Portland General Electric
121 SW Salmon Street • Portland, Ore. 97204
PortlandGeneral.com

February 1, 2019

Public Utility Commission of Oregon
Attn: Filing Center
201 High Street, S.E.
P.O. Box 1088
Salem, OR 97308-1088

RE: **UM 1856 – PGE's Baldock Mid-Feeder Site Analysis**

Pursuant to Public Utility Commission of Oregon (OPUC or Commission) Order No. 18-290, enclosed is Portland General Electric Company's (PGE's) site analysis for its Baldock Mid-feeder proposal. Per the Stipulation, paragraph 28, PGE requests that OPUC Staff express its agreement that PGE presented adequate evidence that Baldock Mid-Feeder is the best site for the energy storage system based on the universe of available feeder sites within PGE's system.

The Commission opened Docket No. UM 1751, in September 2015, to implement House Bill 2193. This House Bill requires large Oregon electric companies (i.e. Pacific Power or PAC, and PGE) to submit proposals by January 1, 2018, to develop qualifying energy storage systems with the capacity to store at least five megawatt hours. In UM 1751, the Commission adopted specific guidelines and requirements for energy storage project proposals, in late 2016, and a framework for PAC's and PGE's Energy Storage Potential Evaluations (Potential Evaluations) in March 2017.

PGE filed its Energy Storage Proposal and Final Potential Evaluation on November 1, 2017, which were investigated in the subsequently opened Docket No. UM 1856. Following multiple rounds of testimony and numerous data requests, workshops and a settlement conference, stakeholders and PGE reached a Partial Stipulation and submitted Joint Testimony in support of the Stipulation. The stipulation resolved nearly all the issues in the proceeding.

Attachment A provides the site analysis for PGE's Baldock Mid-Feeder proposal to comply with Item No. 02 of Order No. 18-290. Attachment B provides a list of all PGE feeders and the site selection for the energy storage system. Attachment B is confidential and subject to Protective Order No. 17-441 and sent to Staff via US Mail.

PGE looks forward to working with OPUC Staff in determining the adequacy of evidence in the site analysis. Should you have any questions or comments regarding this filing, please contact Kalia Savage at (503) 464-7432.

Please direct all formal correspondence and requests to the following email address pge.opuc.filings@pgn.com

Sincerely,

Karla Wenzel
Manager, Pricing & Tariffs

Enclosures
Cc: UM 1856 Service List

Attachment A

Provided in Electronic Format only

Baldock Mid-Feeder Site Analysis

Attachment A - Baldock Mid-Feeder Energy Storage Site Analysis

Introduction

Portland General Electric Company ("PGE" or "Company") files this document to comply with Public Utility Commission of Oregon ("OPUC" or "Commission") Order No. 18-290 which states "to be able to proceed with this project, PGE must first present an analysis to Staff, supported by adequate evidence, that Baldock is the best site to locate the energy storage system given the universe of available feeders on PGE's system." This document provides a procedural background, describes the site selection process for the Baldock mid-feeder project, and provides a detailed review matrix regarding the site selection.

Background: Storage Law, PGE's Proposal, and Partial Stipulation

The Commission opened Docket No. UM 1751 in September 2015 to implement House Bill ("HB") 2193 (2015 Regular Legislative Session), which requires large Oregon electric companies to submit proposals to develop qualifying energy storage systems with the capacity to store at least five megawatt hours ("MWh") the Commission by January 1, 2018. On December 28, 2016, the Commission adopted specific guidelines and requirements, in Order No. 16-504, that encourage Pacific Power's ("PAC's") and PGE's energy storage project proposals. On March 21, 2017, in Order No. 17-118, the Commission adopted a framework for PAC's and PGE's Energy Storage Potential Evaluations ("Potential Evaluations") that includes seven elements. On July 14, 2017, PGE filed its Draft Potential Evaluation. Staff and stakeholders reviewed this draft and made recommendations to the Commission through a Staff Report. In Order No. 17-375, the Commission adopted the following schedule: (1) by January 1, 2018, PGE and PAC were to file draft project proposals and updated draft potential evaluations that incorporated the improvements outlined by Staff in its Report; (2) by April 2, 2018, the utilities were to file final project proposals and final potential evaluations; and (3) no later than April 2, 2018, the Commission would begin review of the final filings. PGE's submitted Proposal and Potential Evaluation resulted in a partial stipulation among most of the Parties (i.e. PGE, OPUC Staff, CUB, AWEC, NIPPC and RNW), with no party objecting to the stipulation.

As part of the stipulation, Parties agreed that PGE would present its analysis to Staff that the Baldock mid-feeder is the best site for the mid-feeder energy storage system based on the options of available feeders on PGE's system. The stipulation further provided that if Staff did not agree, the Commission would determine whether PGE could move forward with the project. In adopting the stipulation, the Commission clarified that its involvement in a dispute on whether the evidence is adequate would not occur until a prudence determination is made as part of a cost recovery proceeding.

Mid-Feeder Project Benefits

Baldock is the mid-feeder project identified in PGE's Energy Storage Proposals submitted November 1, 2017. The mid-feeder project is intended to explore the specific benefits an energy storage system can provide in supporting potential feeder reliability and power quality issues stemming from high penetrations of distributed solar. Applicable learnings will help PGE evaluate energy storage systems for their suitability as a non-wires alternative to traditional Transmission and Distribution infrastructure investments, and the degree to which any co-optimized benefits can enhance the Energy Storage system's value in this context. With this objective in mind, PGE sought PGE feeders with high penetrations of distributed solar which could present associated reliability and/or power quality concerns.

PGE regularly deploys voltage control devices at its substations. These devices can raise or lower voltage at the substation, with a goal of maintaining distribution system voltages within an acceptable bandwidth. In general, the measured voltage at any point along a distribution feeder decreases in proportion to the distance from the substation, especially as load[1] on the feeder increases. Utilities may also deploy additional voltage control and other reactive devices (e.g. feeder regulators, feeder capacity banks) at selected locations along a feeder (outside of the substation) to improve the feeder voltage profile for the range of expected system conditions.

One of the challenges utilities have with integrating large sums of distributed solar on its distribution feeders has to do with the impact these solar facilities can have on the distribution feeder voltage profile. Distributed energy resources, such as solar, can have the effect of raising voltages on the feeder when energy output is high. When compensating adjustments cannot be made to the substation voltage control devices without negatively impacting distribution system voltages elsewhere on the feeder, additional investment may be needed for downstream (outside of the substation) voltage control and reactive devices to better manage the feeder voltage profile.

Another challenge utilities can have with integrating large sums of distributed solar on its distribution feeders has to do with the loading capability, or capacity, of the distribution feeder. When energy production is high, reverse flow can occur on the distribution feeders to the point where the power flow in a given location can exceed the feeder's capacity. Distribution feeder capacity is generally limited by thermal constraints, and capacity can be increased with a distribution feeder reconductor of larger size wire.

For the mid-feeder project, PGE is exploring the use of energy storage to facilitate the integration of high penetration solar as a mitigating resource in lieu of investment in more traditional downstream voltage control and reactive devices or feeder reconductor projects. The mid-feeder project also affords PGE the opportunity to explore the prospect of direct coupling utility scale solar with storage as a combined resource.

Mid-Feeder Site Selection Analysis

The determination that the Baldock mid-feeder was the best among feeders for energy storage started with the ranking of distribution feeders based on the site-specific outage mitigation benefits (also known as the locational value) as identified by the Integrated Planning Tool ("IPT").[2] PGE evaluated all 589 radial distribution feeders using the IPT and ranked them from highest locational value to lowest locational value for a two-hour energy storage system.

The following steps were taken to filter the IPT results and identify the best site for a mid-feeder project, with consideration for high T&D value, per the IPT, and potential for learnings affecting the integration of Distributed Energy Resources (DER) on high-penetration feeders. Please see Confidential Attachment B, "Feeder Energy Storage Site Selection," for the detailed site review matrix for the feeder site selection process described in this section.

1. **Highest value:** The first screening mechanism considered the availability of locational value as calculated in the IPT:

   The IPT results were sorted based on largest to smallest on the dollar per kilowatt hour ("kWh") benefit for a two-hour energy storage system.[3] This can be seen in column H of the site selection

[1] While this is generally true of loads with a lagging power factor, the inverse can be true for a load with a leading power factor.

[2] The details of the IPT modeling and analysis are covered in OPUC Docket No. UM 1856 PGE Exhibit 101, Section 2.2(a) and Appendix 2 and PGE Exhibit 200, page 18.

[3] The highest site-specific benefits were seen with a two-hour system, but the overall benefits were maximized with a four-hour system due to the stacked benefits available from the Bulk Energy & Ancillary Services value streams.

spreadsheet. Further review of potential sites was prioritized starting at the top of this list with the locations demonstrating the highest potential value as indicated by the IPT model.

2. **Feeder Configuration** was then considered, and feeders demonstrating adequate connectivity to adjacent feeders were removed from consideration due to their suitability for the implementation of lower cost options for outage mitigation. Most feeders on PGE's system are designed in a manner where load can be transferred from one feeder to another, especially in response to an outage. In some instances, it is not practicable to construct adequate feeder ties especially in more rural locations. Feeders without adequate ties to adjacent feeders are considered better candidates for alternative outage mitigation measures, such as implementation of energy storage to support outage mitigation.
3. **High Solar Penetration** was then considered, and feeders were reviewed with respect to the level of distributed solar penetration as a percentage of peak load. PGE reviewed a study, compiled by the National Renewable Energy Laboratory ("NREL")[4], in which research showed that the maximum Photovoltaic penetration allowable on an average feeder without negatively impacting voltages or overcurrent protection devices was typically at least 30% of the peak load. PGE ranked its 589 distribution feeders using the Active Generator List[5] to determine which feeders had the greatest penetration of solar resources.

The following steps were taken to filter the results of the Active Generator List and identify the short list of potential sites. Attachment A "Active Generators for Energy Storage" provides the detailed site review matrix for the mid-feeder site selection process described in this section.

The first screening mechanism considered the penetration level of distributed solar as a percentage of feeder peak load.

1. All distributed solar installations in PGE's service territory were grouped by feeder to sum the total nameplate capacity (kW) of connected solar on each distribution feeder.
2. PGE then identified the hourly-averaged peak load (kW) recorded for each feeder as of the Summer 2017 operating season.
3. The total nameplate capacity of connected solar was divided by the hourly-average peak load, by feeder, to identify the percent penetration of solar by feeder. The feeders were ranked from highest penetration of solar to lowest penetration of solar.
4. Feeders which reported solar penetration less than 30% were omitted from further analysis since the NREL analysis indicated that these low-penetration feeders are less likely to experience reliability and power quality constraints resulting from connected solar installations.
5. The remaining high-penetration feeders provide PGE with a selection of feeders from which PGE can collect and evaluate unique benefits in optimizing and integrating energy storage coupled with renewable generation for solar firming, feeder reliability, and power quality management given a high penetration of solar resources.

[4] Hoke, Anderson, et al. "Maximum Photovoltaic Penetration Levels on Typical Distribution Feeders." *IEEE Transactions on Sustainable Energy*, July 2012, www.nrel.gov/docs/fy12osti/55094.pdf.
[5] The Active Generator List is a compilation of all known distribution-connected, customer-owned generation resources existing within PGE's service territory.

After applying the filters listed above for feeders with high (>30%) penetration of distributed solar, the universe of available feeders on PGE's system was winnowed to three remaining candidate feeders for the short-list evaluation:

- Canby-Butteville feeder
- Amity-13 feeder
- Amity-Bellevue feeder

Implementation risks were then considered, and sites were removed based on the following implementation risks:

1. **Readiness of Communications Infrastructure.** Each of the remaining high-penetration feeders were evaluated for their access to existing telecommunications infrastructure, such as fiber available on the feeder and in proximity to the proposed mid-feeder project site. PGE estimates the unloaded cost to install fiber on an existing distribution feeder to be approximately $50,000 per mile.

2. **Other Considerations:** The more proximate a major source of distributed solar is to the mid-feeder project, the greater is the potential to access specific learnings around feeder reliability and power quality as affected by high penetrations of distributed solar. The Baldock solar facility is the largest distributed solar resource on the Canby-Butteville feeder, and the site was reviewed to determine its suitability to incorporate an energy storage system.
   - Environmental Review – An internal review of the environmental considerations indicated there are no major concerns with a proposed energy storage project at the Baldock site.
   - Permitting/Land Use Review – An internal review of the permitting and land use indicated there are no major concerns regarding permitting requirements and timeframes as well as zoning changes due to the proposed use for an energy storage project at the Baldock site.
   - Available space – Available space on the existing PGE parcel for the Baldock site was reviewed to determine if there was enough physical space to locate the proposed energy storage system. Additional costs for land preparation or additional land purchase or leases would have a negative impact on the project economics.

Final Feeder Selection

The short-list evaluation resulted with the selection of the Baldock site on the Canby-Butteville as the optimal site for the mid-feeder project. The specific benefits that led to the selection of Baldock includes the high penetration of distributed solar allowing the testing and direct integration of solar and energy storage at the site, the presence of existing telecommunications infrastructure available to support the project, and existing space at the facility to readily integrate an energy storage system, which facilitates an accelerated deployment on the timeline necessary to fulfill the requirements of HB 2193.

Detailed Site Review Matrix

Confidential Attachment B provides a detailed review matrix for the feeder site selection process.

Attachment B

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Protected Information Subject to Protective Order 17-441

Feeder Energy Storage Site Selection