Virginia Solar Pathways Project

December 4, 2017 Report

Dominion Energy®

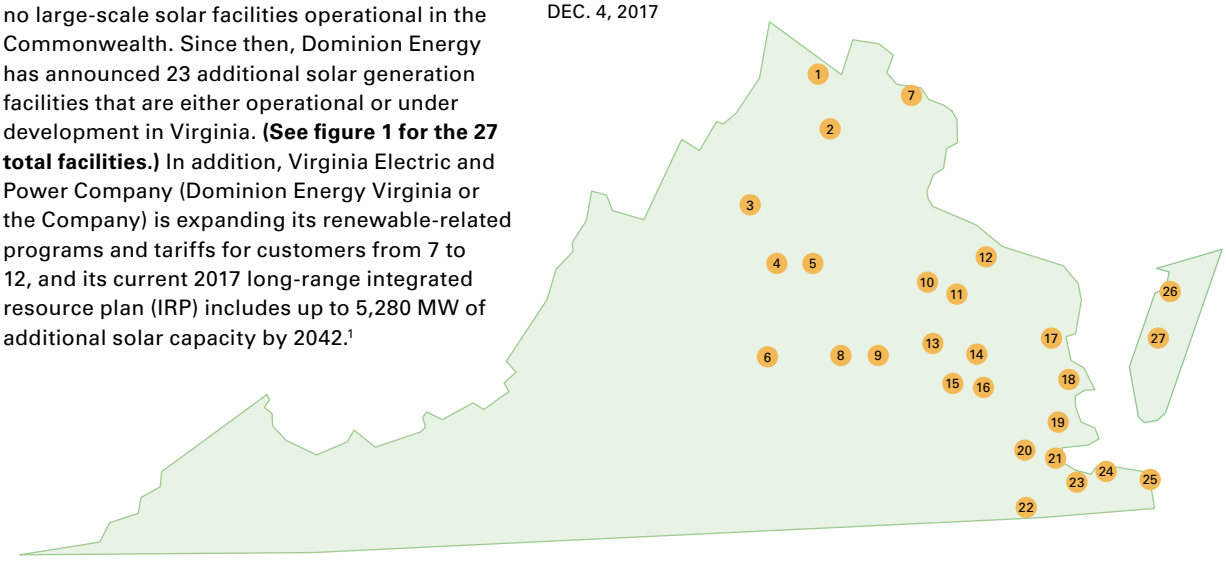
Contents

This work is based upon work supported by the U.S. Department of Energy Solar Energy Technologies Office, under Award Number DE-EE0006914.

Dominion Energy, Inc. (formerly Dominion Resources, Inc.) (Dominion Energy) currently has more than 27 solar generating installations either operational or under development in Virginia. This equates to approximately 744 megawatts (MW) of solar capacity, enough to power more than 186,000 homes at peak solar output.

However, at the end of 2014, before the grant-term began, the situation was very different. At that time, Dominion Energy's generation fleet in Virginia included only four solar distributed generation (DG) facilities **(listed in yellow below)** totaling a little more than one megawatt with no large-scale solar facilities operational in the Commonwealth. Since then, Dominion Energy has announced 23 additional solar generation facilities that are either operational or under development in Virginia. **(See figure 1 for the 27 total facilities.)** In addition, Virginia Electric and Power Company (Dominion Energy Virginia or the Company) is expanding its renewable-related programs and tariffs for customers from 7 to 12, and its current 2017 long-range integrated resource plan (IRP) includes up to 5,280 MW of additional solar capacity by 2042.[1]

FIGURE 1: DOMINION ENERGY SOLAR ASSETS IN VIRGINIA AS OF DEC. 4, 2017



Solar in operation or under development (includes power purchase agreements): Up to 744 MW

Initial four facilities in yellow (1.18 MW)

1. Clarke 10 MW
2. Remington 20 MW
3. Merck 1.5 MW
4. UVA 0.4 MW
5. Whitehouse Solar 20 MW
6. Buckingham 20 MW**
7. Prologis 0.74 MW
8. Scott II 20 MW**
9. Scott 17 MW
10. RMC 0.05 MW
11. UVA Hollyfield 17 MW
12. Essex 20 MW*
13. **VUU 0.05 MW**
14. New Kent 20 MW**
15. **Capital One 0.5 MW**
16. Philip Morris 2 MW
17. UVA Puller 15 MW
18. **Canon 0.5 MW**
19. Canon 1 MW
20. Sappony 20 MW**
21. Woodland 19 MW
22. Southampton 100 MW**
23. Western Branch HS 0.8 MW
24. **ODU 0.13 MW**
25. Oceana 18 MW
26. Accomack 80 MW**
27. Cherrydale 20 MW

** Reflects power purchase agreement executed with Dominion Energy Virginia*

*** Amazon Solar Farm Virginia*

Note: 300 MW of solar generation under development in partnership with Facebook, not reflected on map.

WHITEHOUSE SOLAR

Dominion Energy's recent rapid expansion of solar capacity in Virginia is the result of a comprehensive solar strategy. This report is the result of a three-year project, the Virginia Solar Pathways Project, funded by the Solar Energy Technologies Office of the U.S. Department of Energy (DOE).

A central goal of the Virginia Solar Pathways Project was to develop workable models for sustainable solar deployment that are appropriate for states with policy and program frameworks similar to the Commonwealth. Primarily, these are southeastern states that share Virginia's policy model of vertically integrated utilities with low retail electric rates. With solar generation now cost competitive with conventional energy sources,[2] utilities will need to adapt to a new paradigm in electricity generation. In three short years, Dominion Energy has made strides in adapting to this new model, and it continues to execute its strategy to expand the use of solar power in Virginia.

The Company now faces this question: "How do we build an environment around this expanding technology that sustainably supports it?" In addition to documenting how it has implemented its solar strategy to-date and providing recommendations to other utilities who wish to adopt this strategy, the pages that follow also offer the Company's take on how best to answer this question.

This paper also documents how Dominion Energy's strategy has allowed it to surpass its goal three years early to have 400 MW of large-scale solar under development in Virginia by 2020.[3] Dominion Energy is now ranked 6th in the nation among investor-owned utility holding companies in terms of ownership of operating and planned solar capacity. The Virginia Solar Pathways Project puts forth a model for other utilities that wish to increase their ability to manage and administer solar programs and sustainably expand large-scale and distributed solar capacity.

AMAZON SOLAR FARM VIRGINIA–BUCKINGHAM

Background and Project Objectives

The Virginia Solar Pathways Project's primary goal was development of a utility-administered solar strategy for Virginia through a collaborative process.

To accomplish this, Dominion Energy Virginia sought to establish a policy and program framework that would integrate existing solar programs with new options appropriate for the Commonwealth's policy environment and broader economic development objectives; promote wider deployment of solar within a low retail electric rate environment; and serve as a sustainable, utility-administered solar model that could be replicated in other states with similar policy environments, including, but not limited to, the entire Southeast region.

The resulting Virginia Solar Pathways Utility-Administered Solar Strategy was developed based on the following foundational objectives:

- Be achieved within Virginia's fully regulated utility framework;
- Be informed by input from a broad range of stakeholders and encourage continuation of the collaborative process;
- Involve data-driven decision-making, including studies conducted as part of the project along with data analysis and input from subject matter experts;
- Support sustainable expansion of solar generation that promotes affordable electric rates and Virginia's economy and economic development;
- Focus on the customer through:
  - Fair allocation of quantifiable costs and benefits through properly designed rate structures, while providing enhanced access to information, choice, and control;
  - Program structures that offer solar options for customers in all customer classes and maximum flexibility with respect to opt-in/opt-out, especially for residential customers; and
  - Equitable distribution of quantifiable costs and benefits associated with both large-scale solar and solar distributed generation and equitable recovery of costs to support all customers whether they choose to self-generate or not.
- Recognize that Dominion Energy Virginia's existing utility grid was not designed for the two-way flow of power and that increased solar deployment may require additional utility investment to offer enhanced access to information, choice, and control that customers seek, while ensuring the same or better levels of service reliability.

Dominion Energy also recognized that through the collaborative process, several items needed to be addressed: (1) an assessment of Dominion Energy's existing solar programs and their potential for wider-scale deployment; (2) the performance of technical engineering and business planning studies to identify solar photovoltaic (PV) integration impacts across the generation, transmission and distribution systems; and (3) an economic study of utility-administered solar, inclusive of an evaluation of the impacts of tax policy on solar deployment and an assessment of soft cost reduction opportunities. To that end, the Virginia Solar Pathways Project's results were also guided by the synthesis of conclusions and findings from a set of comprehensive studies.

CORE ADVISORY TEAM

One key component of the Virginia Solar Pathways Project was collaboration among stakeholders and participants in the development of a comprehensive solar strategy. The project engaged a Core Advisory Team (Advisory Team) made up of a diverse group of stakeholders, consisting of a state government agency, an environmental organization, local community representatives, research and educational institutions, and a solar installation company. They included:

- Bay Electric, Co.
- City of Virginia Beach
- Metropolitan Washington Council of Governments
- National Renewable Energy Laboratory
- Northern Virginia Community College (participated through spring of 2017)
- Old Dominion University
- Piedmont Environmental Council (participated through summer of 2016)
- Virginia Department of Mines, Minerals, and Energy

The success of the Virginia Solar Pathways Project depended upon valuable input from diverse perspectives and experiences. From the outset, Dominion Energy implemented a collaborative process with procedures to drive consensus decision-making. At the beginning of the project, the Advisory Team and the Dominion Energy representatives sought to develop governing principles to ensure that members had the opportunity to take part in the development of a utility-administered strategy. The governing principles outlined key criteria for fostering discussion and promoting collaboration among all participants.

In addition to the Advisory Team, Dominion Energy provided additional opportunities to receive input from and share information on project accomplishments with other interested stakeholders through the Rubin Solar Collaborative discussed later in this document. This approach best served the objective of resolving differences in perspective and interests relating to solar deployment within Virginia.

Transparency

The Advisory Team committed to making information about the Virginia Solar Pathways Project available to

all its members. Additionally, efforts were made to share knowledge and information with the broader public under a communication and dissemination plan, except where confidential or sensitive information required protection from public disclosure.

Communication & Ground Rules

The Advisory Team agreed to the following set of guidelines to promote well-ordered, effective, and efficient discussions during all meetings:

- Make best efforts to start and end on time;
- Ensure that all members are given an opportunity to speak while at the same time respecting the Advisory Team's time and the meeting timetables;
- Seek to be brief and focus on facts, not opinions;
- Place an emphasis on open and honest communication;
- Emphasize collaboration and respect for all positions on important decisions and issues;
- Agree to practice flexibility and assume good intent from members when disagreement arises;
- Work together to solve problems;
- Value the diversity of the Advisory Team members; and
- Stay open to constructive reminders to adhere to these guidelines.

Collaborative Decision-Making

The Advisory Team agreed to seek consensus where possible and acknowledged that consensus does not require unanimity. Additionally, all Advisory Team members agreed that Dominion Energy maintains responsibility over the project deliverables and that Dominion Energy has ultimate decision-making authority after input was received from all members.

Evidence-Based Decision-Making

To the greatest extent possible, the Advisory Team agreed to utilize data to inform decision-making.

Documentation

Minutes of meeting were maintained and distributed to all Advisory Team members for review.

Developing and Implementing the Solar Strategy

CHALLENGES

In developing and implementing a solar strategy, Dominion Energy faced significant challenges in 2014. Key challenges addressed in this section included:

- Solar economics,
- The integration of solar into the grid, and
- Developing a framework for community solar.

In 2014, the economics of solar were not as viable in Virginia as they are today and Dominion Energy lacked experience with large-scale solar development in the Commonwealth. To support sustainable growth of solar in Virginia, Dominion Energy Virginia needed the ability to integrate large amounts of this variable resource into its distribution system that delivers power to customer homes and businesses, and also into the upstream transmission and generation systems where the bulk of electricity is generated, transported, and interconnected to the multistate regional grid. Finally, the Company knew there was an appetite for a community solar offering in Virginia, but the Company needed a policy and regulatory framework to make community solar workable.

Dominion Energy met these challenges head-on, and through collaboration, innovation, and a favorable change in market forces, has created a viable path forward for the development of additional large-scale and distributed solar generation projects and their integration into the transmission and distribution grids.

SOLAR ECONOMICS

Absent financial incentive mechanisms, the high costs of solar development in the Southeast made electricity generation from solar unfavorable compared with traditional sources of energy like coal or natural gas. As a result, until recently solar development was more often driven by its ability to help organizations and individuals meet environmental goals and greenhouse gas emission reduction targets, and projects were often relatively limited in size or were implemented as pilot projects.

Soft costs, such as financing, customer acquisition, permitting, zoning, and planning also made the economics of solar difficult. Consequences of federal tax policy, including tax normalization, tilted the playing field away from solar and towards traditional energy generation. Dominion Energy confronted these challenges, and creatively worked through them to eliminate barriers and streamline processes. The primary driver of solar economics—falling solar panel prices—coupled with creative solutions to reduce soft costs, have currently made solar energy not only economically competitive but also economically advantageous. The dramatic price reductions of solar panels, coupled with their increasing efficiency, were among the principal reasons that solar energy crossed a critical economic threshold in the Company's Virginia service territory as described in its 2017 IRP.[4]

To aid in its strategy to address the economic challenges of solar deployment, Dominion Energy Virginia contracted with the National Renewable Energy Laboratory (NREL) to complete a Utility-Administered Solar Economic

Study which was published in June 2016.[5] Emerson Reiter, this study's lead author, represented NREL on the Project's Core Advisory Team. Three major topics are considered in the report:

1. **The potential for soft cost reductions through utility-administered solar.** Soft costs are all non-hardware costs associated with the installation of solar systems. Major types of soft costs include installation labor, customer acquisition, financing, permitting, inspections, and interconnection. This study assessed the ability to reduce "soft costs" through increased utility involvement in the development of solar generation systems. After conducting surveys of several utilities with current solar programs, NREL identified customer acquisition and insurance costs as areas with significant potential for cost savings. The study's findings can assist community solar programs as well, by applying economies of scale resulting in additional cost savings for individual consumers. However, the report concluded that the ability to gain regulatory approval of these programs could be a hurdle to their success. With the enactment of 2017 legislation calling for utility-administered community solar pilot programs in Virginia, the General Assembly sought to remove barriers to community solar programs in the Commonwealth.

2. **Utility involvement in community solar development in the Southeast.** This topic was chosen because of its (1) potential to reduce solar energy costs through the economies of scale of large installations and (2) ability to reach customers who might not be able to procure solar energy through other means, such as those living in multifamily housing or whose property is heavily shaded. NREL developed a set of regional "readiness criteria" for community solar that incorporates information about state-level deployment of solar energy technologies generally, as well as community solar programs specifically.

3. **The financial impacts of tax normalization policy on utility-led solar development.** Tax normalization continues to have a relatively large impact on soft costs of utility-developed solar, given the federal tax credits currently available for solar. In fact, one NREL finding was that if "all other factors are equal, [tax normalization] has the ultimate effect of increasing the cost of solar energy from utility-owned facilities as compared to those developed by an outside entity."[6] Tax normalization requires electric utilities to spread the benefit of the federal investment tax credit (ITC) of a utility-owned solar installation over the life of the asset. Due to the time value of money, this increases costs relative to non-utility owned projects, which can realize the benefits of the ITC and accelerated depreciation in the year that they occur. Ultimately, Dominion Energy was successful in obtaining a first-of-its kind Private Letter Ruling (PLR) from the U.S. Internal Revenue Service (IRS) to address the challenge of tax normalization's impacts on the economics of solar facilities developed by the utility, as discussed in more depth later in this paper.

GENERATION, TRANSMISSION, AND DISTRIBUTION

With increasing amounts of solar energy being integrated into the grid, all utilities—including Dominion Energy Virginia—face concerns and challenges relating to interconnection, performance, operational safety, and grid stability at all levels: generation, transmission, and distribution. Since grid infrastructure is built to carry electricity at steady voltage and frequency levels, electric utilities must find ways to understand and address technical issues associated with solar energy's variability. Furthermore, what was designed as a one-way grid now faces challenges in adapting to the new reality of customer generation and two-way flow of electricity. Overarching principles associated with the connection of any generation source or technology are reliability, safety, and performance, which must be maintained for Dominion Energy Virginia's system and customers.

The DG interconnection process, grid protection, operational safety, grid stability, telecommunication and data transfer, and emerging technology all affect solar integration into the electric grid. In addition to these other challenges, it is difficult to predict the location of solar DG projects moving forward, which can impact grid planning and operation.

To examine these challenges at the distribution level, Navigant Consulting (Navigant) conducted a study[7] examining how increasing penetration of solar DG may impact grid stability, operability and reliability on Dominion Energy Virginia's distribution system. Completed in April 2016, the study identified the levels of solar penetration and the distribution system upgrades required to ensure thermal loading, performance, and operational standards would be within acceptable limits. The results of this study provide a partial analysis and a roadmap for Dominion Energy Virginia to safely and reliably integrate increasing amounts of solar DG capacity into its distribution system.

Some key takeaways from the report include:

- There is no single approach or standard associated with system protection practices;
- There are industry-wide concerns about the potential of dynamic impacts, including short-term voltage and stability;
- System upgrade costs are highly locational;
- Hosting capacity of circuits decreases when dynamic effects are considered; and
- Energy storage and other emerging technologies have the potential to enhance the ability to integrate greater amounts of solar DG and increase the benefits associated with such DG.

At the transmission and generation levels, a second study[8] from Navigant, also completed in April 2016, focused on impacts and challenges of both large-scale and distributed solar penetration at the upstream transmission and generation system levels. The study was designed to provide a framework under

which Dominion Energy Virginia and other regional utilities could evaluate solar impacts with greater rigor and detail, including the dynamic analysis of solar impacts and their effects on net benefits and costs to utility operations.

Some key takeaways from the report include:

- At this upstream level, impacts similar to those at the distribution level can occur, just at larger scale and magnitude;
- High penetrations of solar generation can impact not just the transmission system itself, but also how and when major upstream generation facilities run; and
- Many utilities participate in multistate transmission networks. These generally enhance reliability, but add additional layers of complexity in understanding solar impacts.

The two studies conducted by Navigant created an iterative process for evaluating solar penetration on the distribution, transmission, and generation systems as solar penetration levels increase. This process can be repeated as solar installations grow, and can be further refined as solar sites are selected and developed in Virginia. Additionally, since these studies were completed nearly two years ago, they are based on assumptions about Dominion Energy Virginia's system, the bulk power system, commodity and fuel costs, and solar generation and integration costs that are not current. Therefore, the conclusions reached in these studies should be viewed only in the context of each full study report and the timing of the assumptions and inputs that went into them.

In addition to the above-referenced studies, on Nov. 16–17, 2016, Navigant provided training to Advisory Team members and Dominion Energy employees in Richmond. The two-day training session provided training and documentation of the process Navigant went through to develop solar scenarios and assess their impact on Dominion Energy Virginia's distribution, transmission, and generation systems, as included in their two technical studies. Navigant documented the processes and assumptions for the commercial simulation models (SynerGi, PSS/E, and PROMOD) that were used in the technical studies. Model inputs, outputs, and key assumptions were discussed, so that team members understood how they provide the basis for the charts and tables that appeared in the technical studies. Training materials have been developed including clear instructions on developing the model inputs and outputs, as well as a user guide that explains each step in the overall methodology developed by Navigant.

COMMUNITY SOLAR

While community solar has the potential to reduce soft costs through the economies of scale of larger installations and the ability to reach customers who might not otherwise be able to procure solar energy, Virginia did not have a policy framework in 2014 to support it. The Company sought to survey programs in other states and at other utilities to inform community solar program development in Virginia. As a key part of this effort, the Company commissioned the Smart Electric Power Alliance (SEPA) to provide information about how utilities in other states have designed and administered community solar programs. This information would help lay the groundwork for the development of a community solar program in Virginia.

As the August 2016 SEPA report[9] noted, community solar programs are structured differently around the country, but the basic concept of community solar is relatively similar: many different individual customers can have a proportional ownership of (or subscription to) a commercial-size or larger solar installation located in or near their community. This concept is very popular with customers who cannot (or choose not to) install solar on their residences or businesses (e.g., they may live in multi-family housing or rent, instead of owning, their homes).

SEPA conducted interviews with utilities that have fully-implemented community solar programs. Topics addressed in the utility survey included solar asset management, program management, and lessons learned from the programs' implementation. Once the utility interviews were completed, surveys were distributed to utility customers taking part in each program. Through these surveys, the project team could better understand customer perspective, feedback, and recommendations for future project improvements.

Some key takeaways from the report include:

- Many customers want sustainable solutions;
- Design and implementation of community solar programs can be complex;
- Programs benefit from stakeholder collaboration, especially early in the design process;
- Information Technology integration, especially the billing process, is a considerably significant and challenging task;
- Customers respond to simplicity and flexibility in program design. They also like to see benefits earlier in the process rather than later;
- Economies of scale must be leveraged to keep programs affordable and accessible to the widest variety of customers; and
- Over-promising and under-delivering for community solar programs were the main customer complaint.

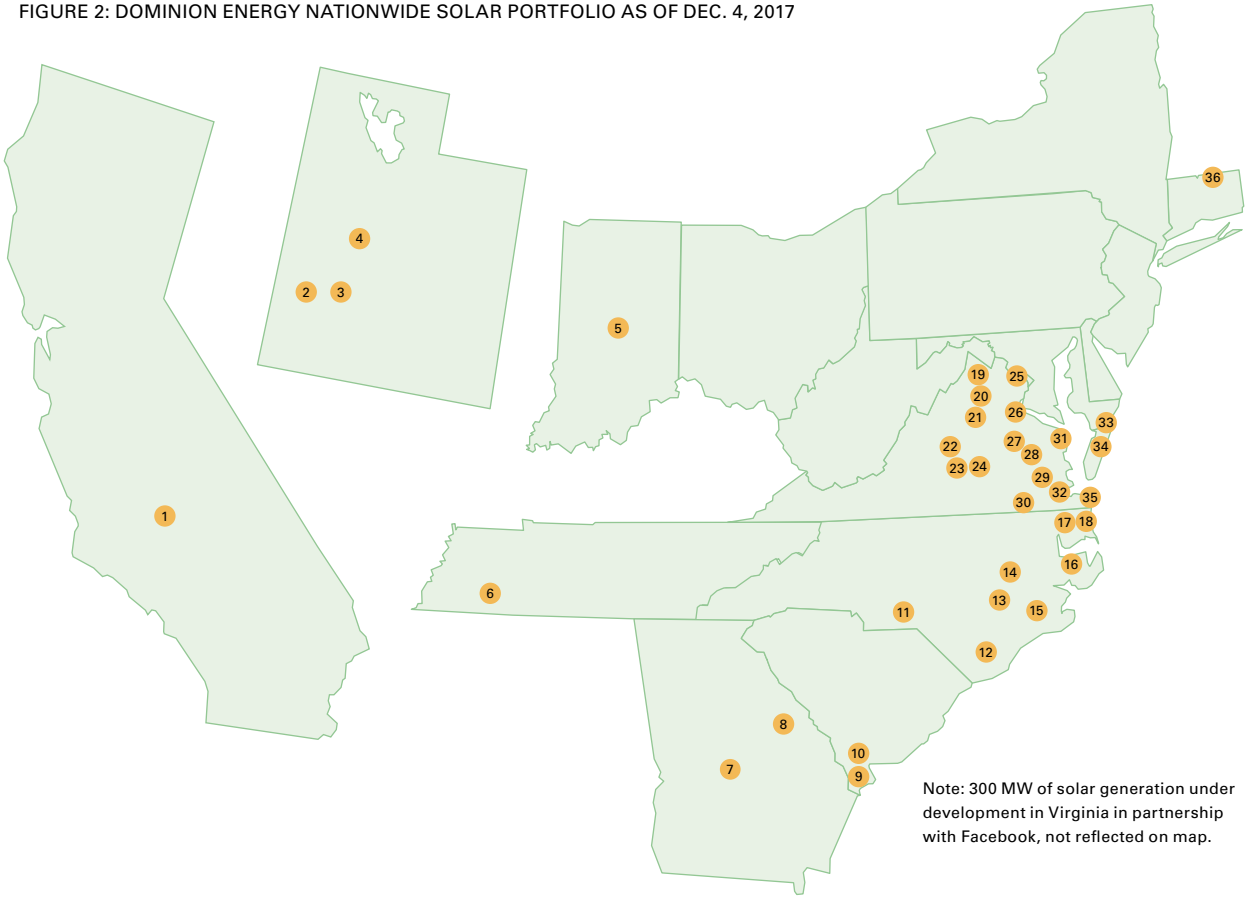
This information is being used in the development of Dominion Energy Virginia's Community Solar program, which is described further in the next section.

CORE ELEMENTS OF THE STATEWIDE SOLAR STRATEGY

Dominion Energy's solar capacity is expanding rapidly. When the grant project began at the end of 2014, Dominion Energy had no large-scale solar facilities in Virginia. Its entire solar portfolio in Virginia consisted of four solar DG facilities totaling just over 1 MW in capacity. These facilities were all developed as part of the Company's Solar Partnership Program,[10] a demonstration program approved in 2013 aimed at assessing the impact and potential benefits of strategically siting solar DG facilities on targeted distribution circuits with selective criteria. Just three years later, Dominion Energy now has more than 27 facilities totaling 744 MW of solar generation operational or under development in the Commonwealth.

Similarly, Dominion Energy Virginia is working to expand its suite of programs

FIGURE 2: DOMINION ENERGY NATIONWIDE SOLAR PORTFOLIO AS OF DEC. 4, 2017



Note: 300 MW of solar generation under development in Virginia in partnership with Facebook, not reflected on map.

Solar in operation or under development (includes power purchase agreements): Up to 2,528 MW

1. CA Solar 311 MW***
2. 4 Brothers Solar 320 MW***
3. Three Cedars 210 MW***
4. Pavant Solar 50 MW***
5. Indy Solar 28.6 MW***
6. TN Solar 32 MW***
7. Richland 20 MW***
8. Azalea Solar 7.7 MW***
9. Ridgeland Solar 10 MW
10. Solvay Solar 71.4 MW
11. IS37 79 MW
12. Clipperton 5 MW
13. Pikeville 5 MW
14. Freemont 5 MW
15. Moorings 2, 5 MW
16. NC Solar 540 MW**
17. Morgans Corner 20 MW
18. Summit Farms 60 MW
19. Clarke 10 MW
20. Remington 20 MW
21. Whitehouse Solar 20 MW
22. Buckingham 20 MW****
23. Scott II 20 MW****
24. Scott 17 MW
25. VA Solar Partnership Program 8 MW
26. Essex 20 MW*
27. UVA Hollyfield 17 MW
28. New Kent 20 MW****
29. Sappony 20 MW****
30. Southampton 100 MW****
31. UVA Puller 15 MW
32. Woodland 19 MW
33. Accomack 80 MW****
34. Cherrydale 20 MW
35. Oceana 18 MW
36. Somers Solar Center 5 MW***

** Reflects power purchase agreement executed with Dominion Energy Virginia*

*** Reflects multiple power purchase agreements executed with Dominion Energy North Carolina*

**** Capacity (MW) reflects Dominion Energy ownership in whole or in part*

***** Amazon Solar Farm Virginia*

allowing customers to adopt and promote solar and renewable energy. At the end of 2014, seven customer programs existed with a total of 26,570 customers participating and 10.2 MW of renewable energy installed. For calendar year 2014, annual energy production from these programs totaled 773,000 kilowatt-hours (kWh). Currently, the Company has 12 customer programs or select tariffs either implemented or planned with a total of 28,654 customers participating in programs and 32.4 MW installed. For calendar year 2016, annual energy production for these programs totaled 8,414,000 kWh.[11] Dominion Energy Green Power® participation numbers vary from year to year as reflected later in the report in **Figure 8 on page 14**. This variability accounts for the relatively small change in customer participation numbers at the current time compared with the participation numbers at the end of 2014.

Although Dominion Energy had no large-scale solar projects in Virginia at the beginning of grant term, it had already begun developing large-scale solar generation outside the state a year before it applied for the grant project. Dominion Energy entered the solar development business in 2013 with five projects totaling 42 MW in certain states outside Virginia where, at the time, solar was considered cost-effective. Its strategy was to learn the solar development business in states where solar generation was cost-effective with the goal of bringing large-scale solar development to Virginia. Dominion Energy has continued to expand its fleet of solar facilities around the country since that time, and its solar investments have supported more than 2,500 MW of large-scale solar facilities either operational or under development in nine states. **(See Figure 2 on page 9.)**

In 2014, after Dominion Energy established itself as a leading solar owner in states outside Virginia, an internal strategic review indicated that solar made economic sense for customers in Virginia, where electric rates are significantly lower than regional and national averages. Drivers were maturing—e.g., the U.S. Environmental Protection Agency's (EPA) Clean Power Plan was imminent, solar costs continued to fall, and governmental and business customers were signaling a higher demand for renewable energy. In February 2015, Dominion Energy committed to investing $700 million to support development of multiple solar projects in the Commonwealth totaling 400 MW by 2020.[12]

Dominion Energy has surpassed the 400 MW goal three years early with 744 MW of solar generation currently under development or operational in the Commonwealth. Furthermore, because of significant reductions in the overall cost of solar generation development, the Company has reached the point where solar resources in Virginia are now cost-competitive with conventional generation. As discussed later in **State and Market Distinctions,** solar costs have decreased approximately 18 percent in the past year as reflected in the Company's most recent IRP.[13] In large part because of favorable economics, the IRP model results reflect that Dominion Energy Virginia could potentially develop up to 5,280 MW of solar generation by 2042.

In addition to favorable economics, customer preferences continue to be a significant catalyst for solar growth. Over the past several years, large corporate and organizational customers around the country have increasingly sought options to increase the sustainability of their operations, including decreasing their carbon footprint and increasing adoption of renewable energy. These customers expect their electricity providers to be integral partners in these efforts, and Dominion Energy Virginia has a long history of customer engagement. One of the Company's first responses was creation of its original Schedule RG tariff intended to empower large institutional and corporate customers to meet a larger portion of their energy needs with renewable energy.

In charting a path forward, Dominion Energy recognizes the continued need to formulate customized solutions for customers based on their size, needs, and preferences. There is strong customer demand for renewable energy solutions, including solar generation; however, in terms of what customers themselves define as renewable sources, solutions often vary widely.

With institutional desires for renewable energy options continuing to grow, a few years ago the World Resources Institute (WRI) and World Wildlife Federation (WWF) collectively undertook a formal effort to convene institutional and corporate interests and develop a set of Corporate Buyers Principles.[14] Dominion Energy has been engaged with WRI and WWF since 2015 in response to this effort. In fact, WRI has recognized Dominion Energy Virginia's Schedule RG tariff as an innovative customized solution for helping institutional customers adopt renewable energy.[15] The Company remains engaged with WRI and WWF and with its customers seeking customized solutions.

As evidenced by the Company's numerous partnerships with large customers and its suite of existing and planned customer programs detailed in later sections of this report, developing and delivering solutions to meet customer demands for renewable energy remains a top priority.

CUSTOMER PROGRAMS AND DISTRIBUTED GENERATION

Dominion Energy Virginia has multiple customer renewable programs and has learned a great deal through public participation and feedback over the course of the grant term. Ongoing engagement and dialogue with its customers has been integral to the process of evaluating existing customer programs for potential expansion. Engagement and dialogue are also essential in helping the Company propose new programs giving customers additional renewable energy options.

EXISTING PROGRAMS

Both the number of options and number of customers participating in Company renewable energy programs have grown since the beginning of the grant term. At its beginning, seven customer programs existed for the Company's Virginia customers: the Solar Partnership Program, the Solar Purchase Program, traditional net metering, agricultural net metering, Schedule RG, the Dominion

FIGURE 3: EXISTING CUSTOMER PROGRAMS AND SELECT TARIFFS AS OF DECEMBER 2014

		Customer Group				Size Limitations		
Renewable Program	Brief Description	Residential	Small Commercial	Large Commercial	Industrial	Individual	Program	Current Participation/ Capacity (as of Sept. 30, 2017)
Solar Partnership	Demonstration program in which the Company constructs and operates solar DG facilities on leased customer property		•	•	•	500 kW – 2 MW	30 MW	7.7 MW at 11 sites
Solar Purchase	Demonstration program in which the Company purchases output and RECs from participants at a premium rate; alternative to net metering	•	•			Res: ≤ 20 kW Non-res: ≤ 50 kW	3 MW	1.8 MW at 146 customer sites
Dominion Energy Green Power	Allows customers to purchase RECs equal to a portion or 100% of their usage	•	•	•	•	None	None	25,934 customer participants
Renewable Energy (Third-Party PPA) Pilot	Allows qualified customers to enter into a PPA with a third party renewable energy supplier	•	•	•	•	50 kW – 1 MW	50 MW	1.5 MW at 10 sites
Net Metering	Allows eligible customer-generators producing renewable energy to offset their own usage	•	•	•	•	Res: 20 kW Non-res: 1 MW	1% of adjusted peak load forecast for prior year	21.4 MW with 2,553 participating customers
Agricultural Net Metering*	Allows eligible agricultural customers to net meter across multiple accounts on contiguous property		•	•	•	500 kW	Within Net Metering Cap	
Rate Schedule RG Pilot**	Allows eligible large non-residential customers to meet a greater portion of their energy requirements with renewable energy			•	•	1,000 to 24,000 MWh per year	100 customers and 240,000 MWh per year	N/A pilot program has expired

* Size Cap is 1.5 MW if customer is participating under the "Small Agricultural Generating Facility" Option VA Code § 56-594.2.

** Pilot program expired April 1, 2017.

Energy Green Power Program, and the Renewable Energy Pilot Program. **(See Figure 3 above.)** Today, a total of 12 programs or select tariffs are either implemented or planned. These include all programs in existence at the beginning of the grant term except the Company's original Schedule RG tariff. While the original Schedule RG tariff was a pilot program that was not renewed, the Company submitted a petition to the State Corporation Commission of Virginia (VA SCC) on Dec. 1, 2017 to offer a Schedule RG tariff as discussed later in this report. Below is a discussion of accomplishments and lessons learned from existing programs as well as plans for new programs, which are in varying stages of development.

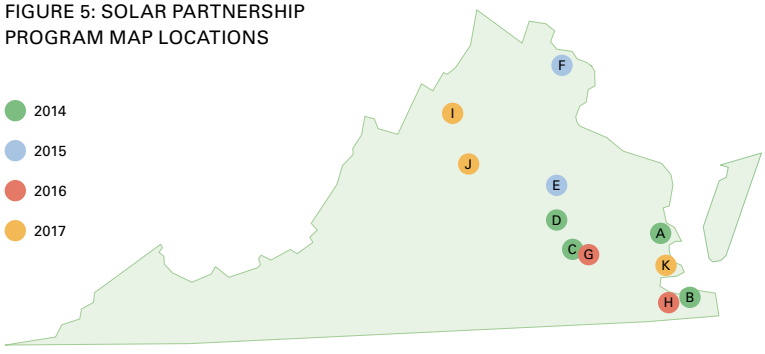
Solar Partnership Program

Approved by regulators in 2012, the Solar Partnership Program is a multiyear pilot program designed to expand Dominion Energy Virginia's understanding of solar DG by studying its impact and assessing its benefits while supporting and encouraging solar energy growth in Virginia. The current installed capacity of the program is 7.7 MW alternating current (AC).

FIGURE 4: SOLAR PARTNERSHIP PROGRAM INSTALLATIONS AS OF SEPT. 30, 2017

Map Location	Site	Study Type (Circuit Characteristic/ Demonstration)	Size (kW DC)	Size (kW AC)	Status/ In-service Date
A	Canon – Gloucester	Heavily Loaded	521	500	6/14/14
B	Old Dominion University	Demonstration	151	125	7/3/14
C	Capital One	Heavily Loaded	633	500	12/17/14
D	Virginia Union University	Demonstration	69	50	12/31/14
E	Randolph-Macon College	Demonstration	69	50	3/31/15
F	Prologis – Concorde Center	Heavily Loaded	859	746	3/31/15
G	Philip Morris Park 500	Lightly Loaded	2,450	2,000	3/31/16
H	Western Branch High School	Heavily Loaded	1,003	806	4/25/16
I	Merck	Heavily Loaded	2,211	1,512	6/20/17
J	University of Virginia	Demonstration	452	364	3/3/17
K	Canon – Newport News	Heavily Loaded	1,235	1,000	9/5/17
			9,653 Total	**7,653 Total**	

FIGURE 5: SOLAR PARTNERSHIP PROGRAM MAP LOCATIONS



Under the Solar Partnership Program, Dominion Energy Virginia is authorized to construct and operate a limited amount of Company-owned solar generation capacity on leased rooftops or on the grounds of commercial businesses and public properties throughout its Virginia service area. Installations range in size from 50 kilowatts (kW) to 2 MW. **(See Figures 4 and 5 on page 11.)** This program was intended as a rolling five-year demonstration program to study the benefits and impacts of solar DG on targeted distribution circuits. Under the program, each facility is studied for five years from the date it becomes operational.

Accomplishments and Lessons Learned
The Solar Partnership Program has provided Dominion Energy Virginia with initial insight into the process of integrating limited targeted amounts of relatively small solar DG facilities into the distribution system. As the program has continued to grow, performance improvements to solar arrays and inverters have been made, and operational performance routinely exceeds 95 percent at all participant sites. New and larger solar PV sites have begun to introduce reverse power flow scenarios, reduction in circuit line losses, and peak shaving load support.

Among the biggest challenges in implementing the program have been finding suitable sites, meeting circuit requirements, and negotiating lease terms. Additionally, the Company found that it needed to define its target audience early and explain the qualifications, as it had a great deal of early interest from ineligible customers. Because of these challenges, the program's greatest successes have been with universities, schools, and publicly-traded companies. In general, they have sought the installation of solar DG facilities to demonstrate their commitment to green energy, not because of potential financial gain.

The Company has learned to enter into a lease option before final lease negotiation. A lease option allows Dominion Energy Virginia access to the site to optimize due diligence activities before a final lease is executed. This includes conducting circuit analysis in advance (one of the largest barriers). This growing experience has allowed Dominion Energy Virginia to leverage legal and procurement expertise and create form agreements, easing the overall siting process.

Further study and additional installation operating information is required to determine if long-term benefits accrue from solar DG by reducing line losses from on-site electricity production, and whether increasing the amount of electricity distributed through certain targeted circuits or other specifically identified areas of the Company's grid produces meaningful or tangible benefits to customers. The Company will continue with efforts to understand how smaller, locally-sited solar generation will affect the grid in the future.

Solar Purchase Program

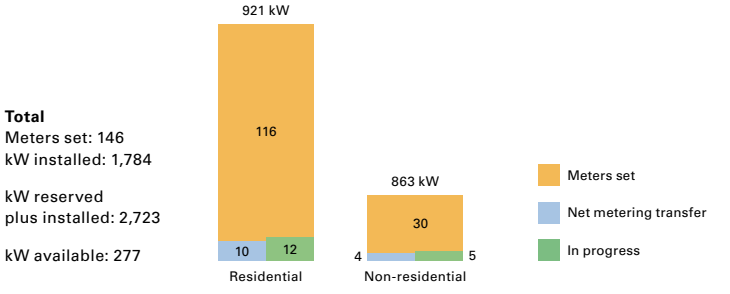
Approved as a demonstration program by regulators in 2013, the Solar Purchase Program facilitates customer-owned solar DG as an alternative to net metering. As participants in the Solar Purchase Program, qualifying homeowners and businesses generate and sell electricity and solar Renewable Energy Certificates (RECs) directly to Dominion Energy Virginia. The program was designed to help customers cover the cost of installing solar generation while also promoting more local solar energy production. Dominion Energy Green Power directly supports the Solar Purchase Program through the purchase and retirement of produced solar RECs.

As of Sept. 30, 2017, the Solar Purchase program has 146 active participants (116 residential and 30 non-residential) with a total of 1,784 kW in capacity, and an additional 17 participants in progress. **(See Figure 6 below.)**

Participating customers install and own the solar generation systems located on their property, but sell the electricity and solar RECs back to the Company at a premium rate of 15 cents per kWh. Participating customers purchase all of the electricity for their home or business from the Company on their current rate schedule. The Company has not determined if the program will be renewed at the end of its term. If the program is not renewed, customers will be notified and given the option to move to another program or go back to their regular residential or commercial rate.

Accomplishments and Lessons Learned
There were several challenges to address in implementing this program. First, the application process had to ensure fairness. Dominion Energy Virginia determined that each participant must have an existing customer account. Customers can have multiple agreements if they have multiple accounts. Secondly, the Company had to modify the billing system to pay customers for generation received (up to this point, the Company had typically billed customers only for usage). In addressing this issue, the Company had to adjust its meters, in that the meter used to measure solar generated had to be wired in a manner that is opposite

FIGURE 6: SOLAR PURCHASE PROGRAM AS OF SEPT. 30, 2017



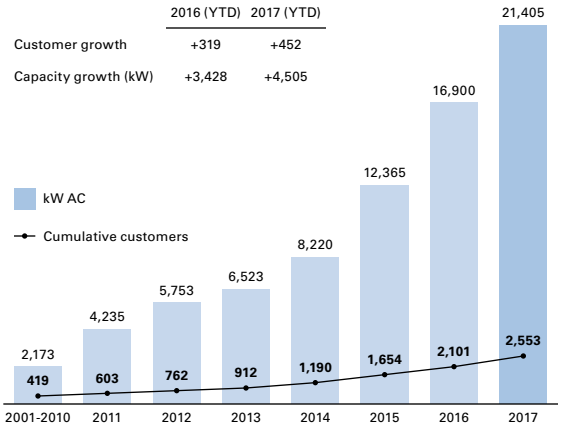
from usage meters. Any detection of load on the generation meter at night signals that it was wired backwards.

Lastly, since customer participation in Dominion Energy Green Power provided funding for purchase of the energy from customers participating in the Solar Purchase Program, the Dominion Energy Green Power vendor encountered challenges in balancing the financial linkages between these two programs. In striking a balance, the Company established a process for grouping approvals for customer participation in the Solar Purchase Program in incremental segments to better align with timing of the REC transactions associated with Dominion Energy Green Power. However, as the Solar Purchase Program has progressed, the customer enrollment/fulfillment process has created an approval segmentation period that led to a much slower installation process than anticipated. Despite attempts at balancing transactional timing between the two programs, the slower installation process has created forecasting difficulties for the Dominion Energy Green Power vendor in balancing the mix of RECs that support the funding of the Solar Purchase Program.

The Company was pleased that its customers were satisfied with the transparency, consistency, and predictability of the program. Superior and proactive communication are key; for example, Dominion Energy Virginia created an electrical guide in response to confusion regarding metering and wiring. Additionally, Dominion Energy Virginia recognized that it was communicating with two very different parties: the customer and the installer/electrician. Appropriate communication with both is critical to success.

Among the most notable complaints were the upfront wiring costs for second metering, which averaged approximately $1,200. The Company believes that this led to fewer conversions from net metering than had been anticipated; large customers didn't migrate from net metering to the program, and none of its customers subject to standby charge have converted. It has also been conveyed that the five-year term of purchase agreements under this program may be perceived by some residential customers as not providing enough certainty to justify investment in rooftop solar. Lastly, customers also complained about the issuance of a 1099 tax form if the value of energy generated exceeded $600, an IRS requirement related to taxable income. Upfront communication about this potential impact has helped resolve this issue.

FIGURE 7: NET METERING CUSTOMER GROWTH AS OF SEPT. 30, 2017



Net Metering

Traditional net metering has been in place in Virginia since the year 2000, subject to an overall cap of one percent of the adjusted peak load forecast for each utility for the previous year, and allows eligible customer-generators producing renewable generation to offset all or part of their own electricity usage consistent with Va. Code § 56-594 and regulations governing net metering in the Virginia Administrative Code (20 VAC 5-315-10, et seq.). While net metering participation in Dominion Energy Virginia's service territory is well below the one percent cap, the Company has experienced steady growth in net metering participation. As of Sept. 30, 2017, out of the Company's total 2.6 million customer base in Virginia and North Carolina, there are 2,553 net metering customer-generators with a total installed capacity of approximately 21.4 MW. For comparison purposes, the one percent of adjusted peak load forecast cap for Dominion Energy Virginia's service territory would currently equate to approximately 200 MW based on the Company's 2016 adjusted peak load. Net metering is an ongoing offering to customers. **(See Figure 7 above.)**

Accomplishments and Lessons Learned

As practiced currently, net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. Customers are only billed for their "net" energy use, are credited at the retail rate for the energy their systems place on the grid, and in some cases, they only pay the basic monthly charge, taxes, and fees. With a growing number of customers interested in net metering, challenges for utilities begin to increase. Because they pay no charges for their kWh consumption that is offset by their onsite generation, many net metering customers do not understand how they are still using the grid (HVAC systems, for example, cannot start without the surge provided by grid connection). But utilities still have the costs associated with building and maintaining wires, transformers, poles, line workers, trucks, and other assorted costs related to grid maintenance. This

maintenance has a cost which is partially incorporated in customer rates, but net metering allows customers to avoid paying some of these costs, which then must be borne by other customers not participating in net metering.

Net metering highlights the need for additional customer communication to explain these issues surrounding net metering and grid modifications. It also highlights a need to develop collaborative and cooperative approaches to addressing these challenges and the need for advanced metering infrastructure (AMI), which can provide better data collection to help quantify the impacts of net metering.

A debate regarding the extent of costs and benefits associated with net metering is ongoing around the country. Net metering, by its nature, is dependent on the underlying rate structure, so cost recovery issues may be addressed through changes to the underlying retail rate design. Net metering policies have already been modified in several states. Other states are examining the structure of net metering to consider modifications to the structure of the billing mechanism. The grid modernization plan currently under development by the Company includes the deployment of smart meters, which will allow more precise data collection on a sub-hourly basis of the customer's usage of energy from the grid. In some states, smart meter data has helped inform a new structure for net metering to address some of the above-referenced challenges.

Agricultural Net-Metering

In 2013, the Virginia General Assembly enacted agricultural net metering to allow agricultural customers to net meter across multiple accounts on contiguous property. During the 2017 Virginia legislative session, additional options were made available to agricultural customer-generators. The legislation allows farm owners to enter into agreements with utilities to sell their on-site solar output at market price plus a capacity credit and expands the size of eligible solar projects to 1.5 MW and 150 percent of the farm's usage. Eligible customers may elect to interconnect through the new offering or the traditional agricultural net metering offering. As of Sept. 30, 2017, one customer is participating in agricultural net metering.

Accomplishments and Lessons Learned
Options for agricultural generators are being expanded to offer an additional compensation mechanism as an alternative to conventional agricultural net metering. Also, under this additional mechanism, agricultural generators will be able to install significantly larger systems than permitted under conventional agricultural net metering.

Renewable Energy Supply Service —Schedule RG

Approved by regulators in late 2013, Rate Schedule RG (Renewable Generation) was a pilot program that provided qualifying large non-residential customers in Virginia with the option to meet a greater portion of their energy requirements with renewable energy. Eligible customers would elect to sign a contract for the Company to purchase additional amounts of renewable energy from a third party as determined by the customer. As designed, the program was capped at 240,000 megawatt-hours (MWh), 100 customers, or three-year enrollment period, whichever occurred first. The original Schedule RG pilot program concluded on April 1, 2017.

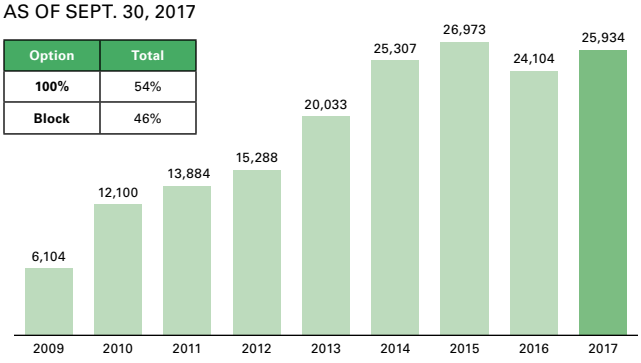
Accomplishments and Lessons Learned
Throughout the Schedule RG pilot program, several customers expressed interest, but the program concluded with no participants. Through customer feedback, the Company learned that the primary barrier to participation was the premium purchase price for the renewable energy and the associated RECs. Customers also said that the administrative costs were too high. Taking into consideration this and other feedback from customers, the Company filed a petition with the VA SCC on December 1, 2017 for approval to offer a revised version of Schedule RG.[16] As part of its ongoing commitment to provide programs that meet its customers' needs, the Company has also proposed several additional program offerings and select tariffs, since the initial version of Schedule RG was approved in 2013. **Figure 9 on page 15** provides a matrix of new Dominion Energy Virginia programs and select tariffs (implemented or under development since 2014).

Dominion Energy Green Power

Dominion Energy Green Power allows customers to promote renewable energy by purchasing, through the Company, RECs in discrete blocks equal to 100 percent of their usage or a portion of their usage. The Company purchases and retires RECs on behalf of participants. There are approximately 25,934 customers participating in this program as of Sept. 30, 2017. **(See Figure 8 above.)** Dominion Energy Green Power

FIGURE 8: DOMINION ENERGY GREEN POWER PARTICIPATION AS OF SEPT. 30, 2017

Option	Total
100%	54%
Block	46%



Option	Total MWh
2009	22,995
2010	81,968
2011	116,576
2012	151,845
2013	164,333
2014	244,855
2015	345,226
2016	336,917
2017	205,181
Total	1,669,896

FIGURE 9: NEW CUSTOMER PROGRAMS AND SELECT TARIFFS (IMPLEMENTED OR UNDER DEVELOPMENT SINCE 2014)

		Customer Group				Size Limitations	
New Renewable Program/Tariff	Brief Description	Residential	Small Commercial	Large Commercial	Industrial	Individual	Program
Community Solar Pilot*	Allows customers to purchase energy and RECs from solar facilities in communities in Virginia service area	•	•	•**	•**	Each site: ≤ 2 MW	Program: 10 MW
100% Renewable Option—Large Commercial*	Allows eligible customers to purchase energy, capacity, and RECs to meet 100% of their energy usage 100% of the time			•	•	Must = 100% of customer load	None
100% Renewable Option—Residential and Small Commercial*		•	•			Must = 100% of customer load	Initial cap = 25 MW of peak customer load
Revised Schedule RG*	Allows eligible large non-residential customers to meet a greater portion of their energy requirements with renewable energy		•	•	•	Up to 100% of customer load	Initial cap = 50 customers
Market Based Rate (MBR) Schedule (Experimental)	Allows customers to take service under rate schedules that more closely match pricing in the wholesale market to financially correlate wholesale renewable energy purchases with their retail billing			•	•	≥ 5 MW and ≥ 85% load factor	200 MW***
Schedule RF (Experimental)*	Allows customers to promote development of new renewable energy generation facilities by enhancing their cost effectiveness for all customers in exchange for the environmental attributes for up to 100% of the facility			•	•	Each customer must add ≥ 30,000 MWh of new load	None

* Programs are proposed and not yet approved. Design parameters are preliminary and subject to change.

** Potential participation as program sponsor.

*** Applies to the Experimental MBR approved by the VA SCC in 2016 in Docket No. PUE-2015-00108.

is Green-e® Energy certified, and meets the environmental and consumer-protection standards set forth by the nonprofit Center for Resource Solutions. This program is ongoing.

Accomplishments and Lessons Learned
According to the National Renewable Energy Laboratory's "Top 10" rankings for Utility Green Power Programs for 2016, Dominion Energy ranked 6th for customer green power participation, with 24,104 customers participating, and ranked 7th in customer green power sales, with 336,917 MWh/year in sales. Dominion Energy Green Power demonstrates that customers are interested in supporting renewable energy, even at a premium. There is a substantial and growing appetite for sustainable, green energy solutions among all customer classifications.

Renewable Energy (Third-Party PPA) Pilot

Facilitated by 2013 Virginia legislation, the Renewable Energy Pilot Program[17] allows qualified customers to enter into a Power Purchase Agreement ("PPA") with a third-party renewable energy supplier. The energy supplied must come from a wind or solar generator located on the customer's premises. The program includes an aggregate cap of 50 MW. As of Sept. 30, 2017, 10 customers are participating with a total installed capacity of approximately 1.5 MW (either operational or under construction). This Program is administered through the VA SCC. Dominion Energy Virginia, as a pilot utility, tracks program participation and complies with Commission reporting requirements. The 2013 legislation that established the Renewable Energy Pilot Program in Dominion Energy Virginia's service territory did not contain a sunset date for the pilot in the Company's service territory; however, the legislation does require the VA SCC to review the pilot program every two years to determine whether certain limitations of the legislation should be expanded, reduced, or continued.

NEW PROGRAMS AND SELECT TARIFFS

The additional customer programs and select tariffs currently proposed include community solar pilot, a 100 percent renewable energy option for large commercial customers, a 100 percent renewable energy option for residential and small commercial customers, and a new version of Schedule RG designed to allow non-residential customers to meet a larger portion of their energy requirements with renewable energy from a dedicated resource. Schedule RF, another newly proposed experimental tariff, would allow large non-residential customers to promote development of renewable energy in exchange for the environmental attributes. New offerings of experimental Market-based Rate (MBR) Schedules have also been approved by the VA SCC since the inception of the Virginia Solar Pathways Project. The MBR Schedules allow large non-residential customers to take service under rate schedules that more closely match pricing in the wholesale market to financially correlate wholesale renewable energy purchases with their retail billing. **Figure 9 above** describes the new programs.

Community Solar

Working through a stakeholder process in 2016 helped to establish a community solar framework. Legislation requiring utility-administered community solar pilot programs was approved during the 2017 Virginia legislative session. Dominion Energy Virginia anticipates requesting VA SCC approval of a community solar pilot by the end of 2017 or in early 2018. An expanded description of the program, as well as the stakeholder process which was implemented to develop the program, is described later **on page 19**.

Continuous Renewable Generation (CRG) (Tariff for 100 percent renewable energy 100 percent of the time)

Large energy users have become increasingly interested and sophisticated regarding renewable energy

procurement. Many of the Company's largest users have set their own goals for vastly increasing their support of renewable energy. Some large customers are setting goals to achieve 100 percent renewable energy within just a few years. Additionally, many large energy users are working together and with their respective utilities to, among other things, expand their choices for buying renewable energy.

In response to this growing interest, the Company is continually engaged with its customers to learn about their needs and desires, and to provide solutions where appropriate. The Company's goals in working through these solutions include both serving these customer needs and supporting renewable generation and economic development in the Commonwealth. For commercial and industrial customers, the Company currently offers renewable energy program options including, among others, Dominion Energy Green Power, which allows customers to support renewable energy through the purchase of RECs in varying increments, and the Solar Purchase Program, which allows the Company to purchase the output and associated RECs of participating customers' privately-owned solar generation at a fixed premium rate.

In recent years, the Company has also completed transactions with large customers, including the U.S. Department of the Navy, the Commonwealth of Virginia, and a large university, which have supported their renewable energy development goals. At present, the Company continues to be engaged with several other existing and prospective customers with similar requirements. To date, these customers have uniquely been interested in solar energy, where the Company has seen very favorable cost reductions in recent years. However, a typical solar output profile does not match any customer's load profile, and using solar alone to achieve a 100 percent load offset creates volume balancing challenges for these customers. With the CRG Rate Schedules, the Company intends to secure a volume matching 100 percent renewable energy portfolio for its customers who desire such a solution. Specifically, the Company's proposed CRG Rate Schedules are designed to serve eligible customers who wish to displace 100 percent of their traditional tariff electricity supply from the Company with the supply of renewable energy provided by the Company on a continuous hourly basis through a portfolio of resources assembled by the Company on behalf of such customers.[18] In May 2017, the Company filed for regulatory approval of CRG Rate Schedules for large commercial customers. A 100 percent renewable energy tariff option for residential, small commercial, or other customers not meeting the CRG Rate Schedule renewable energy demand threshold for large commercial customers was filed in November 2017.[19] Both CRG Rate Schedule petitions are currently pending before the VA SCC.

Revised Schedule RG

As referenced earlier, on Dec. 1, 2017, Dominion Energy Virginia filed a petition[20] seeking approval of an offering that would improve upon its original Schedule RG Pilot Program, which is described earlier in the report and which ended in early 2017. The revised Schedule RG is intended to allow eligible non-residential customers to meet a greater portion (up to 100 percent) of their energy requirements with renewable energy. The revised Schedule RG is proposed to have an initial aggregate participation cap of 50 customers, but the Company has asked to reserve the right to propose an increase of the initial customer cap in the future, if needed.

The revised Schedule RG makes four significant improvements upon the original Schedule RG Pilot Program. First, under the original Schedule RG Pilot Program, the billing adjustment received by participating customers was a credit primarily based on the Company's fuel rider charge for the quantity of renewable energy purchased. Under the revised Schedule RG, a participating customer will see a billing adjustment reflecting the market value of renewable energy purchased from specified renewable energy resources under the rate schedule. Second, the original Schedule RG Pilot Program did not permit aggregation of accounts, whereas the revised Schedule RG permits a single customer to aggregate multiple accounts. Third, the administrative charge under the original Schedule RG Pilot Program was $500 per month per account served. By contrast, the revised Schedule RG administrative charge is assessed for each customer per renewable generation facility, which may serve multiple accounts for the same customer. Fourth, unlike the original Schedule RG Pilot Program which restricted each customer's renewable energy purchases to a maximum of 24,000 MWh per year, the revised Schedule RG only limits participating customers' renewable energy purchases to the customer's actual annual energy load. Because these improvements were based on discussions with customers, the Company believes they will significantly increase customer interest in the revised Schedule RG.

Market Based Rate Schedules

In 2016, the VA SCC approved Dominion Energy Virginia's petition to establish experimental MBR Rate Schedules. The Experimental MBR Rate Schedules were designed for customers with a high load factor who may be interested in rate schedules that more closely match pricing in the wholesale market. The optional MBR Rate Schedules allow customers, who may be considering or actively making investments of their own in renewable generation at the wholesale level, to financially correlate their wholesale PJM electric market participation with their retail billing. This structure has been publicly recognized as an innovative renewable energy solution.

The MBR Rate Schedules contain a margin intended to cover any differences between the MBR and the actual marginal PJM costs for serving participating customers, and provide some contribution toward the Company's administrative and fixed costs. The MBR Rate Schedules are available to any customers eligible for the Company's Rate Schedules GS-3 or GS-4, have a measured peak demand of 5 MW or more, have a qualifying average monthly load factor of at least 85 percent, provide a signed officer certification affidavit, and meet the additional criteria set forth in

the MBR Rate Schedules. The MBR Rate Schedules have a combined aggregate participation cap of 200 MW. The MBR Rate Schedules contain a minimum three-year term with automatic renewals, on a year-to-year basis, subject to certain qualifications and requirements, with the overall term of the MBR Rate Schedules proposed to expire on Dec. 31, 2022.

Schedule RF

On Oct. 23, 2017, Dominion Energy Virginia filed a petition with the VA SCC seeking approval for Schedule RF, an experimental, voluntary companion tariff available to eligible existing or new commercial and industrial customers who (1) will bring incremental load to the Company's system that will support the development of new renewable generation facilities and (2) commit to support the development of such renewable generation facilities by enhancing their cost-effectiveness for all customers in exchange for the environmental attributes associated with these new facilities in an amount that corresponds to up to 100 percent of the energy the facilities produce.[21]

Any customer wishing to participate in the proposed Schedule RF must add new load of at least 30,000,000 kWh at one account or in total across multiple accounts. The customer would also be required to execute a separate contractual agreement with the Company committing to purchase environmental attributes from one or more new renewable generation facilities associated with the customer's incremental energy and capacity needs.

Scout Development LLC, a subsidiary of Facebook, Inc. (Facebook) has already made a provisional commitment to subscribe to Schedule RF, if approved by the VA SCC. The commitment from Facebook is the first of what the Company hopes will be multiple commitments of its kind.

LARGE-SCALE SOLAR

A key to Dominion Energy's success in rapidly expanding large-scale solar in Virginia has been the use of multiple regulatory and financing structures customized to align with the needs of different customer segments. The conventional rate-based cost-of-service ratemaking process works well in the case of generation assets intended to serve an entire customer base, since costs are shared across the entire customer base for the life of the asset. In addition, in recent years, Dominion Energy Virginia has been approached by certain large customers in Virginia who have expressed a desire for a greater portion of solar energy assets dedicated to the customers' specific needs. Thus, Dominion Energy has established additional financing pathways to provide dedicated solar generation for specific customers. These additional financing pathways are structured to ensure that costs to provide dedicated solar generation to specific customers are borne only by the respective customers to whom the solar generation is dedicated, since it would not be equitable to allocate these costs to the remainder of the customer base.

Below is an overview of the three pathways Dominion Energy has utilized to achieve the rapid expansion of solar capacity in Virginia since 2015: (1) regulated rate-based facilities under a cost-of-service model; (2) regulated "ring-fenced" facilities; and (3) merchant solar developed by an unregulated Dominion Energy affiliate.

Regulated Rate-Based Facilities (Cost-of-Service)

The conventional path for developing large-scale electric generation projects in a state, such as Virginia, with vertically integrated utilities, is through the use of a cost-of-service rate-based approach. Dominion Energy Virginia has taken the regulated rate-based approach with three of its large-scale facilities: the Whitehouse Solar facility (20 MW in Louisa County), Woodland Solar facility (19 MW in Isle of Wight County), and the Scott Solar facility (17 MW in Powhatan County), which were approved by regulators in June 2016 and became operational in December of that same year to serve Dominion Energy's 2.6 million customers in its Virginia and North Carolina service territories. Under this approach, a utility identifies the need for more electric generation to serve all customers in its entire electric service territory. The utility then evaluates alternative options for meeting that need, either through the purchase of power in the market (e.g., from PJM or third-parties) or building new generation. If the evaluation indicates that building new generation is in the best interest of customers and aligns with the state's policy goals, then the utility files a petition with its regulator for a Certificate of Public Convenience and Necessity (CPCN). In a CPCN proceeding, the utility must prove that the proposed electric generation facility is the appropriate option, among the available alternatives, for supplying additional electricity to its customers.

The VA SCC, which regulates Dominion Energy Virginia and other public utilities

WOODLAND SOLAR

in Virginia, has a 9-month period to consider a small renewable energy project like a typical solar facility for approval; however, from the time the utility begins to prepare its filing to the time the regulator rules on its CPCN, the process can take a year or more. The CPCN process is robust for good reason. The regulator must compare the cost and resource characteristics of the proposed facility, such as a large-scale solar facility, with the cost and resource characteristics of other types of generation: e.g., coal, natural gas, nuclear, and other renewables. To approve the CPCN, the regulator must ensure that the proposed facility, in this case a solar installation, is the appropriate option among all the available options and that the cost of constructing it is reasonable and prudent. Improving solar economics have been integral to the success of this approach.

As discussed earlier, Dominion Energy Virginia recently filed a petition with the VA SCC for Rate Schedule RF, which would allow qualifying customers to support the development of new renewable energy facilities by enhancing their cost-effectiveness for all customers in exchange for the environmental attributes associated with these new facilities in an amount up to 100 percent of the energy they produce. Through the proposed Schedule RF, Facebook has indicated the desire to support the development of new renewable resources equivalent to the energy usage at a new data center it plans to build in Henrico County, Va. The Facebook commitment is expected to lead to the development of up to 300 MW of solar generation being added to the grid in Dominion Energy Virginia's service territory.

Regulated Ring-Fenced Facilities

In recent years certain large customers, such as the U.S. Navy and the Commonwealth of Virginia, have approached Dominion Energy Virginia to explore ways to contract for a larger amount of dedicated solar energy to serve their needs. Governmental customers in Virginia are considered non-jurisdictional, meaning that they obtain electric service under a contract with Dominion Energy Virginia that falls outside the jurisdiction of the VA SCC which regulates its service with non-governmental retail customers. The non-jurisdictional nature of these contracts allowed Dominion Energy Virginia to develop a novel "ring-fencing" structure whereby the Company builds a regulated asset that is dedicated to one or more specific customers, with costs for the asset segregated and assigned only to the dedicated customer(s).

Up until the 2017 Virginia General Assembly session, Dominion Energy Virginia was still required to undergo a full CPCN process even for ring-fenced facilities; however, since each ring-fenced facility is dedicated to one customer who bears the full cost of the asset, while all other customers are left neutral from a cost perspective, the CPCN proceedings for ring-fenced facilities have been non-controversial. In 2017, the Virginia General Assembly approved legislation that expands an expedited "Permit by Rule" (PBR) process for seeking approval of renewable facilities that fall outside of VA SCC jurisdiction, such as ring-fenced assets for non-jurisdictional customers.

Under the PBR process, the utility will now be able to forgo the lengthier CPCN process in favor of a streamlined permitting process through the Virginia Department of Environmental Quality (DEQ) for large ring-fenced solar facilities. This means that permitting of these facilities can be done faster and more efficiently, resulting in lower administrative costs and more rapid growth of dedicated solar customers.

Since late 2015, Dominion Energy Virginia has announced several large-scale solar facilities that are being developed to serve its customers under the ring-fenced model:

- **Morgans Corner** — 20 MW facility operational in Pasquotank County, NC to serve the U.S. Navy, profiled in more depth **on page 21;**
- **Remington** — In late 2015, the Commonwealth of Virginia, one of Dominion Energy Virginia's largest utility customers, announced a goal to meet eight percent of its energy needs with renewable energy, which equates to about 110 MW of solar energy. In early 2016, Dominion Energy Virginia and the Commonwealth signed a cooperative agreement to help reach this goal. Dominion Energy Virginia will develop approximately 75 percent of this capacity through large-scale solar facilities with the remaining 25 percent being provided by third-party solar developers in the form of smaller scale solar facilities. Dominion Energy Virginia is currently developing additional solar facilities in partnership with the Commonwealth of Virginia. Located in Fauquier County, the 20 MW Remington Solar Facility has been approved by regulators, and it became operational on Oct. 1, 2017. Microsoft has agreed to purchase the renewable attributes from the facility, which lowers the overall cost of the project to the benefit of the Commonwealth, which is purchasing the output from Dominion Energy Virginia under a long-term agreement.
- **Oceana** – In Aug. 2016, Dominion Energy Virginia announced the 18 MW Oceana Solar installation, which was approved by state regulators in March 2017. The facility located at Naval Air Station Oceana in Virginia Beach became operational on Dec. 1, 2017. The Commonwealth will purchase the energy output as well as the renewable attributes from the facility, and the Navy will receive an alternative electric feed, which will increase resiliency on the base.
- **UVA Hollyfield** — In Nov. 2016, Dominion Energy Virginia announced the 17 MW UVA Hollyfield Solar facility under development in King William County, Virginia. The University of Virginia (UVA) and its Darden School of Business will purchase the entire output under long-term agreement, which represents about 12 percent of UVA's electric demand. Having recently obtained PBR approval, the facility is expected to begin operating by year 2018.
- **UVA Puller** — This 15 MW facility in Middlesex County, Va. to serve the University of Virginia is expected to come online in 2018.

Merchant Solar—Developed by Unregulated Dominion Energy Affiliate

In addition to the two regulated pathways, rate-based and ring-fenced discussed above, Dominion Energy has also begun developing solar in Virginia via affiliates not regulated by the VA SCC. The term "merchant" is used to describe a generation facility owned by an independent power producer not subject to regulation by a state public utility commission including an unregulated affiliate of an electric utility. The merchant pathway can only be used with counterparties, who want to contract for power in the wholesale PJM marketplace. Amazon Web Services (AWS) is one such counterparty.

Within the last few years, AWS has sought to rapidly expand the amount of renewable energy supporting its operations. AWS has publicly shared a long-term goal to achieve 100 percent renewable energy usage for its global infrastructure. AWS also established a new target to be powered by 50 percent renewable energy by the end of 2017. Given AWS' desire for adoption of significant amounts of renewable energy in a relatively quick turnaround time combined with their ability to participate in the PJM wholesale market, Dominion Energy was able to utilize the merchant pathway to support AWS' renewable energy goals.

In Nov. 2015, Dominion Energy acquired an 80 MW solar facility located in Accomack County on Virginia's Eastern Shore to increase the renewable energy on the electrical grid that supplies both current and future AWS data centers. This was the first solar facility acquired by Dominion Energy to serve AWS. Following the completion of that project in Oct. 2016, a major expansion of its solar energy collaboration with AWS was announced in Nov. 2016, to add 180 MW of solar generating capacity in five Virginia counties. Dominion Energy has acquired four 20 MW projects from Virginia Solar LLC and is developing these facilities in Buckingham, New Kent, Powhatan (Scott II), and Sussex Counties.

In total, the solar installations at parcels in these four counties will cover approximately 1,000 acres with a total generating capacity of 80 MW collectively utilizing more than 300,000 solar panels. Dominion Energy has signed an engineering, procurement and construction (EPC) contract with Strata Solar to construct the projects. This announcement also included an additional 100 MW solar facility being developed in Southampton County, Va. The five additional facilities are expected to begin generating electricity in late 2017. These newly announced projects bring the total capacity of Dominion Energy's solar energy alliance with AWS to 260 MW.

Aside from the Amazon Alliance, Dominion Energy is also utilizing the merchant pathway in Virginia to construct solar for wholesale customers. For example, the company recently announced the acquisition of the 20 MW Cherrydale facility in Northampton County, Va. and the 10 MW Clarke County facility in White Post, Va. to serve the customers of Old Dominion Electric Cooperative (ODEC).

COMMUNITY SOLAR

Customer interest in subscribing to successful and sustainable community solar programs has gained momentum around the country in the past several years. Community solar programs allow customers to "go solar" even if they cannot or do not wish to install solar panels on their homes or businesses. Dominion Energy Virginia began exploring this option in 2013, and in Aug. 2015, the VA SCC approved the Company's proposal to establish a Dominion Community Solar ("DCS") pilot program. The goal of the experimental Rider DCS was to give residential and commercial customers a convenient option to support the development of additional Company-owned solar distributed generation facilities in Virginia without the personal investment of installing solar panels and related equipment at their homes or businesses. While the VA SCC ultimately approved Rider DCS, the Company requested in the spring of 2017 that the Commission allow it to cancel the experimental program before it became operational. The Company sought cancellation of the program because of its plans to develop a new community solar offering facilitated by 2017 legislation related to utility-administered community solar pilot programs in Virginia.

For several years in Virginia, proposed legislation involving key topics related to solar and other renewable energy policies often ended in stalemate due to the divergent and conflicting views among various impacted stakeholders, including solar advocates and electric utilities. During the 2016 session of the Virginia General Assembly, the Chairmen of the House and Senate Commerce and Labor Committees (in which the majority of energy-related legislation in Virginia is considered) formed a subcommittee on renewable energy which requested a collaborative process with relevant stakeholders be convened to discuss solar policy and legislation.

To inform the subcommittee, several relevant stakeholders convened with Mark Rubin of the Virginia Center for Consensus Building at Virginia Commonwealth University as their facilitator. In addition to Dominion Energy Virginia, members of the 2016 Rubin Solar Collaborative (as it came to be known) were Appalachian Power Company (investor-owned utility serving the southwestern region of Virginia), Virginia's electric cooperatives, the Maryland, Virginia, and DC Solar Energy Industries Association (MDV-SEIA), and Powered by Facts (a renewable energy advocacy organization).

The Rubin Solar Collaborative spent several months in 2016 educating each other on their various points of view and identifying areas where they needed further discussion as well as areas where they thought they could reach compromise. They identified several topic areas where they thought they could work together to advance solar generation in Virginia. Those areas included:

- Utility-administered community solar;
- Expansion of self-generation options for agricultural customers;
- Streamlined permitting for larger solar projects; and
- Others.

On the community solar topic, the Rubin Solar Collaborative needed more input from subject matter experts to further develop a concept for how best to structure community solar programs in Virginia. Therefore, they established a Community Solar Working Group which consisted of the original Rubin Solar Collaborative members in addition to other parties. The Community Solar Working Group commissioned a request for information (RFI) and conducted listening sessions around the Commonwealth.[22]

Because of the feedback from the community solar listening sessions and responses to the RFI, the Rubin Solar Collaborative worked through several topics at a granular level to determine a conceptual framework for a community solar program structure. Senate Bill 1393, enacted in 2017, requires Dominion Energy Virginia and Appalachian Power Company to conduct 3-year community solar pilot programs in their respective Virginia service areas. Dominion Energy Virginia is working with internal and external stakeholders to refine the program design within the requirements of the legislation with the aim to request VA SCC approval of a community solar pilot by the end of 2017 or early 2018. Utility-administered community solar programs required by Senate Bill 1393 will allow Virginia retail electric customers to subscribe to solar energy through a voluntary, companion rate schedule. Program costs will be recovered through the rate schedule and will not be passed to non-participants.

To supply its community solar program, Dominion Energy Virginia has issued a public request for proposals (RFP) for all energy and RECs from qualifying third-party solar facilities. The RFP includes both the price and non-price evaluation criteria. Requirements for qualifying solar facilities are as follows: they (1) may not be constructed by a utility; (2) must be placed in service on or after July 1, 2017; and (3) must be sized less than or equal to 2 MW or a carve out of up to 2 MW of a larger facility. The aggregate generating capacity of the eligible generating facilities must be at least 10 MW but not more than 40 MW.

In terms of the regulatory process, the pilot program design, costs, and rate schedule(s) are subject to VA SCC review and approval. The legislation does not contain a deadline for the VA SCC to act on the Company's petition to launch the Community Solar program; however, the legislation does require the Company to launch the program within 6 months of VA SCC approval. In designing its community solar program structure, Dominion Energy Virginia is endeavoring to apply lessons learned from the SEPA community solar study conducted for this grant project. The SEPA report notes that customers desire flexibility, simplicity, and affordability as key design attributes for community solar programs. Accordingly, the Company plans to design its community solar program in a manner to avoid both high upfront costs and long-term participation commitments.

The Company is actively researching options for facilitating low-income customer participation in community solar. As part of its stakeholder meetings dedicated to the development of a community solar program, the Company discussed its intention to evaluate options for low-income customer participation in the Community Solar Pilot and specifically sought input from meeting attendees on this topic. The Company hosted four conference calls in the third quarter of 2017 with entities that are familiar with community solar programs and low-income participation in such programs to obtain lessons learned and to understand how the programs work. These entities included NREL and non-profit organizations focused on advancing solar energy and having specific expertise in low-income solar programs. Beyond Dominion Energy representatives, members of the expanded Rubin Solar Collaborative with interest and expertise in low-income solar also participated on one or more of these conference calls.

LONG-TERM FORECAST FOR SOLAR TO SERVE DOMINION ENERGY VIRGINIA'S CUSTOMERS

In addition to the existing and planned solar energy facilities and the existing and planned customer programs discussed above, Dominion Energy Virginia is forecasting that solar energy will play a major role in meeting the energy needs of customers for years into the future. That is because solar technology, for the first time, is now cost-competitive with other more traditional forms of electricity generation, primarily because of its current favorable economics. As reported in Dominion Energy Virginia's 2017 IRP, the installed cost of solar PV generation has decreased by approximately 18 percent since the filing of its 2016 IRP.[23]

In the Company's 2017 IRP, large amounts of solar PV resources are included not only because of their zero-emissions characteristics, but also because of their optimal economics. In fact, all but one of the IRP's modeling plans call for the addition of at least 3,200 MW of additional solar capacity to the Company's generation fleet by 2032 and at least 5,280 MW of additional solar capacity by the conclusion of a longer, 25-year study period concluding in 2042.

This solar development builds upon a solid foundation. The Company has already added 56 MW of solar capacity to its fleet in Virginia, and has also built or is developing other solar facilities serving the needs of specific governmental and large business customers. Additionally, Dominion Energy Virginia anticipates signing long-term contracts with 990 MW of solar facilities built by non-utility generators in Virginia and northeastern North Carolina by 2022.

The 2017 IRP includes, for modeling purposes, large-scale solar facilities that are assumed to be between 20 MW and 80 MW in size and predominantly interconnected to the Company's transmission network. But in reality, solar PV can be a collection of different-sized facilities ranging from just a few kilowatts to 100 MW or more, which may be interconnected along the Company's distribution or transmission networks. The Company must now prepare for a future in which solar PV generation is anticipated to become a major contributor to the Company's overall energy mix.

Overcoming Challenges to a Successful Solar Strategy

Despite Dominion Energy's interest in solar energy generation and efforts to actively incorporate large-scale solar into its generation portfolio, several challenges specific to large-scale solar and often unique to Virginia stood in its way.

A common challenge to all utilities, the economics of solar were particularly difficult in Virginia because of its low retail electric rates. Other issues, such as federal tax policy and unique state policy distinctions had to be overcome. Below is a discussion of these challenges and how they were overcome to allow Dominion Energy's solar portfolio in Virginia to grow to 744 MW of solar generation either in operation or under development in Virginia, and to project the development of as much as 5,200 MW of solar in the Company's service territory by 2042, as described in its 2017 IRP.

FEDERAL TAX POLICY

Tax normalization, which requires a utility to spread the benefit of a solar installation's ITC and accelerated tax depreciation ratably over the life of the asset, poses a challenge to the development of utility-owned solar. The motivation behind normalization requirements for these tax benefits as promulgated by Congress was to incentivize capital investment and not subsidize ratepayers—thus, normalization respects the cost-of-service method of ratably recovering capital investments. Conversely, an independent power producer (IPP) typically establishes a price for a PPA by incorporating the time value of money—allowing for such tax benefits to be essentially flowed back faster than ratably since IPPs are not subject to normalization requirements. This can result in an increase in the levelized cost of energy over the lifetime of a utility-owned solar project as compared to an IPP-owned facility.

As an additional hurdle, because regulated utilities are generally required to use the least-cost standard as well as tax normalization, utilities experience challenges in obtaining regulatory approval for construction and ownership of solar assets where cost recovery follows traditional cost-of-service based ratemaking.

To overcome the tax normalization challenge, Dominion Energy Virginia requested and received a PLR from the IRS confirming that the normalization requirement is not applicable if rates are not established based upon the cost-of-service method.

PRIVATE LETTER RULING

Dominion Energy Virginia was the first utility in the country to seek and receive a PLR from the IRS providing for favorable tax treatment which allowed the Company to realize the financial benefits of the federal ITC in year one as opposed to normalizing the tax credits over the life of a project so long as certain conditions are met. This groundbreaking IRS ruling enhanced the financial viability of the Company's 20 MW Morgans Corner solar facility in North Carolina, Dominion Energy Virginia's first regulated large-scale solar project. The structure set in place for Morgans Corner continues to serve as a model for additional solar facilities being developed in partnership with Dominion Energy Virginia's large customers in its electric service territory.

Morgans Corner

In 2014, the U.S. Navy set a goal to bring one gigawatt of renewable energy into procurement by the end of 2015 and established the Renewable Energy Program Office (REPO) to work with utilities and others to reach this goal. To address their needs, Dominion Energy Virginia selected the Morgans Corner solar facility as the best option to bring solar to Naval Station Norfolk, the world's largest naval station. The Company acquired the 20 MW solar facility, already under development, and entered into a long-term agreement with the Navy to purchase the output.

MORGANS CORNER

Typically, utilities are required to normalize the tax credits over the life of the project in part because rates for public utility service are established on a rate-of-return basis. However, since the rate established in the renewable energy supply contract with the Navy was a negotiated rate, and not established on a rate-of-return basis, the IRS PLR confirmed that normalization of the ITC over the life of the facility is not required. This groundbreaking IRS ruling enhanced the financial results of this project, and provides long-term cost stability and energy savings for the Navy over the term of the contract.

In addition to the PLR, Dominion Energy Virginia faced a unique challenge: "How to provide a greater amount of renewable energy to its largest customer without impacting the energy costs of its remaining utility customers?" Creative problem solving led to the solution: an innovative "ring-fenced" agreement, which was supported by the groundbreaking IRS ruling. The "ring-fence" approach provided a dedicated solar facility that supplies the equivalent of 6 percent of Naval Station Norfolk's energy needs while preventing the higher costs of the asset from impacting other ratepayers.

STATE AND MARKET DISTINCTIONS

Virginia's regulatory and policy climate creates an environment for third-party solar development that significantly differs from those of deregulated states or states with higher electricity rates. Two principal aspects of this regulatory and policy climate—low retail electric rates and a regulated, vertically integrated utility model—present a markedly different landscape for solar developers in Virginia than in states with deregulated electric systems, mandatory renewable portfolio standards (RPS) with solar carve-outs, high prices, or all three.

Historically, comparatively low retail electric rates have made solar economics challenging in Virginia and thus innovative approaches have been required to grow solar development in the Commonwealth. Virginia also has a conservative fiscal approach in all areas of government, reflected in the AAA bond rating it has enjoyed since the 1930s, that has mitigated against adopting some of the state-level incentives employed in other states to encourage solar development, such as state tax credits, mandatory RPS, and other subsidies. While these aspects presented challenges to solar development, Dominion Energy has overcome these challenges through a mix of creative partnerships, novel financing approaches, and a landmark IRS ruling.

Unlike many of its neighboring utilities in the Southeast, Dominion Energy Virginia is a member of the PJM wholesale market.[24] Membership in PJM has helped facilitate the creative partnerships that have resulted in the significant growth in solar capacity in Virginia. Dominion Energy Virginia's membership in PJM means that a customer can enter into a dedicated regulated, ring-fenced contract for solar facilities, as referenced **on page 18,** with the solar output actually being cleared in the PJM market which can then also be reconciled with the customer. PJM membership also facilitates customer adoption of solar through a merchant pathway, described **on page 19,** by allowing entities to enter into wholesale contracts and arrange delivery of the energy into Dominion Energy Virginia's PJM zone.

COST AND "LEAST-COST STANDARD" IN VIRGINIA

In Virginia, utilities are required to request a CPCN before commencing construction of large projects. In such a proceeding, the utility must demonstrate the need for the project and show that the project is a reasonable and cost-effective way to meet that need. The regulatory compact in Virginia tends to favor the "least-cost standard."

Until recently, solar generation simply did not meet the least-cost standard required in Virginia. Dominion Energy Virginia experienced this challenge when utility regulators in Virginia denied approval for the utility to construct and rate-base its 20 MW Remington Solar Facility in Oct. 2015 because the effect on rates could have been greater than if the utility were to simply purchase power from an IPP. As a result, until recently solar development was a means of addressing environmental concerns and greenhouse gas targets, or was accomplished only through small feasibility pilot projects. Two primary drivers addressed this challenge:

Yancey Legislation

In 2015, Virginia Delegate David Yancey sponsored House Bill 2237, which declared 500 MW of solar generation constructed or purchased by electric utilities to be in the public interest. HB 2237 has helped to catalyze the development of solar energy in Virginia. This legislation also allows utilities to propose an alternative cost recovery mechanism, a market index in lieu of cost-of-service, when proposing construction of a solar facility for its customers. The market index mechanism, in conjunction with the landmark IRS PLR issued to Dominion Energy Virginia, provides an avenue for the utility to take the benefit of the federal ITC upfront, instead of normalizing it over the life of the asset, enhancing the economics of utility solar development.

While HB 2237 does not compel the VA SCC to approve construction of solar generation in Virginia at any cost, the public interest finding does establish utility solar development as a state policy priority, which the regulator must take into consideration when evaluating a utility petition to develop solar generation facilities in the Commonwealth. Costs still must be prudent and reasonable, and still must be comparatively better than the open market. However, this legislation has served as a valuable tool for determining costs and advancing solar generation in the Commonwealth.

Falling Prices

With the dramatic lowering of costs (the installed cost of solar PV generation has decreased by approximately 18 percent[25] between the filing of the Dominion Energy Virginia's 2016 and 2017 IRPs), solar energy generation in many instances is now the least-cost option, compared with alternatives including traditional forms of electric generation.

PERMIT BY RULE

Permit by rule legislation was enacted in 2009 which provides a streamlined permitting process in Virginia for what are considered "small renewable energy projects". Prior to the PBR, there were two permitting authorities for small-scale solar—the VA SCC and the DEQ. The PBR allows utilities and other solar developers to go through the DEQ process only, thus streamlining the permitting of small renewable energy projects as defined by Virginia law.

In 2017, the Virginia General Assembly approved expanded PBR legislation[26] for renewable facilities that fall outside VA SCC jurisdiction, such as ring-fenced assets for non-jurisdictional customers. Expansion of the PBR legislation increases the size caps for what is considered a small renewable energy project. The expanded PBR has the potential to streamline agency consideration of each project.

Under the PBR process, the utility will now be able to forgo the lengthier CPCN process in favor of a streamlined permitting process through the DEQ for eligible facilities. This means that permitting of these facilities can be done faster and more efficiently, resulting in lower administrative costs and more rapid growth of dedicated solar facilities.

Emerging Challenges and Opportunities

Dominion Energy has already overcome numerous challenges and implemented innovative solutions to support customers interested in deploying solar energy systems on their properties and to build a substantial fleet of large-scale solar generation assets currently either operational or under development in Virginia, but the Company understands that several uncertainties and opportunities lie ahead.

For example, aging grid infrastructure presents a challenge with respect to integration of high penetrations of solar, but grid modernization and the various supporting technologies, such as energy storage, have the potential to present game-changing opportunities to drive substantial future solar development. It is difficult to predict the effects of emerging policy and market issues on future solar deployment, such as uncertainty of future of carbon policy and potential for international trade tariffs on solar panels.

UNCERTAINTY AROUND CARBON REGULATION

There is a great deal of uncertainty around carbon regulations and their potential impact for the electric industry, including Dominion Energy, and the solar marketplace in large part due to ongoing regulatory and legal challenges associated with the federal Clean Power Plan (CPP). The CPP, promulgated in 2015, set the first ever limits on carbon dioxide emissions from existing fossil fueled electric generating units. The rule is currently stayed by a February 2016 order[27] of the U.S. Supreme Court pending the outcome of a legal challenge to the rule in the U.S. Court of Appeals for the District of Columbia Circuit. Additionally, responding to an executive order from President Donald Trump and a subsequent review of the rule, the EPA issued a notice in October 2017 proposing to repeal the CPP, stating that the previous administration had exceeded its legal authority in promulgating the CPP.[28] At this time, EPA has not made any decision whether it will replace the CPP. Environmental groups and several states have pledged to challenge the repeal proposal in federal court. However, even if the CPP is ultimately repealed by EPA or overturned by a court, Dominion Energy believes power station carbon regulation is virtually assured in the future, regardless of the outcome of the CPP's current regulatory and legal challenges.

Additionally, many states, including Virginia, are moving forward with their own efforts to address climate change. In May 2017, Virginia Governor Terry McAuliffe, issued Executive Directive 11[29] ordering the DEQ to develop a proposed regulation for consideration by the Virginia State Air Pollution Control Board (SAPCB) to reduce carbon dioxide emissions from power plants. On Nov. 16, 2017, DEQ received approval from the Virginia SAPCB to proceed with formal publication seeking public comment on its proposed regulation to reduce carbon emissions from fossil fuel-fired electric generating units pursuant to Governor McAuliffe's Executive Directive 11. The publication of notice in the *Virginia Register,* possibly by early January 2018, will kick off a 60-day comment period on the proposed regulation.

The proposed rule seeks to establish a carbon dioxide emissions cap-and-trade program in Virginia with intended linkage to the existing northeast states Regional Greenhouse Gas Initiative (RGGI) trading program. The regulation includes most of the elements of the Aug. 2017 RGGI-proposed modifications to the RGGI model rule in order to facilitate this linkage.

INTERNATIONAL TRADE DEVELOPMENTS

One of the primary drivers of increased solar development has been the precipitous fall in prices of solar panels. As an example, the installed cost of solar PV generation has decreased by about

18 percent between the filing of the Company's 2016 and 2017 IRPs.[30]

However, Suniva Inc., a solar manufacturer based outside of Atlanta, and Oregon-based SolarWorld USA filed a petition with the U.S. International Trade Commission (ITC) requesting that the government immediately impose tariffs on solar cells and modules imported from around the globe. Previous tariffs on China, they argue, were circumvented when China moved operations to Thailand, Malaysia, Vietnam and Canada. On Sept. 22, 2017, the U.S. ITC upheld the complaint brought by Suniva and SolarWorld USA. The U.S. ITC has proposed remedies in response to the harm suffered by the U.S. solar manufacturers. In crafting their proposal, they sought input from solar companies. A decision by the President on specific remedies is expected by Jan. 2018.

While panel price reductions have made solar competitive with other sources of electricity on the grid, higher prices would likely slow the rapid uptake of residential rooftop or commercial solar installations. But the biggest impact of higher costs could be on large-scale solar projects. The final structure of the remedy could have major implications for the industry and the future of solar generation, both small-scale and large-scale in the U.S.

AGING GRID INFRASTRUCTURE AND THE OPPORTUNITY FOR GRID MODERNIZATION

As a regulated utility, Dominion Energy Virginia has an obligation to serve, with reliability and safety its foremost priorities. Current solar PV technology produces variable energy that is non-dispatchable and subject to sudden changes in generation output along with voltage inconsistencies. Therefore, integrating large volumes of solar PV into the Company's grid presents service reliability challenges that the Company continues to examine. Like most of the industry, the Company's electric distribution system was designed for "one-way" delivery of energy to meet customer demand from the generator, to the transmission network, then to the distribution network, and finally to the customer meter.

As the penetration of solar PV generation facilities continues to rapidly increase, we must be prepared to meet a new paradigm. This requires transforming the existing electric delivery system from its original one-way design to a modern two-way network capable of facilitating instantaneous energy injections and withdrawals at any point along the network. Paramount in this effort is maintaining the highest level of reliability and service levels that customers expect and deserve. The first step in this transformation process is the modernization of the electric power grid, at both the distribution and transmission levels, to create a more dynamic system better able to respond to the growth of large-scale solar facilities, as well as the proliferation of smaller, widely-dispersed solar generation facilities. That preparation includes a plan to create a more flexible electric power grid that will accommodate the highly variable output associated with solar PV and other intermittent forms of generation, and new forms of energy storage and dispatch, while still maintaining reliability.

The modernized system would need to include elements such as (1) "smart" meters, also known as automated metering infrastructure (AMI); (2) improved communications network; (3) intelligent devices to monitor, predict and control the grid; (4) distribution substation automation; (5) plans to replace aging infrastructure; (6) improvements to security; (7) methods to investigate new innovative technologies; and (8) an enhanced customer information platform to enable management of energy usage. Together, these essential elements of the modernized grid will not only enhance reliability and resiliency, but also facilitate adoption of technologies that give customers more choices and control over their energy usage. Additionally, the dynamic nature of a modernized grid creates more responsiveness and flexibility through greater data availability and transfer, which facilitates more advanced pricing options for customers as well as more customer interaction with the grid through various types of distributed energy resources, including customer-sited generation, electric vehicles, and energy storage.

LOCAL PUSHBACK AND OTHER SITING/PERMITTING CHALLENGES

One growing barrier for solar generation is the increased amount of pushback from the local level. A variety of issues—including land use, line of sight, concerns about reduced local tax revenue and decommissioning of projects—has meant that Dominion Energy is sometimes facing challenges in getting local approval for projects. For example, a proposed solar generation facility in Chesapeake, Va. was recently denied, with the local board of supervisors citing line of sight and tax issues. Technical issues such as lack of sufficient fiber optic cable have also presented siting challenges in rural areas.

Land Use

One factor to consider for large-scale solar installation is the amount of land required. For example, approximately 6 to 8 acres of land is required for 1 MW of solar PV; therefore, the installation of 1,000 MW of solar requires approximately 6,000 to 8,000 acres of land. Because the amount of land required for large-scale ground mount solar is so large, localities are faced with difficult decisions in permitting large-scale solar generation facilities. In many instances, solar generation faces strong competition from the agricultural and food production industries, which in addition to providing income, support local jobs. Much of this flat, open land is fertile farmland, and residents and local officials are reluctant to relinquish this land for solar projects. The Remington solar facility was the first large-scale project in Virginia that went before a local commission. There was at least one environmental organization asking the board of supervisors to reject the project because they believed it was better to leave the area as open space rather than approve the siting of solar panels.

Sites that work well for large-scale solar

generation are flat, open, and near electric infrastructure. However, the same attributes that make these sites good for solar generation also make them viable and desirable areas for economic development projects. Localities are faced with the decision to approve the projects (a 25 to 30-year lease commitment), or to hold the land and wait for economic development projects which can promise both increased tax revenue and the more than the one to two incremental jobs that operational solar facilities typically provide.

Lastly, historic preservation poses another hurdle in Virginia to appropriately siting solar generation facilities. Many of the flat, open spaces in the Commonwealth are preserved battlefields, and at least one has contacted Dominion Energy about solar generation, but legal challenges (not to mention community goodwill challenges) are a hurdle. In general, the Company has not reached its upper limit on its ability to find locations for solar, but numerable complex siting challenges remain.

Line of Sight

Another issue of local concern is line of sight. In many localities, residents simply dislike the look of large-scale solar facilities, preferring agricultural land or open space. In Currituck County, N.C., where Dominion Energy developed a solar project last year, the county has enacted a moratorium on additional solar array construction, specifically citing problems with the solar panels covering farmland and disturbing nearby residents. To date, the Company has managed to mitigate some line of sight problems by planting additional trees and taking other proactive measures. But line of sight issues are a growing concern for locating new projects.

Tax Exemptions

Localities are faced with difficult decisions relating to permitting solar generation facilities. In Virginia, tax exemptions for large-scale solar farms have been in place for several years. At present, large-scale solar projects are not fully tax-exempt, but they do receive significant incentives, including property tax and machinery and tool tax exemptions on the equipment used in solar arrays. Depending on the size of the project, solar farms are granted between an 80 to 100 percent exemption from payment of machinery and tool taxes.

These incentives were put in place to encourage investment in solar, and they are very advantageous for the developer. However, they create little to no incentive for localities; in some instances, they can even cause the locality financial harm. Once a parcel is dedicated to solar, the property tax and machinery and tool tax exemption means that localities will receive little tax benefit from the facility. Often, local governments believe that leaving the parcel as agricultural land or waiting for other development provides better alternatives. For example, if an agricultural parcel is rezoned for commercial use, this change can positively impact local funding for schools.

A consultant for Mecklenburg County, Va. recently assessed tax impacts from a solar installation on agricultural property in the locality and concluded that the county could see an overall net loss of nearly $64,000 in revenue after all factors are considered. Although the county would receive an additional $84,000 in real property tax receipts, state educational revenue would decrease by nearly $148,000 given that the fully-assessed value of that property would greatly boost the share of local funding required for the school budget under the composite index.[31]

Decommissioning/End of Project Life Concerns

Another concern for local officials involves deciding what happens to these projects once they reach the ends of their useful lives. Large-scale solar projects may cover hundreds of acres. Local officials, as well as landowners, need to be sure that a plan and funding are in place for decommissioning a project and remediating the land occupied by the facility. This concern has led local officials in many rural areas to condition permitting upon the requirement that the developer establish a reserve fund that will cover the cost of decommissioning and remediation when the time comes to remove the facility.

FIBER OPTIC/ COMMUNICATION AVAILABILITY

Dominion Energy has recognized that even when challenges can be overcome at the local level to purchase land and resolve permitting issues, there often is not a "perfect" place for solar facilities. While an out-of-the-way or remote location may resolve local pushback around line of sight and land use concerns, the rural nature of the site often means that basic infrastructure needed to operate a facility—e.g., fiber optic cable and communication equipment—is not already located there. While not insurmountable, lack of communications infrastructure has been a challenge.

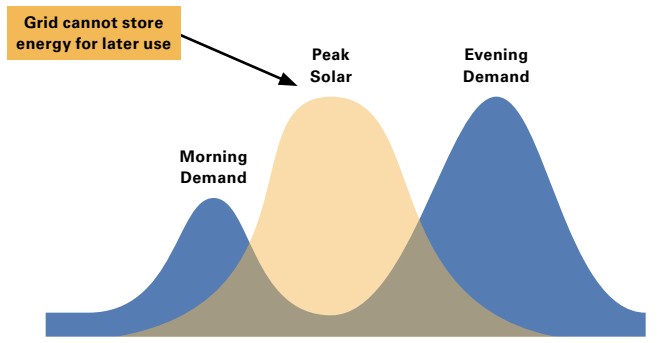
LACK OF WIDE DEPLOYMENT OF ENERGY STORAGE

One of the biggest challenges in harnessing power generated from the sun is its variability. Power is needed by customers, even when the sun is not shining, such as at night or on days with significant cloud cover. Contrary to what many customers believe, the energy grid does not act as a battery and cannot store electricity for later use. This can only be accomplished with energy storage devices. This challenge is illustrated in **Figure 10 on the next page.**

Energy storage technologies, in addition to fast ramping natural gas generating facilities, can also be used to provide grid stability as more renewable generation sources are integrated into the grid. In addition to mitigating issues posed by the intermittency of wind and solar generation resources, energy storage can shift power output from periods of low demand to periods of peak demand. This increases the dispatchability and flexibility of these resources.

One type of energy storage that has attracted significant investment has been battery storage. Batteries serve a variety of purposes that make them attractive options to meet energy needs in both distributed and large-scale applications. Batteries can be used to provide energy for a variety of purposes, such as power station operation, "blackstart" capability, peak load

FIGURE 10: COMPARISON OF SOLAR SUPPLY AND DEMAND CURVE



shaving, frequency regulation services, or shifting peak load to off-peak periods. They vary in size, differ in performance characteristics, and are usable in different locations. Recently, batteries have gained considerable attention due to their ability to integrate variable generation sources such as wind and solar onto the grid. Battery storage technology approximates dispatchability for these variable energy resources.

Investment in research and development to improve the economics of large-scale energy storage devices has been substantial, but the battery storage industry has not experienced the same gains in energy storage as with data storage in recent decades. In addition to cost, other factors such as recharge times, variance in temperature, energy efficiency, and capacity degradation are also important considerations for large-scale battery systems. Dominion Energy continues to monitor and assess battery storage and its capabilities. Recently, the Company installed two emerging battery technologies at a rooftop solar facility located at Randolph-Macon College. These two small batteries are designed to test the extended capabilities of these new devices, and prove the potential benefits when integrated with existing solar generation. Dominion Energy is also testing battery storage as part of a small microgrid project at its Kitty Hawk district office in North Carolina.

RANDOLPH-MACON COLLEGE

There is also increasing interest in pumped storage hydroelectric power as a storage mechanism for the intermittent and highly variable output of electric generation facilities powered by renewable energy such as solar and wind. For example, the 2017 session of the Virginia General Assembly passed Senate Bill 1418[32] supporting construction of "one or more pumped hydroelectric generation and storage facilities that utilize on-site or off-site renewable energy resources as all or a portion of their power source and such facilities and associated resources are located in the coalfield region of the Commonwealth." The bill became law, effective July 1, 2017, after the General Assembly adopted the Governor's amendments to it on April 5, 2017. Dominion Energy Virginia is currently evaluating two sites in Southwest Virginia as possible locations for a pumped storage project. On Sept. 2, 2017, the Company filed a preliminary permit with the Federal Energy Regulatory Commission (FERC) for a 4,100-acre site in Tazewell County. The Company has also contracted with Virginia Tech for a study of the possible use of an abandoned mine near Appalachia, Va., as part of a pumped storage facility.

Solar Workforce Development Strategy

As part of its Solar Pathways work, the project team committed to develop a solar workforce development strategy. The team evaluated solar jobs in the United States and Virginia to identify trends and gathered real-world data from actual solar installers operating in Virginia to supplement the workforce trend data.

"Solar employment factors" were derived to reflect the actual number of jobs created per increment of solar capacity, and the team worked with Northern Virginia Community College (NVCC) to analyze job postings referencing "solar" and to develop a snapshot of solar-related jobs in Virginia. Dominion Energy evaluated its own support for existing workforce development and education initiatives, and evaluated energy education courses and certificates currently available in Virginia. Lastly, the team made recommendations for additional energy education pathways in Virginia. Included here is a synopsis of the team's work along with key findings and recommendations.

- **The majority of solar jobs arise from the solar installation job sector.** Solar jobs fall into four main categories: manufacturing, system design, project development, and installation and operations. As reported by the Solar Foundation, the majority of solar jobs are created in the installations and operations sector.[33] Dominion Energy's solar development experience supports the conclusion that the majority of incremental job growth results from the actual construction of new solar facilities. However, these jobs are temporary in nature, lasting five to six months, and once construction of a solar facility has been completed, minimal operations and maintenance work is required to maintain the facility.
- **Although solar installation jobs are temporary in nature, a single large-scale project can employ hundreds of temporary workers.** Dominion Energy's own data shows that approximately 145 temporary construction jobs are created for every 20 MW solar installation. These are substantial job numbers and are jobs that cannot be outsourced.
- **Operational solar installations provide very few incremental jobs.** In the utility sector, based on primary research conducted by Dominion Energy's Solar Pathways team, for every 20 MW large-scale solar facility, only one new incremental full-time equivalent (FTE) position is needed to carry out operations and maintenance functions.
- **The biggest concern voiced by solar installers to the project team was the overall shortage of skilled tradespeople.** The Solar Foundation's data substantiates what the team heard from the solar installation companies it interviewed. In a report issued in April, the Solar Foundation indicates that despite increased efforts by both public and private solar training organizations, solar installation companies around the entire country continue to complain of substantial difficulty finding qualified workers. Specifically, the report states that in 2016, 84 percent of solar installers in the U.S. reported challenges with filling open solar installation positions. Furthermore, more than three-quarters (77.6 percent) of all employers report struggles finding candidates with any training specific to the position, and a similar number (77.9 percent) say they cannot find candidates with any relevant work experience. More specifically, the report states "Electrical experience, soft skills (work ethic, dependability, critical thinking), and roofing experience ranked highest in terms of areas of expertise that are most difficult to find in solar job applicants." It goes on to note that 61 percent of employers cited experience in a non-solar construction trade as being important to hiring decisions.[34]

Summary Recommendations

- **The Commonwealth should focus on emphasizing the skilled trades in general, rather than developing a solar-specific curriculum for entry-level workers. However, solar-specific course work may be beneficial for employees seeking to advance in their careers beyond the entry-level roles.** The report suggested that training providers should work closely with employers to enhance solar training both pre- and post-hire. Pre-hire training should concentrate on a preliminary understanding of system components and electric basics, safety, and soft skills, and should maximize opportunities for hands-on worksite experience. The solar installation companies with whom the team spoke echoed these recommendations. Rather than solar specific training, they expressed a need for workers trained in the skilled trades, basic electricity, and soft-skills. In most instances, the installation companies provide on-the-job training specific to solar installation so there is not a critical need for workers to have specific solar installation training or certification prior to being hired.
- **Any certificate or curriculum programs to support job-seekers in the solar installation sector should include two essential components: (1) Occupational Safety and Health Administration (OSHA) training and (2) preparation for the NABCEP Associate Exam.** All energy education programs should include an appropriate level of OSHA safety training. OSHA recommends Outreach Training Programs as an orientation to occupational safety and health for workers. The North American Board of Certified Energy Practitioners (NABCEP, **www.nabcep.org**) is one of the top

preferred certifications for renewable and solar professionals. Ensuring that training programs include OSHA and NABCEP training and preparation for certification benefits both job-seekers and employers alike and should be incorporated into both certificate and curriculum programs.

- **A 17th Career Cluster focused specifically on the energy industry should be developed.** Currently, federal law mandates that states offer career and technical programs to equip students to successfully progress into post-secondary education or the workplace. Programs offered by each state may fall into one or more of 16 career clusters recognized by the Office of Vocational Adult Education (OVAE) and the National Association for State Directors of Career Technical Education Consortium (NASDCTEC). These clusters consist of occupational categories with industry-verified knowledge, skills, and abilities that describe the aptitudes necessary to achieve success in a given field. Unfortunately, energy jobs and the education pathways leading to these careers tend to get hidden in other education clusters, such as Architecture & Construction, Manufacturing, and Science, Engineering, Technology and Mathematics (STEM) because no specific energy-related Career Cluster exists. With the importance of the Commonwealth of Virginia's clean energy future, it's time to have a new cluster in Virginia that focuses on the jobs needed for impending retirements.
- **The Virginia Solar Pathways Project Team also recommends that Virginia's Community Colleges partner with the industry to implement Associates of Applied Science (AAS) degrees in Energy Technology.** These degrees may be general energy technology degrees with course options in power systems, nuclear, natural gas, and renewables to include solar. The AAS degrees may also have a specific focus such as renewable energy technology or solar energy technology; however, it is critical that the AAS degree foundational curriculum provide a broad base of energy industry fundamentals to maximize employment opportunities for students attaining these degrees.

Findings and Recommendations for Replicating the Virginia Solar Pathways Strategy for Sustainable Solar Deployment

Based on experience and knowledge gained during the grant period from collaboration with stakeholders and the operation of Dominion Energy's own solar projects, Dominion Energy and the project team offer the following recommendations for replicating the Virginia Solar Pathways strategy for sustainable solar deployment in other states.

ENGAGE IN STAKEHOLDER COLLABORATION

The first recommendation is that stakeholder collaboration and engagement are paramount for any successful solar strategy. Solar energy generation is a new paradigm with many competing views and interests. Customers (including those of various sizes), environmental groups, policymakers, and elected officials at the state and local level each have different interests, goals, and aims. The Rubin Solar Collaborative's 2016 successes and work so far in 2017 prove that the collaborative process can work, even in a state that has experienced several years of deadlock on solar policy issues between utility interests and interests of solar advocates. Starting with a focused group of committed and people with diverse interests, the Collaborative made progress on many issues from community solar to the expansion of self-generation options for agricultural customers.

While the Rubin Solar Collaborative made significant progress in 2016 to advance solar in Virginia, they have continued their work in 2017 and expanded the Collaborative to include a significant number of additional stakeholders. The goal of this continued dialogue and further analysis is to find common ground on additional topics of importance such as distributed generation, net metering, and zoning issues.

One of the elements that contributed greatly to the Rubin Solar Collaborative's success in 2016 was the openness with which members of the group were willing to share information. This willingness likely resulted from the decision to execute confidentiality agreements as a condition of participation in the group along with an agreement not to speak to the media or talk publicly about the topics discussed as part of the collaborative process.

To realize significant results, the project team recommends a capable facilitator who fosters an environment of trust. For example, as we try to address concerns relating to land use, our region must balance the desire for autonomy on behalf of localities with the desire of statewide officeholders to increase the amount of solar energy in the state. While it is desirable for solar developers to establish some standard processes and requirements, it is equally important for localities to have options regarding how they manage their local policy frameworks. What works for one locality might not be a fit for another.

Similarly, collaboration and cooperation will be critical in addressing net metering moving forward. Given the success with collaboration in the Rubin Solar Collaborative last year, the project team believes that decisions about net metering reform are best addressed through a collaborative process aimed at an outcome that will be fair to all parties, including both customer-generators and customers not engaging in self-generation.

Summary Recommendations

- Use stakeholder collaboration, but only with a strong, respected, and unbiased mediator;
- In the beginning, smaller is better. Expand the stakeholder group only once initial progress has been achieved;
- Expansion of the stakeholder group is essential to tackling the toughest issues; and
- Be deliberate and patient.

WORK TO AVOID UNINTENDED ADVERSE CONSEQUENCES OF STATE POLICY CHANGES

The project team has found that sometimes policy measures enacted to foster solar development can have the opposite effect. Therefore, policymakers and solar stakeholders, including utilities, should carefully consider all potential outcomes of policy changes before determining whether to support them.

For example, in the **Emerging Challenges and Opportunities section of this report on page 23,** we discuss that the Virginia legislature has enacted measures allowing for various property and sales tax exemptions for solar installations in the Commonwealth with an installed capacity of 20 MW or less. The intent of these measures was to reduce the tax burden on solar development and lower the overall cost of projects, thereby enhancing project economics to facilitate more solar energy projects in the Commonwealth. While these tax exemptions lower the cost of projects, they also lower the amount of tax revenue flowing into local communities.

Rural localities with large tracts of open farmland are often the most attractive areas to site large-scale solar facilities. Unfortunately, they also can be most susceptible to revenue challenges due to a lack of industry and economic development. Policymakers in rural areas are under enormous pressure to approve projects that will bring tax revenue and jobs to their regions; therefore, these local boards of supervisors or town councils tend to favor projects that will bring the best revenue proposition. By reducing the revenue proposition, a tax exemption for solar can create a disincentive for solar development in the eyes of local officials faced with decisions about whether to permit these facilities.

While interest in and support for solar energy generation projects continues to grow at the state and federal levels, localities are increasingly becoming battlegrounds for solar generation projects. Beyond land use and line of sight issues, local tax policy issues are some of the main barriers to successfully siting and building new projects. Incentives for developers to invest in solar projects can have the unfortunate effect of making localities much less receptive to siting these projects.

Development of large-scale solar installations in rural areas provides potential revenue opportunities to local farmers and other rural property owners and may help preserve open space. However, projects need to offer tangible financial benefits to a locality as a whole—developers and utilities must be able to demonstrate that a project in a given locality will provide revenue, especially with growing environmental, line of sight, and land use challenges facing solar developments. In some instances, not only are current solar projects not able to offer a tangible benefit to local jurisdictions, they actually pose a potential financial loss.

Utilities, solar developers, customers, local officials, and state officeholders should come together to address these challenges. In considering solar policy incentives, the project team urges policymakers to seek input from a wide swath of stakeholders, especially those directly impacted by any revenue implications of those decisions.

Summary Recommendations

- Policymakers and solar stakeholders, including utilities, should continue to carefully consider all potential outcomes of policy changes and the effect on all impacted stakeholders before determining whether to support them.
- Solar projects must offer localities tangible financial benefits. Don't assume reducing the tax burden on solar developers and lowering the overall cost of projects will drive further solar development. It can have the opposite effect if it has the potential to reduce revenue to localities in which the proposed solar facility will be sited.

FOSTER AND MAINTAIN DIALOGUE WITH LARGE CUSTOMERS

Many of the breakthroughs that Dominion Energy has achieved in the past three years have resulted from engagement and collaborative problem solving with its large customers. While energy savings and cost reductions have been key reasons organizations have focused on sustainability and energy efficiency, company culture and values, along with corporate reputation and public relations concerns, have increasingly risen to the top. To some extent, local, state, and federal

requirements have provided incentives for large customers—including corporations, universities, and government entities—to seek renewable energy options.

In Virginia, achieving cost-effective renewable energy options increasingly means solar energy deployment. Dominion Energy has responded strategically to customer needs and desires by providing innovative solutions which have demonstrated that significant solar deployment can be achieved without impacting the entire customer base. This has allowed the Company to grow solar one large customer at a time and may involve partnering with multiple customers on a single project.

As an example, the 20 MW Remington solar project in Fauquier County, Va., is a partnership between Dominion Energy Virginia, the Commonwealth of Virginia, and Microsoft and came online in October 2017. Dominion Energy Virginia executed a long-term power sales agreement with the Commonwealth of Virginia and all of the renewable attributes (including solar RECs) from the project are being sold to Microsoft. Under this unique arrangement, all parties benefit. The Commonwealth of Virginia advances its goal for more solar deployment in the Commonwealth and supports the goals of one of its largest businesses. Microsoft, which sought to increase its renewable portfolio, can accomplish its goal through the purchase of RECs, which would not have been possible without the long-term sales agreement from the Commonwealth. Using its ring-fencing model, Dominion Energy Virginia could build Remington for the benefit of the Commonwealth and Microsoft without spreading costs among other utility customers.

Summary Recommendations

- Foster and maintain an ongoing dialogue with your largest customers to truly understand their goals and needs.
- Consider partnering with multiple customers on a single project that may meet differing needs of all customers, such as the example above with the Commonwealth of Virginia and Microsoft.

LISTEN TO CUSTOMER PREFERENCES AND MATCH THEM TO RESOURCE AVAILABILITY/ATTRIBUTES

The project team strongly recommends listening to customers about their preferences. The Company's experience has shown that while some customers specifically demonstrate interest in solar, others are interested in renewable energy of any type. Beyond this, each customer's definition of "renewable", as applied to himself or herself, is often fluid. For some customers, RECs may be a solution; others are interested in more directly supporting and receiving benefit from renewable energy including solar; and yet others may be interested in projects that are additive—adding more solar capacity to the system and not just using output from existing systems.

Dominion Energy Virginia's customer programs have demonstrated a clear and growing appetite for solar energy in Virginia. Actively communicating with customers is key to connecting them with existing programs that meet their needs. Dominion Energy Virginia has created a variety of options for its customers moving forward. Yet directly communicating with customers of all types can help to develop new and innovative projects and programs that provide even more options for customers.

As with customer approaches, there is no one-size-fits-all approach for utilities. Instead, utilities must do the work to fully understand what programs, approaches, and challenges need to be addressed.

Undertaking a collaborative stakeholder process in these efforts is critical to provide customers, policymakers, and the public with the information necessary to move forward. Where possible, find organizations who can act as a clearinghouse to help distill and define the needs of large institutional customers. As referenced earlier in this report, Dominion Energy found that the World Resources Institute and the World Wildlife Fund were valuable partners in fulfilling this role by bringing together large institutional customers operating in its service territory and helping give collective voice to their needs.

Summary Recommendations

- Make sure you understand the customer's definition of "renewable energy". Customers may define it differently.
- Discuss the need to support the variability of non-dispatchable resources, such as wind and solar, through various mitigations measures and technologies, such as conventional sources of electric generation and/or energy storage.
- Proactively seek out your customers' preferences with respect to renewable energy offerings. Solving a problem for one customer may lead to new program offerings that would be attractive to many customers.
- Don't assume you must do all the work yourself. Seek help from organizations dedicated to helping understand the collective needs of similarly-situated corporate customers and other large institutions.

DEVELOP CUSTOMIZED APPROACHES TO MODELING AND PLANNING FOR SOLAR INTEGRATION

As with every other source of electric generation, solar has unique characteristics, benefits, and challenges. Developing a successful utility-administered solar strategy requires an examination of and integration with the entire electric utility system—generation, transmission, and distribution.

Each utility must apply the specific characteristics of its distribution and transmission grid, its market structure for generation, and region-specific cost data to truly understand the technical and financial impacts and opportunities. Dominion Energy Virginia made progress to this end through the two Navigant studies[35] on Solar PV Generation System Integration Impacts

FIGURE 11: VARIABILITY IN SOLAR OUTPUT

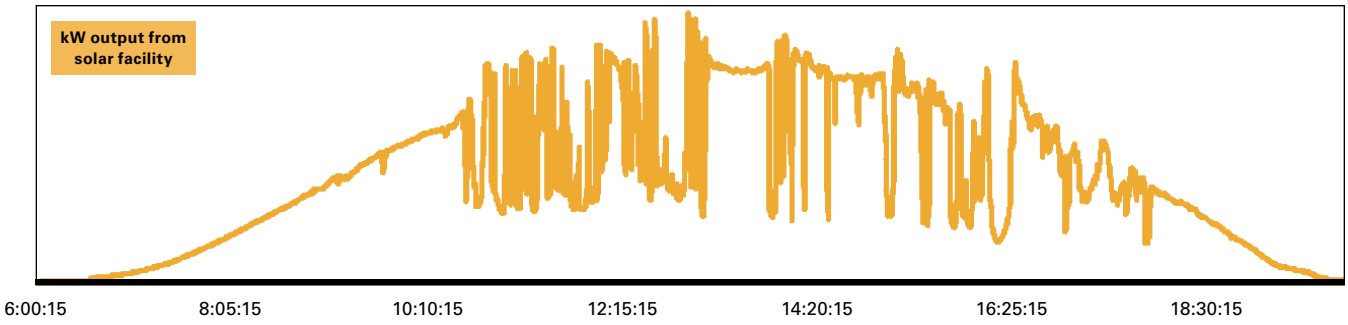
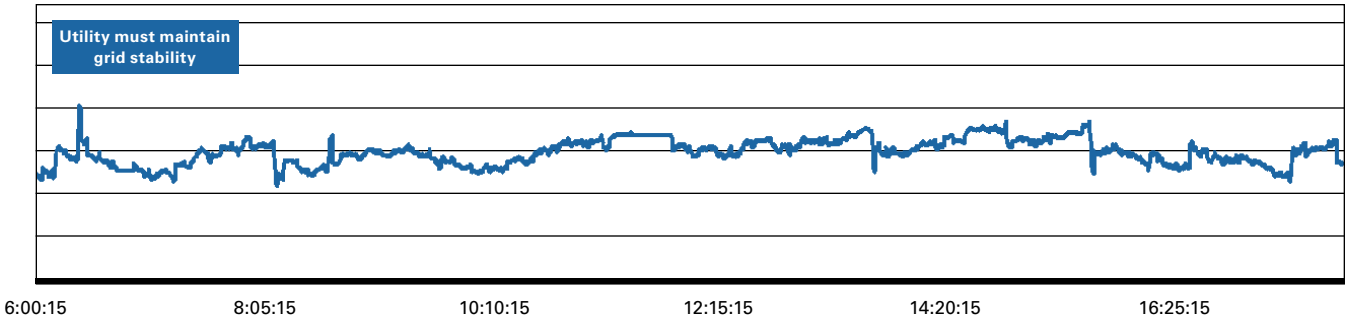


FIGURE 12: REQUIRED GRID STABILITY



and Distributed Solar Generation Integration and Best Practices, both of which considered technical and cost characteristics and attributes specific to Dominion Energy Virginia's system and the PJM region. As robust as they were, the Navigant studies were conducted based on static inputs and assumptions. The Dominion Energy Integrated Resource Planning team knows that further study and ongoing modeling will be necessary to understand impacts of solar integration from a dynamic perspective. That is why, as referenced earlier in this report, the Company had Navigant provide training in late 2016 to the Advisory Team and Dominion Energy representatives to equip them to conduct additional modeling, utilizing the commercial simulation models used in the original studies.

Summary Recommendations

- When it comes to solar integration, one size doesn't fit all. The most informative and valuable information comes from modeling that is customized to your utility's technical and market characteristics.
- While secondary research can offer useful information, it cannot take the place of a study customized to your utility's unique architecture, market, and policy attributes.
- Scenario-driven modeling that makes use of multiple and differing data sets and assumptions is necessary to understand the dynamic impacts related to the integration of solar, distributed energy resources, and other technologies.

PRIORITIZE GRID MODERNIZATION AND CUSTOMER EMPOWERMENT

A modern energy grid is an essential foundation for wide-scale solar deployment and unlocking the benefits of solar for customers. Dominion Energy Virginia has a primary mission to assure reliability for all customers and safety, particularly during outage restoration or other projects. Utilities in many states, including Dominion Energy Virginia, have expressed the need for a more modern grid. Most of the grid, as we know it today, was designed with a one-way flow of electricity in mind. Many of the elements of the grid were designed to last for decades, and are decades old today. The question remains: What should the grid look like in the age of solar, enabling two-way use and generation of energy?

Currently, at the generation and transmission levels, the Company's electric system operators possess real-time visibility, communications, and control. Now is the time to provide similar operational improvement at the distribution level. Implementing a comprehensive program will not only improve and modernize the distribution grid, but make it adaptable to evolving technological changes. Ultimately, this sophisticated distribution system of communication and control will be similar to what system operators currently utilize at the generation and transmission levels.

In a future where potentially tens of thousands of distributed energy resource devices are located at homes or businesses throughout Virginia, system operators will need the ability to monitor these devices to adjust the distribution network appropriately so that overall electric service

reliability can be safely and efficiently maintained. (**Figures 11 and 12 on page 31** demonstrate the variability of solar output compared to the necessary stability that a grid must possess). In addition to ensuring reliability and accommodating integration of distributed energy resources into the grid, this modernization program will offer customers a new information platform and opportunities to manage their energy usage. The Company is assessing the details and costs associated with developing a future distribution grid modernization plan that is stronger, smarter, and greener than today's network.

In addition to enhancing the safety and reliability of the grid, which are two essential components of any path forward, the Company must extend control and communication beyond the substation to the distribution system. To expand benefits to customers most effectively, it would be beneficial for utilities to develop visibility at the distribution level to see what is happening at the feeder/neighborhood level.

Maintaining grid stability and improving reliability will be supported through the installation of intelligent grid devices, improving the communications network and implementing new automated control systems. These resources can react quickly in response to varying intermittent renewable resources, such as solar and wind to support bulk electric grid stability.

Other innovations include real-time pricing options that can result from more modern metering technology and could ensure more responsive pricing aligned with usage, both for what customers take from and deliver to the grid. These types of options will empower Dominion Energy Virginia customers with timely data and ensure they are fairly compensated for energy they create while not creating a subsidy for non-solar customers. The grid modernization plan under development by Dominion Energy Virginia, also includes other customer benefits such as an educational portal, customer self-service, including mobile and web-based tools, and additional rate options.

Summary Recommendations

Initial recommendations for grid modernization include:

- Smart metering for all customers;
- Improved communications network, including within the distribution system;
- Intelligent devices to monitor, predict and control the grid;
- Automating distribution substation operations;
- Aging infrastructure replacement;
- Improvements to security, both cyber and physical;
- Methods to leverage new innovative technologies; and
- Enhanced customer information platform to enable management of energy usage.

SCOTT SOLAR

Acknowledgments

Dominion Energy wishes to thank the following organizations and individuals for their contribution to the Virginia Solar Pathways Project.

Bay Electric Co., Inc.
John Biagas
Daryl Lanouette

City of Virginia Beach
Lori Herrick
Bob Matthias

Metropolitan Washington Council of Governments
Jeff King
Steve Walz

National Renewable Energy Laboratory
Travis Lowder
Shivani Mathur
Megan Mercer
Emerson Reiter

Navigant Consulting, Inc.
Eugene Shlatz
Steven Tobias
Robert Wilhite

Northern Virginia Community College
Alex Cooley
Vonzell Mattocks
Sheyda Nabaee
Steve Partridge

Old Dominion University
Shirshak Dhali

Piedmont Environmental Council
Rob Marmet

Smart Electric Power Alliance
Dan Chwastyk
Nick Esch
John Sterling

Virginia Community College System
Craig Herndon
Elizabeth Moran
Randy Stamper

Virginia Department of Mines, Minerals, and Energy
Al Christopher
Ken Jurman

List of Acronyms and Descriptions

AAA: The highest tier in credit or bond ratings, denoting "prime," investment-grade status.

AAS: Associates of Applied Science; two-year undergraduate degree focused on entering the workforce in a technical field.

AWS: Amazon Web Services; a subsidiary of Amazon.com that provides cloud computing platforms for individuals, companies, and governments.

CPCN: Certificate of Public Convenience and Necessity; a permit issued regarding supervision of public facilities, such as public utilities, that authorizes the holder to operate a public facility within a particular area.

CPP: Clean Power Plan; an Obama administration policy introduced in Aug. 2015 that includes new Environmental Protection Agency standards for reducing carbon emissions from power plants. The plan aims at combating climate change.

CRG: Continuous Renewable Generation; used in reference to the Dominion Energy Virginia's proposed CRG Rate Schedules.

DEQ: Department of Environmental Quality; the Virginia agency responsible for the management of air, land, and water resources, involving permitting and oversight of projects affecting such resources.

DG: distributed generation; the use of small grid-connected power generating units located close to the place where electricity is used.

DOE: U.S. Department of Energy; department within the Cabinet of the Executive Branch of the United States responsible for policies regarding energy and safety in handling nuclear material.

EPA: U.S. Environmental Protection Agency; federal agency responsible for writing and enforcing environmental regulations based on laws passed by Congress.

EPC: engineering, procurement and construction; a contracting arrangement in which the contractor is responsible for design, procurement, construction, and commissioning of a project before handing it off to the owner.

FERC: Federal Energy Regulatory Commission; federal agency that regulates, monitors, and investigates manners related to electricity generation and transmission.

FTE: full-time equivalent; the workload of one full-time employee.

HB: House Bill; any bill introduced by the Virginia House of Delegates.

HVAC: heating, ventilation, and air conditioning; the system that regulates indoor air quality.

IRP: Integrated Resource Plan; a comprehensive road map for meeting a utility's objective for providing electric service.

IRS: Internal Revenue Service; the U.S. federal tax collection agency.

ITC: investment tax credit; the amount that a business is allowed to deduct from taxes based on the amount it reinvests in itself.

ITC: International Trade Commission; the U.S. federal agency that provides trade expertise to

the legislative and executive branches of the federal government.

kW: kilowatt; a measure of 1,000 watts of electric power.

kWh: kilowatt-hour; a measure of 1,000 watt-hours of energy.

MBR: Market-Based Rate; refers to rate schedules approved by the State Corporation Commission designed to more closely match pricing in the PJM wholesale energy market.

MDV-SEIA: Maryland, Virginia, and DC Solar Energy Industries Association; solar industry trade association for the Maryland, Virginia, and Washington D.C. region.

MW: megawatt; 1,000,000 watts or 1,000 kilowatts of electric power.

MWh: megawatt-hour; 1,000,000 watt-hours or 1,000 kilowatt-hours of energy.

NABCEP: North American Board of Certified Energy Practitioners; provides professional certification and company accreditation programs to renewable energy professionals.

NASDCTEC: National Association for State Directors of Career Technical Education Consortium; an association that advocates for high-quality career technical education programs, which in turn provide students with training and education in applied sciences, trades, and modern technologies.

NREL: National Renewable Energy Laboratory; a federal laboratory focused on research, development, commercialization, and deployment of renewable energy and energy efficiency technologies, located in Colorado.

NVCC: Northern Virginia Community College; a community college system in Northern Virginia with a total enrollment of almost 77,000 students.

ODEC: Old Dominion Electric Cooperative; electric cooperative headquartered in Glen Allen, Virginia, and servicing customers in Virginia, Maryland, and Delaware through eleven partners.

OSHA: Occupational Safety and Health Administration; federal agency that sets and enforces workplace safety standards.

OVAE: Office of Vocational Adult Education; subdivision of the U.S. Department of Education that manages policies and programs related to vocational and adult education, postsecondary education, and college aid.

PBR: Permit by Rule; provides a streamlined DEQ permitting process for small renewable energy projects as defined in the Code of Virginia.

PJM: PJM Interconnection, technically Pennsylvania-New Jersey-Maryland Interconnection; regional transmission organization of energy providers in 13 states, located primarily along the East Coast, and the District of Columbia that oversees the operation of an interconnected electric market across state and utility boundaries.

PLR: Private Letter Ruling; a written statement issued to a taxpayer that interprets and applies tax laws based on the taxpayer's set of facts.

PPA: power purchase agreement; a contract between two parties in which one party generates electricity and the other buys it.

PROMOD: a commercial simulation model designed to simulate an industry-standard electric market for economic planning.

PSS/E: Power System Simulator for Engineering; a commercial simulation model designed to simulate industry-standard transmission systems.

PV: photovoltaic; a photovoltaic system is a power system that converts sunlight into electricity using solar panels.

REC: Renewable Energy Certificate; a tradable energy commodity representing proof that 1 MWh of electricity was generated from a renewable energy source.

REPO: Renewable Energy Program Office; office of the U.S. Navy designed to work with utilities and other parties to reach renewable energy procurement goals.

RF: renewable facility; used in reference to Schedule RF.

RFI: request for information; often used when a party needs written information necessary to confirm the interpretation of details.

RFP: public request for proposals; a document that solicits third party business proposals in order to procure a product or service through the responding proposals.

RG: renewable generation; used in reference to Schedule RG.

RGGI: Regional Greenhouse Gas Initiative; the first mandatory market-based program in the U.S. to reduce greenhouse gas emissions with current membership made up of the following states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

RPS: renewable portfolio standard; regulation that requires the increased production of energy from renewable energy sources.

SEPA: Smart Electric Power Alliance; an organization aimed at helping utilities develop and deploy clean energy resources.

STEM: Science, Engineering, Technology and Mathematics; a set of academic disciplines grouped together by their applied approach, often taught in an interdisciplinary method.

UVA: University of Virginia; a public research university in Charlottesville, Va., with a total enrollment of almost 22,000 students.

VAC: Virginia Administrative Code; state law consisting of the regulations and decisions made by Virginia agencies.

VA SCC: State Corporation Commission of Virginia; the regulatory agency in Virginia that manages and oversees regulations regarding utilities, insurance, state-chartered financial institutions, securities, retail franchising and railroads.

WRI: World Resources Institute; a global research organization dedicated to achieving sustainable resource management.

WWF: World Wildlife Fund; an international organization dedicated to wildlife conservation as well as reducing human impact on the environment.

Endnotes

1 *Virginia Electric and Power Company's Report of Its Integrated Resource Plan,* VA SCC Case No. PUR-2017-00051, filed May 1, 2017, as subsequently corrected in the proceeding.

2 Ibid.

3 Dominion Energy News Release: *Dominion Virginia Power Planning Major Expansion of Large-Scale Solar in Virginia,* Feb. 5, 2015. **http://dominionenergy.mediaroom.com/2015-02-05-Dominion-Virginia-Power-Planning-Major-Expansion-of-Large-Scale-Solar-in-Virginia** accessed Nov. 1, 2017.

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5 *Economic Study of Utility-Administered Solar Programs: Soft Costs, Community Solar, and Tax Normalization Considerations.* Emerson Reiter, Travis Lowder, Shivani Mathur, and Megan Mercer. Produced under the Company's direction by the National Renewable Energy Laboratory Work for Others Agreement. June 2016. **http://solarmarketpathways.org/project/dominion** accessed Nov. 5, 2017.

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7 Navigant Consulting, Inc. *Virginia Solar Pathways Project Study 1: Distributed Solar Generation Integration and Best Practices Review,* April 30, 2016. **http://solarmarketpathways.org/project/dominion** accessed Nov. 5, 2017.

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9 Smart Electric Power Alliance, *Community Shared Solar in Real Life: A Summary of Interviews with Utility Program Administrators at Nine Community Shared Solar Programs and Surveys of Subscribers,* August 2016. **http://solarmarketpathways.org/project/dominion** accessed Nov. 5, 2017.

10 See VA SCC Docket No. PUE-2011-00117 for more details on the Dominion Energy Virginia's Solar Partnership Program.

11 2014 numbers reflect data current as of Dec. 31, 2014. Current numbers reflect data as of Sept. 30, 2017, except that total current kWh reflect annual kWh produced as of Dec. 31, 2016. The kWh figures exclude energy production from net metering which is not tracked by the Company.

12 Dominion Energy News Release: *Dominion Virginia Power Planning Major Expansion of Large-Scale Solar in Virginia,* Feb. 5, 2015. **http://dominionenergy.mediaroom.com/2015-02-05-Dominion-Virginia-Power-Planning-Major-Expansion-of-Large-Scale-Solar-in-Virginia** accessed Nov. 1, 2017.

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14 **http://buyersprinciples.org/principles/** accessed Nov. 2, 2017.

15 World Resources Institute, Emerging Green Tariffs in U.S. Regulated Electricity Markets, Updated May 2017, **http://www.wri.org/sites/default/files/Emerging_Green_Tariffs_in_US_Reg_Elec_Markets_May_2017_0.pdf** accessed Aug. 31, 2017.

16 *Application of Virginia Electric and Power Company for approval to establish a companion tariff, designated Schedule RG pursuant to § 56-234 of the Code of Virginia,* Case No. PUR-2017-00163, Dec. 1, 2017.

17 Renewable Energy Pilot Program established under the 2013 Virginia Acts of Assembly—Chapter 382. **https://www.scc.virginia.gov/pur/pilot.aspx** accessed Nov. 5, 2017.

18 VA SCC Docket No. PUR-2017-00060.

19 VA SCC Docket No. PUR-2017-00157.

20 *Application of Virginia Electric and Power Company for approval to establish a companion tariff, designated Schedule RG pursuant to § 56-234 of the Code of Virginia,* Case No. PUR-2017-00163, Dec. 1, 2017.

21 VA SCC Docket No. PUR-2017-00137.

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23 *Virginia Electric and Power Company's Report of Its Integrated Resource Plan,* VA SCC Case No. PUR-2017-00051, filed May 1, 2017, as subsequently corrected in the proceeding.

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35 See Endnotes 7 and 8.

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