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BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

In the Matter of the Application of Rocky Mountain Power to Establish Export Credits for Customer Generated Electricity	**Docket No. 17-035-61 Phase 1** Vote Solar Exhibit 1.0 (DT)

DIRECT TESTIMONY OF RICK GILLIAM

ON BEHALF OF

VOTE SOLAR

March 22, 2018

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INTRODUCTION

Q: Please state your name and business address.

A: My name is Rick Gilliam. My business address is 590 Redstone Drive, Suite 100, Broomfield, CO 80020.

Q: On whose behalf are you testifying?

A: I am testifying on behalf of Vote Solar.

Q. Please describe Vote Solar.

A. Vote Solar is a non-profit organization working to foster economic opportunity, promote energy independence, and fight climate change by making solar a mainstream energy resource across the United States. Vote Solar was founded in 2002 in order to lower solar costs and expand solar access to make solar power a universal energy resource nationwide. Since our founding, we have engaged in state, local, and federal advocacy in order to help stabilize the global climate as well as to improve health, well-being, and economic opportunity for all people living in the U.S. Vote Solar is not a trade group nor does it have corporate members. Vote Solar has over 80,000 members across the country and approximately 200 members in Utah, many of whom are customers of Rocky Mountain Power ("RMP").

Q: Please provide your professional experience and qualifications.

A: I have been with Vote Solar since January of 2012 overseeing policy initiative development and implementation particularly as it relates to distributed solar generation. Prior to joining Vote Solar, my regulatory and policy experience included five years in

the Government Affairs group at Sun Edison, one of the world's largest solar developers at the time, as a manager, director, and eventually vice president; twelve years with Western Resource Advocates as Senior Policy Advisor; and twelve years in the Public Service Company of Colorado rate division as Director of Revenue Requirements. Prior to that, I spent six years with the Federal Energy Regulatory Commission as a technical witness. All told, I have nearly 40 years of experience in utility regulatory matters.

I have a Master's Degree in Environmental Policy and Management from the University of Denver and a Bachelor of Science Degree in Electrical Engineering from Rensselaer Polytechnic Institute in Troy, New York. My CV is attached at the end of this testimony.

Q: Have you testified previously before this Commission?

A: Yes, I testified in Docket Nos. 01-035-10 and 99-035-10. More recently, I testified in RMP's most recent rate case Docket No. 13-035-184 on the solar surcharge proposed by RMP and the subsequent Compliance Filing in Docket No 14-036-114 which led to the filing of this Export Credit proceeding. I have also testified in proceedings before the Arizona Corporation Commission, the Public Utilities Commission of Colorado, the Idaho Public Utilities Commission, the Kansas Corporation Commission, the Nevada Public Utilities Commission, the New Mexico Public Regulation Commission, the Wisconsin Public Service Commission, the Wyoming Public Service Commission, and the Federal Energy Regulatory Commission.

PURPOSE AND SUMMARY OF TESTIMONY

Q: What is the purpose of your testimony?

A: The purpose of my testimony is to address the proposed load research plan of RMP submitted to this Commission on February 15, 2018 through the testimony of its witness Kenneth Lee Elder.

Q. Please summarize your testimony.

A. My testimony first reminds the Commission that the data to be collected during Phase 1 of this proceeding will be the only opportunity for intervening parties to identify the customer data needed to carry our burden of proof in Phase 2. Because RMP has sole access to the data and is the proponent of the Phase I load research plan, it is Vote Solar's position that RMP should bear the ultimate risk associated with technically insufficient or improper sampling. Vote Solar reserves all rights to challenge the validity of any subsequent RMP studies, analyses, or conclusions on grounds that the sample size is insufficient in either quantity or quality.

I find that RMP's proposed load research plan does not acquire the data necessary for the analyses Vote Solar intends to perform. In particular, RMP should collect temporally and locationally consistent delivery, export, and production data from individual customers in the two groups with rooftop solar systems – grandfathered and transition customers. There are 36 grandfathered customers that already have both production and load profile meters, and data should be collected to provide an adequate and representative sample of the load profile of such grandfathered customers. I also recommend collecting the data for transition customers by installing production meters at the same time as residential billing meter change-out until an adequate sample is obtained or until initial date of the data collection, whichever comes first. It is also important for Vote Solar's analyses that

any approved load research plan include a larger sample size that includes consumption data for grandfathered and transition customers both before and after rooftop solar installation and that RMP identify each customer's major appliances and other electrical devices in use behind the meter.

Because this proceeding will result in valuing and pricing rooftop solar generation net exports, the total load of each rooftop solar customer is the most appropriate variable to be used for stratification as it will capture the load diversity in the residential and small commercial customer classes which directly impact the level of exported energy. Accordingly, Vote Solar objects to RMP's proposed use of rooftop solar capacity as the auxiliary variable.

It is also critical to identify the characteristics of each system including verified system capacity, orientation and tilt angle, as well as the location (by zip code) and estimated degree of shading as part of the research plan.

Finally, I find RMP should sample and gather data for small commercial customers based on the same criteria used for the residential customers, as modified herein, and should collect the additional information previously noted for commercial customers as well.

SUMMARY OF THIS PROCEEDING

Q. Please summarize the events that led to the RMP load research plan submittal.

A. This proceeding arises from the Settlement Stipulation ("Stipulation") that concluded Docket No 14-036-114. As part of the Stipulation, paragraphs 28 to 31 address the initiation, purpose, and process of a new Export Credit proceeding to determine the

compensation for exported power from customer generation systems, taking into account evidence addressing reasonably quantifiable cost and benefits presented by parties.

This docket has been split into two phases. The first phase addresses the gathering of data and load research to be used by all parties as a basis for the evidence to be presented in the second phase. The second phase will address the Export Credit itself.

Q. Are there any other preliminary matters you wish to address?

A. Yes. Because I will frequently refer to three different groups of rooftop solar customers in my testimony, I set forth here, at the outset, my definitions of these groups.

Grandfathered customers: This group is comprised of the customers who either installed or submitted a complete interconnection application to install rooftop solar systems by 12:00 a.m. on November 15, 2017. These customers will remain on net metering service Schedule 135 through December 31, 2035. After the grandfathering period, these customers will become subject to the applicable rate class and any rate and rate structure then in effect that would otherwise apply to those customers. In common terms, these are conventional net metering customers during the grandfathering period.

Transition customers: This group is comprised of the customers who submitted a complete interconnection application to install rooftop solar systems after 12:00 a.m. on November 15, 2017 and before the Commission issues a final Order in this Export Credit proceeding or the transition program reaches the designated capacity cap. These customers are subject to a compensation structure that is different than net metering service in that imported energy and exported energy are netted every fifteen minutes. Net imports are paid by the customer to RMP at the customer's otherwise applicable rate, while net exports are compensated by RMP to the customer at rates set forth in paragraph 19 of the Stipulation. This structure (Schedule 136), which I refer to as a net billing mechanism, remains in place for this group until the end of the transition period - December 31, 2032, at which time these customers will become subject to the applicable rate class and any rate and rate structure then in effect that would otherwise apply to those customers.

Post-transition customers: This group is comprised of the customers that submit a complete interconnection application to install rooftop solar systems after the Commission issues a final Order in this Export Credit proceeding or the transition program reaches the designated capacity cap. These customers will be subject to the rates and terms resulting from this proceeding.

RMP LOAD RESEARCH STUDY PROPOSAL

Q. Please describe the proposed load research plan submitted by Rocky Mountain Power.

A. RMP's load research plan acknowledges that RMP should collect a statistically significant[1] sample of profiles for energy delivered from the grid to customers with rooftop solar systems,[2] and energy exported from those customers to the grid from their rooftop solar systems, net of any energy consumed on-site, in order to calculate the value of energy exported. According to RMP, the study is intended to "further supplement the body of data available and to better understand the intertemporal relationship between [rooftop solar], delivered energy, exported energy, and full requirements energy."[3]

To gather the data required for the load research plan, RMP proposes a systematic-random sample size of just 70 sites that it contends will represent the population according to key variables of interest with a minimum accuracy of plus or minus 10% at the 95% confidence level. RMP proposes to stratify the sample, *i.e.*, subdivide the group of 70 into smaller groups, on the basis of the capacity of the rooftop solar systems, in an effort to improve homogeneity and reduce the sample size necessary for the Phase 2

[1] RMP's actual proposal, however, will not yield a sample that is sufficient to draw statistically significant conclusions.
[2] RMP uses the confusing term "private generation" based upon an Edison Electric Institute communications handbook dated April 12, 2016. According to the handbook, the equivalent term in common use is "distributed generation." In response to Vote Solar Discovery Request 1.25, RMP explains that "private generation" explicitly indicates the distinction in ownership, adding to the confusion. Whether the solar generation is owned by the utility, a customer, or a third party, it is all privately owned. This proceeding specifically addresses the export credit rate for rooftop solar installations; thus, I will use the common and well understood term "rooftop solar" throughout this testimony.
[3] Elder Direct Testimony, lines 26-28.

analyses. It further proposes to use production data it currently obtains from the existing 36 grandfathered customers' production meters and deploy another 34 production meters on grandfathered customers to achieve a purportedly complete set of data for the group of 70 required. Finally, it appears the plan would utilize a single sampling analysis for residential and small commercial customers.

Q. Do you have concerns with RMP's proposal?

A. Yes, I do. The Stipulation included the following language in paragraph 30:

> 30. In the Export Credit Proceeding, the Commission will determine a just and reasonable rate for export credits for customer generated electricity. Parties may present evidence addressing reasonably quantifiable costs or benefits or other considerations they deem relevant, but the Party asserting any position will bear the burden of proving its assertions (for example, parties may present evidence addressing the following costs or benefits: energy value, appropriate measurement intervals, generation capacity, line losses, transmission and distribution capacity and investments, integration and administrative costs, grid and ancillary services, fuel hedging, environmental compliance, and other considerations). The Commission will also determine the appropriate study period over which to quantify and model export credit components. In addition, the Parties agree that nothing from the November 2015 Order or other aspects of this Docket No. 14-035-114 will: (a) limit or preclude a Party from presenting evidence in the Export Credit Proceeding identified in this Paragraph 30, or (b) be precedential in the Export Credit Proceeding or any future case. (emphasis added)

Because each party presenting evidence addressing reasonably quantifiable costs or benefits or other considerations bears the burden of proof, the importance of a robust and properly sampled data set upon which all parties can base analyses and recommendations cannot be overstated. There is an information asymmetry in regulatory proceedings because the utility has access to far more data at a granular level than other participants in the proceeding. Importantly, the utility is not unbiased. RMP generates and sells electricity in competition with rooftop solar providers and has an economic incentive to

bias data in favor of its own recommendations in Phase 2. Limiting the load research plan in the manner set forth by RMP limits the ability of intervening parties to perform the analyses needed for Phase 2 of this proceeding, including analyses that may challenge the conclusions put forward by RMP. RMP should not be able to dictate the data intervenors have available with which to work, while also putting the onus on those parties to prove their cases. Moreover, once a plan is approved by the Commission and the load research begins, any data the parties believe they would need that is not collected is lost. There is no going back to access more complete and consistent data.

For all of these reasons, the Commission should err on the side of the requests for data collection in the load research plan by non-utility parties with no other avenue for source data. RMP's analysis is subject to basic measurement flaws including (1) a failure to measure the most relevant variables of interest, (2) a failure to design the sample size to take into account variability in the load profile of residential customers, (3) a failure to assess statistical significance based upon the non-binary characteristics of such load profiles, and (4) an inability to draw statistically significant conclusions as to either production or consumption of energy from the inadequate samples and improper mixing of data proposed by RMP. The risk of incomplete or inaccurate analyses due to improper sampling or under-sampling should lie squarely with RMP.

Q. Do you have specific concerns with RMP's approach to load research for the purposes of determining an export credit for rooftop solar systems?

A. Yes, I do. I will break down the discrete elements of the load research plan and propose changes in the areas required.

- **Data to be collected**: There are three streams of energy or load data that can be metered and collected. These are the (1) imports of energy by customers from the grid, (2) exports of energy from the customer to the grid, and (3) on-site production of energy by the rooftop solar system. I have concerns about the proposed sources of data, *i.e.*, from whom to collect each stream of data and how RMP proposes to combine it to produce load curves. In addition, I believe that information related to behind the meter electrical devices is important.
- **Variable of interest**: I disagree with RMP's variable of interest and the auxiliary (*i.e.*, proxy) variable upon which RMP proposes to subdivide, or stratify, its sample. The selection of the variable of interest and auxiliary variable, if necessary, will have a profound effect on the appropriate size of the sample.
- **System characteristics**: I believe rooftop system characteristics including verified system capacity, orientation, tilt, location, and shading are important characteristics of each system that can significantly affect the results and should be captured.
- **Customer classes**: I don't believe a single data set based on the residential class is representative of the data set for small commercial customers.

DATA TO BE COLLECTED

Q. Please identify your concerns with the data to be collected.

A. I have three concerns. First, RMP proposes to mix production data from grandfathered customers with import and export data from transition customers to construct load curves for rooftop solar customers in Utah. While it is important and helpful to have data from

before and after November 15, 2017 in order to understand changes in the market interest for rooftop solar capacity, I believe it's inappropriate to mix and match this data for individual customers as RMP proposes to do. Second, because grandfathered customers installed their systems under a different set of economic conditions from transition customers, data from each group should remain separated. Third, other electrical devices on customer premises can impact both the timing and magnitude of net exports and should be documented as part of the research plan.

Q. Please explain your first concern with RMP's data collection proposal.

A. There are three streams of data to be collected from rooftop solar customers in order to get an accurate picture of the consumption patterns of individual customers – (1) deliveries, (2) exports, and (3) total rooftop solar system production. Acquiring these three streams from the same customers provides the information necessary to determine an accurate picture of the total and behind the meter consumption patterns of the host customer.

RMP, however, proposes to "acquire a census of export and delivery data from Schedule 136 [transition] customers, whereas the generation sample will be based on Schedule 135 [grandfathered] customers."[4] RMP believes "a single production profile and the sample data used to derive it should be sufficient to provide an understanding of (A) Full Requirements Usage and (C) "Behind the Meter' Consumption for this proceeding."[5]

[4] Elder Direct Testimony, lines 211-213.
[5] Response to Vote Solar Data Request 1.16. The letters (A) and (C) refer to a diagram in the response that is also found on page 7 of Mr. Elder's Direct Testimony.

I believe it is highly unlikely that Schedule 135 rooftop solar system output will be representative of the output of rooftop systems on Schedule 136 customers given differences in capacity, manufacturer, geographic location, orientation, tilt angle, and degree of shading. The resulting integrity of the sample and all ensuing analyses would thus be sub-optimal. On the other hand, there is an opportunity now to capture actual generation data for Schedule 136 customers that is time-correlated to customer deliveries, consumption, and exports. Thus, there is no reason to settle for "an understanding" based on estimates[6] when full knowledge is possible.

Q. Why is it important to have a more temporally accurate understanding of individual customers' actual rooftop solar production, total consumption, and behind the meter consumption?

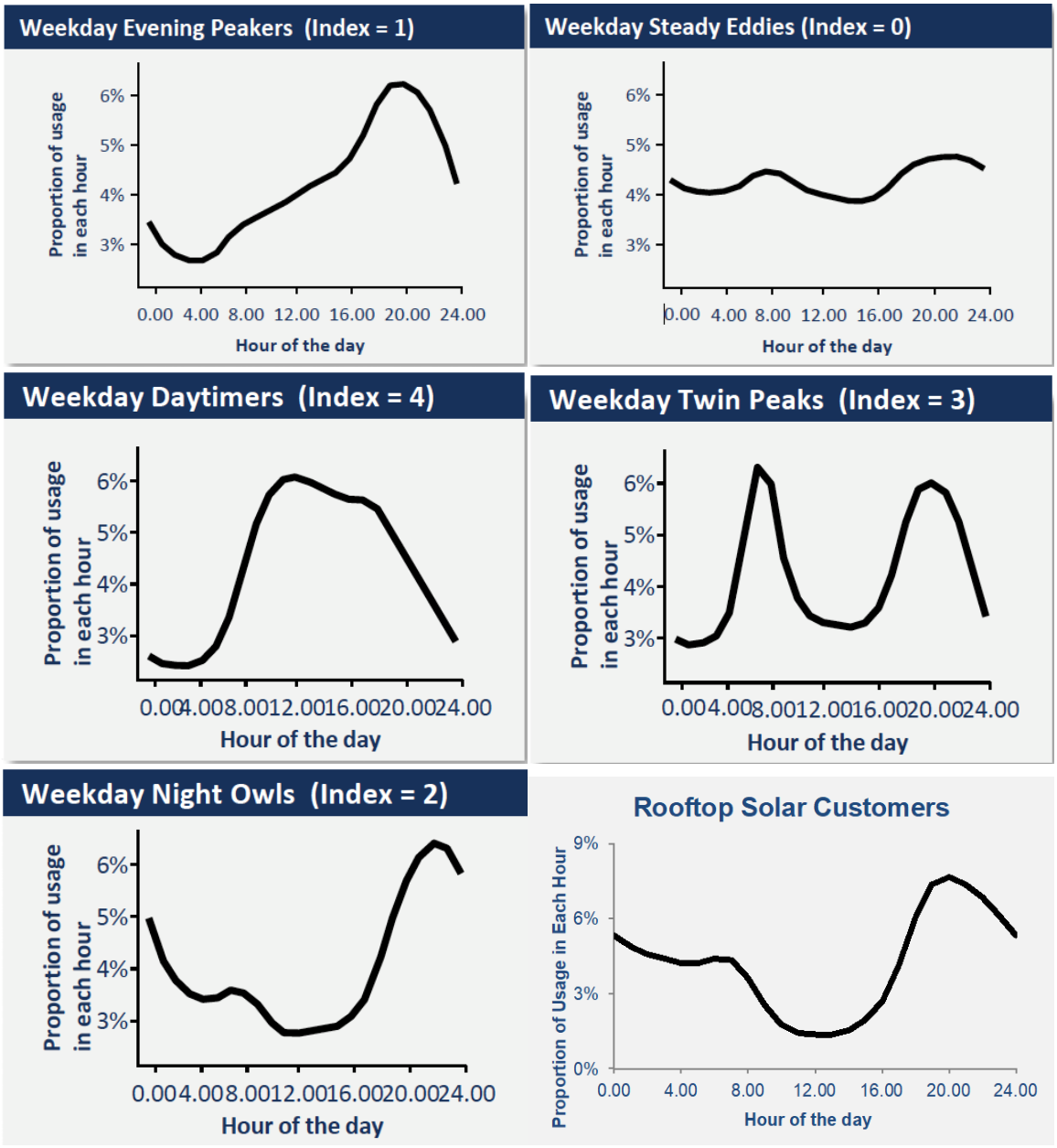
A. It is important to understand the intertemporal patterns of total and behind the meter consumption of individual customers in order to understand how representative and durable the patterns of export may be and how they might change over time. In addition to variations that might result from the different economic incentives in play for the grandfathered and transitional customers, individual customer patterns can vary widely depending on lifestyle, employment situation, number of people in the household, age of people in the household, and other factors.

[6] Elder Direct Testimony, lines 143-145.

For example, a recent study from Arizona Public Service Company ("APS") found considerable variation in load shapes among residential customers.[7] In that study, APS identified five different types of residential customers with very different usage patterns. Illustrative load shapes from these customers are shown in Figure 1 below.[8]

[7] *See* Direct Testimony of Briana Kobor on Behalf of Vote Solar, Arizona Corporation Commission Docket Nos. E-01345A-16-0036 and E-01345A-16-0123, p. 69 (Feb. 3, 2017), http://images.edocket.azcc.gov/docketpdf/0000177081.pdf ("Kobor APS Direct").
[8] Also shown is the load shape of APS's rooftop solar customers.

Figure 1: APS Residential Customer Load Types[9]



APS additionally indicated that the residential class breaks down into the various customer types as shown in Table 1 below.

[9] Kobor APS Direct, page 69.

Table 1: APS Residential Customer Class by Customer Type[10]

Customer Type	Percentage of Customers
Weekday Evening Peakers	42%
Weekday Steady Eddies	19%
Weekday Daytimers	16%
Weekday Twin Peaks	10%
Weekday Night Owls	10%
Rooftop Solar Customers	3%

Results from the APS study demonstrate that it is possible to identify several distinct groups of customers with highly varying load shapes. While we don't currently have the data to demonstrate similar variability among RMP's customers, it would be very surprising if such variability didn't exist to a significant degree in other states including Utah. Such variability in load profiles shows that RMP's assumption of uniformity in generation and consumption – which is necessary for its assertions of statistical significance to be correct – is false.

Q. Are there other reasons production meters should be installed on the transition customers, rather than the grandfathered customers?

A. Yes, there are several. It is well known RMP had difficulty in its load research in the prior docket finding 36 customers in the 52 sampled who were willing to allow a production meter to be installed. RMP ultimately provided a one-hundred-dollar incentive to each. Both the very small size of the sample and the issue of sampling bias call into question the randomness and representativeness of the customers selected for production monitoring. It also raises the question as to the difficulty of achieving a proper sample from that same group of customers to round out the remaining 34 production

[10] Kobor APS Direct, page 70.

meters needed under its proposal.[11] Importantly, grandfathered customers are under no obligation to allow production meters whereas Schedule 136 transition customers do have such an obligation.[12]

Installing a production meter on the same Schedule 136 rooftop solar systems producing the exports that will be measured as part of the sample provides both locational and temporal consistency across all three data streams.

In addition, there are logistical efficiency reasons for installing production meters on the transition customers. Whenever a customer installs rooftop solar (and becomes a transition customer), RMP changes the residential meter from a single register meter to a bi-directional meter capable of measuring flows in each direction on a fifteen-minute basis. It would be an efficient use of the employee's (or contractor's) time to install a production meter at the same time. Rolling a truck or sending a contractor to an existing grandfathered customer's residence for the sole purpose of installing a production meter would be less efficient and costlier.

RMP's cost estimates for a contractor installing a single production meter are $2,319.50, of which $2,080.00 are electrical contractor costs (2014 data). Of the $2,080, $1,524 or 66% are contractor labor. [13] RMP states the contractor portion of installing a production meter requires 20 hours of labor at a rate of $76/hour.[14] These estimates are not supported by market research. The U.S. Bureau of Labor Statistics reports the average

[11] It appears the rationale for this approach is found in RMP's response to Vote Solar Data Request 1.4: "At the time of sample design, the Company only had nameplate capacity available for grandfathered NEM customers."
[12] Stipulation, paragraph 29.
[13] Response to Vote Solar Data Request 1.6.
[14] Response to Vote Solar Data Request 1.23.

mean wage for electricians in Utah is $24.95.[15] This suggests that the cost of installing production meters could be far lower. I recommend RMP issue a discrete request for proposals to reduce costs for this work.

RMP also states "[l]oad-research participants have specialized profile metering installed at the site. These meters record exported energy, delivered energy, and [rooftop solar] system production in sub-hourly increments for the duration of the load study."[16] If true, it would seem to solve the problem of production meters for transition customers.

In any event, data should be collected from transition customers by installing production meters at the same time as residential billing meter change-out until an adequate sample is obtained or until the initial date of the data collection, whichever comes first.

Q. Please explain your second concern with RMP's data collection proposal.

A. Grandfathered customers installed their rooftop solar systems based upon the economics of net metering, *i.e.*, the economic terms for those customers includes one-for-one energy exchange between exported energy and future consumption. For example, excess energy generated during a given day can be "used" effectively by the customer-generator that same night even though the solar system is not generating. The one-for-one energy exchanges can occur (*i.e.*, be netted) throughout a billing month. Grandfathered customers are assured of this treatment through December 31, 2035.[17]

In contrast, transition customers operate under a different policy and set of economic conditions through a process generally known as net billing. The customer-generator is

[15] 2016 data: https://www.bls.gov/oes/2016/may/oes472111.htm#st
[16] Elder Direct Testimony, lines 249-251.
[17] Stipulation, paragraph 12.

compensated for any net excess energy produced by the rooftop solar system in each fifteen-minute period throughout the billing month at a rate less than the full retail rate.[18] For example, the compensation rate was calculated at 90% of the average energy rate for residential customers. Transition customers are assured of this treatment through December 31, 2032.[19]

The combination of a shorter netting period[20] (fifteen minutes), a lower compensation rate, and a shorter period of certainty of treatment would lead any "rational actor" to change behavior. These behavioral changes could include a change in consumption patterns to align usage with solar production, selecting a smaller capacity rooftop solar system to reduce exports compensated at a reduced rate, acquiring discrete control systems or appliances with built-in timers to more closely manage consumption with the same goal of reducing exports, or even acquiring a storage system at the same time to dramatically reduce exports.

For these reasons, it is important to capture the consumption patterns of transition customers and grandfathered customers separately in order to identify the effect of changes that may result from the different policies and economics reflected in the Stipulation versus the net metering program.

Q. When will Schedule 135 and Schedule 136 customers become subject to the export rates that result from this proceeding?

[18] *Id*., paragraph 19.
[19] *Id*., paragraph 16.
[20] The shorter the netting period in general, the greater the amount of exports for a given system configuration.

A. Schedule 135 (grandfathered) and 136 (transition) customers will not be subject to the new export rates until January 1, 2036 and January 1, 2033, respectively. However, post-transition customers will be subjected to these rates following the conclusion of this proceeding, as early as December 1, 2020 (three years after the proceeding was initiated). It is thus very important to this future group of net billing customers to understand how the changing economics impact behavior and system size selection, ability to modify load shapes, and use of on-site storage systems.

Q. Do you support RMP's recommended sample of 70 customers for its load research plan?

A. No. I cannot endorse either RMP's method of sampling or the sample size of 70, particularly in light of the other flaws in the load research plan described herein, such as the changing economics of rooftop solar and the proper variable of interest. According to RMP, a non-stratified approach would require almost 3,000 samples to achieve a precision of +/- 10% at the 90% confidence level.[21] Because we don't know any of the parameters at this time, *i.e.*, total load or rooftop solar system size of the group of customers currently applying for interconnection under Schedule 136, it's important that a production meter be installed concurrently with each change-out of the billing meter to maximize the data with which to perform analyses for phase 2 of this proceeding. Should the characteristics of the interconnected transition customers fall short of those needed for the stratified sample of 70 (or whatever the proper amount is after designing the load

[21] Response to Vote Solar Data Request 1.8, based on rooftop solar production.

research on total consumption rather than system size), the remainder can be filled in with data from Schedule 135 customers.

I cannot endorse in advance – and do not believe that the Commission can endorse in advance – any particular sample size without understanding how RMP has developed the sample and collected the data relative to the changes recommended herein. Notably, RMP does not confirm that it will only proffer its sample data if that sample meets basic tests to ensure the representativeness of the data to the population, including as to the load variability of residential consumers. In any event, given RMP's unique control over data and data collection, the risk of inadequate data collection lies solely with RMP.

Q. How many transition customers have been interconnected?

A. While the number of customers has not been posted, the RMP website shows that, as of March 22, 2018, 65.39 kW of residential and small business customer capacity have been interconnected out of about 3.65 MW of applications. The most current information available for number of customers is 13[22] as of February 6, 2018 out of 406 Applications.[23]

Finally, RMP should retain, and make available, usage data for the sampled transition customers for a minimum of twelve months prior to the installation of the rooftop solar system. This will allow comparisons of before and after total consumption patterns and will help identify changes that may have occurred due to changed incentives.

Q. Please explain your third concern with RMP's data collection proposal.

[22] Revised Response to Vote Solar Data Request 1.12.
[23] Response to Vote Solar Data Request 1.11.

A. In order to understand whether transition customers are indeed viewing and responding to the new net billing regime differently from customers living under the net metering paradigm, RMP should survey the customers in both grandfathered and transition sampled groups to document the types of appliances and other electric devices they may have, and particularly any that have been acquired around the time of the rooftop solar system installation.[24] For instance, a significant 6.1% of rooftop solar customers self-reported as having battery storage for their systems.[25]

Q. Please summarize your conclusions and recommendations on the data collection issue.

A. Based on the foregoing I reach the following conclusions:

- Mixing data from grandfathered customers and transition customers leads to the use of estimates and compromises the integrity and reliability of any conclusions drawn regarding behind the meter consumption patterns.
- The unreliability of the sampling method is compounded by the failure to draw samples of sufficient size to generate statistically significant conclusions.
- Because load profile curves are not uniform, even if production characteristics are assumed to be uniform, there can be no confidence that estimates as to energy consumption are accurate.
- Collecting similarly consistent delivery, export, and production data from grandfathered rooftop solar customers would help identify changing motivations and behaviors among transition customers.
- It is more efficient to install production meters on transition customers concurrently with residential billing meter change-out.
- The collection of consumption data for transition customers both before and after rooftop solar installation will help identify how transition customers are understanding and responding to the new net-billing transition paradigm.

[24] The response to Vote Solar Data Request 1.26 indicates such a survey would cost $10,000 plus perhaps another $16,000 of RMP staff time.
[25] Response to Workshop Data Request 15.

- Understanding the use of behind the meter appliances and other electrical devices will help determine changing patterns of use.

In light of these conclusions, I make the following recommendations:

- The Commission should require delivery, export, and production data be acquired consistently from the 36 individual customers in the grandfathered group.
- The Commission should require RMP to install production meters concurrently with each residential billing meter change-out for all transition customers until an adequate sample is obtained or until the initial date of the data collection, whichever comes first.
- The Commission should require RMP to capture and retain consumption data for transition customers before and after rooftop solar installation.
- The Commission should require that RMP survey each sampled customer's major appliances and other electrical devices in use behind the meter.

VARIABLE OF INTEREST

Q. What is the variable of interest, and what is RMP's approach to this variable?

A. In any statistical study, the variable of interest is the item or quantity that the study seeks to measure. In this case, the variable of interest is the exported energy from rooftop solar customers, for which this proceeding will establish pricing. The variable of interest should be the basis upon which the customers to be sampled are stratified, or broken down into smaller subsets. RMP notes that load research samples are typically designed and stratified based on billed energy but, in this case, it proposes to use nameplate capacity of the rooftop solar systems.[26] RMP explains that exports are not known and rationalizes using system size as "an auxiliary variable that is highly correlated with the

[26] Elder Direct Testimony, lines 173-175.

variable of interest."[27] According to RMP, "[a] highly correlated auxiliary variable enables accurate strata definition and assignment of units to the proper strata."[28]

In contrast, during the workshop process that considered the Phase 1 load research process earlier this year, RMP took the position that the variable of interest is rooftop solar energy production[29] and indicated the generation sample was designed as a mechanism to randomly select sites to measure solar output.[30] While acknowledging that "[f]or the most part, solar panels are [sic] will exhibit similar generation characteristics."[31]

Q. Do you agree with RMP's approach?

A. No, I do not. Regardless of whether RMP thinks solar system size or solar generation is the variable of interest or a relevant auxiliary variable, the approach is fatally flawed. Neither rooftop solar capacity nor generation is a proxy for the variable of interest in this proceeding – exported energy – nor will either provide sufficient information about the customers' load profiles or the behaviors that drive the exported energy profile for which this proceeding will establish a rate.

Further, RMP has provided no supporting evidence for its rationale of high correlation between solar generation (or capacity) and exported energy, the variable of interest, and there are many reasons to question such a correlation. Exported energy represents the difference between two variables – the amount of energy generated by the rooftop solar

[27] *Id*., lines 185-186.
[28] *Id*., lines 188-189.
[29] Response to Workshop Data Request 18.
[30] Response to Vote Solar Data Request 1.2.
[31] *Id*.

system, and the amount of energy consumed on-site. For a given rooftop solar system, higher consumption means fewer exports. While it is true that for any given load profile, a larger system will generate more exported energy, we know with certainty that sampled customers will not have a uniform load profile. The choice of the auxiliary variable for stratification should be based on the planned use of the data collected.

As described above, transition customers may exhibit changed behavior (from that of grandfathered customers) when it comes to selecting system size to balance their needs, risk tolerance, and economic situation. In the second phase of this proceeding, the ability to compare the system sizing decisions of similarly situated (*i.e.*, total load and load profile) customers will aid in the prediction of customer responses to anticipated compensation changes for post-transition customers. In turn, this comparison will be important to determining the amount and value of solar-generated exports for both transition and post transition customers. Stratification based on system size would undermine the reliability of the data collected for this review and analysis by including customers with a wide variety of consumption levels and patterns in the same strata.

For these reasons and given the lack of any information supporting any correlation with system size than customer load, there is no basis for departing from the conventional auxiliary variable, *i.e.* total load, for stratification.[32]

Q. Is the size of the sample likely to change as a result of utilizing the appropriate variable of interest?

[32] RMP used billed net energy usage as the basis for sample selection of 52 customers, of which the 36 customers studied agreed to production metering in Docket No. 14-035-114.

A. Yes. RMP's proposed sample size is based upon its preferred but improper variable of interest – rooftop solar generation – which it admits varies little. The sample size will be considerably larger when sampling the population for total customer consumption, necessary because of the variability of customer sizes and load profiles.

Q. Has RMP provided any indication of the sample size for stratification based upon total load, *i.e.*, deliveries pre-solar?

A. No. The only load-based estimated sample size provided by RMP is 358 based upon net annual load with only two strata. RMP notes without any further explanation that "only a 2 strata design is possible because of the large variance between small and large customers."[33] It is precisely this large variance with which we are concerned.

SYSTEM CHARACTERISTICS

Q. What does RMP say about system characteristics?

A. RMP discusses orientation and tilt angle on lines 229 through 241, noting that it has orientation and tilt data for over 10,000 customers, explaining that it has "numerous concerns with designing a multi-dimensional sample that specifically accounts for orientation and tilt."[34]

Q. Do you agree with RMP?

A. Not entirely. While I agree that there is some complexity and cost associated with designing a multi-dimensional sample, that does not mean that additional information

[33] Response to Vote Solar Data Request 1.17(e).
[34] Elder Direct Testimony, lines 231-232.

should not be gathered. As noted above, this is our one chance to gather information that could be necessary to understand why exported energy exhibits certain temporal and amplitude patterns. The Commission needs to be able to rely on the technical validity of conclusions and recommendations offered by the parties to this proceeding. The system characteristics identified by RMP, along with other relevant information, are important to any reasonable analysis of the value of solar.

Q. What system characteristics do you believe RMP should acquire and retain?

A. RMP should verify the rooftop system capacity, the orientation, and tilt angle of each system, as well as the location (zip code) and estimated degree of shading. RMP may already have this data for the grandfathered group of customers but should verify the accuracy of its data during the change-out of the customer's billing meter. RMP should also use the opportunity of the visit(s) required to each transition customer for other purposes to capture the data for this group of customers. For customers that have panels on different sections of roof with different orientations and tilt angles, the characteristics of each subset of panels should be captured, along with the number of panels in each subgroup.

CUSTOMER CLASSES

Q. How does RMP treat the different customer classes in its proposed load research study?

A. It appears that RMP does not intend to separately sample non-residential, *e.g.* small Schedule 23, commercial customers. While it has 130 profile meters installed on

Schedule 23 customers, it does not indicate whether these customers have loads larger or smaller than 15 kW. Further, RMP has provided no information about any similarities in load patterns between residential customers under Schedules 1, 2, or 3 and small commercial customers under Schedule 23. Because of the different nature of commercial customers, the export characteristics are likely to be different from those of residential customers. For instance, it is already well-known and documented that commercial load profiles are different from residential load profiles, including because commercial customer peak loads tend to occur in the middle of the day rather than the evening. Commercial customers may also have smaller systems relative to their load, and those systems are likely to be mounted closer to horizontal than at a residential roof pitch. As a result, the values attributable to commercial rooftop solar are likely to vary from those of the residential customers.

Q. Has RMP designed a separate sampling for non-residential customers?

A. Yes. In response to Workshop Data Request 5, RMP provided a sample design for residential (sample size=40) and non-residential (sample size=41) with four strata that it represented would achieve a precision of +/- 10% at the 90% confidence level. Because RMP has now committed to a 95% confidence level, I expect the number of samples required for non-residential would increase as it did for the residential sample design. In addition, other changes recommended herein may have an impact on sample size.

Q. What do you recommend?

A. I recommend the Commission require RMP to do parallel sampling and data gathering based on the same criteria used for the residential customers, as modified herein.

RECOMMENDATIONS

Q. Please summarize your recommendations to this Commission.

A. Keeping in mind that the data to be collected during Phase 1 of this proceeding will be the only opportunity for intervening parties to identify the data needed to carry our burden of proof in Phase 2 and that the Commission needs to be able rely on the technical validity of the analyses presented by the parties I recommend the Commission take the following actions.

With respect to the data acquisition plan:

- Require delivery, export, and production data be acquired consistently from the 36 individual customers in the grandfathered group and expand the size of the grandfathered group to allow for statistically significant conclusions as to energy consumption to be drawn from such group.
- Require RMP to install production meters concurrently with residential billing meter change-out for all transition customers at least to the start date of the data-gathering period.
- Require RMP to capture and retain consumption data for transition customers before and after rooftop solar installation
- Require that RMP survey each sampled customer's major appliances and other electrical devices in use behind the meter.

I further recommend the conventionally-accepted auxiliary variable (*i.e.*, total load) be used for stratification, not system size. This change is likely to result in a larger sample size.

I further recommend RMP be required to verify the system capacity, the orientation, and tilt angle of each system, as well as the location (zip code) and estimated degree of shading. For customers that have panels on different sections of roof with different

orientations and tilt angles, the characteristics of each subset of panels should be captured, along with the number of panels in each subgroup.

I further recommend the Commission require RMP to do parallel sampling and data gathering for small commercial customers based on the same criteria used for the residential customers, as modified herein.

Q: Does this conclude your testimony?

A: Yes.

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Professional Employment

January 2012 to Present: Program Director, DG Regulatory Policy, Vote Solar. Manage technical and policy research for Vote Solar, and engage in state, regional, and national campaigns related to distributed solar generation. Expert witness in many formal state regulatory proceedings addressing issues related to distributed solar resources.

March-April 2012: Solar Energy Industries Association - Under a short-term contract with SEIA to participate in an Xcel Energy distributed solar generation Technical Review Committee and to manage consulting support also under contract to SEIA.

January 2007 to January 2012: SunEdison, LLC - Various solar policy related positions beginning with Director of Interior West Policy to Managing Director of Western Policy (July 2007), to Vice President of North American Government Affairs (July 2009) to Global Policy Advisor (July 2011). In each of these roles, directed and managed policy research, development and implementation for the company for the various geographies identified at the regulatory and legislative levels.

June 2011 to December 2011: Chair of the Solar Alliance Board.

Dec 1994 to Jan 2007: Senior Energy Policy Advisor, Western Resource Advocates (formerly the Land and Water Fund of the Rockies), Boulder, Colorado. Develop innovative clean energy and air quality public policies within the economic and cultural framework unique to this region. Lead environmental advocate in development of Arizona Environmental Portfolio Standard, Nevada Renewable Portfolio Standard implementation rules, Colorado Renewable Energy Standard legislative proposals, and the 2003 Utah Renewable Energy Standard legislative proposal. Principal author of Colorado's Amendment 37 and lead advocate for related PUC rule development.

Jan 1983 to Dec 1994: Director of Revenue Requirements, Public Service Company of Colorado, Denver, Colorado. Primary responsibility for development of formal rate-related filings for this investor-owned utility for electric, gas, and thermal energy service in two states and the FERC. Developed and responded to a variety of proposed mechanisms to encourage the use of energy efficiency technologies, including innovative rate design approaches.

Dec 1976 to Dec 1982: Technical Witness (Engineer), Federal Energy Regulatory Commission, Washington, D.C. Testified as expert witness on behalf of the FERC in wholesale rate filings on technical, accounting, and economic issues related to rate design, pricing, and other issues.

Education

Masters, Environmental Policy and Management, University of Denver, Denver, Colorado

Bachelor of Science, Electrical Engineering, Rensselaer Polytechnic Institute, Troy, New York

Summary of Formal Testimonies and Rulemaking Participation

Representing Vote Solar

- Idaho Power Company, Case No. IPC-E-17-13, Net Metering Service Class
- Nevada Power Company Docket No. 17-06003, et al., GRC Rate Design
- Public Service Company of CO Docket 16A-0396E: Electric Resource Planning
- Nevada Energy Docket No. 17-03009/10: Proposed Subscription Solar Program
- Pacificorp/RMP Docket No. 14-035-114: Costs and Benefits of Net Energy Metering
- Kansas Corporation Commission Investigation Docket 16-GIME-403-GIE: Rate Design for Distributed Generation Customers
- Public Service Company of CO Docket 16A-0546E: Decoupling
- Sierra-Pacific Power Company Docket 16-06006, et al: GRC Phase 2
- Sierra-Pacific Power Company Docket 16-07001, et al: IRP
- Public Service Company of CO Docket 16AL-0048E, et al: Three docket settlement
- Public Service Company of CO Docket 16AL-0048E: GRC Phase2
- Public Service Company of CO Docket 16A-0055E: Solar*Connect 2 Subscription Proposal
- Nevada Energy Docket No. 15-07041, et al.: Cost of Service Study and Net Metering Tariffs
- El Paso Electric Company Case No. 15-00127-UT: General Rate Case
- Public Service Company of CO Docket 13AL-0958E: Qualifying Facilities Rates/Remand
- Public Service Company of CO Docket 14A-0302E: Solar*Connect Subscription Proposal
- We Energies (WI) Docket No. 05-UR-107, General Rate Case
- Rocky Mountain Power (UT) Docket No. 13-035-184: General Rate Case
- Public Service Company of CO Docket 13AL-0958E: Qualifying Facilities (QF) Rates
- Public Service Company of CO Docket 13A-0836E: 2014 RES Compliance Plan
- Public Service Company of CO Docket 13AL-0695E: Line Extension Policy
- Idaho Power Company, Case No. IPC-E-12-27, Net Metering Service
- Arizona Public Service, et al., Docket No. E-01345A-10-0394, et al., RES Compliance
- New Mexico PRC Case No. 11-00218-UT: RPS Reasonable Cost Threshold
- Tucson Electric Power Docket No. E-01933A-12-0291: General Rate Case

Representing SunEdison LLC

- Public Service Co of New Mexico Case No. 10-00037-UT 2010 Procurement Plan
- Public Service Company of CO Docket 09A-772E: 2010 Compliance Plan
- Public Service Company of CO Docket 09AL-299E: 2009 Rate Case Phase 2
- Public Service Company of CO Docket 08A-532E: 2009 Compliance Plan
- Colorado PUC Rulemaking Docket 08R-424E: Renewable Energy Standard Rules
- New Mexico PRC Case No. 08-00084-UT: Reasonable Cost Threshold Rulemaking
- Nevada PUC Docket No. 07-10007: Petition for Declaratory Order re 3rd party ownership
- Public Service Company of CO Docket 07A-447E: 2007 Resource Plan
- Public Service Company of CO Docket 07A-462E: 2008 Compliance Plan
- New Mexico PRC Case No. 07-00157-UT: RPS Rulemaking; diversity standard
- Public Service Company of CO Docket 06A-478E: 2007 Compliance Plan
- Public Service Company of CO Docket 06A-534E: Approval of Alamosa Contract

Representing large commercial customers

- Nevada Power Company Docket No. 02-11037: Electric Tariff Rule related to loss factor associated with metering secondary service at primary level
- Nevada Power Company Docket No. 02-5044: Electric Tariff Rule related to metering

Representing Western Resource Advocates
(formerly the Land and Water Fund of the Rockies)

- Public Service Company of CO Docket 06S-234EG: 2006 GRC - Windsource issue
- Public Service Company of CO Docket 05A-112E: Renewable Energy Standard Rulemaking
- Public Service Company of CO Docket 05A-288E: Electric Quality of Service Monitoring & Reporting Plan: 2007-08
- Public Service Company of CO Dockets 06S-016E: Renewable Energy Service Adjustment
- Public Service Company of CO Consolidated Dockets 04A-214E, 215, 216E: Resource Plan
- Public Service Company of CO Docket No. 04S-164E: GRC Windsource & Net Metering
- Public Service Company of CO Docket 02S-315EG: 2002 GRC - Windsource issue
- Nevada Power Company Docket No. 01-7016: Demand-side Management Programs
- PacifiCorp Rate Case Docket No. 01-035-10: Demand-side Mgt Cost Recovery
- Public Service Company of CO Docket No. 00A-008E: IRP - DSM & Wind Resources
- PacifiCorp Rate Case Docket No. 99-035-10: System Benefit Charge Proposal
- Arizona Restructuring Rulemaking Docket No. 99-205: Renewable Portfolio Standard
- Public Service Company of CO Docket No. 98A-511E: Air Quality Improvement Rider
- Arizona Restructuring Rulemaking Docket No. 94-165: Stranded Cost Proceeding
- Nevada Power Company Docket No. 94-7001 (Refiled): Integrated Resource Plan
- Southwestern Public Service Case No. 2678: Merger Proceeding
- PSCo Docket No. 95A-531EG: Merger Proceeding

Representing Public Service Company of Colorado

- Public Service Company of CO Docket No. 93S-001EG GRC Revenue Requirements
- Public Service Company of CO Docket No. 91A-480EG DSM & Decoupling Proceeding
- Public Service Company of CO Docket No. 93I-199EG Incentive Regulation Investigation
- Public Service Company of CO Docket No. 91S-091EG GRC
- Public Service Company of CO No. 91A-281E Fort St. Vrain Supplemental Settlement
- Various PSCo FERC rate proceedings, and subsidiary rate proceedings

Representing the Staff of the Federal Energy Regulatory Commission

- Connecticut Light & Power Company, Docket ER 82-301
- Kentucky Utilities Company, Docket ER 81-341
- Philadelphia Electric Company, Docket ER 80-557, et al.
- Minnesota Power & Light Company, Docket ER 80-5
- Boston Edison Company, Docket ER 79-216, et al.
- Connecticut Light & Power Company, Docket ER 78-517
- South Carolina Electric & Gas Company, Docket ER 78-283
- Minnesota Power & Light Company, Docket ER 78-245
- New England Power Company, Docket ER 78-78
- New England Power Company, Docket ER 77-97