Virginia State Corporation Commission
eFiling CASE Document Cover Sheet

Case Number (if already assigned)	PUR-2019-00124
Case Name (if known)	Application of Virginia Electric and Power Company To participate in the pilot program for electric power storage batteries
Document Type	RETE
Document Description Summary	Rebuttal Testimony of Virginia Electric and Power Company
Total Number of Pages	52
Submission ID	17846
eFiling Date Stamp	12/20/2019 3:09:15PM

McGuireWoods LLP
Gateway Plaza
800 East Canal Street
Richmond, VA 23219
Tel 804.775.1000
Fax 804.775.1061
www.mcguirewoods.com

Vishwa B. Link
Direct: 804.775.4330

McGUIREWOODS

vlink@mcguirewoods.com

December 20, 2019

BY ELECRONIC DELIVERY

Joel H. Peck, Clerk
State Corporation Commission
c/o Document Control Center
Tyler Building – First Floor
1300 East Main Street
Richmond, Virginia 23219

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. Peck:

Please find enclosed for electronic filing in the above-referenced matter the Rebuttal Testimony of Virginia Electric and Power Company.

Please do not hesitate to contact me if you have any questions in regard to this filing.

Highest regards,

Vishwa B. Link

Enc.

cc: Hon. Alexander F. Skirpan, Jr., Chief Hearing Examiner
Paul E. Pfeffer, Esq.
Audrey T. Bauhan, Esq.
Sarah R. Bennett, Esq.
April M. Jones, Esq.
Service List

WITNESS REBUTTAL TESTIMONY SUMMARY

Witness: Robert S. Wright, Jr.

Title: Director, Distribution Grid Planning and Asset Management

Summary:

Company Witness Robert S. Wright, Jr., responds to the testimony and recommendations offered by Staff and Environmental Respondents. He first responds to general comments about the Pilot Program, including recommendations regarding additional metrics to track and report. He then responds to specific testimony and recommendations related to BESS-1 and BESS-2.

The Pilot Program provides the Company with a valuable opportunity to test the functionality, capability, and operability of battery energy storage systems in various use cases. The Pilot Program will result in a deeper understanding of how BESS can be applied to achieve specific objectives, and enable the Company to successfully apply these new technologies in the future. The Pilot Program is an important step that will allow the Company to gain necessary experience and information without exposing customers or other grid assets to unnecessary risk through an ineffective deployment of BESS. Each pilot project was developed to test a specific primary use case with the understanding that there would likely be opportunities for evaluation of other applications in the future. The Company has proposed BESS-1, BESS-2, and BESS-3 to study important statutory objectives, and believes that the information and experience gained from each will provide valuable insight and experience toward deployment of BESS in the future.

In his Rebuttal Schedule 1, Company Witness Wright provides a comprehensive summary of the metrics and topics the Company proposes to initially include in its annual report on the Pilot Program. As use cases for each BESS evolve, the Company will work with Staff to ensure the appropriate additional metrics are added to this list.

As to BESS-1, the Company seeks to study the prevention of solar backfeeding. Current Company interconnection practices (e.g., limits on the amount of reverse flow) and engineering practices reduce the risk presented by reverse power flow, but do not completely eliminate it. The Company believes that the installation of a BESS will help to further manage the risk by minimizing the time that these conditions are present, thus improving system reliability.

BESS-2 is primarily intended to study how a BESS can be used to reduce transformer loading so that investments in additional capacity can be deferred. Although the targeted transformer is not expected to require replacement in the near future, BESS-2 can still be operated using a "pseudo-limit" such that useful data and operating experience can be obtained. This not only satisfies the objective of the Pilot Program, but also ensures that the safe and reliable operation of the distribution grid will not be negatively affected should the battery fail to perform as expected. The Company disagrees with the recommendation to relocate BESS-2. At Hanover Substation, BESS-2 can be operated to satisfy a load shaving objective without putting safety and customer reliability at risk. Additionally, Hanover Substation has sufficient space to install the BESS, which obviates the need to expand the substation footprint, and thereby minimizes the cost of BESS-2.

REBUTTAL TESTIMONY
OF
ROBERT S. WRIGHT, JR.
ON BEHALF OF
VIRGINIA ELECTRIC AND POWER COMPANY
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NO. PUR-2019-00124

Q. Please state your name, business address, and position with Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company").

A. My name is Robert S. Wright, Jr., and I am Director of Distribution Grid Planning and Asset Management in the Company's Power Delivery Group. My business address is 600 East Canal Street, Richmond, Virginia 23219.

Q. Have you previously submitted testimony in this proceeding?

A. Yes. My pre-filed direct testimony on behalf of Dominion Energy Virginia was submitted to the State Corporation Commission of Virginia (the "Commission") in this proceeding on August 26, 2019, as revised on September 12, 2019.

Q. What is the purpose of your rebuttal testimony in this proceeding?

A. I am testifying in support of the Company's application ("Application") (i) for approval to deploy three battery energy storage systems ("BESS")—designated BESS-1, BESS-2, and BESS-3—as part of the pilot program for electric power storage batteries (the "Pilot Program") and (ii) for an amended certificate of public convenience and necessity ("CPCN") to construct and operate BESS-3 at the Company's Scott Solar Facility, to the extent required by the Commission.

Specifically, I will respond to the testimony and recommendations offered by Commission Staff ("Staff") Witnesses Neil P. Joshipura and David J. Dalton and

Appalachian Voices ("Environmental Respondents" or "ER") Witness Kerinia Cusick. I will first respond to a general comment about the Pilot Program, including recommendations regarding additional metrics to track and report. I will then respond to specific testimony and recommendations related to BESS-1 and BESS-2.

Q. Mr. Wright, how is your testimony organized?

A. My testimony is organized as follows:

I. Pilot Program

II. BESS-1

III. BESS-2

IV. Summary of Testimony

I. Pilot Program

Q. Do you have any initial comments in response to the testimony from Staff and Environmental Respondents about the Pilot Program generally?

A. Yes. The Company is pleased that both Staff and Environmental Respondents seem to recognize the value in this Pilot Program, providing the opportunity to test the functionality, capability, and operability of battery energy storage systems in various use cases. The Pilot Program will result in a deeper understanding of how BESS can be applied to achieve specific objectives, and enable the Company to successfully apply these new technologies in the future.

The General Assembly set forth five objectives for the Company to study through the Pilot Program, and the Company views them as just that—objectives. Approval of a specific BESS for the Pilot Program at this stage should not depend on whether that

BESS will actually successfully accomplish a specific objective, as the whole purpose of the Pilot Program is to study whether and how the Company can depend upon BESS for those uses in the future. In this way, the Pilot Program is an important step in the deployment of a new technology that will allow the Company to gain necessary experience and information without exposing customers or other grid assets to unnecessary risk through an ineffective deployment of BESS. Staff Witness Joshipura seems to recognize this experimental nature of the Pilot Program, as he notes on page 17 of his testimony, "because BESS is an untested technology, it may not be prudent for the Company to rely entirely on an experimental BESS to resolve an immediate reliability problem. The untested BESS could experience an unexpected failure that would make it unavailable for use, thus potentially leaving the Company exposed to a reliability problem without another solution." Similarly, as Company Witness Abhijit Rajan discusses further, it may not be prudent for the Company to bid a BESS into the PJM wholesale markets exposing it to possible risks until it better understands the capability and operability of the BESS.

The Company has proposed BESS-1, BESS-2, and BESS-3 to study important statutory objectives, and believes that the information and experience gained from each will provide valuable insight and experience toward deployment of BESS in the future.

Q. Both Staff and Environmental Respondents highlight the ability of BESS to provide multiple services to maximize their value. Staff Witness Joshipura (page 37) refers to this concept in terms of value stacking, and ER Witness Cusick (page 12) in terms of utilization. Please comment.

A. The Company agrees with the concept of value stacking and utilization to maximize the benefits achieved with BESS and to enhance the economic value of a BESS. Each pilot project was developed to test a specific primary use case with the understanding that there would likely be opportunities for evaluation of other applications in the future. The Company fully expects that each BESS will be used for more than just a single function during the Pilot Program, thereby increasing utilization.

That being said, testing additional use cases should be done in a measured and deliberate manner. The Company would not want to jeopardize the information and experience gained from the primary use case by adding secondary and tertiary use cases too quickly. The Company is committed to testing additional applications of each BESS beyond its stated primary application to the extent that these additional applications (i) are compatible with the primary use case for each system, and (ii) do not significantly degrade the life of the BESS.

The Company commits to reporting on its progress in assessing additional use cases for each BESS as part of its annual report on the Pilot Program, and will keep Staff informed during the development of additional use cases. As additional, compatible applications are identified, the Company will work with Staff to determine what additional metrics should be tracked, as suggested by Staff Witness Joshipura.

Q. To support her argument for increased utilization of the proposed BESS, ER Witness Cusick argues that most warranties for BESS "will accommodate over 5,000 cycles with minimal degradation, which equates to over 13 complete charge/discharge cycles per day over a 5 year pilot time period." Please respond.

A. I would like to provide a few comments. First, as stated in the Application, although the duration of the Pilot Program is five years, the Company expects to operate each BESS for up to ten years. Second, the warranty and operations and maintenance ("O&M") costs for each of the proposed BESS are based on one complete charge/discharge cycle per day. Increasing the number of charge/discharge cycles per day would require a BESS that is oversized at the time of installation, or would require the BESS to have its cells replaced periodically over the course of its useful life. Either of these changes would increase the initial capital cost of the BESS, as well as the cost of the warranty and expected O&M. Finally, the Company disagrees that 13 complete charge/discharge cycles per day is realistic. A two-hour BESS (such as BESS-1 and BESS-2) can only undergo a maximum of six complete charge/discharge cycles per day because each charge/discharge cycle requires four hours.

Q. Because the Company proposes to initially study the primary use case for each BESS, ER Witness Cusick states that advanced lead acid may have been a better choice of technology. Please comment.

A. The Company disagrees. As mentioned, the Company fully expects that each BESS will be used for more than just a single function during their useful lives. Choosing lithium-ion technology will allow the Company to study secondary and tertiary use cases in the future.

There are several other reasons why the Company chose lithium-ion over other advanced lead acid technology. First, lithium-ion technology offers higher energy density than advanced lead acid, meaning that more energy can be stored in the same amount of space in lithium-ion BESS compared to advanced lead acid BESS. This is an important consideration for any energy storage system, but especially where space constraints exist, such as for both BESS-1 and BESS-2. Second, there are many different vendors offering lithium ion-based BESS compared to advanced lead acid, resulting in more competition to drive down prices. Price decreases for lithium ion technology are expected to continue for at least several more years and are expected to continue to outpace reductions in the costs of lead-acid technology. Finally, lead-acid batteries are not well suited for deep cycling (*i.e.*, discharging the battery until it is nearly empty) and generally have lower cycle lives (*i.e.*, the number of times the battery can be fully charged and discharged).

Q. Staff suggests additional metrics for the Company to track and report. Does the Company agree with these recommendations?

A. Yes, the Company agrees with tracking the recommended metrics. For all three BESS, this includes (i) planned and unplanned maintenance, as recommended by Staff Witness Joshipura (page 36); and (ii) cost and benefit data, as recommended by Staff Witness Dalton (pages 11 and 12). As noted by Company Witness Karl E. Humberson, the Company also does not oppose the two additional metrics proposed by Staff Witness Joshipura related to BESS-3.

In addition to these metrics, as discussed above, the Company commits to reporting on its progress in assessing additional use cases for each BESS. Further, as discussed by

Company Witness Rajan, the Company commits to reporting on the PJM wholesale markets as they relate to BESS.

My Rebuttal Schedule 1 provides a comprehensive summary of the metrics and topics the Company proposes to initially include in its annual report on the Pilot Program. As discussed above, as use cases for each BESS evolve, the Company will work with Staff to ensure the appropriate additional metrics are added to this list.

Q. ER Witness Cusick suggest that the Company also report utilization rate, which she describes on page 34 of her testimony as "the numbers of hours per day the assets are charging/discharging or providing services." Does the Company oppose this recommendation?

A. Yes. While the Company does not oppose tracking and reporting on utilization, the Company does not view using charge and discharge time as an informative measure of utilization, mainly because it is dependent on—and can be manipulated by—changing the charge/discharge rates that are used. Instead, to track utilization, the Company proposes to track total energy throughput, which provides a better metric for this purpose. Energy throughput is a measure of how much energy the BESS stores and discharges over its lifetime, and is measured in megawatt-hours. Much like the mileage on an automobile, the throughput gives some indication of the wear and tear experienced by the battery.

Q. To the extent the Commission directs the Company to track utilization rate as recommended by ER Witness Cusick, does the Company agree with her recommendation to target 80%?

A. No, the Company does not believe that setting an artificial target utilization rate would be appropriate because it does not have any evidence to support that target as realistic or suitable for any of the proposed BESS. As discussed above, the purpose of the Pilot Program is to gain information and experience with BESS. The Company will report this information using the proposed metrics. Specific targets for each metric are not needed at this time, nor would they prove useful.

Q. On page 39 of his testimony, Staff Witness Joshipura invited the Company to explain how there is no duplication of purpose between the Pilot Program and other study of BESS that the Company is working on. Please comment.

A. In addition to the BESS proposed in this Pilot Program, the Company is also proposing to install a BESS as a component of the Locks Microgrid Project, included as part of the Company's Grid Transformation Plan in Case No. PUR-2019-00154. Through both the Pilot Program and the Locks Microgrid Project, the Company seeks to gain operational experience and knowledge by exploring various use cases of technologies that are still relatively new. The Locks Microgrid Project is comprised of a variety of distributed energy resources such as solar photovoltaic arrays, electric vehicle charging stations, gas-fired generators, and battery energy storage systems. These resources are networked together, and their operation is coordinated by a microgrid controller to achieve a particular goal, such as islanded operation for reliability, peak shaving, solar smoothing, phase load balancing, and harmonics mitigation. Although the proposed BESS projects

will explore some of these functions, a critical difference is that the Locks Microgrid Project can operate as an electrically isolated "islanded" system, whereas the BESS in the Pilot Program cannot. In addition, the BESS in the Pilot Program will operate independently based upon predetermined settings and control algorithms that respond to external conditions. This contrasts with a microgrid, where the controller determines how different grid resources are operated. Based on these differences, there is no duplication of purpose between use cases for the BESS, so no duplication of cost between these two projects.

In addition to the Locks Microgrid Project, Staff Witness Joshipura at page 38 of his testimony mentions two reports evaluating non-wires alternatives on the Company's system. The Company will use the results of these two reports as it continues to develop its integrated distribution planning process. The information gathered from the Pilot Program, in conjunction with the information learned from these two studies, will enhance the Company's understanding of and potential use of BESS on its distribution system.

II. BESS-1

Q. Do you have any initial comments in response to the testimony of Staff and Environmental Respondents on BESS-1?

A. Yes. Both Staff and Environmental Respondents agree with the choice of lithium-ion technology for BESS-1, with ER Witness Cusick stating on page 7 of her testimony that the costs associated with the technology appears to be reasonable. The outstanding issues related to BESS-1 appear to be objectives and utilization.

Q. Staff Witness Joshipura states that BESS-1 would accomplish the objective of improved integration of renewable resources, but questions whether BESS-1 will achieve the objective of improved reliability. Please comment.

A. With BESS-1, the Company seeks to study the prevention of solar backfeeding. Current Company interconnection practices (*e.g.*, limits on the amount of reverse flow) and engineering practices reduce the risk presented by reverse power flow, but do not completely eliminate it. The Company believes that the installation of a BESS will help to further manage the risk by minimizing the time that these conditions are present, thus improving system reliability.

As discussed above, the goal of the Pilot Program is to study BESS to see if they can achieve specific objectives, including improved reliability. The Company disagrees that it needs to actually show an incremental reliability improvement to meet this statutory objective at this stage before Pilot Program approval, or perhaps even during the Pilot Program itself. In fact, Staff Witness Joshipura recognizes that "because BESS is an untested technology, it may not be prudent for the Company to rely entirely on an experimental BESS to resolve an immediate reliability problem." The Company agrees with this statement and believes that this further underscores the need to test BESS-1 for its effectiveness to prevent solar backfeeding before actually using BESS-1 to solve a known solar backfeeding reliability issue in any particular location. Stated another way, the Company does not seek to use BESS-1 to resolve an immediate reliability problem but seeks to study and validate whether it can rely on BESS in the future to resolve future reliability issues.

Q. You mentioned the risk presented by solar backfeeding, what are these risks?

A. Excessive backfeeding or reverse power flow on a substation transformer has the potential to pose several threats to the asset, which could reduce its useful life. These threats could come in the following forms:

1. Excessive heating of the transformer winding. This causes insulation breakdown, which can lead to internal damage, and potential failure.
2. Excessive wear and tear on voltage control devices such as load tap changers and voltage regulators. Load tap changers are placed on either the high voltage side or the low voltage side of the transformer and regulate output voltage of the transformer. Line voltage regulators work in a similar fashion, but are installed on the individual feeders fed by the transformer. The voltage variability caused by backfeeding results in more frequent use of these devices, contributing to degradation in the useful life of the equipment. Staff Witness Joshipura appears to recognize the existence of this threat on pages 10 and 15 of his testimony.
3. Overvoltage exposure to the transformer during fault conditions. Faults occur when energized conductors make contact with each other or with a grounded object. Faults cause large currents to flow, and in some cases result in larger than normal voltages to appear on the non-faulted conductors. These voltages may well exceed the rated voltage of the affected equipment, resulting in damage. The typical mitigation for this situation is to install relay protection. While relay protection limits the amount of time that the overvoltage is present during the fault condition, it does not completely eliminate it from occurring. Staff Witness Joshipura appears to recognize the existence of this threat on page 10 of his testimony, listing "temporary overvoltage

conditions" as one of several potential system issues that Staff found resulting from backfeeding.

The Company believes that these threats constitute reliability issues that BESS might be able to address. BESS-1 will help the Company to further understand the possibilities.

Q. ER Witness Cusick questions the proposed utilization of BESS-1. Do you have any comment?

A. Yes. As I discussed earlier, the Company anticipates identifying and testing additional use cases for BESS-1, hopefully addressing Ms. Cusick's concerns.

The use case identified by Ms. Cusick that the Company likely will *not* consider for BESS-1 at this time is participation in PJM ancillary services markets. To participate in these markets, the Company would need to file an interconnection request, as well as additional agreements through PJM, as described further by Company Witness Rajan. BESS-1 was designed specifically for distribution grid support use cases, and the Company made a conscious decision to forego exploration of BESS-1 as an ancillary services asset. To attempt to add this application after the BESS has been sized, designed, and priced would jeopardize its ability to meet its primary function—prevention of solar backfeeding.

Q. For BESS-1, voltage regulation is one possible future use case the Company may explore. In response, ER Witness Cusick states that mitigating voltage through a BESS will not be a cost-effective long-term solution with the 2018 update to "IEEE regulations" controlling interconnection of distributed generation because smart inverters will be able to automatically correct voltage on the line. Please comment.

A. As an initial matter, while ER Witness Cusick refers to "IEEE regulations," IEEE does not provide regulations but rather guidelines that must then be adopted by the jurisdiction with authority before becoming enforceable. Regardless, the Company does not necessarily agree with her statement that BESS will not be a cost-effective long-term solution for voltage regulation. Inverters have a limited view of the larger distribution system and generally cannot "see" beyond the point at which they are connected to the grid, thus limiting their ability to manage voltage to local remediation (*i.e.*, at their immediate surrounding). In order to have a more widespread impact on voltage, the inverters would need to be combined with additional equipment such as intelligent grid devices with telecommunications infrastructure that enable data flow to and from the Grid Operator and control systems. Furthermore, inverters typically have limited ability to regulate the voltage issues that are related to real power drop off due to reduced solar irradiance (*e.g.*, cloud cover) and would require supplemental devices such as storage systems to help smooth out the impact on voltage related to the intermittency that is inherit in the nature of solar systems.

Q. Staff Witness Dalton states at pages 4 to 5 of his testimony that it may be appropriate to allocate or assign costs of BESS-1 to the solar facility causing the backfeeding. Do you have any comment?

A. Through its Application, the Company asks for approval to participate in the Pilot Program. As I understand it, the statute establishing the Pilot Program specified that costs would be recovered through base rates on a nondiscriminatory basis. Because this is not a rate recovery proceeding, it does not appear that the Commission need make a decision on allocation or assignment of costs here. I would note, however, that although the purpose of BESS-1 is to test its ability to prevent solar backfeeding onto the transmission grid, there is currently no immediate reliability problem caused by the amount of backfeeding observed on Correctional Transformer #1, as discussed above.

III. BESS-2

Q. Do you have any initial comments in response to the testimony of Staff and Environmental Respondents on BESS-2?

A. Yes. Both Staff and Environmental Respondents agree with the choice of lithium-ion technology for BESS-2, with ER Witness Cusick stating on page 7 of her testimony that the costs associated with the technology appears to be reasonable. The outstanding issues related to BESS-2 appear to be objectives and utilization.

Q. Staff Witness Joshipura states that BESS-2 may not accomplish either of the two identified objectives. Please comment.

A. I would reiterate my comments above. A pilot project is investigatory in nature; it is performed to determine whether or not a particular solution performs as expected, and whether the solution is capable of achieving the desired objective prior to wide-scale

deployment. BESS-2 is primarily intended to study how a BESS can be used to reduce transformer loading so that investments in additional capacity can be deferred. Although the targeted transformer is not expected to require replacement in the near future, BESS-2 can still be operated using a "pseudo-limit" such that useful data and operating experience can be obtained. A pseudo-limit is a pre-determined limit (less than the actual normal overload limit of the transformer) that will be used to trigger the BESS to discharge—and thus reduce loading on the transformer—as it would for an actual overload situation. This not only satisfies the objectives of the Pilot Program, but also ensures that the safe and reliable operation of the distribution grid will not be negatively affected should the battery fail to perform as expected.

In addition to the possible reliability benefits discussed in the Application that BESS-2 may provide, BESS-2 will also allow the Company to study how BESS can support reliability of the distribution system during certain contingency scenarios, such as during restoration during an area-wide outage. The Company utilizes feeder tie switches and substation tie equipment to restore large segments of customers during an area-wide outage, with the amount of effort and time to restore customers depending on the loading at the time of the outage and the capacity of adjacent feeders and substation transformers to handle the load. More load typically means more feeder and substation ties are needed to restore all customers. BESS-2 will provide additional capacity at Hanover Substation that can be used to help restore customers. Like the load reduction objective, the BESS can be operated to simulate how it would perform in the event of a contingency, even if no such contingency exists. This approach will allow the Company to investigate this particular use case without potentially creating negative impacts upon its customers.

Q. Staff Witness Joshipura provides a table to show the use of BESS-2 if the Company were to operate it with a pseudo-limit on the loading of the transformer. Do you agree with this concept?

A. Yes, the Company agrees, and had planned to test the load reduction capabilities of BESS-2 using a pseudo-limit. If BESS-2 is approved for the Pilot Program, the Company will work with Staff to select an appropriate limit.

Q. Similar to BESS-1, ER Witness Cusick questions the utilization of BESS-2. Please comment.

A. Establishing a pseudo-limit as supported by Staff should address Ms. Cusick's concerns. In addition, as discussed earlier, the Company anticipates identifying and testing additional use cases for BESS-2. Like BESS-1, however, the Company likely will not consider BESS-2 for participation in PJM ancillary services markets for the reasons discussed above.

Q. ER Witness Cusick recommends that the Company relocate BESS-2. Does the Company agree with this recommendation?

A. No, the Company does not agree with this recommendation. The Company does not believe that it would be prudent to rely solely on BESS-2 to prevent overloading a transformer. Accordingly, the Company selected a location where overload beyond the transformer's normal overload rating is not expected for several more years. At Hanover Substation, BESS-2 can be operated to satisfy a load shaving objective without putting safety and customer reliability at risk. This will allow the Company to obtain experience and knowledge of using the BESS for this application, which is the ultimate goal of the Pilot Program.

Additionally, Hanover Substation has sufficient space to install the BESS, which obviates the need to expand the substation footprint and thereby minimizes the cost of BESS-2. Although there are other transformers that are similarly loaded, the Company's review of other substation locations determined that they would have required the acquisition of additional land and associated activities for permitting and construction, including the expansion of the physical fenced area. Also, Hanover Substation's proximity to Richmond simplifies accessibility for the vendor's technicians and construction crews for the initial installation and ongoing maintenance, as well as Company personnel for operational response and inspections.

Q. If the Company were directed to change the location of BESS-2, what practical implications would that have?

A. There are several implications to consider if the Company were directed to change the location of BESS-2, leading to different costs than those presented in this proceeding. First, based on the Company's initial review of possible locations, the new location would require an assessment to determine if the substation can be expanded. Expansion could require the purchase of additional land, a review for possible environmental impacts, and the potential acquisition of new permits. Also, because the vendor has designed and priced the proposed BESS for a particular geographical location, changing the location to one that is more remote could increase costs. In addition, the HVAC systems responsible for keeping the BESS at the correct operating temperature may require redesign in order to accommodate different weather conditions, which would likely affect the price.

IV. Summary of Testimony

Q. Mr. Wright, please summarize your testimony.

A. The Pilot Program provides the Company with a valuable opportunity to test the functionality, capability, and operability of battery energy storage systems in various use cases. The Pilot Program will result in a deeper understanding of how BESS can be applied to achieve specific objectives, and enable the Company to successfully apply these new technologies in the future. The Pilot Program is an important step that will allow the Company to gain necessary experience and information without exposing customers or other grid assets to unnecessary risk through an ineffective deployment of BESS. Each pilot project was developed to test a specific primary use case with the understanding that there would likely be opportunities for evaluation of other applications in the future. The Company has proposed BESS-1, BESS-2, and BESS-3 to study important statutory objectives, and believes that the information and experience gained from each will provide valuable insight and experience toward deployment of BESS in the future. Accordingly, the Company urges Commission approval of these three BESS as part of the Pilot Program.

Q. Does this conclude your rebuttal testimony?

A. Yes, it does.

Annual Report on Electric Power Storage Battery Pilot Program

As established by the Guidelines ("Guidelines") Regarding Electric Power Storage Battery Pilot Program (the "Pilot Program"), Virginia Electric and Power Company (the "Company") will file an annual consolidated report (the "Annual Report") on the status of the Pilot Program with the State Corporation Commission of Virginia (the "Commission") by March 31 of the following year.

The Annual Report will include the following general information:

- The aggregate capacity of the Commission-approved proposals under the Pilot Program (Guidelines).

The Annual Report will include a discussion of the following topics:

- Transmission and distribution system benefits (Guidelines);
- Line-loss savings (Guidelines);
- Enhanced electric generation capacity (Guidelines);
- Fuel cost savings (Guidelines);
- Ancillary services benefits (Guidelines);
- Any readily quantifiable economic development and job creation benefits across the Commonwealth (Guidelines); and
- PJM wholesale markets as they relate to BESS (Company Rebuttal).

For each approved project, the Annual Report will include the following specific information:

- An update on the progress of the specific proposal in meeting its objectives, using the metrics identified in Attachment 1 (Guidelines);
- An update on the installation cost, as well as actual and projected operation and maintenance ("O&M") costs (Guidelines);
- Performance data and metrics over time, including any additional metrics developed during the course of deployment (Guidelines); and
- Progress in assessing additional use cases (Company Rebuttal).

As additional, compatible applications are identified, the Company will work with Staff to determine what additional metrics should be tracked.

The Company will note and explain the omission of any information that is not available or applicable at the time of each Annual Report.

Proposed Annual Reporting Metrics by Project

Metrics	Metric Description	Proposed By	BESS-1	BESS-2	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.	Company	•	•	•
Durability	Monitor degradation over time to determine if it is consistent with expected operations.	Company	•	•	•
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.	Company	•	•	•
Planned/unplanned maintenance	Quantify the number of times the BESS requires maintenance work and identify the cause of any unplanned maintenance work.	Staff	•	•	•
Cost and benefit data	Collect all relevant cost and benefit data for the BESS.	Staff	•	•	•
Energy throughput	Measure how much energy has gone into and out of the BESS in MWh.	Company Rebuttal	•	•	•
Avoided hours/MWh of backfeeding	Compare backfeeding data preceding installation of the BESS with data collected after the device has been in service.	Company	•		
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.	Company	•		
Avoided overload energy	Quantify how much energy the BESS supplies during periods of peak load, and compare to historical transformer loading data.	Company		•	
Discharge/charge efficiency	Measure the ability to perform peak shifting (AC-coupled) or clipping (DC-coupled) function.	Company			•
MWh of clipped losses captured	Quantify the amount of clipped losses captured by the DC-coupled BESS on an annual basis.	Staff			•
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.	Staff			•

WITNESS REBUTTAL TESTIMONY SUMMARY

Witness: Karl E. Humberson

Title: Director, Generation Projects

Summary:

Company Witness Karl E. Humberson responds to the testimony and recommendations of Staff Witness Joshipura and ER Witness Cusick related to BESS-3.

Mr. Humberson first notes that there seems to be significant agreement related to BESS-3. Both Staff and Environmental Respondents agree with the choice of lithium-ion technology for BESS-3, with ER Witness Cusick stating that the costs associated with the technology appears to be reasonable. Staff Witness Joshipura notes that BESS-3 is designed to accomplish the two objectives identified by the Company—improved integration of renewable resources and reduced need for additional generation during times of peak demand. The Company is also pleased that Staff does not oppose the Company's request for approval of an amended CPCN for the BESS-3.

Company Witness Humberson addresses the remaining issues related to BESS-3 in his rebuttal testimony, primarily issues surrounding the size and utilization of BESS-3. He explains how the Company determined the size of BESS-3 based on the intended applications and factoring in additional opportunities to test other use cases in the future. Specifically, the DC-coupled system of BESS-3 is intended to study a BESS's ability to clip and store energy, while the AC-coupled system is intended to study a BESS's ability to reduce the need for additional generation during times of peak demand through peak shifting. The AC-coupled and DC-coupled battery systems are appropriately sized to allow for, and capture the benefits of, multiple use cases over the life of the project.

Mr. Humberson testifies that if the Company were directed to reduce the size of BESS-3, the Company would need to renegotiate the EPC contract for the project, leading to different costs than those presented in this proceeding. He further explains that one of the factors in the sizing of BESS-3 was the economies of scale of an increased battery size, and that reducing the size of BESS-3 would not have a one-to-one relationship on costs. Lastly, reducing the size of BESS-3 while also increasing the applications of the BESS may also reduce its useful life.

Finally, Company Witness Humberson briefly comments on utilization of BESS-3, noting that BESS-3 is eligible for approximately $5 million in investment tax credits ("ITCs") if it remains a behind-the-meter resource paired with the Scott Solar Facility. Accordingly, if the Company were to move BESS-3 (or a portion of BESS-3) in front of the meter, it would forego some portion of ITCs. This adds an economic decision point for the Company when deciding whether to move BESS-3 in front of the meter and the timing of such a move.

REBUTTAL TESTIMONY
OF
KARL E. HUMBERSON
ON BEHALF OF
VIRGINIA ELECTRIC AND POWER COMPANY
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NO. PUR-2019-00124

Q. Please state your name, business address, and position of employment.

A. My name is Karl E. Humberson, and I am Director of Construction Projects for Dominion Energy Services, Inc., testifying on behalf of Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company"). My business address is 600 East Canal Place, Richmond, Virginia, 23219.

Q. Have you previously submitted testimony in this proceeding?

A. Yes. My pre-filed direct testimony on behalf of Dominion Energy Virginia was submitted to the State Corporation Commission of Virginia (the "Commission") in this proceeding on August 26, 2019.

Q. What is the purpose of your rebuttal testimony in this proceeding?

A. I am testifying in support of the Company's application ("Application") (i) for approval to deploy three battery energy storage systems ("BESS")—designated BESS-1, BESS-2, and BESS-3—as part of the pilot program for electric power storage batteries (the "Pilot Program") and (ii) for an amended certificate of public convenience and necessity ("CPCN") to construct and operate BESS-3 at the Company's Scott Solar Facility, to the extent required by the Commission. Specifically, I will respond to the testimony and recommendations of Commission Staff ("Staff") Witness Neil P. Joshipura and

Appalachian Voices ("Environmental Respondents" or "ER") Witness Kerinia Cusick related to BESS-3.

Q. Do you have any initial comments in response to the testimony of Staff and Environmental Respondents on BESS-3?

A. Yes. The Company is pleased that there seems to be significant agreement related to BESS-3. Both Staff and Environmental Respondents agree with the choice of lithium-ion technology for BESS-3, with ER Witness Cusick stating on page 7 of her testimony that the costs associated with the technology appears to be reasonable. On page 31 of his testimony, Staff Witness Joshipura notes that BESS-3 is designed to accomplish the two objectives identified by the Company—improved integration of renewable resources and reduced need for additional generation during times of peak demand. The Company is also pleased that Staff does not oppose the Company's request for approval of an amended CPCN for the BESS-3.

Q. What issues remain related to BESS-3?

A. The primary issue among the parties seems to be the size of BESS-3. BESS-3 as proposed consists of a 2 megawatt ("MW") / 8 megawatt-hour ("MWh") direct current ("DC")-coupled system and a 10 MW / 40 MWh alternating current ("AC")-coupled system. As described in my direct testimony, the DC-coupled system will be located in two containers at different locations within Scott Solar Facility, with each container housing a 1 MW / 4 MWh BESS. Staff questions the size of the AC-coupled system, while Environmental Respondents question the size of the DC-coupled system. The other issue discussed by both Staff and Environmental Respondents is utilization of BESS-3.

Q. Generally, how did the Company determine the size of BESS-3?

A. The Company determined the size of BESS-3 based on the intended applications, factoring in additional opportunities to test other use cases in the future. The DC-coupled system of BESS-3 is intended to study a BESS's ability to clip and store energy, while the AC-coupled system is intended to study a BESS's ability to reduce the need for additional generation during times of peak demand through peak shifting. Both systems of BESS-3 are sized correctly for these functions. The Company initially plans to systematically evaluate BESS-3 and the applications for testing outlined in the Application. That being said, the Company's contract with the engineering, procurement, and construction ("EPC") contractor allows for optionality to test additional applications of BESS-3, such as participation in the PJM Frequency Regulation Market.

Q. Staff Witness Joshipura states on page 32 of his testimony that a smaller-sized AC-coupled system for BESS-3 would be less expensive while still achieving the intended statutory objectives. Do you have any comment?

A. Yes. I agree with Staff Witness Joshipura that a smaller sized AC-coupled system would cost less and could still achieve the intended statutory objectives. However, installing a 10 MW AC-coupled system will afford additional opportunities in the future to study different use cases at a lower capital cost based on economies of scale, providing increased customer benefits from the Pilot Program.

For example, with a 10 MW AC-coupled system, the Company can test higher BESS output on days when peak hour production from the Scott Solar Facility may not be possible due to weather such as regional shading based on cloud cover. As the value of energy is the highest at peak times, discharging the full 10 MW of the system over the

peak hour would reduce the Company's load demand, providing a greater benefit to customers than would a smaller system. Additionally, sizing the AC-coupled system to 10 MW allows optionality for proving out other potential objectives, such as participation in the PJM Frequency Regulation Market. The AC-coupled BESS could participate in the Frequency Regulation Market while simultaneously acting as a load reducer. The Company is in the process of filing a feasibility study with PJM to explore this future option. Another future option would be moving BESS-3 (or a portion of BESS-3) in front of the meter to allow for grid charging and an increased generating capacity at the point of interconnection. Company Witness Abhijit Rajan describes these concepts in more detail.

Q. ER Witness Cusick at page 31 recommends that the DC-coupled BESS-3 be reduced in size given the amount of energy and capacity being clipped. What does it mean for solar energy to be clipped?

A. Solar projects are designed to produce solar energy up to the allowable interconnection. In the case of Scott Solar Facility, the allowable interconnection is 17.4 MW AC. Solar inverters capture the total amount of solar energy produced up to the size limitations of the inverters, not the peak energy production of the panels. Therefore, at times of peak energy production from the solar panels, some energy may be lost, or "clipped." Solar clipping is not uncommon because inverters are sized to capture the maximum economic value of energy produced from the solar panels, not to meet the peaks of energy output.

Q. With that context in mind, how did the Company determine the size of the DC-coupled BESS-3?

A. Based on economies of scale, the Company decided to utilize two 1 MW DC-coupled systems. The decision to utilize two systems allows the Company to test the DC-coupled application on identically sized inverters at the same facility. This decision was also made due to the limited market comparisons available for operational DC-coupled systems to inform on the systems' ability to clip solar energy. Moreover, sizing the DC-coupled systems below the size of the inverters will allow for the full charge of clipped energy captured by the BESS to be discharged daily.

Q. Do you agree that the Company opted to "throw away" approximately $37,200 in energy when it determined the size of the inverters at the Scott Solar Facility, as ER Witness Cusick states on page 25 of her testimony?

A. No. ER Witness Cusick incorrectly assumes that solar inverters are sized to capture all energy produced from the facility. As discussed above, the Scott Solar Facility inverters were sized to capture the maximum economic value of energy produced, not to meet the peaks of energy output.

Q. Please briefly summarize why BESS-3 is appropriately sized.

A. The AC-coupled and DC-coupled battery systems are appropriately sized to allow for, and capture the benefits of, multiple use cases over the life of the project. As discussed above, the AC-coupled BESS is sized to work as both a behind-the-meter and an in-front-of-the-meter resource. The DC-coupled BESS is sized to effectively capture and compare the energy clipped from each system and inverter.

Q. If the Company were directed to resize BESS-3, what practical implications would that have?

A. Resizing of the BESS-3 would require the Company to renegotiate the EPC contract for the project, leading to different costs than those presented in this proceeding. It is important to understand, however, that one of the factors in the sizing of BESS-3 was the economies of scale of an increased battery size. Reducing the size of BESS-3 would not have a one-to-one relationship on costs. Additionally, as discussed above, reducing the size of the BESS-3 may limit additional future applications. Reducing the size of BESS-3 while also increasing the applications (and, therefore, the cycling) of the BESS may also reduce its useful life.

Q. ER Witness Cusick discusses the utilization of BESS-3 in the PJM wholesale markets. Do you have any comment?

A. Company Witness Rajan discusses this topic in detail. However, I do want to elaborate on one consideration he raises related to investment tax credits ("ITCs"). When BESS are charged from the output of solar facilities, they are considered renewable resources. As renewable resources, BESS are able to benefit from ITCs of up to 26% in 2020 of allowable construction costs. ITCs are then recovered over a five-year period. In the case of the BESS-3, the total value of ITCs is approximately $5 million. In contrast, BESS that are located in front of the meter are not eligible for the ITCs because the BESS is technically being charged from the grid—not from renewable resources. Accordingly, if the Company were to move BESS-3 (or a portion of BESS-3) in front of the meter, it would forego some portion of ITCs. This adds an economic decision point for the

Company when deciding whether to move BESS-3 in front of the meter and the timing of such a move.

Q. Staff proposes additional metrics for the Company to track related to BESS-3. Does the Company agree with these recommendations?

A. Yes, the Company agrees with the two additional metrics recommended by Staff Witness Joshipura on page 36 of his testimony related to BESS-3. Company Witness Robert S. Wright, Jr. presents a summary of all metrics and topics the Company proposes to include in its annual report on the Pilot Program.

Q. Beyond metrics, ER Witness Cusick recommends on page 30 of her testimony that the Company should be asked to evaluate whether there is an economic advantage of adding storage to solar to increase the capacity of solar facilities. Please comment.

A. The Company evaluates all future generating assets annually through its integrated resource planning process. As battery storage technology evolves, the Company plans to monitor BESS-3 to determine the optimal usage of BESS on the Company's system. The Company will determine the future value of BESS and their applications based on the economic benefit to customers and knowledge gained from the Pilot Program.

Q. Does this conclude your rebuttal testimony?

A. Yes, it does.

WITNESS REBUTTAL TESTIMONY SUMMARY

Witness: Abhijit Rajan

Title: Manager, Market Analytics

Summary:

Company Witness Abhijit Rajan responds to the testimony and recommendations of ER Witness Cusick related to BESS-3 and its potential participation in PJM wholesale markets.

Mr. Rajan first discusses the value of BESS participation in wholesale markets, including the requirements for participation and various factors the Company should take into account before determining that BESS-3 will participate in PJM wholesale markets. Additionally, Mr. Rajan addresses the applicability of FERC Order No. 841 to BESS-3, and clarifies any implications the order will have on BESS-3 should the Company decide that BESS-3 will participate in the PJM wholesale markets. Mr. Rajan notes that the BESS-3 use case as originally envisioned included pairing BESS-3 with Scott Solar Facility as a behind-the-meter ("BTM") resource to use it for peak shifting, as well as for reducing the Company's capacity obligation. Mr. Rajan further explains that to participate in the PJM wholesale markets, BESS-3 would effectively become a front-of-the-meter resource.

Mr. Rajan notes that the Company is not opposed to considering wholesale market participation options. He explains that currently, the Frequency Regulation Market in particular is over-saturated, but that demand for frequency regulation is expected to increase in the future. Additionally, he notes that FERC Order No. 841 could also provide an opportunity for the Company to develop other use cases for BESS-3, such as participation in five-minute Energy and Reserve Markets, as well as in the PJM Capacity Market. The Company intends to initiate the feasibility study with PJM in the first quarter of 2020 to begin the Wholesale Market Participation Agreement application process.

Next, Mr. Rajan explains the value of BESS-3 as a BTM resource, including the potential downsides to wholesale market participation that BESS-3 might avoid. For instance, a capacity resource would be subject to Capacity Performance penalties in the event of a Performance Assessment Interval. The resource would also be subject to the final Energy Storage Resource rules currently pending before FERC. Additionally, BESS-3 would be participating in a relatively saturated market, and would be subject to any regulation market rule changes and PJM signal design changes that might occur. Finally, it would be subject to more frequent cycling, thereby shortening its useful life. Placing BESS-3 BTM, meanwhile, would provide energy arbitrage opportunities for the Company's load portfolio at an hourly level, and would reduce the Company's transmission service obligation.

Finally, Mr. Rajan notes that although the Pilot Program should be used as a learning tool, the Company should approach wholesale market use cases incrementally and systematically, thus striking a balance between learning from the Pilot Program and extracting benefits as both a wholesale and BTM resource.

REBUTTAL TESTIMONY
OF
ABHIJIT RAJAN
ON BEHALF OF
VIRGINIA ELECTRIC AND POWER COMPANY
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NO. PUR-2019-00124

Q. Please state your name, business address, and position with Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company").

A. My name is Abhijit Rajan, and I am Manager of Market Analytics for the Company. My business address is 600 Canal Street, Richmond, Virginia 23219. A statement of my background and experience is included as Appendix A.

Q. What are your responsibilities as Manager of Market Analytics?

A. My responsibilities include portfolio analysis, valuation, statistical modeling, and forecasting in support of the Company's generation and load positions in PJM Interconnection, LLC ("PJM") markets. My job also includes managing the Company's financial transmission rights portfolio by utilizing locational marginal pricing modeling and congestion analysis.

Q. What is the purpose of your rebuttal testimony in this proceeding?

A. I am testifying in support of the Company's application ("Application") (i) for approval to deploy three battery energy storage systems ("BESS")—designated BESS-1, BESS-2, and BESS-3—as part of the pilot program for electric power storage batteries (the "Pilot Program") and (ii) for an amended certificate of public convenience and necessity ("CPCN") to construct and operate BESS-3 at the Company's Scott Solar Facility, to the extent required by the Commission.

Specifically, I will respond to the testimony and recommendations of Kerinia Cusick on behalf of Appalachian Voices ("Environmental Respondents" or "ER") related to BESS-3 and its potential participation in PJM wholesale markets. I will discuss the value of BESS participation in wholesale markets, including the requirements for PJM participation and various factors the Company should take into account before determining that BESS-3 will participate in PJM wholesale markets. Company Witness Robert S. Wright, Jr., addresses why the Company does not intend to have BESS-1 or BESS-2 participate in PJM wholesale markets. Additionally, I will address Ms. Cusick's comments regarding whether Federal Energy Regulatory Commission ("FERC") Order No. 841 applies to BESS-3 and will clarify that the Company does—and will continue to—track the PJM wholesale markets and the Order No. 841 proceeding. I also explain the value of BESS as a behind-the-meter ("BTM") resource, and clarify that the Company will continue to evaluate BESS-3 for multiple use cases, while striking a balance between learning from BESS-3 and extracting benefits as both a wholesale and BTM resource. I also note that the Company does not oppose providing an update in its annual report on these issues.

Q. Mr. Rajan, how is your testimony organized?

A. My testimony is organized as follows:

I. Potential Participation of BESS-3 in the PJM Wholesale Markets

II. Value of BESS-3 as a BTM Resource

III. Summary of Testimony

I. Potential Participation of BESS-3 in the PJM Wholesale Markets

Q. ER Witness Cusick focuses on participation of BESS in the PJM markets. What are the different ways a BESS can participate in PJM markets?

A. Since the redesign of the PJM Frequency Regulation Market in 2012, BESS has mostly participated only in this market. As an ancillaries services product, the Frequency Regulation Market provides compensation to resources that provide service by adjusting output or consumption in response to an automated signal. This service aims to stabilize the system by maintaining the difference between scheduled and actual generation, which account for system frequency, within acceptable limits. Because of the large and diverse nature of the PJM footprint, the Frequency Regulation Market is relatively small (on average just over 500 megawatts ("MW") currently clear the market) and has become over-saturated with short-duration BESS over the last few years. Apart from the Frequency Regulation Market, FERC Order No. 841 has made it possible for batteries to participate in Energy, Synchronized Reserve ("Reserve"), and Capacity Markets. To participate in Energy and Reserve Markets, the BESS would have to submit a bid containing its mode of operation (*i.e.*, charge, discharge, or continuous), a market price bid, and bidding parameters such as its state of charge and its operating range. PJM would then use the price bid to send a dispatch signal to the storage resource, which would enable five-minute energy market arbitrage—that is, discharging the resource when power prices are high and charging the resource when power prices are low. However, it would still be up to the resource owner to optimize the resource through the offer parameters in the Energy Market. For example, if a resource had an hour of charge left, it would be up to the resource owner to either discharge the resource with the

remaining charge, or charge the resource while waiting for a better price interval. The resource owner could also simultaneously offer the resource in the Energy and Reserve Markets and have PJM assign the resource for best use. Lastly, BESS can participate in the PJM Capacity Market, but the value would depend on the final minimum run-time requirement as determined in the FERC Order No. 841 proceeding specific to PJM.

Q. What is FERC Order No. 841?

A. As I briefly noted above, FERC Order No. 841 opened the door to energy storage participation in wholesale markets in all regional transmission organizations ("RTOs") and independent system operators ("ISOs"). Because PJM already allowed energy storage participation in the Frequency Regulation Market, Order No. 841 enabled participation in other markets besides just the Frequency Regulation Market in PJM. Among other things, the Order directed RTOs and ISOs to file compliance filings showing how they would implement energy storage participation in other markets. As Ms. Cusick notes, PJM's compliance filing was partially accepted in October 2019, with minimum run-time being the only issue still open.

Q. Ms. Cusick states on page 27 of her testimony that the Company's statement in its Application that FERC Order No. 841 does not apply to BESS-3 is incorrect. Do you have any comments?

A. Yes, I do. FERC Order No. 841 does not apply to BTM resources. Because the Company originally envisioned BESS-3 as a BTM peak shifting resource, the Company's statement was correct that the provisions of FERC Order No. 841 would not apply. Further, even if the Company decides to participate in the Frequency Regulation Market for BESS-3, that option has been available in PJM since 2012 and is not impacted by

FERC Order No. 841. Nevertheless, as discussed below, the Company is also open to systematically exploring BESS-3 participation in other wholesale markets, such as Energy, Reserve, and Capacity Markets. Should a decision be made to participate in these other wholesale markets, provisions of FERC Order No. 841 would apply.

Q. What is a BTM resource?

A. A BTM resource, as referred to in my testimony, is a resource that interconnects to the electric grid at a distribution circuit level and that does not directly participate in the wholesale market as a generator. The BTM resource under this definition may or may not physically reside behind a customer meter, but it reduces load of the relevant the load serving entity ("LSE") in PJM because it is located behind the PJM transmission meter. The Scott Solar Facility, for instance, which is connected at the distribution level and reduces the Company's energy and capacity obligation in PJM, is a BTM resource.

Q. Describe the BESS-3 use case as originally envisioned by the Company.

A. The Company originally envisioned pairing BESS-3 with Scott Solar Facility as a BTM resource to use it for peak shifting, as well as for reducing the Company's capacity obligation. At the time the project was initiated, the Frequency Regulation Market in PJM was over-saturated with batteries. Additionally, FERC Order No. 841 had just been issued, and many details around the BESS participation model were still evolving. Now, the details of BESS participation have become clearer and barriers to market participation are being lifted. However, the Frequency Regulation Market still remains saturated, and the extent of value BESS can extract from Energy, Reserve, and Capacity markets is still unclear.

Q. ER Witness Cusick states that BESS-3 could be bid into PJM's Frequency Regulation Market. What are the general requirements for energy storage resources to participate in the PJM Frequency Regulation Market?

A. Energy storage resources that are distribution connected, such as BESS-3, would need to have a Wholesale Market Participation Agreement ("WMPA") in place with PJM to participate in PJM Frequency Regulation Market. The resource would also need to meet PJM's real-time telemetry and metering requirements and to demonstrate the ability to accurately follow PJM regulation signal. Once a resource files a WMPA and starts providing frequency regulation service, it effectively becomes a front-of-the-meter resource.

Q. What is a WMPA?

A. A WMPA is a three-way interconnection agreement between the resource owner, PJM, and the distribution facility owners in situations where the resource has been non-FERC jurisdictional, such as a resource connected at the distribution level. A WMPA gives the distribution-connected resource owner access to the wholesale market subject to PJM studying and ensuring that the transmission system can absorb any grid impacts of the resource, and if needed, requiring the appropriate party to pay for any required upgrades to the transmission system.[1]

[1] For definitions and additional details, refer to PJM Manuals 14A, 14C and 14G. These PJM manuals can be found at https://www.pjm.com/library/manuals.aspx.

Q. ER Witness Cusick suggests that the Company consider options with regards to wholesale market participation for BESS-3. Does the Company oppose this suggestion?

A. No. The Company does not oppose exploring additional use cases for BESS-3. While there currently seems to be an oversupply of batteries in the Frequency Regulation Market, demand for frequency regulation is expected to go up with increased renewable penetration in the long run.

FERC Order No. 841 and PJM's partially-approved compliance filing could also provide an opportunity for the Company to develop other use cases for the AC-coupled BESS-3 system, such as participating in five-minute Energy and Reserve markets, as well as in the PJM Capacity Market. This can be done either with a full AC-coupled BESS-3 system or a portion of it (*e.g.*, 5 MW could remain BTM while the other 5 MW could become a PJM resource). As indicated in Company Witness Karl E. Humberson's testimony, the engineering, procurement, and construction ("EPC") contract for BESS-3 provides for the optionality to develop other use cases for BESS-3. The Company intends to initiate the feasibility study with PJM in the first quarter of 2020 to begin the WMPA application process. This would open up many of the above-mentioned opportunities in the Energy, Reserve, and Capacity Markets for BESS-3.

Q. Ms. Cusick states on page 29 that the Company should be required to determine the additional net capacity reduction that it will be able to extract from the BESS in the Pilot Program following resolution of the minimum run-time issues in the Order No. 841 proceedings. Please comment.

A. I assume that by net capacity reduction Ms. Cusick is referring to incremental capacity revenue from BESS-3, which will offset the capacity obligation of load. It is not clear at this point that resolution of minimum run-time would necessarily lead to additional capacity benefits for BESS-3 as compared to the BTM alternative. As a vertically-integrated utility with both generation and load in PJM, the Company is uniquely positioned to realize the capacity benefits from BTM operation of BESS-3. If the Company decides that BESS-3 will participate in the PJM Capacity Market, it would lose the capacity benefit to its load, as well as the federal investment tax credit ("ITC") benefit. Company Witness Humberson describes the considerations related to ITCs in more detail. However, the Company will explore alternatives, such as participation of a portion of BESS-3 in PJM markets, including the Capacity Market, which could enable it to maximize the capacity benefit from the facility. The Company will then weigh these benefits against the loss of ITC benefits and other costs of Capacity Market participation. Therefore, while Ms. Cusick is correct in pointing to the outcome of the minimum run-time proceeding as a determinant for BESS-3 market participation, she omits other important factors, such as the capacity benefits of BESS-3 as a BTM resource and the potential loss of ITCs.

Q. ER Witness Cusick states on page 10 of her testimony that "variable generation assets have a minimum run-time requirement of 4 hours to participate in capacity markets. But, if paired with energy storage, that requirement increases to 10 hours." Therefore, she notes, it may be more cost-effective to site energy storage projects separately from solar. Do you agree with this assertion?

A. No, I do not. Ms. Cusick is using the premise of an increase in minimum run-time to support her argument that siting BESS separately from a wind or solar resource may be more cost effective. However, wind and solar resources do not have a specific minimum run-time requirement in PJM. Instead, PJM studies the daily data of wind and solar resources over peak summer months over a 4-hour period (currently 2 p.m. to 6 p.m.) to determine their unforced capacity offer value.[2] When a storage resource is paired with a solar or wind resource, the maximum unforced capacity offer of the hybrid resource is determined by the sum of Capacity Interconnection Rights ("CIR") of the individual resource. For example, if a 20 MW solar facility with a CIR of 12 MW is paired with a 10 MW / 40 megawatt-hour ("MWh") storage system with a CIR of 4 MW (under a ten-hour rule), the hybrid resource would be eligible to offer up to 16 MW of unforced capacity in the PJM Capacity Market. Under that scenario, even before layering on ITC and other co-location benefits, pairing BESS-3 with solar could actually be more cost-effective than not pairing the two. Therefore, the premise of Ms. Cusick's assertion appears to be incorrect.

[2] *See* PJM Manual 21, Appendix B (2019), https://www.pjm.com/~/media/documents/manuals/m21.ashx (containing the procedure for the calculation of capacity values for all wind and solar capacity resources).

II. Value of BESS-3 as a BTM Resource

Q. Are there any downsides to BESS-3's participation in the wholesale market? If so, what are they?

A. Yes. While wholesale market participation creates value stacking opportunities for BESS-3, there are also certain downsides compared to a BTM application. Value stacking is the concept of maximizing the benefits achieved with BESS and enhancing the economic value of a BESS. From a capacity perspective, the load reductions from a co-located facility (*i.e.*, a BESS co-located with a solar facility not participating in the PJM Capacity Market) would have an incremental impact of lowering the Company's capacity obligation on the load side of its portfolio.

Further, a co-located facility would not be subject to a non-performance penalty during Performance Assessment Intervals ("PAIs"). PJM declares PAIs when PJM experiences a power system emergency. When a PAI is declared, non-performing resources are subject to Capacity Performance penalties if they fail to perform at their expected level. If BESS-3 was instead a PJM capacity resource instead of a BTM resource, it would be subject to penalties and bonuses in the event of a PAI.

Additionally, as a PJM capacity resource, BESS-3 would be subject to the final Energy Storage Resources ("ESR") capacity rules. For example, under PJM's ten-hour ESR proposal in its Order No. 841 compliance filing (which, as Ms. Cusick notes, is still being litigated), a four-hour wholesale market battery can only get paid 40% of its maximum output in the PJM Capacity Market. Further, as a wholesale resource in the Frequency Regulation Market, BESS-3 would be participating in a relatively saturated PJM market, and would be subject to market rule changes as well as PJM signal design changes.

BESS-3 would also be subject to more frequent cycling, which would likely shorten its useful life. Lastly, wholesale market participation of BESS-3 in the first five years would likely result in the project not receiving the full value of ITCs, as discussed by Company Witness Humberson. Ultimately, any benefits gained by placing BESS-3 into the wholesale Capacity Market would be impaired by these risks.

Placing BESS-3 BTM, meanwhile, provides energy arbitrage opportunities for the Company's load portfolio at an hourly level.[3] It also reduces the Company's transmission service obligation, as the transmission service charge is based on LSE load during peak periods. While BESS-3 would also have opportunities to participate in both the five-minute Energy and Reserve Markets as a PJM wholesale resource, such participation would impose significant analytical and administrative burdens. For example, BESS-3 would be required to calculate and update offer parameters on a continuous basis, and comply with PJM's offer rules. Nevertheless, the Company will examine all these factors before making a decision on whether BESS-3 will participate in any particular PJM wholesale market. This discussion is summarized in in Table 1 below.

[3] Generation in PJM settles on a five-minute basis, while load settles on an hourly integrated basis.

Table 1: Pros (+) and Cons (-) of BESS Options

Market/Value Driver	Wholesale Resource	BTM Resource
Capacity Market	+ Ongoing minimum run-time proceeding may increase market opportunity - Subject to non-performance penalty	+ Because of being co-located with solar, load likely to receive full or near-full capacity benefit + Not subject to non-performance penalty - Accounting for co-located storage with solar not a current PJM process but PJM is looking to account for it in future
Energy Market	+ Increased energy arbitrage opportunities on a five-minute basis - Loss of BTM Capacity benefit - Must meet metering and telemetry requirements - Analytical and administrative burdens	+ Hourly arbitrage available + Reduced energy and ancillaries cost assignment - Five-minute arbitrage not available to load
Reserve Market	+ Reserve Market revenues + Presents opportunities to co-optimize with energy and frequency regulation	- No Reserve Market participation or revenues
Frequency Regulation Market	+ Frequency Regulation Market revenue - Loss of BTM capacity benefit - Reduction in useful life	- No Frequency Regulation Market participation or revenues
Investment Tax Credits (ITCs)	- Loss of ITC benefit	+ Full ITC benefit + Option available to participate in wholesale market in future
Transmission Service Charge	- No benefit, since there is no impact on load	+ Reduces LSE charge

Q. Is it possible for BESS-3 to perform peak shifting and participate in the PJM Frequency Regulation Market?

A. It depends. If a resource started participating in PJM Frequency Regulation Market, it would become a wholesale market resource and receive payment for charging and discharging at the wholesale market price. In other words, its generation would no longer net against the load. However, if only a portion of BESS-3 participates in the wholesale market, such as the Frequency Regulation Market, the remaining BTM portion can continue to perform peak shaving.

Q. You mentioned that as a BTM resource, BESS-3 would reduce the Company's capacity obligation and therefore provide a Capacity Market benefit. Please describe how the capacity obligation for load in PJM is determined.

A. In order to explain the capacity obligation of load, I'll need to discuss PJM's load forecasting process. In the first part of this two-step process, PJM produces a coincident peak load forecast for each transmission zone. This peak load forecast, produced in January of each year, sets the basis for the capacity obligation applicable to each transmission zone for the following delivery year (from June to May). For example, the most recent peak load forecast issued in January 2019 provides the basis for the calculation of the capacity obligation for the Dominion Energy Zone ("DOM Zone") for the capacity delivery year from June 1, 2019 through May 31, 2020.

As the second step, the zonal capacity obligation is then allocated to LSEs within each zone. In the DOM Zone, this obligation is currently determined by averaging each LSE's prior year's five coincident peak ("5CP") contribution.

Q. What is the current process by which BTM solar generation is accounted for in the PJM load forecast?

A. As part of the first step described above (*i.e.*, producing a coincident peak forecast for each zone), PJM first adds the estimated historical solar output back to each zone's historical load values. This helps PJM produce a forecast as if there were no BTM solar resources in the load zone. PJM then develops a BTM solar nameplate capacity forecast by zone. This includes historical and future resources. This nameplate capacity installation forecast is then used in conjunction with historic summer output at peak hour to obtain the solar capacity at the time of PJM peak load. This estimated solar capacity at peak is then subtracted from the forecast estimated to create the final zonal load peak forecast.[4]

Q. How does the solar co-located battery affect the load forecast?

A. To the extent the BTM battery is discharging during the time of peak, the actual DOM Zone load measured by PJM will be lower. Thus, history will reflect this lower DOM Zone load and that lower load will be accounted for in PJM's load forecast model coefficients used in future PJM load forecasts.

Q. Is PJM exploring whether to account for storage co-located with solar in its load forecast similar to the way it accounts for BTM distributed solar? How will co-located storage be treated under this scenario?

A. Yes, PJM has expressed an interest in pursuing BTM storage co-located with solar in order to stay ahead of any significant growth in such projects. Under this scenario, the

[4] https://www.pjm.com/-/media/committees-groups/subcommittees/las/20191203/20191203-item-03b-pjm-distributed-solar-generation-2020.ashx.

distributed solar capacity at peak, as described earlier, would include the storage output at peak. The advantage of this method of forecasting would be that the impact of storage on DOM Zone peak load forecast would be reflected explicitly, as opposed to through load forecast model coefficients.

Q. Will the Company agree to evaluate potential participation of BESS-3 in the PJM wholesale markets?

A. Yes. The Company agrees to include an update in its annual reports on the potential for BESS-3 wholesale market participation.

Q. Do you have any other comments regarding participation of BESS in the PJM wholesale markets?

A. Yes. While the Company should utilize the Pilot Program as a learning tool, it should approach wholesale market use cases incrementally and systematically. For example, PJM made significant changes to its regulation signal in early 2017, and there is potential for future changes in regulation signal design (*e.g.*, a single regulation signal instead of the current two) that could be more taxing to BESS. Also, hybrid solutions, such as taking part of the BESS-3 to the wholesale markets while keeping the remaining portion BTM, should be fully explored, as this would diversify the risks I described above and would help the Company assess the real-life impacts of cycling without subjecting the whole system to frequent cycling under the Frequency Regulation Market.

III. Summary of Testimony

Q. Please summarize your rebuttal testimony.

A. First, I explained the value of BESS as wholesale resource, including the value of BESS-3's potential participation in the wholesale markets, and made certain clarifications regarding the impact of FERC Order No. 841 on BESS-3. I explained that since the Company began pursuing the Pilot Program, several developments have taken place that have made additional use cases feasible that will help the Company further optimize BESS-3. The Company has ensured optionality in its EPC contract to be able to pursue these potential use cases. Next, I explained the value BESS-3 would provide as a BTM resource, and explained that the Company will continue to evaluate BESS-3 for multiple use cases, while striking a balance between learning from the Pilot Program and extracting benefit as both wholesale and BTM resource. I also noted that the Company does not oppose providing an update in its annual report on these issues. Ultimately, I concluded that BESS-3 should be utilized in a way that ensures the Company: (i) gains experience from the use cases; (ii) assesses longevity and performance impacts; and (iii) learns to optimize BESS benefits. Indeed, co-location of BESS-3 with a BTM solar site would appear to create more opportunities for optimization.

Q. Does this conclude your rebuttal testimony?

A. Yes, it does.

BACKGROUND AND QUALIFICATIONS OF ABHIJIT RAJAN

Abhijit Rajan graduated from Indian Institute of Technology, Roorkee, India in 1996 with a Bachelor of Engineering degree in Civil Engineering. Mr. Rajan received a Master of Business Administration ("MBA") degree in Finance from Case Western Reserve University, Cleveland, Ohio in 2001. Between 1996 and 2001 Mr. Rajan worked initially in the Transportation sector in various quality control roles and later in the area of web application development.

After completing his Master's degree in 2001, Mr. Rajan worked for Louisville Gas & Electric between 2001 and 2006 in various analyst roles involving financial valuation, option pricing, trading support and long-term econometric load forecasting. Mr. Rajan joined the Company in 2006 as Market Operations Advisor in the Energy Supply group. Mr. Rajan was promoted in 2009 to his current role as Manager of Market Analytics. In this role, Mr. Rajan is responsible for providing analytical support for PJM market operations in Energy, Ancillaries and Capacity markets. Mr. Rajan is also responsible for managing the Company's Financial Transmission Rights portfolio in PJM. In addition, Mr. Rajan is also responsible for day-ahead load procurement in PJM and various analyses involving wholesale power markets.

WITNESS REBUTTAL TESTIMONY SUMMARY

Witness: Richard B. Gangle

Title: Director – Environmental Services

Summary:

Company Witness Richard B. Gangle addresses the recommendations contained in the Virginia Department of Environmental Quality's coordinated review of the Battery Pilot Program submitted to the Commission on November 8, 2019 ("DEQ Report"). He represents that the Company does not have any objections with the summary recommendations in the DEQ Report.

REBUTTAL TESTIMONY
OF
RICHARD B. GANGLE
ON BEHALF OF
VIRGINIA ELECTRIC AND POWER COMPANY
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NO. PUR-2019-00124

Q. Please state your name, business address, and position of employment.

A. My name is Richard B. Gangle and I am Director, Environmental Services for Dominion Energy Environment and Sustainability, testifying on behalf of Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company"). My business address is 5000 Dominion Boulevard, Glen Allen, Virginia, 23060.

Q. Have you previously submitted testimony in this proceeding?

A. Yes. My pre-filed direct testimony on behalf of Dominion Energy Virginia was submitted to the State Corporation Commission of Virginia (the "Commission") in this proceeding on August 26, 2019.

Q. What is the purpose of your rebuttal testimony in this proceeding?

A. I am testifying in support of the Company's application ("Application") (i) for approval to deploy three battery energy storage systems ("BESS")—designated BESS-1, BESS-2, and BESS-3—as part of the pilot program for electric power storage batteries (the "Pilot Program") and (ii) for an amended certificate of public convenience and necessity ("CPCN") to construct and operate BESS-3 at the Company's Scott Solar Facility, to the extent required by the Commission. Specifically, I will address the recommendations contained in the Virginia Department of Environmental Quality's ("DEQ") coordinated

review of the Pilot Program submitted to the Commission on November 8, 2019 ("DEQ Report").

Q. Have you reviewed the DEQ Report submitted to the Commission as a result of the DEQ-coordinated review of the Pilot Program?

A. Yes, I have reviewed the DEQ Report and the Company does not have any objections with the summary recommendations.

Q. Does this conclude your rebuttal testimony?

A. Yes, it does.

CERTIFICATE OF SERVICE

I hereby certify that on this 20th day of December 2019, 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:

William H. Chambliss, Esq.
Ashely B. Macko, Esq.
Office of General Counsel
State Corporation Commission
1300 E. Main Street, Tyler Bldg., 10th Fl.
Richmond, VA 23219

C. Meade Browder, Jr., Esq.
John E. Farmer, Jr., Esq.
Office of the Attorney General
Division of Consumer Counsel
202 North Ninth Street, 8th Fl.
Richmond, VA 23219

James R. Bacha, Esq.
American Electric Power Service Corp.
1 Riverside Plaza, 29th Floor
Columbus, OH 43215-2355

Noelle J. Coates, Esq.
American Electric Power Service Corp.
1051 East Cary St., Ste. 1100
Richmond, VA 23219

William C. Cleveland, Esq.
Hannah C. Coman, Esq.
Southern Environmental Law Center
201 West Main Street, Suite 14
Charlottesville, VA 22902-5065