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Via Electronic Mail

Steven V. King, Executive Director and Secretary
Washington Utilities and Transportation Commission
P.O. Box 47250
1300 S. Evergreen Park Drive S.W.
Olympia, Washington 98504-7250

Re: Docket UE-151069
Comments of Puget Sound Energy, Inc. on modeling energy storage in integrated resource planning

Dear Mr. King:

Puget Sound Energy, Inc. ("PSE," "Company") submits the following comments in response to the Washington Utilities and Transportation Commission's ("Commission" "WUTC") Notice of Opportunity to File Written Comments ("Notice") issued in Docket UE-151069 regarding modeling energy storage in integrated resource planning.

PSE's battery storage project

PSE is developing a 2 megawatt ("MW") battery storage pilot project in partnership with the Washington State Department of Commerce. The project is located in Glacier, which is a small town in rural Washington State east of Bellingham. The town is served by a radial transmission and distribution line that runs along a heavily forested highway and experiences frequent and lengthy outages during storms because of how challenging it is for repair crews to reach and repair the lines. The project is currently in the design phase and when completed will interconnect a 2MW/4.4 MWh lithium-ion battery system to a 12.5 kilovolt ("kV") distribution system near Glacier's existing substation. The goal of this pilot project is to test three primary use cases including 1) Outage mitigation; 2) system-wide peaking; and 3) system flexibility. After the battery system is commissioned, Pacific Northwest National Laboratories ("PNNL") will conduct four to six months of testing on the project to help PSE identify future applications and feasibility.

Question 1

The following list identifies some of the potential uses, benefits or “value propositions” that energy storage systems could offer to a utility. How should a utility model such benefits in an IRP or resource procurement process?

1. Peak Shaving
2. Transmission and Distribution Upgrade Deferrals
3. Outage Mitigation
4. System Balancing
 - a. Regulation/frequency control
 - b. Load Following
 - c. Energy Imbalance
5. Contingency Reserves
6. Reactive Power Support
7. Network Stability Services
9. System Black Start Capability
9. Other

PSE Response

PSE agrees that energy storage systems could offer utilities some or all of the services listed above but current technologies are not cost-effective compared to other resources in providing those services. Today, modeling benefits or value propositions of energy storage systems into the future is a highly speculative exercise. Generally, PSE knows the costs of today’s energy storage systems, but is less certain of the benefits and services those systems provide at the scope and scale necessary to add value to PSE’s grid or mix of supply side resources. This is one reason PSE elected to undertake an energy storage system pilot project near Glacier, WA (described above) so that it can gain a better understanding of the potential benefits an energy storage system may provide. Pilot projects like Glacier can provide a more in-depth understanding of potential value propositions or benefits to energy storage systems and lead to more accurate modeling in the future.

At this point, we can categorize uses for energy storage systems, such as those services listed above, based on the functions they may provide including: 1) energy or capacity service; 2) real power (MW) or reactive power (MVar). PSE also knows that some potential uses of an energy storage system require detailed transmission/distribution line modeling while others do not. PSE does model some of the services listed above in the Integrated Resource Plan (“IRP”). PSE has

created the table below to categorize its understanding of the services listed in question #1, whether those services are currently modeled in the IRP and what traditional model/process could be used to model energy storage systems and services.

Please note that an IRP generally deals with energy and capacity services. Most ancillary services are real power (MW) instead of reactive power (MVar) and reactive power is calculated by AC power flow, which is out of the IRP scope. It is possible to incorporate a high-level transmission description into an IRP, but detailed transmission or distribution system modeling is not an IRP process.

Services	Energy/capacity	MW/MVar	Transmission /Distribution model required	Model/process required	Modeled in IRP
Peak Shaving	Energy	MW	No	Economic Dispatch without transmission	Yes
Transmission and Distribution Upgrade Deferrals	Energy	MW	Yes	Transmission planning /Distribution planning	No
Outage mitigation	Energy	MW	Yes	Depending on location of battery and Outage	Yes- reflected in planning margin
Regulation Control	Capacity	MW	No	1 min net load distribution v.s. AGC ¹ installed in on-line units	Yes- reflected in regulating reserve requirement
Load following	Capacity	MW	No	10 mins Economic Dispatch	Yes-needs improvement

Energy imbalance	Capacity	MW	Yes	Economic Dispatch with interchange between markets	No
Contingency Reserve	Capacity	MW	No	Unit commitment without transmission	Yes
Reactive power supply	-	MVar	Yes	Full AC power flow, System planning	No
Network stability service	-	MW and MVar	Yes	Transient stability, System Planning	No
Black start	-	MW and MVar	-	System planning	No

1. AGC: Automatic Generation Control

Question 2

Models are available today that assign values to the many different use cases of a storage system. These models optimize the value of a storage system by selecting the service that provides the most benefit to the utility and consumers at a particular moment. What technical capability do the utilities have to perform similar modeling? Given that planning in Washington focuses on a least-cost, least-risk resource analysis, how could utility resource plans best analyze and incorporate such analysis into existing IRP and resource procurement models?

PSE Response

PSE agrees there are several possible options to model energy storage systems in the IRP or a resource procurement process. However, it is important to note the difference between determining how to co-optimize the value of a specific resource in isolation versus making portfolio level decisions based on the relative value of different resources that lead to least-cost,

least-risk outcomes. There is potential for energy storage systems to be modeled using more traditional models such as capacity expansion planning or production cost modeling. PSE is aware of some modeling tools that may help in terms of co-optimization such as the PNNL model demonstrated at the WUTC's workshop on August 25, 2015. Such a model may be helpful in estimating an adjustment to the relative value of energy storage. However, it is far from a model that can efficiently analyze the relative flexibility value of different kinds of resources in different portfolios.

For context, a capacity expansion planning model minimizes the total investment cost and operation cost to meet the peak load and energy needs while subject to environmental and other constraints. It provides new resources with fuel type and installed capacity. In general, operation cost in capacity expansion planning is obtained by using either a load during curve or chronologic time slices. Existing and new resources are dispatched to the load based on fuel and other variable costs. Due to the long time horizon, such dispatch modeling is quite rough since the capacity expansion planning model focuses on year, season, and typical day in a month.

A typical production cost model usually includes unit commitment and economic dispatch at the hourly level, and sometimes at the sub-hour level. Unlike traditional capacity expansion planning model, a production cost model can reflect parameters which determine unit commitment and economic dispatch, such as start-up cost, minimum up and down time and unit ramp rate. A production cost model that does co-optimization of both energy market and capacity market is desired to evaluate flexibility needs due to integration of intermittent renewable energy resources. However, a production cost model is performed based on already known resources. Therefore, a production cost model in a resource planning process works as an assessment tool to estimate total cost for different portfolios. An example of using a production cost model to evaluate energy storage systems in an IRP can be found in the "Maui Energy Storage Study" produced by Sandia National Laboratories.

PSE applies a modified capacity expansion planning model. In this model, the operational cost of a resource is obtained outside the capacity expansion planning model. Using this method, existing and new resources are dispatched to forecasted Mid-C prices. The model can consider start-up cost, minimum up and down for a resource, and the resource's ramp rate to a certain level. PSE is evaluating the possibility of applying the same methodology to include energy storage to capacity expansion planning, however this is a challenging exercise.

PSE's approach for examining the value of load following is a helpful comparison to the challenges of modeling energy storage systems. The concept is to start with a least cost portfolio and a deterministic dispatch of that portfolio using a production cost model. That dispatch is then run through a redispatch model to ensure the portfolio has adequate flexibility for load following; i.e. to ensure enough incremental and decremental capability exists to meet 10 minute load variations within each hour. That redispatched operation is then run back through the production cost model to estimate an adjusted portfolio cost. PSE then performs the same exercise with a different portfolio that has a different expected dispatch, redispatch, then recalculate dispatch cost.

The key takeaways for IRP or resource procurement models are represented in the above example:

- *Portfolio Matters*: Flexibility of existing resources and resource additions will impact results of the analysis.
- *Relative Value of Resources*: Estimating the value of any resource on a stand-alone basis is not the goal. The core economic issue is the relative value of different resources, and how the relative value of different resources changes in the context of the portfolio.

PSE is not aware of models that can estimate different sub-hourly flexibility values and incorporate them into a portfolio analysis. If such models do exist, we would be interested in examining them more closely. In order to use any new modeling tools developed specifically for energy storage system evaluation, PSE would need to examine the methodology used in those tools, data needed for the tools and its availability, and how to integrate the output of the tools to IRP or resource acquisition process.

Rather than focusing on energy storage system modeling in isolation, a more near-term and helpful approach may be to attempt to estimate the individual elements of flexibility for different resources in different portfolios in order to perform the relative cost analysis. This information would be very helpful in supporting decision making.

Question 3

Utilities, as balancing authority areas, currently provide ancillary services. As balancing authorities, what ancillary services are the utilities responsible for providing? What resources are do utilities currently use to provide ancillary services? What are the costs associated with using these resources to provide ancillary services, and what is the opportunity cost of using the resources to provide ancillary services? Would it be appropriate for Washington to use rates for ancillary services in organized electricity markets as a proxy for valuing the ancillary benefits of energy storage in Washington?

PSE Response

The PSEI Transmission Provider (“TP”) function makes available (or requires) to transmission customers ancillary services under the schedules described below that are contained in the PSE Open Access Transmission Tariff (“OATT”): To the extent the PSE Balancing Authority (“BA”) performs the service for the TP, charges to the transmission customer are to reflect only a pass through of the costs charged to the TP by the BA.

- Schedule 1 Scheduling, System Control and Dispatch
- Schedule 2 Reactive Supply and Voltage Control from Generation or other Sources Service
- Schedule 3 Regulation and Frequency Response Service
- Schedule 4 Energy Imbalance Service
- Schedule4R Energy Imbalance service for Retail Customers
- Schedule 5 Operating Reserve – Spinning Reserve Service
- Schedule 6 Operating Reserve – Supplemental Reserve Service
- Schedule 9 Generator Imbalance Service
- Schedule 13 Regulation and Frequency Response Service for Generators Selling Outside of the Control Area

Transmission customers have the option of self-supplying these services or taking them from the PSEI. The rates charged for ancillary services by the PSEI are described in the PSE OATT and have been approved by the Federal Energy Regulatory Commission (“FERC”).

Schedule 2 is achieved through automatic voltage regulation at each PSE generation resource and other resources capable of providing voltage regulation. PSE coordinates its voltage set-points to minimize VAR circulation and losses.

PSE manages a diversified generation portfolio which is economically dispatched to serve native load and provide ancillary services to the PSEI BA. PSE’s merchant function commits

generation resources through the preschedule trading and scheduling window based upon market conditions, native load requirements, resource availability, and takes into account an appropriate capacity buffer necessary to maintain reliable and compliant operations within the PSEI BA. As the delivery window nears real-time, energy traders position the generation portfolio to begin each operating hour with sufficient balancing reserve set aside. This balancing reserve set aside is intended to provide support for Schedule 3, Schedule 4, Schedule 5 and Schedule 9. In addition, supplemental reserves (Schedule 6) are set aside consistent with PSE's obligation to the North West Power Pool Reserve Sharing Group. As system conditions change, PSEI BA dispatchers inform energy traders of incremental generation dispatch changes that are necessary to maintain minimum reliability obligations and ancillary service needs within the BA.

Ancillary services rates in organized electric markets would not be an appropriate proxy to value the benefits of energy storage as an ancillary service in Washington State. However, organized electric markets could provide some guidance in helping to understand the value of energy storage in unorganized markets. Ancillary services in many organized markets have different depth, maturity and scale that provide a better indicator of value compared to unorganized markets, especially those ancillary services with prices determined from a robust locational marginal pricing scheme. Ancillary services rates in many bilateral markets, including PSE's, are cost-based stated rates, i.e. derived through cost of service proceedings at FERC, and do not frequently update. Costed based stated rates are not updated unless a FERC 205 or 206 proceeding is undertaken, often times not for many years. Some services, such as PSEI Schedule 1, are part of a formula rate that updates yearly. In the future, PSE expects that rates Schedules 4 and 9 will be part of the CAISO EIM based on location marginal pricing. A proxy value for energy storage based on an organized market strike price that updates frequently would not provide a fair comparison to the value of ancillary services to transmission customers, TPs or BAs with stated or formula rates for ancillary services that update less frequently.

Question 4

What additional questions should the Commission consider in the course of this investigation?

PSE Response

Energy storage is an exciting field with lots of research and upside potential. For these and other reasons, PSE has invested in the energy storage pilot project in Glacier, WA to better understand the technology's capability to integrate with PSE's grid, as well as the other operational benefits it can provide. However, this investigation may benefit from more in-depth questioning into the current state of energy storage technology and the barriers (real or perceived) that are preventing utilities from integrating energy storage systems into their portfolios. This may lead to more refined policies in the future. Some questions may include:

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- Do utilities think they need energy storage for operational reasons or to minimize costs to customers?
- Do utilities feel confident they can perform analysis on energy storage systems that could pass a prudence test?
- Are there financial disincentives to utilities investing in energy storage?
- Are there operational barriers (real or perceived) that are preventing utilities from embracing energy storage?

PSE appreciates the opportunity to provide these responses to the questions identified above in the Notice of Opportunity to File Written Comments. Please contact Nate Hill, Regulatory Affairs Initiatives Manager at (425) 457-5524 or myself at (425) 456-2110 for additional information about this filing.

Sincerely,

Nate Hill, Manager Regulatory Initiatives

on behalf of

Ken Johnson

Director, State Regulatory Affairs

cc: Simon fitch
Sheree Carson