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Application of Virginia Electric and Power Company, To participate in the pilot program for electric power storage batteries pursuant to § 56-585.1:6 of the Code of Virginia, and for certification of a proposed battery energy storage system pursuant to § 56-580 D of the Code of Virginia
Case No. PUR-2019-00124

Dear Mr. Logan:

Please find enclosed for electronic filing in the above-captioned proceeding the **public version** of Virginia Electric and Power Company's Annual Report on Electric Power Storage Battery Pilot Program. An extraordinarily sensitive version is also being filed under seal under separate cover.

Please do not hesitate to call if you have any questions regarding the enclosed.

Very truly yours,

/s/ Sarah Bennett Bures

Sarah Bennett Bures

Enclosures

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Service List

Annual Report on Electric Power Storage Battery Pilot Program
March 31, 2023

Through its Final Order dated February 14, 2020, in Case No. PUR-2019-00124 (the "2019 Final Order"), the Commission approved Virginia Electric and Power Company (the "Company") for three battery energy storage systems ("BESS") to participate in the pilot program established by Va. Code 56-585.1:6 ("Pilot Program"), which were referred to as BESS-1, BESS-2, and BESS-3. Consistent with Section G of the Commission's Guidelines Regarding Electric Power Storage Battery Pilot Programs issued on November 26, 2018, in Case No. PUR-2018-00060 ("Guidelines"), the Company submitted notifications to the Commission that it had placed BESS-1, BESS-2, and BESS-3 into service on June 28, 2022, November 14, 2022, and May 23, 2022, respectively.

The Company now files its first annual consolidated report on the status of the Pilot Program consistent with the reporting requirements outlined in Guideline Section G and the 2019 Final Order. The information in this report is based on 2022 calendar year data. To the extent any of the required information is not available or applicable at this time, the Company has noted and provided an explanation for the omission. In addition, for this first annual report, the Company has provided a summary of lessons learned from the construction of these three BESS pilots.

General Information

The annual report will include the aggregate capacity of the Commission-approved proposals under the Pilot Program. The aggregate capacity of Commission-approved proposals under the Pilot Program is 16 MW. Accordingly, there are 14 MW of capacity available to the Company for future proposals under the Pilot Program.

BESS-Related Topic Discussion

The annual report will include a discussion of the certain topics related to BESS.

Transmission and distribution system benefits. BESS can provide numerous benefits to the distribution system. The most prominent benefits evaluated to date include distribution asset upgrade deferral, distributed generation backfeed reduction, and voltage support:

- Asset upgrade deferral is typically carried out by reducing load on distribution assets, such as substation transformers. Asset upgrade deferral can also be carried out by extending the life of equipment such as voltage regulation equipment. BESS can reduce the number of operations required of voltage regulation equipment, thus extending the life of that equipment.
- Distributed generation backfeed reduction is carried out by charging a BESS when local distributed generation on a specific circuit exceeds local load. This use of BESS allows power flows onto the transmission system to be controlled and reduces the rate of load ramping during solar production shoulder hours.

- Voltage support is carried out by setting the BESS to export reactive power when local voltage drops and to import reactive power when local voltage increases. This results in more stable voltages on the distribution system and reduces operations on other voltage regulation assets. Because reactive power import and export does not significantly impact stored energy, voltage support can typically be carried out simultaneously with use cases focused on asset upgrade deferral and distributed generation backfeed reduction.

Line-loss savings. Traditionally, power generation and loads are separated by many miles of transmission and distribution lines, as well as several transformers. As power flows through these lines and equipment, power losses can occur. As the distance between generation and loads increases, these line losses increase as well. Distributed energy resources, such as solar generation, can provide generation directly on distribution circuits where the power can be absorbed locally without first traversing the transmission system. Yet depending on the timing of distributed generation compared to local load, production at distributed generation sites at times can still result in power traversing the transmission system.

BESS can charge when local generation exceeds local load, and discharge at other times of day when local generation is reduced. This results in more generation being absorbed closer to the generation site, thereby reducing line losses as compared to the generation traversing the transmission system to be used elsewhere.

Enhanced electric generation capacity. BESS classified as generation assets can provide enhanced system capacity in one of two ways. When operating under a peak shifting behind-the-meter ("BTM") mode of operation, BESS provide enhanced electric generation capacity to the Company by reducing the need for additional generation during times of peak demand. Operating in this mode, BESS can provide output on days when peak hour production from co-located or localized intermittent resource facilities such as solar may not be possible due to weather. Since the value of energy is highest at times of peak system demand, discharge from a BESS can reduce the Company's load demand and PJM capacity obligation. Alternatively, when operating as a front-of-the-meter ("FTM") resource, a BESS can provide generation capacity to the PJM wholesale markets. Under this mode of operation, BESS can deliver output as a generation resource and contribute to the PJM system's reliability during peak demand hours.

Fuel cost savings. BESS classified as generation assets create fuel cost savings by reducing the Company's PJM energy purchase costs. When utilized for peak shifting as a BTM resource, BESS can provide energy arbitrage at the hourly level for the Company's load portfolio by charging during periods of low demand and discharging during periods of high demand. For example, operating as a BTM resource throughout 2022, BESS-3 reduced the cost of the Company's PJM energy purchases, resulting in estimated fuel cost savings of $60,455. If used as an FTM resource in the PJM wholesale markets, BESS can reduce fuel costs for the Company similarly by providing energy arbitrage down to the five-minute level.

Ancillary services benefits. As a load serving entity ("LSE") in PJM, the Company incurs ancillary service procurement expenses for frequency regulation and reserves:

- Frequency regulation is a reliability product that corrects for short-term changes in electricity use that might affect the stability of the power system and is provided by resources which can adjust their output or consumption in response to an automated signal. There are currently two types of frequency regulation in PJM: (i) Regulation D ("RegD") for fast responding resources, and (ii) Regulation A ("RegA") for traditional resources.
- Reserves are electricity supplies that are not currently being used but that can be made quickly available in case of an unexpected loss of generation. Reserves can be supplied by synchronized generators, non-synchronized generators, or demand (load) capable of being removed from the grid.

BESS, if used as a peak shifting BTM resource, reduce the cost of fulfilling the Company's ancillary service obligations in PJM by charging during periods of low demand, when ancillary service costs are typically lower, and discharging during periods of high demand, when ancillary service costs are typically higher. For example, in 2022, BESS-3 reduced the cost of the Company's net ancillary services purchase, resulting in estimated avoided cost savings of $333. If used as an FTM resource in the PJM wholesale markets, BESS have the potential to similarly reduce net ancillary service purchases for the Company by providing frequency regulation and reserve capabilities to PJM as a generation resource.

Any readily quantifiable economic development and job creation benefits across the Commonwealth. The largest quantifiable benefit with respect to job creation across the Commonwealth is associated with construction activities for BESS. For example:

- For BESS-1, the Company hired a crew of six to install all foundations, perform all control house wiring, set all auxiliary components, and set the transformer. This created six jobs for the five-month duration construction activities lasted at the station.
- For BESS-2, the EPC contractor sub-contracted a crew of six to install the BESS, inverters, foundations, and below grade infrastructure. The Company also sub-contracted a crew of six for all control house wiring, bus work installations, and transformer setting. This created a total of 12 jobs for the five-month duration construction activities lasted at the station.
- For BESS-3, during the active construction period of May 2021 through May 2022 there were 77,468 labor hours worked by individuals.

Jobs and labor hours translate into individuals who provided a local economic impact, as well as increased local tax revenues through temporary housing expenses, along with other consumables such as food, fuel, and other miscellaneous living expenses. As additional BESS are installed across the Company's system, additional jobs will be needed to support operations and maintenance of these systems.

PJM wholesale markets as they relate to BESS. PJM wholesale market participation opportunities for BESS have systematically evolved since the resource was conceived.

First, FERC Order No. 841 in 2018 opened the door for energy storage to participate in wholesale markets by requiring that all regional transmission organizations ("RTOs") and independent system operators ("ISOs") allow energy storage to sell products and services they are technically capable of providing, including energy, capacity, and ancillary services. Among other things, Order 841 directed RTOs and ISOs to submit compliance filings showing how they would implement energy storage participation in other markets. In response to Order 841, PJM created the Energy Storage Resource Participation Model (the "ESR Model"). The ESR Model allows resources access to a set of market offer parameters and business rules tailored to the unique operating characteristics of energy storage resources, further reducing storage resource barriers to access in PJM wholesale energy and ancillary service markets. After the launch of the ESR Model in 2019, PJM further refined its business rules and processes in 2021 by providing resources with additional clarification around the different types of energy storage resource participation modes. Specifically, PJM created four classes: (i) a standalone energy storage resource class; (ii) an "open-loop hybrid" class for resources that wish to participate as a single market resource with mixed-technology (*e.g.*, solar plus storage) in which the storage resource does charge from the grid; (iii) a "closed-loop hybrid" class for resources that wish to participate as a single market resource with mixed-technology in which the storage resource does not charge from the grid; and (iv) a "co-located" class for resources that wish to participate as two market units with mixed-technology in which the resources operate independently. The Company actively tracked both proceedings and remains a regular participant in the PJM stakeholder processes pertaining to these business rules.

Second, in 2021 PJM implemented a new capacity construct aimed at valuing the capacity value of renewable and limited-duration energy storage resources. This approach utilizes a concept called effective load carrying capability ("ELCC"). As defined by PJM, ELCC is a measure of the additional load that a particular generator of interest can supply without a change in reliability._ELCC can also be defined as the equivalent MW of a traditional generator that results in the same reliability outcome that a particular generator of interest (such as an intermittent generator or energy storage resource) can provide. The metric of reliability used by PJM is loss-of-load expectation, a probabilistic metric that is driven by the timing of high loss-of-load probability hours. Utilizing this methodology, PJM states that a resource that contributes a significant level of capacity during high-risk hours will have a higher capacity value (*i.e.*, a higher ELCC) than a resource that delivers the same capacity only during low-risk hours. "High-risk hours" are those hours during which PJM expects the peak demand to occur. Prior to this methodology being adopted, a four-hour wholesale market battery would only get paid 40% of its maximum output in the PJM capacity market. For the three upcoming PJM capacity market auctions using the ELCC concept, a four-hour hybrid resource could get paid approximately 83% of its maximum output.

The Company continues to track other PJM wholesale market developments, including the status of the frequency regulation market. BESS are particularly well suited to provide RegD in the PJM frequency regulation market due to their fast-ramping capabilities and ability to closely follow PJM dispatch signals. Although demand for this service is expected to increase in the long run, this market remains oversaturated due to its relatively small size and high penetration of short-duration BESS. In 2022, PJM initiated the Regulation Market Design Senior Task Force stakeholder group to investigate potential reforms in the frequency regulation market. The Company is closely tracking developments in this forum as they relate to potential participation opportunities for the Company's generation-classified storage resources.

BESS-1 Prevention of Solar Backfeeding

Through BESS-1, the Company has deployed a 2 MW / 4 MWh AC coupled lithium-ion BESS that will study the prevention of solar backfeeding onto the transmission grid at the Company's Correctional substation. BESS-1 seeks to accomplish the following objectives from Va. Code § 56-585.1:6 A: (i) improved reliability of electrical transmission or distribution systems; and (ii) improved integration of different types of renewable resources.

Lessons learned from construction and installation. The primary lesson learned from construction of BESS-1 was associated with the advantages of procuring BESS that require little to no assembly. Minimal assembly leads to a more streamlined execution and ultimately a lower project cost. For example, BESS-1 was delivered to the substation as a fully assembled system with the batteries and inverter packaged into the same container. To install the BESS, a concrete foundation was poured within the substation with below grade conduits for interconnecting cables to the step-up transformer and recloser. With the foundation and conduits in place, BESS-1 was simply offloaded to the foundation and interconnecting cables were pulled between components. By contrast, as discussed further below, BESS-2 did not come fully assembled and separate components (*e.g.*, the batteries, the inverters) were manufactured by different vendors, leading to additional time and resources to install BESS-2. As a result, the Company will consider the advantages of self-contained BESS with minimal assembly when evaluating bids for future BESS. The Company notes, however, that there are currently few BESS on the market that are self-contained. Equipment vendors are realizing the advantages of self-contained BESS and are adapting their designs accordingly. As the industry matures, more options will likely become available to streamline installation of BESS at competitive costs.

An update on the installation cost, as well as actual and projected O&M costs. The total installation cost for BESS-1 was approximately $4.5 million, which is higher than the original forecasted installation cost of $2.9 million. The increase costs were attributed to engineering and installation costs being higher than forecasted.

As to O&M costs, the Company is contracting with a vendor for annual monitoring and maintenance services, which cost approximately **[BEGIN EXTRAORDINARILY SENSITIVE INFORMATION]** [redacted] **[END EXTRAORDINARILY SENSITIVE INFORMATION]** Additionally, there will also be Company O&M costs associated with operational coordination and logistics between the Company and the vendor, supervision of the vendor while working in the Company's substation, and operational support from Company personnel. The Company does not have an estimate of these Company O&M costs at this time.

An update on the progress of the specific proposal in meeting its objectives; performance data and metrics over time. Throughout 2022, BESS-1 showed excellent progress towards meeting its objectives. Since commissioning, round-trip efficiency has remained near commissioning metrics, even with self-discharge between charge / discharge cycles included.[1]. BESS-1 was available for use 83.2% of the time, with most of the unavailable time being due to non-BESS

[1] The Company uses the term "self-discharge" to refer to both the gradual loss of potential over time and to the energy used by the BESS for HVAC, communications, and other equipment.

related work done in the substation. Initial data analysis indicates that both transformer load tap changer operations and total back-feed have been reduced. Overall, BESS-1 has imported 983 MWh and exported 834 MWh of energy indicating high utilization of the asset.

- *Round-trip efficiency (calculate by comparing the amount of energy released by the BESS to the amount of energy it consumes during charging).* During commissioning tests, the round-trip efficiency of BESS-1 was determined to be 89.6%. The overall round-trip efficiency, including self-discharge between charge / discharge cycles, was 84.8% in 2022.

Year	Round-Trip Efficiency
Commissioning	89.6%
2022	84.8%

- *Durability (monitor degradation over time to determine if it is consistent with expected operations).* The Company does not have information on durability to report at this time because the contract with the vendor who will monitor and maintain BESS-1 is still being finalized.

- *Availability (measure by comparing the amount of time that the BESS is available for operations to the total amount of time in the study period).* Between commissioning and year-end 2022, BESS-1 has been available for use 83.2% of the time. For the 16.8% of time that the BESS was unavailable, the majority was due to work in the substation or, in one case, a fault condition on a nearby circuit that caused BESS-1 to be offline. The table below provides information on when BESS-1 was offline.

Dates Offline	Total Outage Time	Reason for Outage
7/14/2022-7/19/2022	5 days	Required outage for substation work being performed
10/14/2022-10/30/2022	15 days	Maintenance (described below)
12/23/2022-1/2/2023	10 days	Transfer trip due to winter storm events on nearby circuits.

- *Planned / unplanned maintenance (quantify the number of times the BESS requires maintenance work and identify the cause of any unplanned maintenance work).* Between commissioning and year-end 2022, BESS-1 had one planned maintenance event during which it was offline for 15 days. This maintenance was required for routine internal inspections and due to a blown fuse that needed to be replaced. BESS-1 did not have any unplanned maintenance events in 2022.

- *Cost and benefit data (collect all relevant cost and benefit data for the BESS).* See above for cost data related to BESS-1. As to benefits, while BESS-1 does not have any specific revenue streams, the Company has seen benefits resulting from the installation of BESS-1. For example, BESS-1 successfully prevented solar back feed throughout 2022, allowing Company operators to have better control of power flow onto the transmission system and resulted in slower load ramping at the beginning and end of each day's solar output. Additionally, BESS-1 reduced wear on other equipment by avoiding backfeeding on the substation transformer. See below for details on these benefits. BESS-1 has also provided economic development benefits, such as the six jobs created for the five-month duration of construction and installation activities lasted at the station.

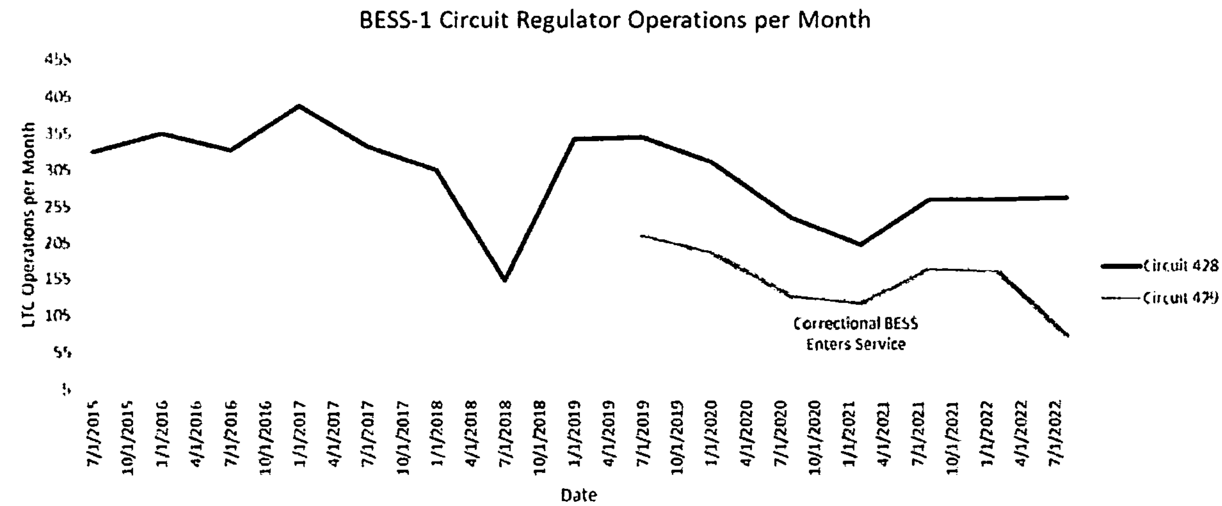
- *Energy throughput (measure how much energy has gone into and out of the BESS in MWh).* Between commissioning and year-end 2022, BESS-1 imported a total of 982.9 MWh and exported a total of 834.3 MWh.

- *Avoided hours / MWh of back feeding (compare back feeding data preceding installation of the BESS with data collected after the device has been in service).* Backfeeding at the Correctional substation where BESS-1 is installed depends on several factors, including daily loading conditions and solar output on the associated circuits. Accordingly, it is difficult to draw conclusions from less than a year's worth of data regarding backfeeding reduction. Yet an initial evaluation of data for BESS-1 does indicate a reduction in total backfeed. Specifically, six of the nine months with data saw a reduction in backfeeding at Correctional. A reduction in solar backfeeding reduces wear on distribution and transmission assets, and is the primary use case for BESS-1.

  Backfeeding results by month for pre- and post-BESS-1 installation are summarized in a table below. The numbers in the table represent the MWh of energy that backfed onto the transmission system in the specific month or year shown. The average was then taken before and after the installation of BESS-1, and then the percentage change in those averages was calculated. A negative percentage change represents a reduction in backfeeding. For example, an average of 22.3 MWh of backfeeding occurred at Correctional substation in December prior to installation of BESS-1. In December 2022, no backfeeding occurred, resulting in a 100% reduction in solar backfeeding in that month.

	Monthly Backfeed (MWh)					Average Backfeed (MWh)		
Year	**2018**	**2019**	**2020**	**2021**	**2022**	**Pre-BESS Average**	**Post-BESS Average**	**% Change**
January	N/A	40.2	42.3	37.3	10.1	32.5	N/A	**N/A**
February	N/A	259.0	159.5	203.6	145.3	191.8	N/A	**N/A**
March	N/A	1096.5	656.5	1112.6	721.3	896.7	N/A	**N/A**
April	N/A	1470.6	2199.3	1613.5	1314.1	1649.4	N/A	**N/A**
May	1131.4	961.7	2019.3	1351.8	428.6	1366.1	428.6	**-69%**
June	297.9	772.4	763.0	689.6	654.7	630.7	654.7	**4%**
July	747.3	335.6	89.6	316.2	55.3	372.2	55.3	**-85%**
August	444.8	302.4	208.1	143.5	180.9	274.7	180.9	**-34%**
September	155.6	286.0	319.0	825.4	426.0	396.5	426.0	**7%**
October	529.9	358.9	484.0	372.2	540.0	436.2	540.0	**24%**
November	178.7	201.6	198.3	214.8	22.9	198.3	22.9	**-88%**
December	11.0	20.0	12.7	45.5	0.0	22.3	0.0	**-100%**

- *Reduced capacitor bank/load tap changer operations (compare the number of device operations in the year before the BESS is installed with those after the device has been in service).* The Correctional substation utilizes circuit voltage regulators for voltage control, with separate voltage regulators for each of the two distribution circuits out of the substation. The total number of regulator operations are monitored and recorded approximately every six months. In the years leading up to the BESS-1 installation, the Circuit 428 and 429 regulators averaged 296 and 165 operations per month, respectively. In 2022, Circuits 428 and 429 have averaged 267 and 78 operations for a decrease of 10% and 53%, respectively. Although this decrease in operations looks promising, more data is needed to determine if this decrease is due to BESS-1 operations or yearly load trends on the two circuits. A graph displaying the regulator operations data is provided below.



- *Progress in assessing additional use cases.* The daily maximum backfeed on the transformer to which BESS-1 is connected ("TX #1") varies from 0 MW up to 20 MW of backfeed, depending on local loading conditions and maximum solar output. BESS-1 is currently automatically charging to absorb this backfeed as soon as transformer load drops below 0 MW and backfeed begins. With a maximum power capacity of 2 MW and energy capacity of 4 MWh, BESS-1 is typically fully charged before the daily maximum backfeed time. Ideally, BESS-1 will charge at the time that loading on TX #1 peaks, thus decreasing the maximum backfeed on TX #1. Several automated dispatch methods will be evaluated as part of the pilot project, including schedule-based operation and rate-of-power-change based operation, to optimize BESS-1 to achieve the objective of reducing solar backfeeding.

  As to additional use cases, the Company plans to test the use of BESS-1 for voltage support over the next year. To do so, a volt-var curve will be activated that uses BESS-1's reactive power capabilities to help control voltage at the substation. This use case can be performed simultaneously with the use case of reducing backfeeding and should help further reduce voltage regulator tap changes, thus extending the operating life of this resource.

BESS-2: BESS as a Non-wires Alternative

Through BESS-2, the Company has deployed a 2 MW / 4 MWh AC coupled lithium-ion BESS that will study BESS as a non-wires alternative to reduce transformer loading at the Company's Hanover substation. BESS-2 seeks to accomplish the following objectives from Va. Code § 56-585.1:6 A: (i) improved reliability of electrical transmission or distribution systems; and (iii) deferred investment in generation, transmission, or distribution of electricity.

Lessons learned from construction and installation. The construction of BESS-2 provided several key lessons for the Company, mostly related to the number of parties involved. While BESS-1 had a single vendor that completed all construction and installation, BESS-2 had an EPC vendor, a battery vendor, and an inverter vendor, along with several other groups involved in the installation of BESS-2. As a result, initial commissioning tests saw delays to coordinate with engineers at several companies. Lessons learned from having multiple vendors involved in the installation of BESS-2 include: (i) scheduling tests with all involved parties to ensure availability for any issues that arise, and (ii) identifying and verifying with all vendors concrete guidelines for a variety of use cases and scenarios.

In addition to multiple vendors causing delays during commissioning, BESS-2 required an undergrounded three-wire 480 volt ("Wye") connection. This differs from the Company's typical configuration for distribution-grade 480V transformers using a four-wire grounded-wye transformer. Because of the deviation from the Company's typical construction practices, the transformer was inadvertently installed as a four-wire grounded-wye system, resulting in additional time and resources to convert the transformer to three-wire system and update the 480V protection. Lessons learned from this issue include noting and carefully tracking installation requirements that differ from the Company's typical practices throughout the life of the project.

An update on the installation cost, as well as actual and projected O&M costs. The total installation cost thus far for BESS-2 is approximately $5.2 million. The Company anticipates additional costs to complete installation of BESS-2, which it estimates will be less than $750,000. The installation cost are higher than the original forecasted installation cost of $4.1 million. These cost increases are attributable to additional equipment that was not originally scoped as part of the conceptual design and increased costs associated with the engineering and installation of the project.

As to O&M costs, the Company is contracting with a vendor for annual monitoring and maintenance services. The Company anticipates these contract costs to be **[BEGIN EXTRAORDINARILY SENSITIVE INFORMATION]** [redacted] **[END EXTRAORDINARILY SENSITIVE INFORMATION]** Additionally, there will be Company O&M costs associated with operational coordination and logistics between the Company and the vendor, supervision of the vendor while working in the Company's substation, and operational support from Company personnel. The Company does not have an estimate of these Company O&M costs at this time.

An update on the progress of the specific proposal in meeting its objectives; performance data and metrics over time. Although there is limited data for BESS-2 in calendar year 2022 based on when the system came online, initial results are very promising. Round-trip efficiency has remained at 88.5%, even with self-discharge between charge / discharge cycles included. BESS-2 was available for use 73.2% of the time in 2022, with the periods of unavailability providing useful feedback on best operating practice. BESS-2 imported 78 MWh and exported 69 MWh of energy in 2022, demonstrating good utilization of the asset. Eighteen percent of the exported energy occurred during the two highest load hours of each day on the associated transformer, and 39% occurred during the four highest load hours of each day.

See below for performance data and metrics identified for evaluating BESS-2.

- *Round-trip efficiency (calculate by comparing the amount of energy released by the BESS to the amount of energy it consumes during charging).* During commissioning tests, the round-trip efficiency of BESS-2 was determined to be 88.0%. The overall round-trip efficiency, including self-discharge between charge / discharge cycles, was 88.5% in 2022. This slight increase in round-trip efficiency is a combination of measurement accuracy, and charge efficiencies fluctuating due to both daily weather and changing charge patterns.

Year	**Round Trip Efficiency**
Commissioning	88.0%
2022	88.5%

- *Durability (monitor degradation over time to determine if it is consistent with expected operations).* The Company does not have information on durability to report at this time because the contract with the vendor who will monitor and maintain BESS-2 is still being finalized.

- *Availability (measure by comparing the amount of time that the BESS is available for operations to the total amount of time in the study period).* Between commissioning and the end of 2022, BESS-2 was available 73.2% of the time. The 26.8% of time unavailable was due to the two unplanned maintenance events discussed below.

- *Planned / unplanned maintenance (quantify the number of times the BESS requires maintenance work and identify the cause of any unplanned maintenance work).* Between commissioning and year-end 2022, BESS-2 had two instances of unplanned maintenance.

    - On November 11, 2022, BESS-2 tripped offline for a fire detection lockout signal received by the automation controller. After a detailed review by the Company and BESS-2 vendors of all signals and conditions during the period leading up to and following the trip, the cause of the signal could not be determined. The Company did identify a possible issue with the BESS controller logic that could have provided the false trip and, as a result, implemented additional data logging systems to better capture the sequence of events if this type of event were to reoccur. Also an unrelated low voltage issue several days prior caused two out of the twenty two total battery packs to trip offline. After rebalancing of these cells, BESS-2 was brought back online. The total outage time was eight days.

- On December 23, 2022, BESS-2 tripped offline due to storm-related fault events on a nearby circuit; it was brought back online December 27, 2022. Because BESS-2 was at a low state of charge when it tripped, 1 of the 22 battery strings remained at an abnormally low voltage for too long and became faulty. This battery pack was kept offline until it was replaced and brought back online on January 30, 2023. During this period of replacement and installation of the one battery pack, BESS-2 remained online and operational with 95.5% of its nominal energy capacity.

- *Cost and benefit data (collect all relevant cost and benefit data for the BESS).* See above for cost data related to BESS-1. As to benefits, while BESS-2 does not have any specific revenue streams, the Company has seen benefits resulting from the installation of BESS-2. For example, BESS-2 has successfully shaved numerous peaks on the substation transformer to which it is connected. See below for details on this benefit. BESS-2 has also provided economic development benefits, such as the 12 jobs created for the five-month duration of construction and installation activities lasted at the station.

- *Energy throughput (measure how much energy has gone into and out of the BESS in MWh).* Between commissioning and year-end 2022, BESS-2 has imported a total of 78.2 MWh and exported a total of 69.2 MWh.

- *Avoided overload energy (quantify how much energy the BESS supplies during periods of peak load, and compare to historical transformer loading data).*[2] The table below gives the total discharge during the 2, 4, 8, and 12 hours of peak load each day on the substation transformer to which BESS-2 is connected.

	Top 2 Peak Hours Daily	Top 4 Peak Hours Daily	Top 8 Peak Hours Daily	Top 12 Peak Hours Daily
Total MWh Discharged	12.72 MWh	26.92 MWh	41.36 MWh	53.85 MWh
Percent of Total	18.4%	38.9%	59.7%	77.8%

- *Progress in assessing additional use cases.* BESS-2's primary use case to reduce transformer loading remains. The Company will continue to work on controls to optimize this use case.

  As to additional use cases, the Company plans to test the use of BESS-2 to provide voltage support for the substation bus to which BESS-2 is connected. To do so, an automatic voltage regulation control scheme was developed and tested, which will

[2] The Company has not provided historical transformer loading data because it would not be a meaningful metric to assess avoided overload energy due to different loading conditions over time.

become active in 2023. This use case can be performed simultaneously with the use case of reducing transformer loading.

BESS-3: Solar Plus Storage

Through BESS-3, the Company has deployed a lithium-ion BESS at its Scott Solar Facility consisting of a 2 MW / 8 MWh direct current ("DC")-coupled system and a 10 MW / 40 MWh AC-coupled system. BESS-3 seeks to study solar plus storage, and to accomplish the following objectives from Va. Code § 56-585.1:6 A: (ii) improve integration of renewable resources; and (iv) reduce the need for additional generation during times of peak demand.

Lessons learned from construction and installation. The construction and installation of BESS-3, the Company's first utility-scale BESS, provided several key lessons learned for future projects. These include: (i) performing third-party battery product testing prior to project design completion and manufacturing; (ii) ensuring the project area includes ample temporary and permanent workspace to ensure successful project execution; (iii) amend construction implementation and O&M training materials to account for the unique characteristics of BESS compared to other generation resources; and (iv) closely coordinating with all stakeholders to ensure that the schedule for commissioning aligns with stakeholder needs.

The Company also learned valuable lessons about retrofitting existing and operational solar facilities to incorporate storage rather than developing and constructing a combined solar plus storage facility from the start. For example, construction at an operating solar facility presented logistical challenges, including equipment laydown, workforce parking / access, and completion of daily construction activities. Additionally, from a design perspective, the Company would consider replacing existing solar inverters with inverters designed for a DC-coupled storage system. Based on these lessons learned, developing and constructing new combined solar plus storage facilities would likely achieve maximum efficiency for a lower overall cost. Yet if the Company does seek to retrofit any other existing solar facilities with storage, the Company can now apply the lessons learned from BESS-3 to achieve greater efficiency.

While not a lesson learned, the Company also notes that it deployed enhanced cyber security architecture as a part of this pilot, which will be used on future BESS projects. This is a centralized cyber infrastructure that provides secure access to employees, O&M providers, and vendors. The SD-WAN technology is flexible for multiple communication methods and the technology enables continuous visibility into the industrial control system.

An update on the installation cost, as well as actual and projected O&M costs. The total installation cost for BESS-3 is approximately $28.4 million (excluding financing costs), which is higher than the original forecasted installation cost of $26.1 million. These cost increases were primarily driven by the need to purchase additional equipment.

As to O&M costs, for the calendar year 2022 the actual O&M costs were $69,000. The projected O&M costs for the year 2023 are approximately $538,000, which is inclusive of preventative and corrective maintenance, technical support, and grid electricity usage. The projected 2024 O&M costs are approximately $150,000 increasing at a rate of 2% through 2027.

An update on the progress of the specific proposal in meeting its objectives; performance data and metrics over time. The first year of deployment of the BESS-3 provided the Company with valuable opportunities for learning and evaluation regarding the integration of battery storage into the generation mix. The AC-coupled system began operations on December 22, 2021, while the DC-coupled system began operations on May 17, 2022. Both systems have proven to be operational and productive during periods of peak load. The BESS were online and producing for 80% of the five summer coincident peaks, which assisted in reducing the need for additional generation during these critical periods. The Company has also had the opportunity to evaluate and enhance the original use case for the AC-coupled and DC-coupled systems to provide opportunities for additional benefit for our customers.

See below for performance data and metrics identified for evaluating BESS-3.

- *Round-trip efficiency (calculate by comparing the amount of energy released by the BESS to the amount of energy it consumes during charging).* For the calendar year 2022 the average AC-coupled system round-trip efficiency was 79% and the average DC-coupled system round-trip efficiency was 79%.

- *Durability (monitor degradation over time to determine if it is consistent with expected operations).* For the calendar year 2022 the AC-coupled system durability (*i.e.*, state of health) was 100% and for the DC-coupled system was 99.9%. The AC-coupled and DC-coupled systems experienced minimal degradation in 2022 compared to the expected 4.6% degradation rate in year one of operations.

- *Availability (measure by comparing the amount of time that the BESS is available for operations to the total amount of time in the study period).* For the calendar year 2022 the AC-coupled system availability was 73% and for the DC-coupled system was 82%. See below for information on BESS-3 outages.

- *Planned / unplanned maintenance (quantify the number of times the BESS requires maintenance work and identify the cause of any unplanned maintenance work).* For BESS-3, the Company is providing information on all outages, as outages typically require some form of maintenance work. BESS-3 experienced 10 planned outages and 73 unplanned outages in 2022. The 10 planned outages were short duration outages related to testing. The following table identifies the causes of the 73 unplanned outages:

Unplanned Outage Cause	Number of Occurrences
Full Site Trip - Grid Event	18
Fire/Hydrogen Alarm Fault	13
Software Issue	13
HVAC Alarm Fault	9
Recloser Trip	7
Undervoltage Alarm Fault	4
AC-DC Power Mismatch Fault	3
Auxiliary Power Alarm Fault	3
Inverter Fault	1
Rack Calibration Issue	1
Undercurrent Alarm Fault	1
Total	**73**

As can be seen in the table, not all of the outages were specific to BESS-3. For example, grid events refer to offsite issues that result in full-site outages, including both solar and battery storage systems.

The key drivers that resulted in unplanned outages in 2022 for BESS-3 itself involved fire, hydrogen, or HVAC alarms; and software issues. The fire and hydrogen alarm outages result from built-in safety features that shut the battery system down should a sensor be triggered for those conditions. All 13 fire or hydrogen alarm-related shutdowns were a result of faulty sensors—there were no actual fire or hydrogen concerns. The faulty sensors have been replaced through the warranty with the vendor. The nine HVAC related outages were due to material issues linked to installed components. These parts were replaced through the warranty process with the vendor as well. Finally, BESS-3 experienced 13 unplanned outages that related to software issues, including the scheduling feature and inconsistent readouts. The EPC contractor for BESS-3 supported efforts to resolve these issues and BESS-3 has had no significant software-related concerns since implementing the software solutions. The remaining faults listed in the table above sometimes occur during the operational period and have since been resolved.

Overall, the Company believes that the unplanned outages for BESS-3 in 2022 resulted from the infancy of incorporating battery storage into the resource mix and the initial startup of a new facility. The Company will continue to monitor planned and unplanned outages of the system and will seek to mitigate outages where possible in the future to optimize facility performance.

- *Cost and benefit data (collect all relevant cost and benefit data for the BESS).* See above for cost data related to BESS-3. As to benefits, BESS-3, in coordination with the Scott Solar Facility, was utilized as a BTM peak shifting resource in 2022, incrementally reducing the Company's capacity, energy, and ancillary service obligations. As discussed above, in the general discussion of the fuel cost savings and ancillary services benefits of BESS, operation of BESS-3 in 2022 resulted in fuel cost savings of $60,455 and estimated avoided cost savings of $333. Additionally, as discussed below, the Company estimates that its capacity obligation will be reduced by approximately 3 MW based on operation of BESS-3 in 2022 during PJM coincident peaks. BESS-3 has also provided economic development benefits, such as the jobs created during construction and installation.

- *Energy throughput (measure how much energy has gone into and out of the BESS in MWh).* For the calendar year 2022 the AC-coupled system imported 5,118.8 MWh and exported 4,019.5 MWh. The DC-coupled system imported 221.2 MWh and exported 174.7 MWh in calendar year 2022.

- *Discharge / charge efficiency (measure the ability to perform peak shifting (AC-coupled) or clipping (DC-coupled) function).* The Company evaluated the discharge / charge efficiency metric for the AC-coupled system by tracking the number of hours the system was available and producing energy during the PJM five coincident ("5CP") hours in 2022, since these are hours when generation resources are most needed to meet peak system conditions in PJM. In addition, and as discussed in more detail below, these hours are used by PJM to determine the allocation of capacity costs to market participants. For the calendar year 2022 the AC-coupled system provided energy during four of the five 5CP hours. For information on the clipping function of the DC-coupled system, see below.

- *MWh of clipped losses captured (quantify the amount of clipped losses captured by the DC-coupled BESS on an annual basis).* For the calendar year 2022 the DC-coupled system captured 221.2 MWh of clipped losses from the Scott Solar Facility.

- *MWh of stored energy used to reduce peak demand (quantify the amount of stored energy discharged during the periods of peak demand on a daily basis).* For the calendar year 2022 the total MWh of stored energy used to reduce peak demand on a daily basis was 696 MWh.

- *Reduction in net PJM capacity obligation (track the reduction in the net PJM capacity obligation resulting from the use of BESS-3).* Operating as a BTM peak shifting resource in 2022, BESS-3 reduced the Company's load obligation by discharging the AC-coupled system during four of the five 5CP hours when production from the Scott Solar Facility was operating at reduced levels due to lack of weather or availability of the combined solar plus storage facility. Since the 5CP hours are used by PJM to determine the allocation of capacity costs to market participants within a transmission zone, the Company's capacity obligation will be reduced on the load side of its portfolio to the extent that its demand obligations are lower during these hours. To that effect, and as a function of the BESS-3 AC-coupled system discharging during the 5CP hours in 2022, it is estimated that the Company's capacity obligation will be reduced by approximately 3 MW.

Progress in assessing additional use cases, specifically addressing the potential participation of BESS-3 in the PJM wholesale markets. The Company began operating BESS-3 as a BTM peak shifting resource. The Company has since assessed and begun to implement additional use cases for BESS-3, including participation in PJM wholesale markets.

First, beginning June 1, 2023, the Company has elected to transition BESS-3 and the Scott Solar Facility into the PJM wholesale markets as an FTM hybrid resource. Having already operated as a BTM resource in 2022, the Company believes that this approach strikes an appropriate balance between continuing to learn from the Pilot Program while extracting value as a wholesale market resource. Under this FTM mode of operation, the Company anticipates that it will gain practical, real-world experience in a variety of additional PJM wholesale markets and operational use cases, including BESS-3 participation in the PJM day-ahead and real-time energy markets, regulation market, and reserve markets.

To facilitate this transition, the Company has taken steps to meet PJM wholesale market participation requirements, including the execution of a wholesale market participation agreement, which is required for distribution-connected resources to participate in PJM wholesale markets. The Company is currently planning for BESS-3, as a component of the Scott Solar plus Storage Hybrid resource, to participate in the PJM capacity market as a generation resource.

Second, the Company's original use case for the DC-coupled system intended to only utilize clipped energy for charging the BESS. Initial operating experience revealed that the amount of available clipped energy would not be sufficient to effectively utilize the DC-coupled system during the months of October through March due to lower available irradiance. To ensure an appropriate amount of utilization, the Company began directing the DC-coupled system to charge from available solar production one hour per day starting on December 2, 2022. The Company expects that this state of operation will be applicable in the months of October through March going forward. This adjustment to the use case should support the long-term health of the batteries and increase the utilization of the DC-coupled system.

The Company will track and evaluate the changes implemented with these use case updates and will report on the progress and findings in the next annual report on the Pilot Program.

CERTIFICATE OF SERVICE

I hereby certify that on this 31st day of March 2023, a true and accurate copy of the foregoing filed in Case No. PUR-2019-00124 was hand delivered, electronically mailed, and/or mailed first class postage pre-paid to the following:

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