Northwest **Power** and
**Conservation** Council



June 28, 2016

Dear Demand Forecast Advisory Committee Members

As part of development of Council's 8th Power Plan, we are embarking on an analytical journey to incorporate battery technology into our long-term load forecasting model.

You may recall that we use an enduse model to estimate range of load forecast. As part of development of the 7th Power Plan we incorporated impact of rooftop solar (PV) on the system load. For the 8th Power Plan we are enhancing this analysis with incorporating battery for storage.

We need you input and advice as we develop this analysis. In this write-up I am proposing an approach for this work. In the next DFAC webinar planned for July 8th, I would like to discuss our proposed methodology and get your feedback. Meanwhile, if you have any comments regarding the proposed approach please do not wait, send them to me. I would love to hear how you are thinking about modeling solar + batteries in your work.

## Proposed Approach for Analysis of Rooftop Solar plus Battery

This task will require changes to Council's long-term model logic so that a portion of consumers can choose battery and solar technology together. Currently model can simulate customer decision making for selecting rooftop PV. We are enhancing this with adding battery storage to the mix. Model will use existing data on market penetration and costs to project market potential into the future.

What Data points will be needed?

1. Hourly customer load (8760) for customer class (Res., Com., Ind., Trans, Ag)
2. Hourly solar generation (8760) by location? We are planning to use NREL tool PVWatts calculator for 18 different sites in the region. We will use population weights to develop hourly solar generation for each state. The solar generation load shape will end up being a 3-point curve, but to simulate the operation of the battery we need a typical day. For example, if the consumer is using the electricity as soon as they need it, then the daily process of charging and discharging will determine the amount discharged at the time of the peak.

www.nwcouncil.org
Fax: 503-820-2370

3. Size of battery will be expressed from zero to daily to weekly. The battery size will be variables, but we need a reasonable range. For example, we are expecting any batteries which are large enough to go past 1 week.
4. Cost of battery- we will use existing literature and anticipated decline in battery cost.
5. How do we calculate the market penetration rate? The penetration will be based on the cost (relative to purchased electricity) and acceptance. The acceptance will increase through time and due to policy impacts (promotion and education). We will enhance what we have been doing to estimate solar PV penetration rates as we have done in the 7$^{th}$ Power Plan.
6. We would need to track the number of batteries and allow for decay of storage capacity overtime. Although current battery life is set at about 10 years, we are planning to set it to 20 years as an initial policy variable. Roughly the same lifetime for the PV panels. We would retire the units continually so if the consumer wants to maintain the same level of generation, they would need to invest in more units.

7. As for the KWH size of batteries, we start with the Tesla's 7 KWH unit, but overtime this variable changes depending how many days of storage is desired. Overtime the capacity increases to about 50 KWH to provide backup to cover needs for one week of power outage.

8. Charge and discharge policy. Charging profile will depend on the solar generation. The discharge profile will be a mix of profiles.

Three different discharge profiles are considered. Profile 1 and 2 can be combined to create the third profile. Each one of these profiles will be modeled separately and generically for all sectors.

Profile 1 – Myopic Control - If the consumer operates Solar and Battery with minimal control and without regard to matching the customer peak. Charging battery when the sun is out and discharging them as soon as possible.

Profile 2 – Optimal Control - If we assume the units are operated to maximize the reduction at the time of peak, then we develop a second profile in which we only release energy when we have enough stored to maximize the reduction to the peak. This would mean storing overnight in the winter. We may want to modify the profile to insure that power is available for the near peak hours as well.

Profile 3 – Program Control - We now have two profiles. The actual contribution to the peak will be a fraction of each profile. The fraction will depend on the effectiveness of the program in moving the discharging to the peak hour. The program could be direct utility control, time-of-use rates, information or other programs.

By adjusting the fraction in our model, we can determine the impact moving the profile between myopic to optimal controls of the units.

Regarding the load profiles, we need the discharging load profiles for each option we want to test. These profiles are for the peak, minimum, and average points of each month. The profile could have negative values for the minimum load points (if they are charging during minimum load). The profiles include:

1. Profile 1 – Solar with No Storage (this is same as solar electricity production)
2. Profile 2 – Myopic Control with Daily Battery
3. Profile 3 – Optimal Control with Daily Battery
4. Profile 4 – Optimal Control with Utility Off-Peak Charging with Daily Battery
5. Profile 5 – Myopic Control with Weekly Battery
6. Profile 6 – Optimal Control with Weekly Battery
7. Profile 7 – Optimal Control with Utility Off-Peak Charging with Weekly Battery.

Do not hesitate to let me know your comments before our webinar on the $8^{th}$.

Thanks in advance.

Massoud Jourabchi