Witness OCS – 2D
Phase 3

BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

In the Matter of the Application of Rocky Mountain Power to Implement Programs Authorized by the Sustainable Transportation and Energy Plan Act	**)** **)** **)** **)** **)**	**Docket No. 16-035-36** **Direct Testimony of** **Jacob Thomas** **on Behalf of the** **Office of Consumer Services**

APRIL 6, 2017

Q. PLEASE STATE YOUR NAME AND PLACE OF EMPLOYMENT.

A. My name is Jacob M. Thomas. I am employed by GDS Associates, Inc. ("GDS"), and my office is located at 1850 Parkway Place, Suite 800, Marietta, Georgia 30067.

Q. WHAT POSITION DO YOU HOLD?

A. I hold the position of Senior Project Manager.

Q. ON WHOSE BEHALF ARE YOU SUBMITTING THIS TESTIMONY?

A. I am submitting this testimony on behalf of the Utah Office of Consumer Services ("OCS").

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND?

A. I graduated from the Georgia Institute of Technology with a Bachelor of Science in Industrial Engineering in 2000. I received a Master's in Business Administration with a concentration in Finance from Auburn University in 2006.

Q. PLEASE DESCRIBE YOUR WORK EXPERIENCE.

A. I began working with GDS in June 1996 as a cooperative student while attending the Georgia Institute of Technology. After graduation in December 2000, I accepted a full-time position in GDS's Distribution Services department and have risen to my current position of Senior Project Manager in that department. In the past 20 years, I have provided statistical, financial, and economic consulting to utilities and regulatory agencies nationwide.

In the area of statistics, I have provided services to clients with respect to load forecasting, market research, sample design, load research, measurement and verification, and other statistical modeling. I have produced dozens of load forecasts, participated in and managed all aspects of load research studies, managed customer survey processes, and performed impact evaluations of demand response and energy efficiency programs for several clients. I have also evaluated short-term and long-term price elasticity of demand for forecasting purposes.

In the areas of finance and economics, I specialize in retail and wholesale cost of service development and design, retail and wholesale rate design, financial forecasting, economic impact analysis, and benefit-cost analysis of demand response programs. In the past three years, I have managed or had significant input into cost of service, rate design, and financial forecasting projects for twenty different clients. I have performed benefit-cost analyses for an additional eight clients in that time.

My resume is provided as exhibit OCS __JMT-1.

Q. DO YOU HAVE ANY PROFESSIONAL REGISTRATIONS AND MEMBERSHIPS?

A. Yes, I am a registered Professional Engineer in Georgia. I am a member of the Institute of Industrial Engineers and the American Statistical Association.

Q. HAVE YOU TESTIFIED IN UTAH IN THE PAST?

A. No, I have not testified as an expert witness in Utah prior to this proceeding. However, I have participated in the development of expert reports submitted to and used by the OCS in proceedings here in Utah.

Q. HAVE YOU TESTIFIED IN OTHER REGULATORY PROCEEDINGS?

A. Yes, I have testified as an expert witness in several other states and been a co-author of joint reports filed in cases as well. I testified as an expert before the Vermont Public Service board, providing testimony regarding the economic impacts of continued operations of the Vermont Yankee nuclear power plant. I testified in the area of weather normalization of gas sales before the Michigan Public Service Commission. I also testified before the North Carolina Utilities Commission, providing testimony supporting cost of service computations for an intervenor. In 2017, I testified before the North Dakota Public Service Commission. I testified in the areas of load research, cost of service, and retail rate design. I have also been a co-author of reports in connection to cases before the Delaware Public Service Commission, the Kentucky Public Service Commission, as well as those in Utah referenced above. In those joint reports, prepared in coordination with other GDS experts, I was tasked with focusing on demand response, load research, and load forecasting issues.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. My testimony focuses on Rocky Mountain Power's ("RMP") load research program designed to collect load data for its Electric Vehicle ("EV") Time-of-Use ("TOU") pilot rate. After briefly describing the current load research design, I recommend a second dimensional stratification variable based on the type of Electric Vehicle Supply Equipment ("EVSE" or "charger") installed in the home, and provide supporting discussion to demonstrate the importance of the type of EVSE in the load research design.

Q. CAN YOU BRIEFLY DESCRIBE THE LOAD RESEARCH DESIGN RECOMMENDED BY RMP FOR THE EV TOU PILOT?

A. Yes, RMP witness Robert Meredith has provided direct testimony and exhibits regarding the Company's load research design. In summary, Mr. Meredith's exhibits RMP__(RMM-1) and RMP__(RMM-2) set forth RMP's suggested load research design as consisting of a single-dimensional stratified random sample with 90% confidence and ±10% precision. The sample will be stratified based on average monthly energy consumption for EV owners. RMP will rely on Utah Department of Motor Vehicle registrations to identify which residential customers are EV owners. Mr. Meredith indicates that a third-party intermediary may be used to protect personal information.[1]

[1] Direct testimony of Robert Meredith, page 9, lines 205-208.

Q. PLEASE DESCRIBE THE CONCEPT OF STRATIFICATION IN SAMPLE DESIGN.

A. Stratification is the process by which the population is divided into mutually exclusive, nonoverlapping groups. The groups are called strata. The technique can increase the precision of sample estimates for a population and/or reduce the required sample size if individuals within each stratum are more homogenous than the overall population[2].

The Association of Edison Illuminating Companies' *Load Research Manual* lists four situations in which stratification may be useful:

1) The population contains obvious divisions;
2) A limited sample must be drawn from a large population while maintaining certain precision goals;
3) The estimate of the load characteristics requires increased precision;
4) Specific data are required on division of the population.[3]

It is not uncommon in a load research study to use monthly or annual energy as a stratification variable, especially for the residential class. This is the approach recommended by Mr. Meredith's testimony and exhibits. Stratifying by energy use will ensure that different consumption levels are appropriately represented in the sample. RMP's

[2] Cochrane, William G. *Sampling Techniques*. 3rd ed. New York: John Wiley & Sons, 1977.
[3] Association of Edison Illuminating Companies. *Load Research Manual*. 2nd ed. 2001.

design is single-dimensional because it is stratifying by only one variable – energy consumption.

Q. DO YOU RECOMMEND ANY REVISIONS TO RMP'S SAMPLE DESIGN?

A. Yes, I recommend RMP adjust its design from a single-dimensional to a two-dimensional design. The second dimension would be the type of charger used in the home to charge the EV.

Q. WHY SHOULD THE TYPE OF CHARGER BE INCLUDED AS A VARIABLE IN THE SAMPLE DESIGN?

A. When selecting a stratification variable, the best characteristic upon which to stratify is the variable of interest in the study. For the EV TOU study, the purpose of the study is described in Mr. Meredith's Exhibit RMP__(RMM-1), the "Draft Utah EV TOU Pilot Study" dated December 2016:

> "…it is necessary for the Company to implement a load research study to accurately measure how peak load for these customers will shift under two TOU regimes."

Therefore, the variable of interest is the amount of energy consumed during on-peak and off-peak periods as defined by pilot TOU rate designs. When information about the variable of interest is unavailable for the population, the next best stratification option is the frequency distribution of some other variable that is highly correlated with the variable of

interest.[4] Monthly energy consumption is often a highly correlated variable with the variables of interest in a load research study (typically, peak demand contributions are important for load research, but timing of consumption can also be of interest). Therefore, I agree with RMP's recommendation of using energy consumption as a stratification variable.

However, in this study, a primary goal is to measure the timing of consumption specific to owners of EV. The type of charger the homeowner uses is likely to be highly correlated with the home's consumption patterns during on- and off-peak periods. Further, different types of chargers are likely to result in substantially different consumption patterns. To ensure the load research sample is representative of the population of EV owners, I recommend using the type of charger in the home as a secondary stratification variable for RMP's load research design.

Q. HOW MIGHT CHARGER TYPE BE CORRELATED WITH TIMING OF HOME CONSUMPTION?

A. For in-home charging, there are generally two types of chargers available: Level 1 and Level 2.[5] Level 1 chargers are compatible with standard US 120 volt outlets, and charging time can take from 8-16 hours to completely

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[4] Cochrane, William G. *Sampling Techniques*. 3rd ed. New York: John Wiley & Sons, 1977.

[5] Although DC direct fast charging units are available, they are typically installed in public places. Although unexpected, RMP may find a portion of the residential population with chargers other than Level 1 and Level 2, in which case I would recommend they take additional charger types into account.

charge a depleted battery. Level 2 chargers require a 208 or 240 volt outlet and may require a dedicated circuit be installed in the home. A Level 2 charger will typically take 4-6 hours to fully charge a depleted battery.

Given the different electrical characteristics of the two kinds of chargers, it is reasonable to assume that usage patterns specifically related to the use of the chargers would be different. Although a homeowner might simply plug their vehicle in overnight, the two types of charging stations will produce different load patterns for that overnight charge. Furthermore, research suggests that Level 1 stations are less efficient than Level 2 stations, and that the efficiency difference increases during extreme climatic conditions.[6,7] Xcel Energy conducted a pilot evaluation of EV in 2015, and found that a 25% portion of their population performed charges in the morning before work as opposed to overnight, creating a primary peak for the EV system overnight and a secondary peak at about 8:00 to 9:00 in the morning.[8] Although this effect might be attributable to a small sample, it also could indicate a difference in behavior for certain owners of Level 2 charging equipment.[9] It would be difficult to achieve a reasonable charge in just a few hours before work on

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[6] Forward, Evan, Karen Glitman, and David Roberts. “An Assessment of Level 1 and Level 2 Electric Vehicle Charging Efficiency.” Vermont Energy Investment Corporation Transportation Efficiency Group. March 2, 2013 (Revised).
[7] “ENERGY STAR Market and Industry Scoping Report: Electric Vehicle Supply Equipment.” September 2013.
[8] “Electric Vehicle Charging Station. Pilot Evaluation Report.” Xcel Energy, May 2015.
[9] Xcel’s study only evaluated Level 2 EVSE.

a Level 1 system with such long charging times required for the equipment. These examples demonstrate the potential for differing load patterns by EVSE in homes, even if all other variables of electricity consumption in the home are the same.

Furthermore, stratification by only monthly energy consumption might mask these differences that are important to the study design. For instance, an all-electric home with a Level 2 EVSE may very well have the same monthly consumption as a home with an evaporative cooling system instead of central air conditioning and a Level 1 EVSE charger. In RMP's current load research design, each of these homes would have equal probability of being selected to participate as a control or pilot TOU participant. With my recommendation of including the EVSE equipment type as a secondary dimension of stratification, these two homes would have different probabilities of selection, being more representative of the proportion of homes with Level 1 or Level 2 charging equipment and with that typical monthly energy consumption.

Q. COULD RMP'S SINGLE-DIMENSIONAL STRATIFICATION PLAN NATURALLY CAPTURE A REPRESENTATIVE POPULATION OF CHARGER TYPES?

A. One might argue that stratifying by household consumption might naturally sort out the charger types in the population. However, many different factors impact household consumption, including but not limited to: the size of the home; the efficiency of the building shell; the quantity, size, and

efficiency of electric end-use appliances; the number of persons residing in the household; and behavioral characteristics of the occupants. These variables along with the type of EV charger in the home would combine to determine the consumption and therefore the stratum into which the home would be placed. RMP could not guarantee that the final sample was representative of the EV population with respect to the type of EVSE in the home without ensuring such representation during the design phase of the load research project.

As a hypothetical example of how bias with respect to the EVSE could occur, it could be that the incentive offered to participate in the pilot load research study is more attractive to homeowners with Level 1 chargers. In such a hypothetical and under RMP's proposed load research approach, the Company would not know if they accidentally end up oversampling Level 1 customers.

As another example, without knowing in advance the type of charger in the home, RMP may coincidentally place an unrepresentative proportion of Level 1 chargers into either the control group or one of the TOU EV groups. When comparisons between the groups are made, it may lead to incorrect conclusions about the effectiveness of the TOU rate designs.

Q. HOW DOES THE RECOMMENDED CHANGE TO THE LOAD RESEARCH PLAN IMPACT THE STUDY?

A. My recommendation will require additional effort and perhaps more load research meters be placed by RMP[10]. As an additional measure in defining its load research study, RMP would have to identify the proportion of homes with Level 1 and Level 2 chargers. This would need to be determined in a manner to provide a reasonable estimate of the overall population proportions. RMP and its intermediary working with DMV data might be able to find existing information representative of Utah EV owners, or they might have to perform a simple high-level survey of many EV owners to determine the proportions. Then, the two-dimensional sample can be designed to incorporate both household consumption and type of charger.

There are likely different ways RMP could estimate the population proportions of charger type. One approach RMP could employ to accomplish this is a Two-Phase sampling approach, in which a sample is first taken to better understand the population proportion. For instance, a recruitment letter might be sent to all 2,000 EV owners encouraging response to an online tool or by mail with the type of charger they own. Then a second sample is designed and recruited for the double-stratified load research design. This Two-Phase design approach is common in the

[10] As described by Mr. Meredith in his direct testimony (page 10, lines 211-213) and in Exhibit RMP__(RMM-2), the final sample size will not be known until population characteristics can be ascertained. However, it could be that a multi-dimensional study will require an expansion in the sample size if any individual stratum is assigned too few participants.

area of Load Research when performing an end-use study to determine load profiles for a particular electric appliance.[11]

Q. CAN YOU SUMMARIZE YOUR TESTIMONY?

A. I recommend that RMP take the type of EV charging equipment installed into the home into account as a part of its load research study supporting the TOU EV pilot evaluations. The charger type installed in the home could have a significant impact on the timing and amount of energy consumed during on-peak and especially off-peak periods of the TOU rate and is therefore of importance to the pilot evaluation. Although additional effort and perhaps load research samples will be required to account for the difference, it is my opinion such additional effort would provide a more representative sample and therefore greater precision in the evaluation of TOU EV rate design.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

[11] Association of Edison Illuminating Companies. *Load Research Manual*. 2nd ed. 2001.