Virginia State Corporation Commission
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Case Number (if already assigned)	PUR-2019-00124
Case Name (if known)	VEPCo - For approval to participate in the pilot program for electric power storage batteries pursuant to VAC § 56-585.1:6, and for certification of proposed battery energy storage system pursuant to VAC § 56-580 D.
Document Type	EXTE
Document Description Summary	Public (Redacted) Version of the pre-filed direct testimony and attachments of Kerinia Cusick on behalf of Appalachian Voices ("Environmental Respondents").
Total Number of Pages	73
Submission ID	17669
eFiling Date Stamp	11/15/2019 12:29:18PM

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November 15, 2019

VIA ELECTRONIC FILING

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

RE: Virginia Electric and Power Company – For approval 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 proposed battery energy storage system pursuant to § 56-580 D of the Code of Virginia.

Case No. PUR-2019-00124

Dear Mr. Peck:

Enclosed for filing in the above-captioned proceeding is the **Public (Redacted) Version** of the pre-filed direct testimony and attachments of Kerinia Cusick on behalf of Appalachian Voices ("Environmental Respondents"). This filing is being completed electronically, pursuant to the Commission's electronic document filing system. Pursuant to 5 VAC 5-20-170 of the Commission's Rules of Practice and Procedure and the Hearing Examiner's Protective Ruling dated August 21, 2019, a Confidential version of this filing is being made under seal, under separate cover.

If you should have any questions regarding this filing, please do not hesitate to contact me at (434) 977-4090.

Regards,

Hannah Coman

Hannah C. Coman

cc: Parties on the Service List
Commission Staff

COMMONWEALTH OF VIRGINIA
STATE CORPORATION COMMISSION

APPLICATION OF	)	
	)	
VIRGINIA ELECTRIC AND POWER COMPANY	)	
	)	
For approval 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 proposed battery energy storage system pursuant to § 56-580 D of the Code of Virginia	)	Case No. PUR-2019-00124

Summary of Direct Testimony of
Kerinia Cusick

On Behalf of
Environmental Respondents

Public Version

November 15, 2019

Summary of Testimony of Kerinia Cusick

The Commission should approve the three projects for deployment of battery energy storage systems as part of the Pilot Program, with specific changes as outlined in my testimony. The purpose of a Pilot Program is for the Company to learn about a new technology and gather information that will be helpful in the future deployment of that technology. My recommendations will ensure that the Company optimize the potential of battery storage in this Pilot Program, and this experience will put the Company in a better position to deploy battery storage cost-effectively in the future.

As proposed, the Company is consistently planning to underutilize the BESS assets, and the Pilot Program will not demonstrate the full capability Lithium Ion BESS can provide. With a typical availability of 98%, and the ability to provide thousands of cycles, Lithium Ion BESS are workhorses that can provide many services and should be used 24/7/365 in order to best optimize the asset. The Company has structured the Pilot Program in a manner that hardly utilizes the assets and leaves them sitting idle the majority of the time. Instead, the Company should layer in additional, complimentary, secondary, or tertiary objectives that can be tested when the BESS are not being used for the primary objective.

At the conclusion of the analysis of each BESS review, I offer specific recommendations to improve each pilot. In all cases, I suggest the Company track asset utilization, not just asset availability. Additionally, I have made specific suggestions with regards to relocating BESS-2 and reducing the size of BESS-3. I also recommend the Company work to determine if there are any barriers to distribution assets participating in PJM markets, specifically Ancillary Services or Frequency Regulation markets. Finally, I recommend the Company track the recently launched FERC proceeding on PJM minimum run time requirements for capacity assets. The outcome of this proceeding will impact how BESS may be used to reduce its net capacity commitment prior to the conclusion of the pilot.

COMMONWEALTH OF VIRGINIA
STATE CORPORATION COMMISSION

APPLICATION OF	)	
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VIRGINIA ELECTRIC AND POWER COMPANY	)	
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For approval 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 proposed battery energy storage system pursuant to § 56-580 D of the Code of Virginia	)	Case No. PUR-2019-00124

Direct Testimony of Kerinia Cusick

On Behalf of
Environmental Respondents

Public Version

November 15, 2019

I. INTRODUCTION AND QUALIFICATIONS

Q: Please state your name, employer, and business address.

A: My name is Kerinia Cusick. I am the Board President of Center for Renewables Integration. My business address is 107 S. West St. #731, Alexandria, VA 22314.

Q: Please describe your current position and provide your education and professional experience as it relates to this direct testimony.

A: I am an engineer, and a solar and energy storage expert. I have worked in renewable energy since 2008. First, at Think Energy, a consulting firm that helped Fortune 100 companies procure clean energy. Then, in a variety of positions at SunEdison, a national solar, wind, and energy storage company, culminating as a Vice President of Energy Storage. Finally, as co-founder of Center for Renewables Integration ("CRI") a 501c(3), and as CEO at Distributed Energy Innovation ("DEI") my own consulting firm. I have a Master of Science in Systems Management from the University of Southern California, and a Bachelor of Science in Mechanical Engineering from Drexel University. My experience and qualifications are described below as well as in my *curriculum vitae* attached as attachment A.

At CRI, I work extensively on policy issues relating to the effective deployment of energy storage assets. On this topic, CRI has participated in ISO stakeholder processes, FERC technical conferences, and performed extensive original qualitative research which is publicly available. CRI was one of the companies engaged by NYSERDA to develop New York's Energy Storage Roadmap, which looked extensively at the issue of using

energy storage as a Non-Wire Alternative Asset on the distribution systems and examined the impact of FERC's Order 841 on possible New York use cases.

At Distributed Energy Innovation, I provide go-to-market consulting services to companies entering the renewable energy sector, renewable companies looking to expand into energy storage, and energy storage companies navigating regulatory models to develop projects. The primary nexus of my focus for clients has been California and New York markets to date.

While at SunEdison, in 2015, I was a leader on the team that was developing, under a joint development agreement, a series of behind-the-meter energy storage projects designed to defer transmission and distribution upgrades. These energy storage projects were contracted by Southern California Edison in 2014 to provide grid-support services as "virtual power plants" and recently announced 2 GWhr of hours in service.[1]

Also at SunEdison, between 2013 and 2015, I led a team developing stand alone, as well as hybrid, solar plus storage systems in CAISO and PJM. SunEdison's assets in PJM participated in PJM's Frequency Regulation market and also provided peak reduction. In that role, I oversaw business development as well as storage financeability.

From 2011 to 2013, I led a team comprised of SunEdison electrical, power controls, and transmission and distribution system engineers, working to develop solutions to integrate solar onto Puerto Rico's island grid. Solutions examined included energy storage, and using those assets to provide frequency, voltage, as well as ramp control to fulfill the utility's interconnection requirements.

[1] Jeff St. John, *AMS Breaks 2 Gigawatt-Hours in Grid Services*, GREENTECH MEDIA (Mar. 19, 2019), https://www.greentechmedia.com/articles/read/advanced-microgrid-solutions-breaks-2-gigawatt-hours-in-grid-services#gs.77t4ui.

Prior to entering the renewable energy sector, I was an aerospace engineer with a specialization in the design of aircraft digital flight control systems, as well systems engineering of complex solutions such as the United States Department of Defense's National Missile Defense system.

Q: On whose behalf are you testifying in this proceeding?

A: I am testifying on behalf of Appalachian Voices, ("Environmental Respondent") in this proceeding.

Q: Have you ever testified before the Virginia State Corporation Commission (the "Commission" or "SCC") or other regulatory agencies?

A: I have not testified before the SCC, but I have testified before the Public Service Commission of Wisconsin (PSC Ref #: 369775 and PSC Ref #: 369221) in 5-CE-146.

Q: How is this testimony organized?

A: My testimony is organized as follows:

I. Introduction and Qualifications

II. Considerations for Cost-Effective Use of Energy Storage in Virginia

II. Analysis of BESS-1

III. Analysis of BESS-2

IV. Analysis of BESS-3

V. Recommendations Summary

Q: Are you submitting attachments along with your testimony?

A: Yes.

Q: What is the purpose of your testimony?

A: My testimony reviews Dominion's application filed with the Commission on August 2, 2019 in this proceeding ("Application")[2] and related testimony and exhibits to determine if Virginia Electric and Power Company ("the Company") has structured the energy storage pilots in a manner that appropriately leverages the capabilities of battery storage, and gathers the data required to inform a prudent deployment of energy storage by the Company in the future. Environmental Respondent is generally supportive of the deployment of energy storage in Virginia, as long as it is utilized strategically and cost-effectively and, in the long-term, enables renewable energy in Virginia.

The purpose of my testimony is to share my experience developing projects in PJM and offer suggestions to ensure that the Company is leveraging the technology cost effectively and identifying additional data that should be collected to inform potential future investments at the conclusion of the pilot.

Q: Based on your review of the record, has the Company designed battery storage pilot projects that are consistent with best practices, and will provide data necessary to develop future cost-effective energy storage systems in Virginia?

A: No, they have not. For each battery energy storage system included in the Application (each of which I refer to as a "BESS"), the Company significantly underutilizes the assets and does not track the necessary metrics to sufficiently inform future battery storage projects.

[2] *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 (Aug. 2, 2019) ("Application").

As the Company has pointed out, I understand that the legislation establishing the pilot program does not require the Company to perform a cost-benefit analysis for the proposed BESS systems.[3] However, the purpose of a pilot program is for the Company to learn about new technologies and how the Company should use the technology in the future. One important lesson for the Company here is how to demonstrate that the benefits of battery storage outweigh the costs. This knowledge will be very important for the Company when it inevitably requests Commission approval for future battery energy storage systems and needs to demonstrate cost-effectiveness. Therefore, it is important that the Company demonstrate the full capability of any BESS in this pilot program, and capture metrics that will be able to inform a future cost-benefit analysis.

I summarize and consolidate recommendations at the conclusion of this testimony which, if implemented, will ensure the Company can fully leverage BESS in the future. I have also highlighted additional metrics for the Company to track to ensure future decisions regarding battery storage deployment are based on Virginia and PJM-specific data, and issues for the Commission to consider as it evaluates energy storage in the future.

II. CONSIDERATIONS FOR COST-EFFECTIVE USE OF ENERGY STORAGE IN VIRGINIA

[3] Company Response to Staff Set 2-37 (included as Attachment B) and 2-38 (included as Attachment C).

Q: How did the Company choose the BESS technology and is the cost of the BESS technology reasonable?

A: The Company's choice of BESS technology is based on an RFP the Company issued to very credible companies and the technology appears to be well-selected. In addition, the cost associated with the BESS technology appears to be reasonable.

Q: The Company is proposing using Lithium Ion based BESS projects, can you explain the considerations that need to be taken into account when using Lithium Ion batteries?

A: The Company is proposing using Lithium Ion batteries in these pilots, which is appropriate since it continues to be the dominant technology in commercial grid-connected applications.[4] Grid-connected Lithium Ion batteries are essentially the same base technology as that used in Electric Vehicles ("EVs"). As a result, all Lithium Ion batteries benefit from the cost declines occurring in the EV sector as manufacturing capability continues to ramp up. This dramatic cost decline, 75% since 2013,[5] combined with continued projected cost reduction, is prompting significant adoption of Lithium Ion batteries in applications or use cases. One of the reasons Lithium Ion batteries are used in the EV sector is because of their ability to withstand a very large number of charge/discharge cycles (*e.g.*, 10 charge/discharge cycles per day) with relatively low degradation.[6]

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[4] *Energy Storage: Tracking Clean Energy Progress* INTERNATIONAL ENERGY AGENCY, https://www.iea.org/tcep/energyintegration/energystorage/. (last visited Nov. 15, 2019).

[5] Trevor Gibson, *Lithium-Ion Battery Prices are Declining, Powering Growth and Opportunity in the U.S. Energy Storage Market*, SMART ELECTRIC POWER ALLIANCE (Aug. 15, 2019), https://sepapower.org/knowledge/lithium-ion-battery-prices-are-declining-powering-growth-and-opportunity-in-the-u-s-energy-storage-market/.

[6] Elena M. Krieger, John Cannarella, Craig B. Arnold, Department of Mechanical and Aerospace Engineering, Princeton University, *A Comparison Of Lead-Acid And Lithium-Based Battery Behavior And Capacity Fade In Off-Grid Renewable Charging Applications*, 60 ENERGY 492, 492-500 (2013).

Lithium Ion battery storage is most cost effective when it is used as a short duration asset, and/or in applications that require significant charge/discharge cycling. In fact, a BESS with a Lithium Ion battery is so cost effective as a short duration asset that it could participate in PJM's ancillary services market and be cost competitive as a Frequency Regulation asset. However, adding duration or depth of discharge to a Lithium Ion battery significantly increases the cost. It is not quite a linear relationship, but in general terms a battery with twice the depth of discharge capability is twice the cost. In other words, a 1 MW / 4 MWhr battery is, roughly, twice as expensive as a 1 MW / 2 MWhr battery. In short, Lithium Ion batteries are best suited to applications that require a large, short duration discharge of electricity, such as Capacity. For the near term, Lithium Ion will not be cost-effective as a pure energy asset, where it is only used to shift electricity from off-peak to peak. But, importantly, if the asset is used to shift energy for a few hours during the day, and used to provide other services for the remaining hours of the day, it can be cost-effective.

Q: Should the Company have considered other BESS solutions such as Advanced Lead Acid or Flow Batteries?

A: Advanced Lead Acid batteries use a technology that has been available for decades. Only modest future cost declines are projected for advanced Lead-Acid batteries, which operate best in a low number of charge/discharge applications (*e.g.*, 1 charge / discharge per day). However, due to its lower capital cost, Lead Acid continues to be deployed in many applications, particularly remote micro-grids in developing countries. By contrast, Flow batteries use proprietary fluids in large containers and are an emerging technology.

Flow batteries are not yet fully commercialized, but they are being designed for applications that require an 8+ hour discharge.

Given the projected future cost declines, it is appropriate for the Company to use Lithium Ion batteries in its pilot program. However, to ensure the technology is being deployed in applications where it can be cost-effective, it is important to ensure the Company is using it in use cases that require fast response, a high number of charge/discharge cycles, or peaking capacity. If the BESS is only going be required to charge/discharge once per day, Virginia ratepayers would be better served if the Company chose advanced Lead Acid due to its lower price point.

Q: Can you explain the impact of FERC Order 841, Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators ("Order 841"), on cost-effectiveness of BESS in Virginia, and PJM, in the future?

A: With Order 841 FERC laid down ground rules to enable the participation of energy storage assets in markets. FERC recently approved the majority of PJM's compliance filing.[7] However, FERC did not approve one portion of PJM's filing, namely the 10-hour minimum-run time requirements necessary to participate in PJM's capacity market.[8] This requirement is controversial, and received significant comments from participants, because of the high cost of Lithium Ion batteries if they are required to achieve a 10-hour run time. For example, a Lithium Ion BESS with the ability to discharge for 10 hours (*e.g.*, 1 MW / 10 MWhr) costs approximately 10 times more than one that discharges for

[7] 169 FERC ¶ 61,049, Order on Compliance Filing, Instituting Section 206 Proceeding, and Establishing Paper Hearing, FEDERAL ENERGY REGULATORY COMMISSION. (Oct. 17, 2019).

[8] *Id.* at 41.

1 hour (*e.g.*, 1 MW / 1 MWhr). FERC opened a new proceeding designed solely to investigate minimum run-time requirements and determine if the 10-hour rule unduly discriminates against energy storage.[9] Until this is resolved, the Company will not be able to determine the capacity value that a BESS can provide, or how it will impact the Company's net capacity obligation. This will be a key factor in determining the future cost effectiveness of BESS in Virginia, as well as all of PJM.

Q: What other implications does FERC Order 841 have on the cost-effectiveness of BESS in Virginia and PJM?

A: In concept, BESS can also be used to firm variable generation assets, such as solar, increasing the capacity factor of those assets by ramping output up and down nearly instantaneously, thereby compensating for passing clouds. However, currently in PJM, 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. As a result, the same cost considerations for the 10-hour run time requirement discussed above would apply to energy storage paired with solar. Therefore, depending on what FERC does, it could be potentially more cost-effective to site energy storage projects separate from solar. However, utilities need to weigh this consideration against the other economic benefits of pairing energy storage with solar, namely the fact that the Internal Revenue Service has determined that a BESS charged by solar is eligible to receive the federal investment tax credit.[10] In short, this question of how to optimally pair

[9] *Id.* at 61. FERC states, "In addition, in that same FPA section 206 proceeding, based on the comments submitted in this proceeding, we institute an in investigation and establish paper hearing procedures regarding the justness and reasonableness of PJM's minimum runt0ime requirements as applied to Capacity Storage Resources."

[10] *Investment Tax Credit for Energy Storage*, SMART ELECTRIC POWER ALLIANCE (May 2018), https://www.seia.org/sites/default/files/2018-05/SEIA-Energy-Storage-ITC-Factsheet-May2018.pdf.

storage with solar – whether storage should be co-located and charged from solar or interconnected independently – is still in flux within PJM. Fortunately, FERC and PJM should resolve these issues by the end of the pilot period.

Q: Besides Capacity and Frequency Regulation, what are the other primary recognized cost effective use cases for in-front-of-the-meter BESS?

A: In addition to the primary use cases for BESS that have already been discussed, specifically using it as a peaking capacity asset (either paired with solar or stand-alone) and providing frequency regulation services, there are a number of other applications for Lithium Ion BESS that can frequently be cost effective. These additional use cases are outlined below.

1) Distribution deferral by using the BESS to reduce load, particularly in urban environments due to the high cost of siting a new substation, upgrading a substation, or running new lines. This application is also known as Non-Wire Alternatives (NWA).
2) Enhancing the effectiveness of the transmission system, either by reducing a thermal constraint, or minimizing congestion and increasing transfer capability. Energy storage can be particularly cost-effective where it is difficult to site a new fossil generation facility, or expensive to run new transmission lines such as under-ground, under-water, or in urban areas. FERC recently termed these applications "grid enhancing", and technologies that can provide this function "grid enhancing technologies" (GET).
3) Energy shifting from peak to off-peak, particularly in markets that see extreme peak costs such as Texas, or in applications where excess solar or wind

generation might otherwise be curtailed and energy markets are flipping negative due to excess generation.

Q: Why is asset utilization important in determining the cost effectiveness of a BESS?

A: In all cases, cost-effectiveness of a BESS is increased by optimizing its utilization, and leveraging the ability of the asset to cycle many times per day without significant degradation, and switch from hour to hour the services that it can provide. Contrary to other assets that can only perform one function, such as a transformer, energy storage can provide multiple services. The key to making energy storage cost effective is fully utilizing the asset and leveraging the flexibility that it provides by "stacking" the services it can provide throughout the day. For example, a cost-effective, highly-utilized BESS might be used to provide Frequency Regulation during the morning ramp when grid operators need it the most, switch to absorb excess solar generation during peak solar hours mid-day, discharge stored solar energy in the late afternoon/early evening during peak hours and/or participate in capacity markets (if ISO/RTO rules allow), provide frequency regulation again during the evening ramp, and absorb excess wind generation overnight.[11] In this example BESS utilization might be closer to 80% or 90% and frequency regulation, energy shifting, curtailment minimization and capacity services have been "stacked" throughout the day while also managing the battery's state of charge. As demonstrated by this example, the more the Company can use the BESS, the more cost-effective it will be to ratepayers.

[11] There are many use cases for energy storage. This is an example designed to show how a BESS can switch from one use case to another throughout the day. In determining the use cases to stack throughout the day the BESS operator needs to consider the state of charge as well as participation rules (e.g. meeting the minimum hours or MW thresholds required to participate). In this scenario, the BESS is participating in frequency regulation, which has a nearly neutral impact on state of charge, charging on solar during off-peak, discharging on-peak, participating in another state-of-charge neutral activity, and then charging again off-peak.

III. ANALYSIS OF BESS-1

Q: Can you summarize the stated intent of BESS-1?

A: BESS-1 is designed to minimize backfeed created by multiple solar systems connected to a feeder in New Kent County. The BESS total cost is projected to be $2.9M for a 2 MW / 4 MWhr Lithium Ion BESS. Backfeed occurs in hours when the solar system is generating, combined with low load. In those conditions, electricity generated can potentially flow "backwards" through the transformer, onto transmission, and cause damage by heating the transformer. To date, the Company has made operational adjustments to ensure damage does not occur to the transformer.[12] The BESS will be charged using excess energy generated by the solar assets, thereby eliminating backfeed.

Q: How has the Company specifically underutilized BESS-1 in its proposal?

A: BESS-1, as currently proposed, will only be utilized for 1,100 hours per year out of a possible 8,760 hours per year.[13] This is an approximate 12% utilization rate, which means that BESS-1 is sitting idle 88% of the year. The Company has discussed other possible uses for the asset at the conclusion of the pilot period, but minimizing backfeed is the only service identified during the pilot period.

Q: Do you agree with the Company's statement in the Application that BESS-1 has been sized to eliminate backfeed and, as a result, that is the only service that can be tested during the pilot?

A: No, I do not. The Company stated that the BESS-1 location "was chosen because it has a feeder with 20 MW of PV generation interconnected that frequently results in

[12] Company Response to ER Set 2-6 (included as Attachment D).

[13] Application, Exhibit 1 at 5.

backfeeding."[14] According to data provided by the Company, "[the substation] experiences backfeeding more than 1,100 hour per year."[15] Further, in response to a question from Commission Staff in discovery regarding why the Company is not analyzing multiple uses for BESS-1 as part of this pilot program,[16] the Company stated that since the primary objective of BESS-1 is to reduce backfeed onto the transmission system, and "the Company sized BESS-1 at this location accordingly."[17]

The Company also provided a spreadsheet with date/time stamp showing the time of day when backfeed occurs.[18] It is intuitively obvious that backfeed can only be occurring during daylight hours, when the solar assets are generating electricity, which means the asset can be used for other purposes in all non-daylight hours without impacting the primary objective of the pilot. A further analysis of the data provided, assuming a normal distribution, shows that 68% of the backfeed occurs between [redacted] and [redacted].[19]

While a more thorough examination of the data would be appropriate, rather than the high-level analysis performed here, there is clearly ample opportunity to use the asset to perform multiple functions, based on time of day.

[14] *Id.* at 1.

[15] *Id.* at 5.

[16] Company Response to Staff Set 1-18 (included as Attachment E).

[17] *Id.*

[18] COC-Sensitive Confidential Attachment Staff Set 1-10.

[19] Based on a calculated mean/average of [redacted].

Q: If the Company were to use BESS-1 to demonstrate other services, would that accelerate the battery degradation and jeopardize the Company's primary objective?

A: No, it would not. The Company stated that it intends to purchase a Lithium Ion-based BESS.[20] The Company should verify the battery warrantee offered by their selected vendor, but most warrantees will accommodate over 5,000 cycles with minimal degradation,[21] which equates to over 13 complete charge/discharge cycles per day over a 5 year pilot time period.

Q: What other services can BESS-1 provide the grid during hours that are not allocated to minimizing backfeed?

A: The Company has stated it "may also explore other uses, such as voltage regulation, peak shaving, phase balancing, and harmonics mitigation depending upon the BESS's capabilities at the end of the Pilot Program."[22] As the Company looks to combine uses to maximize the asset's value it will be important to select services that do not conflict and require the BESS to perform during the same hours of the day.

For example, if BESS-1 were also used to perform peak shaving, BESS-1 would need to discharge during peak hours, by definition. Dominion lists peak hours as 11 AM – 10 PM weekdays during summer months (June 1 to September 30), and 7 AM – 11 AM

[20] Application at 5, 6.

[21] *See e.g., Energy Storage System: Battery Business,* SAMSUNG SDI *available at* http://www.samsungsdi.com/upload/ess_brochure/201803_SamsungSDI%20ESS_EN.pdf. (Samsung warrantee for 6,000 cycles).

[22] Application, Exhibit 1 at 2.

as well as 5 PM – 9 PM weekdays in all other months.[23] Therefore, peak shaving may be a service that cannot be combined with backfeed minimization, since backfeed would require the battery to be charging during the day, and peak reduction would require the battery to discharge during the day to reduce load. As mentioned, a further analysis of the backfeed occurrences would be appropriate, to determine whether these two services conflict or are compatible.

Alternatively, in a Quanta report commissioned by the Company, Quanta notes that approximately 300 MW of energy storage is participating in PJM's Frequency Regulation market[24] and frequency regulation is needed 24 hours a day. This may be a use that is compatible with backfeed mitigation. Although not noted in the Quanta report, it is worth mentioning that the PJM Frequency Regulation market is largely saturated, which has significantly driven down the historical high prices that encouraged the development of a number of BESS projects in PJM from 2013 to 2015. However, as a supplemental value, and to ensure the asset is fully utilized, it may be appropriate for the Company to gain the experience of submitting a BESS into PJM's Frequency Regulation market.

Q: Is backfeed minimization one of the generally recognized use cases for battery storage in the U.S.?

A: No, it is not. Backfeed is normally identified during the interconnection process of a solar facility and upgrades are performed at the time to avoid backfeed. However, the majority

[23] *Schedule IT, Residential Service*, VIRGINIA ELECTRIC AND POWER COMPANY, Filed 03-15-19 https://www.dominionenergy.com/library/domcom/media/home-and-small-business/rates-and-regulation/residential-rates/virginia/schedule-1t.pdf?la=en.

[24] Eric Hsia, *Energy Storage in PJM: A Perspective*, PJM: INSIDE LINES (Nov. 14, 2019), https://insidelines.pjm.com/energy-storage-in-pjm-a-perspective/; *see also* Confidential Attachment Staff Set 4-95 at 35.

of energy storage use cases have been developed in restructured electricity states, where upgrade costs to the distribution line are paid by the generator attempting to interconnect. Given that Virginia is vertically integrated, and the Company owns both the solar facility that causes the backfeed as well as the distribution system, energy storage to address backfeed may be an appropriate use case in Virginia, and prove to be a cost-effective solution to increasing hosting capacity on distribution lines.

Q: The Company suggests that it may explore using BESS-1 to provide voltage regulation. Is voltage regulation a typical cost-effective use case for a BESS in the U.S.?

A: While mitigating voltage changes introduced by DG may be an appropriate use case in the near term, it will not be in the long-term. The Company states that it wants to explore if a BESS may be an appropriate solution to correct voltage drifts caused by distributed generation. Specifically, the Company states, "DG (distributed generation) changes the 'one-way street' into a 'two-way street' by making it possible for energy to flow in reverse from the customer back to the transmission grid when the DG output exceeds the load on the circuit. This introduces several potential issues that a BESS could help mitigate."[25] The Company includes voltage regulation as one of the issues.[26] However, with the 2018 update to IEEE regulations controlling interconnection of DG to the distribution grid, smart inverters will be able to automatically correct voltage on the line,

[25] Application, Exhibit 1 at 4.

[26] Application, Exhibit 1 at 2.

at no additional cost.[27] As a result, mitigating voltage through a BESS will not be a cost effective long-term solution.

Q: Do you agree that the Company has proposed the correct set of tracking metrics for BESS-1?

A: No, I do not. The metrics the Company proposed to track are insufficient to inform future BESS investments. At a minimum, the Company should add asset utilization as a metric to track. Currently the Company proposes tracking "availability" (*e.g.*, how often the asset is available to be used and not subject to an outage), but not how effectively the asset was used during the pilot (*e.g.*, hours per year the asset was charging, discharging, participating in markets, or providing other service).[28] Additionally, if the Company determines they are able to participate in markets such as PJM's Ancillary Services market to provide frequency regulation in non-daylight hours, the Company should also track the revenue generated from that participation.

Q: How would you recommend improving the Company's proposal for BESS-1?

A: BESS-1 pilot can be improved as follows:

(a) The Company should perform a more detailed analysis of conditions in which backfeed occurs to identify the hours per day, which will most probably vary by month, the asset can be used to demonstrate other services.

(b) The Company should consider what other services are time-compatible with the primary pilot objectives. This may be peak shaving some months of the

[27] Kerinia Cusick, Harry Warren & Versha Rangaswamy, *It's Time for States to Get Smart About Smart Inverters*, CENTER FOR RENEWABLE INTEGRATION (Oct. 2019), https://www.center4ri.org/publications.

[28] Application, Exhibit 1 at 7. Availability is defined by the company as "Availability of the BESS will be measured by comparing the amount of time that the BESS is available for operations to the total amount of time in the study period, which will be compared to industry expected levels of approximately 98%."

year, or it may be some of the other services the Company has identified such as harmonics mitigation, or phase balancing.

(c) The Company and the Commission should determine whether there is a conflict in allowing BESS classified as distribution assets to participate in PJM Ancillary Services markets, and what safeguards may be required, by the Commission and/or PJM, to ensure the BESS is not bid artificially low or in a manner that would have potential to skew the market, if propagated in greater quantities. If allowed, the Company should consider having the BESS participate in PJM's Frequency Regulation market.

(d) The Company should identify the non-daylight hour goal for BESS-1 and the appropriate metrics to track to demonstrate the mission has been achieved.

(e) Finally, the Company should also track, and report, a utilization metric, potentially hours per year the asset was charging/discharging and actively providing a service.

IV. ANALYSIS OF BESS-2

Q: Can you summarize the stated intent of BESS-2?

A: The Company intends to use BESS-2 to reduce load on a transformer in order to defer when the transformer would need to be upgraded or replaced.[29] The Company estimates the cost to upgrade the Hanover substation, by adding a second transformer is

[29] Application, Exhibit 2 at 4.

approximately $4M.[30] Using a BESS as an alternative to performing upgrades on the distribution system is a recognized, and valued, use case for BESS in the U.S. given the typical cost of distribution upgrades, particularly in urban environments.

Q: Can you summarize how the Company corrected their Application and how that impacts the potential value of BESS-2?

A: Initially, the Company projected the summer peak load would exceed the transformer's summer overload rating by 2023, during the time period of the Pilot Projects.[31] However, the Company then corrected that statement and changed the date to 2031,[32] well beyond the duration of the Pilot Projects which will conclude in 2025. Given the correction, the value of BESS-2 at the Hanover substation is unclear.

In response to Staff Question 23, the Company provided a spreadsheet showing the number of days per year, as well as hours, when the projected load is expected to exceed the transformers limits in 2031.[33] An analysis of the data provided shows the battery would be discharged [redacted] hours in 2031 in order to keep load limits under thresholds. With 8,760 hours per year, this is the equivalent of a [redacted]% utilization rate in 2031, assuming the projected load materializes.[34] While the data was only provided for the year 2031, presumably there are no instances when load exceeds limits prior to 2025.

[30] Company Response to Staff Set 1-22 (included as Attachment F).

[31] Application, Exhibit 2 at 5.

[32] Company Response to Staff Set 1-3 Corrected (included as Attachment G).

[33] Spreadsheet titled Corrected COC-Sensitive Confidential Attachment Staff Set 1-23 (RSW)

[34] *Id.*

Q: Does BESS-2 provide value to the grid then?

A: The Company has argued there is still value in deploying BESS-2 at the Hanover substation so that it can test using BESS-2 to reduce load at the transformer.[35] Given the projected $4M cost of BESS-2, it seems more effective to find a different transformer at which to deploy BESS-2, such as a transformer that is expected to realize an overload during the pilot period. Then, when the Company successfully demonstrates that it can use a battery to reduce load on a transformer, it can leave the battery in-situ after the conclusion of the pilot, providing Virginia ratepayers with real value.

Let me be clear. Reducing transformer load can be a great use of battery storage, particularly if it delays or obviates the need to upgrade the transformer. The issue is not whether this is a good application but rather whether this is the best location.

Q: How could the Company improve the utilization rate of a load reduction battery in order to deliver more value for Virginia ratepayers?

A: As discussed above, battery storage assets are flexible resources that can, and should be utilized heavily in order to be able to realize the value they can provide. The Company is planning to use BESS-2 to reduce load at a substation. Therefore, by definition, the asset is being used during peak load conditions, which is daytime hours in the summer months, and early and late hours of the day during non-summer months.

With judicious use of weather forecasts to ensure the Company is not surprised by an atypical load profile, the Company could plan to use BESS-2 to provide other services at night during the summer, 24 hours per day in shoulder months, and the middle of the

[35] Company Response to ER Set 2-9 (included as Attachment H).

day during the winter months. Those services might include energy shifting, voltage control, frequency control, or any other use cases the Company identifies.

Contrary to BESS-1, for BESS-2 load reduction at a transformer and overall peak reduction may be compatible services. The Company will be discharging the battery in peak load conditions at the transformer, which may overlap with the Company's overall net capacity commitment to PJM. Depending upon the outcome of the PJM minimum run-time requirement case at FERC, that discharge may be *de minimus*, or not.

Q: How would you recommend improving the Company's proposal for BESS-2?

A: BESS-2 pilot can be improved as follows:

(a) The Company should reexamine the projected load profiles at substations to identify a better location for the pilot. Specifically, a location where the peak load is expected to exceed the transformer limits in the last few years of the 5-year pilot program.

(b) The Company should perform an analysis to determine the hours per day the asset can be used to fulfill secondary, and possibly tertiary, objectives. While the load at the transformer may not directly coincide with the Company's overall peak load profile, it is highly probable BESS-2 can be used to provide other services during all non-peak conditions.

(c) The Company should identify services that are valuable and needed during non-peak hours, and select those that it wishes to use BESS-2 to demonstrate. The Company should also identify metrics associated with those services.

(d) As with BESS-1, the Company should determine under what conditions it is appropriate to have a distribution asset participate in PJM's ancillary services market, and potentially plan to use BESS-2 to provide Frequency Regulation.

(e) Finally, the Company should also track, and report, a utilization metric, potentially hours per year the asset was charging/discharging and actively providing a service.

V. ANALYSIS OF BESS-3

Q: Can you summarize the stated intent of BESS-3?

A: BESS-3 is comprised of two Lithium Ion storage systems, both connected to a 17 MW solar array know as Scott Solar. The first is a 2 MW / 8 MWhr DC-coupled BESS, and the second is a 10 MW / 40 MWhr AC-coupled BESS. The total projected cost for the two assets is approximately $26M, and the cost of the individual BESS has not been separated out. The primary goal of the DC-connected BESS is to capture solar energy that would otherwise be "clipped" by the inverter, and therefore lost, and discharge that energy during peak conditions. The goal of the AC-connected BESS is to shift energy generation from off-peak to peak by charging the BESS during off-peak and discharging during peak.

Q: The Company proposes using both DC-connected and AC-connected for BESS-3. Can you explain the pros and cons of DC-connected versus AC-connected energy storage and solar systems?

A: In a DC-connected solar and storage system the two assets are connected behind one inverter. The benefit is the potential to reduce total system costs by only using one inverter. Inverter costs are a significant percentage of any solar or energy storage system, therefore it can be a measurable savings. The disadvantage of DC-connected is that the two systems are limited by the capacity of the inverter; therefore, it is important to size the inverter correctly. For example, a 100 kW solar system and a 50 kW BESS connected to a 100 kW inverter will never be able to output the maximum nameplate capacity each asset could generate, namely 150 kW. The maximum output will always be limited by the 100 kW capacity of the inverter. Depending upon the use case, this can either have a *de minimis* or a significant impact. Additionally, a single inverter for solar and storage requires that the same party finances both systems since both will want the ability to put electricity onto the grid independent of the other party, and sharing an inverter does not guarantee independent operations. While this can be a complicating factor for private developers, it is an advantage for the Company.

Q: The DC-connected BESS-3 is designed to reduce solar "clipping." Can you explain the reason solar energy would be clipped?

A: As the Company explains in the application, "[t]he DC-tied system will store PV generation that would otherwise be clipped due to max output limitation on the solar inverter ("Clipping")."[36] The Company argues the inverter was economically sized, and

[36] Application, Exhibit 3 at 4.

"the additional capital cost required for an inverter to meet peak energy production outweighs the value of the energy that is clipped."[37]

Q: How much solar is clipped by the inverter per year?

A: The Company clarified that 62 MWh per year of solar is clipped by the inverter and "lost".[38] At a wholesale rate of $30/MWh, that is an equivalent loss of $1,860 per year, or $9,300 over the 5 year pilot period, or $37,200 over the 20 year expected life of the solar array. Based on some "back of the envelope" calculations, the amount of solar energy getting clipped per day is on the order of 345 kWh.[39] This assumes 180 days per year of perfect solar conditions (*e.g.*, no clouds, rain, or snow, perfectly clean solar array, 100% availability of all of the solar panels). The maximum kW clipped per day has not been specified by the Company, nor has the Company specified the size of the inverter (MW).

Q: Can you estimate the size of the inverter based on the Company's statement that it was "economically sized"?

A: Based on benchmark data provided by NREL,[40] the cost of a commercial solar inverter is $0.08 / W in 2017. Scott Solar was built in 2016 and therefore the Company's costs may have been slightly higher. However, using NREL's data, increasing the size of the inverter by 1 MW would result in $80,000.00 additional cost.[41] The Company opted to "throw away" approximately $37,200 in energy, which means the inverter is

[37] Company Response to ER Set 2-8 (included as Attachment I).

[38] Company Response to Staff Set 2-56 (included as Attachment J).

[39] Assumes peak output exceeds inverter limit 180 days per year. If the solar plant exceeded the inverter limit 365 days per year (lowest possible case) the clipped solar energy is 169 kWh per day. If the plant exceeded the limit 100 days per year, the clipped solar energy is 620 kWh per day.

[40] Ran Fu, David Feldman, Robert Margolis, Mike Woodhouse, and Kristen Ardani, *US Solar Photovoltaic System Cost*, NATIONAL RENEWABLE ENERGY LAB (Sept. 2017) at 10, https://www.nrel.gov/docs/fy17osti/68925.pdf.

[41] *Id.*

approximately 0.47 MW,[42] or 470 kW, smaller than an ideally sized inverter which would not clip any energy.

Q: Is the DC-connected BESS-3 appropriately sized?

A: BESS-3 appears to be completely oversized given the amount of energy, and capacity being clipped. While the cost of the DC-connected BESS-3 has not been specified independent of the AC-connected BESS-3, it is reasonable to assume the cost of the 2 MW / 8 MWhr DC-connected BESS-3 is on par with the cost of BESS-1 and BESS-2, since they are all the same size. Therefore, it is appropriate to conclude the Company is conservatively proposing to spend at least $1,000,000 on the DC-connected BESS-3 in order to address an approximately $10,000 solar clipping problem over the duration of the pilot program.

While the Company will learn valuable information from operating a DC-connected solar and storage system, and should be allowed to install it given the potential for long-term savings from only utilizing one inverter, it also seems appropriate to significantly reduce the size of the DC-connected BESS-3 given the complete misalignment of cost for the potential benefit. Using the "back of the envelope" calculations performed above, a 470 kW / 345 kWh BESS seems more than adequate to allow the Company to learn the benefits of operating a DC-coupled solar and BESS assets.

[42] 0.47 MW = $37,200/$80,000 per MW

Q: In response to a discovery question, the Company stated that FERC Order 841, Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators, does not apply to BESS-3. Do you agree?

A: I need to un-pack this question. The Company's statement that FERC Order 841 does not apply to BESS-3 is incorrect, as discussed in additional detail below. In Staff Set 2-54, Commission Staff asked the Company how FERC Order 841 applies to BESS-3. In their response the Company stated, "BESS-3 is located at a load reducing facility and is therefore unaffected by Order 841 and 841 a."[43] However, when the Company uses the term "load" in this response, they mean their net capacity obligation to PJM.[44] This is distinct from FERC's use of the term "load" which can create some confusion.

In concept, BESS-3 could be bid into PJM markets. However, the Company is using Scott Solar, the solar facility connected to BESS-3, to reduce its net capacity obligation, which is the amount of capacity that it must either supply or procure from the market.[45] Similar to BESS-3, the capacity from Scott Solar could be bid into PJM's market, but instead the Company chose to use the facility to reduce its net capacity obligation. Once the relevant PJM rules have been finalized, the Company should calculate the additional capacity reduction that it could obtain from BESS-3 and report on

[43] Company Response to Staff Set 2-54 (included as Attachment K).

[44] Direct Testimony of Ted Fasca, on behalf of Virginia Electric and Power Company, *Application of Virginia Electric and Power Company for approval and certification of the proposed 2016 Solar Projects pursuant to §§ 56-580 D and 56-46.1 of the Code of Virginia and for approval of a rate adjustment clause, designated Rider US-2, under § 56-585.1 A 6 of the Code of Virginia*, Case No.PUE-2015-00104 (Oct. 1, 2015) at 11. Mr Fasca states: "However, because the 2016 Solar Projects are each connected to the Company's distribution network as a load reducer, they will not be directly bid into the PJM capacity performance market. Instead, the Company's net capacity obligations to PJM will be reduced once the generation from the Projects is reflected in PJM's load forecast. This is consistent with PJM's load forecast methodology."

[45] *Id.*

that at the end of the pilot. While those rules have not yet been finalized, as explained in Section II, it is reasonable to assume that they will be determined during the pilot.

In determining which energy storage resources can participate in markets, FERC made it clear that any energy storage asset that receives and injects electricity onto the grid can participate in its markets. FERC's definition of an energy resource is, "a resource capable of receiving electric energy from the grid and storing it later for injection of that electric energy back to the grid."[46] Additionally, FERC states, "we clarify that electric storage resources located on the interstate transmission system, on a distribution system, or behind the meter fall under this definition, subject to the additional clarifications provide below."[47] In their additional clarification FERC states, "[s]ome commenters argue that the Commission should broaden its definition of an electric storage resource to apply to behind-the-meter resources that do not inject electricity onto the grid. We decline to do so."[48]

In summary, FERC refused to extend Order 841 to battery systems that reduce a building's load. For example, a 50 kW battery operating behind-the-meter to reduce the peak load of a building with a minimum load of 200 kW will not be allowed to participate in markets. However, any battery that receives and injects electricity onto the grid can participate in markets, which also means the asset can be used to reduce the net capacity commitment. As a result, FERC Order 841 does not apply to BESS-3 and the Company could bid BESS-3 into the PJM markets.

[46] *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, 162 FERC ¶ 61,127 at 25.

[47] *Id.* at 25.

[48] *Id.* at 27.

Q: How does PJM's implementation of FERC Order 841 impact this Pilot Program and BESS-3 in particular?

A: At the time the Company developed their Application, FERC had not yet approved PJM's Order 841 compliance filing.[49] Therefore, it is appropriate that it was not considered at the time. However, this Pilot Program is designed to run for 5 years, and battery storage assets may be able to provide the Company with capacity value, depending upon the outcome of a pending decision at FERC on PJM's minimum run-time requirements for energy storage resources. Therefore, it would be appropriate to require the Company to determine, before the conclusion of the pilot, the additional net capacity reduction that it will be able to extract from the three BESS programs.

On October 17, 2019 FERC approved the majority of PJM's Order 841 compliance filing.[50] However, one of the exceptions was PJM's capacity market rule which requires an asset to have a minimum run-time of 10 hours.[51] Since Lithium Ion battery storage assets are in essence capacity, not energy assets, this issue was contentious and received significant feedback from numerous parties, as well as FERC.[52] In their order, FERC states: "Accordingly, in the same FPA proceeding directed above in Docket # EL19-100-000, we will initiate paper hearing procedures to investigate whether PJM's minimum run-time rules and procedures are unjust, unreasonable, unduly discriminatory or preferential as applied to Capacity Storage Resources."[53]

[49] 169 FERC ¶ 61,049, Order on Compliance Filing, Instituting Section 206 Proceeding, and Establishing Paper Hearing, FEDERAL ENERGY REGULATORY COMMISSION. (Oct. 17, 2019).

[50] *Id.*

[51] *Id.* at 41.

[52] *Id.* at 42-63.

[53] *Id.* at 62.

Q: The Company has stated that it does not plan to increase the capacity of the Scott Solar facility as a result of adding BESS-3. Can you explain the pros and cons of not doing so?

A: In response to Staff Set 3-86, the Company stated, "BESS-3 is a separate generating asset from the Scott Solar Facility and not intended to increase the capacity factor of the facility."[54] Increasing the capacity of the solar facility would require reexamining the interconnection study to determine if any upgrades are required to host a 27 MW[55] facility on the distribution line and potential upgrade costs. However, by not doing so, the implication is that both assets will have to operate within the interconnection limit of 17 MW. Therefore, if the solar facility is outputting 16 MW, the BESS will be limited to a maximum output of 1 MW. The Company will only be able to output the full 10 MW of the BESS when the solar facility is outputting 7 MW or less. Given that PJM has not finalized its capacity market rules for energy storage participation, this is an appropriate decision. However, given the potential to use energy storage to increase the capacity of a solar facility, either by firming the output of the solar facility, or increasing the total nameplate of solar facility, the Company should be asked to evaluate, before the conclusion of the pilot, whether future solar and storage assets should be treated similarly, or whether there is an economic advantage of adding storage to solar to increase the capacity of the solar facility.

[54] Company Response to Staff Set 3-86 (included as Attachment L).

[55] 27 MW = 17 MW Scott Solar facility + 10 MW BESS

Q: What other services could BESS-3 provide in order to improve the utilization, and therefore the cost effectiveness, of the batteries?

A: Similar to the suggestions provided for BESS-1 and BESS-2, BESS-3 could be bid into PJM's Frequency Regulation market when the AC-connected battery is not being used for its primary purpose, which is shifting electricity from non-peak to peak hours. While the Company has not provided the hours during the day which it plans to use the AC-connected BESS-3 asset to shift electricity from off-peak to peak, it is reasonable to assume that it will be during daylight hours and early evening hours.[56] This means the asset would be available, primarily at night, to provide other services.

Q: How would you recommend improving the Company's proposal for BESS-3?

A: BESS-3 pilot can be improved as follows:

a) The DC-coupled BESS-3 should be significantly reduced in size. Given some back of the envelope calculations, a 470 kW / 345 kWh BESS may be more appropriate.

b) The Company should calculate the hours BESS-3 will not be used to provide energy shifting from off-peak to peak, and therefore the hours per day that it can be used to provide other services. The Company should identify what other valuable services BESS-3 can provide that do not conflict with the primary goal. This may include frequency regulation, voltage control, peak shaving, or others. The Company should identify additional metrics to track based on the additional services added to BESS-3 pilot.

[56] Virginia Dominion lists peak hours as 11 AM – 10 PM weekdays during summer months (June 1 to September 30), and 7 – 11 AM as well as 5 – 9 PM weekdays in all other months. *Schedule IT, Residential Service*, VIRGINIA ELECTRIC AND POWER COMPANY, Filed 03-15-19 https://www.dominionenergy.com/library/domcom/media/home-and-small-business/rates-and-regulation/residential-rates/virginia/schedule-1t.pdf?la=en.

c) The Company should track the FERC proceeding on PJM's minimum run time and, once finalized, calculate the amount of net capacity reduction that could be achieved by pairing solar and storage together. Additionally, based on PJM's rules, the Company should draw a conclusion regarding optimum sitting of energy storage with solar, and whether it should be co-located or interconnected independently.

d) Finally, the Company should also track, and report, a utilization metric, potentially the hours per year the asset was charging/discharging and actively providing a service.

Q: Can you summarize any additional metrics the Company should track in BESS-3 in order to be able to inform the prudency of future potential investments?

A: Yes, as in BESS-1 and BESS-2, the Company should be required to track and report on the following metrics: 1) utilization, which is a measure of the hours per day or year that the asset was used to provide a service, and ideally the Company would strive for a utilization rate above 80%; 2) capacity reduction (MW) of BESS under finalized PJM capacity market minimum run-time rules; 3) calculation of potential increase of solar capacity if BESS is used to increase solar capacity, under finalized PJM capacity market minimum run-time rules.

Q: BESS-1 is classified as a distribution asset while BESS-3 is classified as a generation asset. Does that impact the ability of either asset to participate in PJM's Ancillary Services markets?

A: It may. This is a regulatory issue that should be resolved during the Pilot Program to determine how asset classification will impact the services the asset can provide.

VI. RECOMMENDATIONS SUMMARY:

Q: Can you summarize the various recommendations you have provided in this testimony?

A: The Commission should approve the three projects for deployment of battery energy storage systems as part of the Pilot Program with the following recommendations to improve the pilot program. Additional detail is provided at the conclusion of each BESS section (Sections II, III, and IV).

(a) The BESS-1, BESS-2, and BESS-3 pilots are all structured in a manner that will significantly under-utilize assets and, as designed, are an ineffective use of Lithium Ion batteries. It is understood that this is a pilot program and there is a desire to proceed carefully. However, no effort has been made to identify complimentary services that can be provided by the same BESS, in different hours of the day. The Company should analyze the hours per day it will be using the BESS to accomplish the primary mission, and the hours in which the asset is available to perform other services. Based on that analysis, the

Company should identify second and potentially third functions for each BESS to provide.

(b) The Company should track and report utilization for BESS-1, BESS-2 and BESS-3, or the number of hours per day the assets are charging/discharging or providing services. The Company should agree to target an utilization rate over 80% to ensure that it is using these pilots as effectively as possible to learn how to use BESS to provide complimentary services.

(c) The Company should relocate BESS-2 to a different substation, where it anticipates a real need will be realized during the pilot period. Placing BESS-2 at a location where no need will be realized during the pilot period ensures BESS-2 has no opportunity to provide Virginia ratepayers with value during the pilot.

(d) The Company should significantly reduce the size of the DC-coupled BESS-3. It is understood that no cost-benefit analysis is required for the pilot program. None the less the estimated cost and benefit are so out of proportion at the moment, it should be resized.

(e) The Company should recognize Lithium Ion BESS are most cost effective when they are used in applications that require a short duration and very high number of cycles. As such, where Lithium Ion BESS are most cost effective are in Frequency Regulation applications, and potentially when used as a Capacity asset. The later will depend upon the outcome of FERC proceedings on PJM's minimum run time requirements for BESS to qualify as capacity

assets. Based on the outcome of that proceeding, the Company should calculate the impact that BESS can have on net capacity obligations.

(f) The Company should work with the Commission to determine if BESS that are classified as distribution can participate in PJM markets and whether safeguards are required to do so.

Q: Does this conclude your testimony?

A: Yes, it does.

ATTACHMENT A

KERINIA CUSICK

PROFESSIONAL EXPERIENCE

CENTER FOR RENEWABLES INTEGRATION **(Jan, 2017 – Current)**

Co-founder of team developing policies to enable high penetration variable generation. Working with state electricity regulators, Independent System Operators, FERC, and state energy offices on issues ranging from interconnection to procurement of renewable energy. Relevant projects include:

- Development of New York's energy storage roadmap for in-front of the meter, large-scale energy storage assets. Identified regulatory levers and barriers to encourage large-scale development, assisted in the evaluation of potential incentives structures, and integrated relevant FERC Orders into state's strategy.
- National expert on the growing opportunity for in-front of the meter, large scale energy storage to provide transmission services, such as the development of local capacity to relieve transmission constraints (e.g. PG&E and SCE's 2018 and 2019 procurements for hundreds of MW of energy storage). Extensively researched relevant FERC regulations, participated in year-long ISO workshops, provided expert witness testimony in transmission siting cases, conducted training sessions for state regulators, and briefed FERC staff.

DISTRIBUTED ENERGY INNOVATION **(Jan, 2016 – Current)**

Principal Consultant

Providing go-to-market and regulatory consulting to Fortune 500 companies looking to enter the renewable energy sector, and to renewable energy companies focused on growth. Relevant projects include:

- Market evaluation and regulatory analysis for residential hybrid (solar + storage) developer teamed with leading home builder entering California's virtual power plant market. Analysis included identification and evaluation of potential revenue streams and costs, as well as a deep dive into regulatory enablers and barriers, identification of most favorable interconnection and tariff options for company's desired configuration.
- Go-to-market strategy development for large-scale energy storage developer, funded by leading international energy company, for New York state. Helped company identify appropriate strategy given IRR requirements and timeline. Also performed deep dive analysis of potential sites, which included analysis of ISO interconnection queue, transmission constraints, and NERC reliability requirements. Acted as company representative in interactions with state officials discussing potential procurement and incentive program design.
- Go-to-market analysis for Fortune 500 company entering global wind industry. Analysis included evaluation of world-wide on-shore and off-shore wind markets, addressable market quantification, segment analysis, value chain analysis, competitive analysis, and identification of emerging technologies and opportunities.

SUNEDISON, LLC **(Sept, 2009 – Dec, 2015)**

Vice President, Advanced Solutions / Energy Storage *(2013 – 2015)*

Market development leader launching SunEdison into energy storage market.

- Co-authored SunEdison's energy storage go-to-market strategy, secured $10M from leadership to build new line of business which created $250M pipeline within 20 months through combination of greenfield development, joint development agreements and acquisition.
- Launched Demand Charge Management product offering leading to creation of $32M in new pipeline within 14 months via greenfield development.
- Launched residential storage. Developed cash-sales strategy for Australia and lease model for U.S. Led participation with EPRI/Southern California Edison on zero-net-energy home community with distributed assets controlled by SunEdison's storage NOC.
- Participated on M&A/JDA teams acquiring $53M pipeline and assets in PJM, and securing JDA to develop $165M storage project for Southern California Edison.
- Led storage financeability. Attracted and educated new investors; worked to develop new financial products to hedge merchant revenue streams; teamed with legal and finance to develop new contracts and models; worked on warrantee and insurance products as well as long-term product replacement strategies to mitigate financing risk.
- Led detailed evaluation of solar-diesel hybrid market, ultimately recommended not pursuing market due to limited size and inherent financing challenges.

Managing Director, Government Affairs *(2012 - 2013)*

Led national team responsible for opening and defending markets across the US, concurrently engaging in legislation and regulatory interventions to create opportunities for solar in approximately 15 states and at the federal level. Responsible for:

- Team leadership: secured and managed annual budget over $2.5M, hired and fired, set strategic priorities, defined annual targets and ensured team met or exceeded annual targets, worked with internal customers to ensure satisfaction with results.
- Team results: Delivered NPV greater than $130M in new opportunities. Intervened in Qualifying Facility rate design cases, raised state-wide net-metering caps, mitigated onerous interconnection standards for variable generation, improved interconnection screens at FERC, influenced the design of new solar programs, passed tax parity legislation as well as community solar.

Director, Government Affairs, Eastern US & Caribbean *(2009 - 2012)*

Managed territory of states in Mid Atlantic, Mid-West and Caribbean and led all regulatory and legislative activities in the region.

- Opened and defended solar markets by either getting legislation passed to create incentives, reduce or eliminate taxes, allow net-metering or 3rd party ownership, and facilitate interconnection.

THINK ENERGY **(2008 – 2009)**

Vice President, Business Development

Led business development activities for a small renewable energy consulting firm.

- Negotiated strategic partnership with ESCO to develop state-wide renewable procurement plan

INFORMA, plc **(1999 – 2008)**

Business Development and Project Management consultant

Worked at three Informa wholly owned subsidiaries in District of Columbia metro area: ESI International, Robbins Gioia, and Huthwaite.

- ESI International: Principal Consultant and Business Development COO. Created and delivered new products within Project Management consulting firm. Directed operations for business development, billing over $45M annually in revenue. Consistently exceeded annual revenue commitment for 5 years running.
- Huthwaite: Senior Client Executive responsible delivering business development consulting services to executives at the firm's largest strategic account, which represented 22% of the firm's annual revenue.
- Robbins Gioia: Sales operations consultant advising Business Development VP on compensation plans, organization design, and go-to-market strategy at project management consulting firm.

ADDITIONAL PROFESSIONAL EXPERIENCE

Hughes Electronics Corporation and Grumman Aerospace

Engineer and program manager on aircraft, space-based defense and communication satellites.

EDUCATION & CERTIFICATION

- Master of Science, Systems Management, University of Southern California, Los Angeles, CA
- Bachelor of Science, Mechanical Engineering, Drexel University, Philadelphia, PA
- Master's Certificate, Project Management, George Washington University, Washington D.C.
- Project Management Professional (PMP) ® certification, Project Management Institute

SELECTED PUBLICATIONS & PRESENTATIONS

- VERGE 2019 Conference: Building the Energy Cloud. October, 2019
- DR & DER World Forum: FERC DER Aggregation Opportunities for DER. October, 2019.
- It's Time for States to Get Smart About Smart Inverters. October, 2019.
- Transmission Planning Protocol. August, 2019
- Mid Atlantic Conference of Regulatory Commissioners presentation. June, 2019
- Storage as Transmission Asset, 2018 Progress and Report Card. February, 2019.
- ACORE Renewable Energy Grid Forum presentation. November, 2018.
- DER World Forum presentation. October, 2018
- WIRES Summer Meeting presentation. August, 2018.
- NY Energy Summit presentation. August, 2018.
- Alternative Transmission Solutions: CAISO Planning Process. March, 2018.
- GTM Power & Renewables presentation. November, 2018.
- Common Storage Misperceptions, Public Utilities Fortnightly, June, 2017
- Primary author of Center for Renewable Integration comments in D.C.'s "Modernizing the Energy Delivery System for Increased Sustainability" initiative.
- Puerto Rico Minimum Technical Requirements: Recommendation by the Puerto Rico Energy Cluster Interconnection Committee, filed with Puerto Rico utility (PREPA), Governor's office and General Assembly, June 2013. Detailed analysis of opportunities,

challenges and solutions associated with interconnecting variable generation with Puerto Rico's electricity grid.

- Solar and Storage Trends and Opportunities, Energy Thought Summit, March, 2014.

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ATTACHMENT B

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
Second Set

The following response to Question No. 37 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on October 7, 2019 has been prepared under my supervision.

for Robert Wright

Robert Wright
Director, Grid Planning and Asset Management
Dominion Energy Virginia

Question No. 37

Has the Company performed any cost/benefit analyses for the proposed battery energy storage system ("BESS") identified in the Company's application as BESS-1? If so, please provide the following:

a) All costs considered in such analyses;
b) All benefits considered in such analyses;
c) The results of the Company's analyses; and
d) All workpapers and calculations supporting the cost/benefit analyses as an executable Excel spreadsheet.

Response:

Since this is a Pilot Program, the Company has not performed a cost/benefit analysis for BESS-1.

ATTACHMENT C

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
Second Set

The following response to Question No. 38 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on October 7, 2019 has been prepared under my supervision.

JL for Robert Wright

Robert Wright
Director, Grid Planning and Asset Management
Dominion Energy Virginia

Question No. 38

If the Company has not performed any cost/benefit analyses for the proposed BESS-1, please provide a detailed narrative description of what data the Company hopes to gather through the pilot to demonstrate the economic feasibility of potential future BESS-1-type projects.

Response:

While the intent of the Pilot Program is to study the objectives outlined in the enabling statute, Va. Code § 56-585.1:6, not to inform on the economic feasibility of future BESS projects, the Company intends to collect operational, performance, and maintenance data from the BESS installed as part of the Pilot Program that it can use in future analyses.

ATTACHMENT D

Virginia Electric and Power Company
Case No. PUR-2019-00124
Environmental Respondents
Second Set

The following response to Question No. 6 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by Environmental Respondents received on November 4, 2019, has been prepared under my supervision.

Robert Wright
Director, Grid Planning and Asset Management
Dominion Energy Virginia

The following response to Question No. 6 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by Environmental Respondents received on November 4, 2019, has been prepared under my supervision as it pertains to legal matters.

Sarah R. Bennett
McGuireWoods LLP

Question No. 6

Please reference the Company's response to Staff Set 3-61, which states, "In situation where reverse flow is expected, the relays are set to accommodate these conditions, and additional protection is established to operate the appropriate equipment to ensure safe and reliable grid operations." Have relays and operational procedures, which the company references in their answer, been established for Kent solar system to ensure that backfeed is not occurring?

Response:

The Company objects to this request to the extent "Kent solar system" is vague and undefined. Notwithstanding and subject to this objection, the Company provides the following response assuming the request seeks information about Correctional TX #1, which is the subject of Staff Set 3-61:

Backfeeding is occurring on Correctional TX #1. The appropriate operational adjustments have been made to protective equipment serving that transformer.

ATTACHMENT E

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
First Set

The following response to Question No. 18 of the First Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on September 30, 2019 has been prepared under my supervision.

Robert Wright
Director, Grid Planning and Asset Management
Dominion Energy Virginia

Question No. 18

Please reference page 2 of Exhibit 1 of the Company's Application that states that the Company may also explore other uses, such as voltage regulation, peak shaving, phase balancing, and harmonics mitigation for BESS 1. Please explain why the Company is not analyzing such multiple uses for BESS 1 as part of this pilot program.

Response:

With the primary objective of BESS-1 being the reduction of backfeed onto the transmission system, the Company sized BESS-1 at this location accordingly. Additionally, the Company focused the technical requirements and evaluation of the proposals that were received based on this primary objective. Given that the intent of the BESS pilot projects is to gain technical experience with energy storage technology, the Company believes focusing on a specific use case provides the best opportunity for success. Nevertheless, the Company will continue to explore other uses during the course of the pilot installation.

ATTACHMENT F

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
First Set

The following response to Question No. 22 of the First Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on September 30, 2019 has been prepared under my supervision.

Robert Wright
Director, Grid Planning and Asset Management
Dominion Energy Virginia

Question No. 22

Absent the pilot project, in what year would the Company replace Hanover Substation Transformer #2? Please provide the estimated installed cost of the replacement transformer,

Response:

The Company operates distribution substation transformers to the normal overload (SNOL or WNOL) rating and initiates plans to replace/add capacity when the transformer reaches top nameplate (50 MVA for this unit). Hanover Transformer #2 is projected to exceed this top rating (50 MVA) during winter loading conditions in 2020 and during summer of 2021. The summer loading projection would exceed the SNOL in Summer 2024 and require additional transformer capacity by then.

With Hanover Substation being a single (34.5 kV) transformer station, when load dictates additional capacity at Hanover, a second 230/34.5kV transformer with appropriate bus breakers would be installed as good engineering practice. The rough estimate for the high-side protection, transformer, low-side breakers, and bus-work would be in the $4 million range (no detailed estimate has been performed at this time).

ATTACHMENT G

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
First Set

The following **corrected** response (dated Oct. 16, 2019) to Question No. 3 of the First Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on September 30, 2019 has been prepared under my supervision as it pertains to BESS-1 and BESS-2.

for Robert Wright

Robert Wright
Director, Grid Planning and Asset Management
Dominion Energy Virginia

Question No. 3

Please provide a detailed narrative on why the Company selected each of the three BESS pilot projects. Specifically, describe why the Company selected the identified maximum capacity for each project.

Corrected Response:

For BESS-1, the Company sought to study the prevention of solar generation backfeeding. The Correctional Substation serves a 20 MW solar farm located in New Kent County, Virginia that experiences backfeeding for more than 1,100 hours per year, resulting in 5,847 MWh of energy being supplied to the transmission system. The 2-MW power rating was chosen because about 25% of the backfeeding that occurs (in terms of time) is less than 2 MW. Although the size of the proposed BESS may not be sufficient to completely eliminate backfeeding of energy to the transmission system at all times, the knowledge and experience gained will allow the Company to safely and successfully deploy other battery energy storage systems in the future.

For BESS-2, the Company sought to study BESS as a non-wires alternative. The Company chose a 50-MVA transformer located at a substation in Hanover County, Virginia because the maximum load observed on this device was 49 MVA in 2018. Internal load projections indicate that the summer peak load will reach 55 MVA by ~~2024~~ *2031*, exceeding the transformer's summer normal overload rating. By placing a 2-MW/4-MWh BESS in the substation, transformer loading can be reduced during high load periods, which will allow for the deferral of the capital investment to provide additional capacity at the station. In addition, this substation has sufficient free space that would allow for the addition of a BESS with the selected capacity without requiring expansion of the substation fencing or acquisition of surrounding land. Although the capacity chosen for this pilot project does not completely remove the need for a

future transformer upgrade, the knowledge and experience gained will allow the Company to safely and successfully deploy other battery energy storage systems in the future.

ATTACHMENT H

Virginia Electric and Power Company
Case No. PUR-2019-00124
Environmental Respondents
Second Set

The following response to Question No. 9 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by Environmental Respondents received on November 4, 2019, has been prepared under my supervision.

Robert Wright
Director, Grid Planning and Asset Management
Dominion Energy Virginia

The following response to Question No. 9 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by Environmental Respondents received on November 4, 2019, has been prepared under my supervision as it pertains to legal matters.

Sarah R. Bennett
McGuireWoods LLP

Question No. 9

Please reference the Company's corrected response to Staff Set 1-3, which states, "Internal load projections indicate that the summer peak load will reach 55 MVA by 2031, exceeding the transformer's summer normal overload rating."

a) As a result of this correction, has the Company identified any other transformers that are expected to exceed overload rating during the period of the pilot, specifically between 2020 and 2025?
b) If so, please identify the transformers.

Response:

The correction referenced in the Company's response to Staff Set 1-3 was specific to Hanover TX#1 and did not affect any other transformer loading projections. The Company disagrees with the premise of the question that seems to imply that the value of BESS-2 (*i.e.*, studying BESS as a non-wires alternative to reduce transformer loading at a specific substation) is heavily dependent upon the time when the transformer is projected to overload. Studying the BESS as a non-wires alternative to reduce transformer loading is still a valuable purpose for BESS-2, even if the transformer is not projected to overload until 2031. Therefore, the correction noted in Staff Set 1-3 does not affect the Company's proposal to install BESS-2 at Hanover Substation.

Accordingly, the Company has not identified other locations to study BESS as a non-wires alternative.

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ATTACHMENT I

Virginia Electric and Power Company
Case No. PUR-2019-00124
Environmental Respondents
Second Set

The following response to Question No. 8 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by Environmental Respondents received on November 4, 2019, has been prepared under my supervision.

Bradley M. Hanks
Manager – Construction Services
Dominion Energy Services, Inc.

Question No. 8

For BESS-3, the Company states the DC-connected BESS will be used to reduce solar clipping.

a) Does the Company agree that solar clipping is the result of an under-sized inverter?
b) If not, what causes solar clipping?
c) Can the Company clarify whether solar clipping was identified as a possible issue during the design of the Scott Solar Facility?

Response:

(a-c) The Company does not agree solar clipping is the result of an undersized inverter. Inverters are sized to meet the highest economical energy production for a facility. Inverters are not sized to meet the peaks of energy output. The additional capital cost required for an inverter to meet peak energy production outweighs the value of the energy that is clipped.

ATTACHMENT J

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
Second Set

The following response to Question No. 56 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on October 7, 2019 has been prepared under my supervision.

FOR BRADLEY HANKS

Bradley M. Hanks
Manager – Construction Services
Dominion Energy Services, Inc.

Question No. 56

Please refer to Exhibit 3 to the Application at 4. Please quantify, in both megawatts and percentage, the amount of generation which is "clipped" due to limitations on the Scott Solar Facility's inverter.

Response:

DC coupling enables additional value by clipping energy that is otherwise lost through the solar inverter. A PVSyst hourly energy yield simulation was performed to identify that approximately 1.4% (62 MWh AC annually) of energy is lost through each solar inverter at the Scott Solar Facility.

ATTACHMENT K

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
Second Set

The following response to Question No. 54 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on October 7, 2019 has been prepared under my supervision.

FOR BRADLEY HANKS

Bradley M. Hanks
Manager – Construction Services
Dominion Energy Services, Inc.

Question No. 54

Please provide a narrative explanation of how FERC Order 841 and 841 A affects the Company's intended use of BESS-3, if applicable.

Response:

BESS-3 is located at a load reducing facility and is therefore unaffected by FERC Order 841 and 841 A. However, if PJM were to remove their 10-hour capacity market derate, it would increase revenues and enable earlier profitability of lithium ion battery energy storage projects. BESS capacity payments are low relative to other technologies because PJM requires storage capacity to be derated such that the capacity could be provided for a 10-hour duration. If PJM required only a 4-hour duration the average annual capacity revenue for the same resource would be 60% higher for the 4-hour battery.

ATTACHMENT L

Virginia Electric and Power Company
Case No. PUR-2019-00124
Virginia State Corporation Commission Staff
Third Set

The following response to Question No. 86 of the Third Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on October 21, 2019 has been prepared under my supervision.

Bradley M. Hanks
Manager – Construction Services
Dominion Energy Service, Inc.

Question No. 86

After the installation of BESS-3, what is the projected capacity factor for the Scott Solar Facility in years 2021-2023?

Response:

BESS-3 is a separate generating asset from the Scott Solar Facility and not intended to increase the capacity factor of the facility.

CERTIFICATE OF SERVICE

I hereby certify that the following have been served with a true and accurate copy of the foregoing via first-class mail, postage pre-paid:

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DATED: November 15, 2019