development of the Utah Electric Vehicle (EV) Time of Use (TOU) Load Study. This study will provide load data to estimate the peak energy use shift associated with a TOU program before the Utah Public Service Commission, and for use in other studies of EV owner customer demand characteristics. Recorders will be placed in service effective no later than December 31, 2017, and will be monitored on a continuous basis to insure no significant deviation from billing records.

Proposed Sampling Plan for Utah

This section provides an overview of the process to be used for implementing the Utah EV TOU Load Study. The sampling plan includes several steps:

1. Formalization of sample parameters;
2. Specification of the target variable;
3. Choice of the stratification variable;
4. Choice of the method for estimating kW;
5. Choice of the number of strata;
6. Construction of strata boundaries;
7. Allocation of sample points to each stratum;
8. Selection of sample sites.

Formalization of the sample parameters

Input data to be utilized in this design includes billing data for the period January 2016 – December 2016. The design will be based on a stratified random, single-dimensional sampling schema.

In this approach, customers with similar characteristics are grouped together into non-overlapping, homogeneous groups called "strata," and individual samples are selected from each stratum.

Specification of the target variable

Current cost study methods use the average demand at the hours of the PacifiCorp system peak for twelve consecutive months, as well as estimates of distribution and individual customer maximum demands, each averaged over twelve consecutive months.

The proposed Utah EV TOU Load Study will be prepared in accordance with PURPA standards and, as such, are expected provide estimates of system peak demand that achieve, at minimum, ±10% precision at the 90% confidence level.

Billing data for the twelve months ending December 2016 will be used to determine appropriate stratification.

Choice of the Stratification Variable

A potential stratifying variable, according to Cochran, should meet three criteria:[1]

1. The population is composed of institutions varying widely in size.
2. The principle variables to be measured are closely related to the sizes of the institutions.
3. A good measure of size is available for setting up the strata.

Average monthly billing kWh, which is the average monthly energy registered over a twelve consecutive month period, was selected as the best available variable for this purpose.

Choice of Method for Estimating kW

Mean per unit (MPU) methodology will be used to estimate peak demand. To estimate a peak demand for a population using MPU, the mean peak demand value from the sample is multiplied by the number of elements in the entire population. Use of the MPU method provides an unbiased estimate.

Choice of the Number of Strata

As the number of strata increases, precision of the estimate of the total contribution to demand (kW) at system peak also increases. However, the increase in precision per additional stratum diminishes after a relatively small number of strata.[2] Desire for simplicity and for a reasonable number of sites in each stratum lead to a preference for a small number of strata. A final decision on the number of strata requires actual cost comparison of potential stratification schemes to evaluate effectiveness versus cost. For this study, a three or four strata scheme will be employed and will be consistent with the recommendation of the Utah Load Research Working Group for sample design.

Construction of Strata Boundaries

Various methods might be used for definition of strata boundaries. Cochran found the "cumulative square root of f" rule, as defined by Dalenius and Hodges (1959), to be superior in a comparative study of such methods applied to actual distributions exhibiting a range of skewness.[3]

Steps in calculating strata boundaries under the "cumulative square root of f" rule are as follows. First, tabulate frequencies of the stratifying variable. For these studies, monthly energy from customer billing records for the twelve months ending December 2016 will be used. All Utah residential customers with an EV, whose end of year status was active, will be included in this procedure, and in population figures for the sample design. Second, multiply the number of customers in each interval by the interval factor. Third, take the square root of these frequencies. Fourth, cumulatively sum the square roots.

[1] William G. Cochran, "Sampling Techniques", Third Edition, Wiley, pg.101
[2] William G. Cochran, "Sampling Techniques", Third Edition, Wiley, Pg. 132
[3] William G. Cochran, "Sampling Techniques", Third Edition, Wiley, Pgs. 129-130

The resulting distribution of adjusted cumulative square roots of frequency is then partitioned into equal intervals by dividing by the number of strata. The final stratification scheme assuming three and four strata will be developed. This will show optimal boundaries resulting from the above procedure, after adjustments made to accommodate prior cost analysis requirements (if any).

Allocation of Sample Points to Each Stratum

Once the stratum boundaries have been determined, sample points (i.e., load recorders) must be assigned to the strata. The Tschprow-Neyman allocation procedure allocates an optimal sampling rate to each stratum.[4] Optimal allocation techniques minimize the variance of the population estimates by increasing the sample proportion in the strata having larger variances. This produces a sampling rate for each stratum which is proportional to the standard deviation within the stratum.

Billing energy was selected as the stratification variable. These data will be used to provide estimates for the new Utah EV TOU sample design. For the MPU method, the variance within each stratum was the ordinary variance of the mean.

Sample Selection

Systematic sample selections will be used for each stratum to ensure a representative distribution. For practical reasons, inactive customers, indicated by absence of a kWh meter number), and customers with very low consumption (<250 kWh total in the past 12 billing periods) will be eliminated from the sampling frame.

Eligible customers will then be sorted by stratum and by average monthly billed demand within stratum. The number of customers available in the sampling frame for each stratum will then be divided by the number of recorders allocated to that stratum (Nh/nh), yielding the sampling interval size. A five digit random number between 0 and 1 is then chosen for each stratum, and multiplied by the stratum interval size to obtain the starting selection point for each stratum. Beginning with this site, additional sites will be selected at the given sampling intervals to obtain the desired number of sample sites. This procedure is then repeated four times to provide a list of alternate selection sites.

[4] William G. Cochran, “Sampling Techniques”, Third Edition, Wiley, pgs. 96-99