Dominion Energy®

Grid Transformation Plan

Table of Contents

List of Acronyms

Acronym	Meaning
AC	Alternating current
ACE	Analytics center of excellence
ADMS	Advanced distribution management system
AMI	Advanced metering infrastructure
AMR	Automated meter reading
APT	Advanced persistent threat
AWA	Agency web access
CBA	Cost-benefit analysis
C&I	Commercial and industrial
CCRO	Customer credit reinvestment offset
CI	Customer interruptions
CIP	Customer information platform
CIS	Customer information system
CMD	Connect My Data
CMI	Customer minutes of interruption
COBOL	Common business-oriented language
DAS	Data analytics system
DC	Direct current
DCFC	Direct current fast charging

Acronym	Meaning
DER	Distributed energy resources
DERMS	Distributed energy resource management system
DMD	Download My Data
DSM	Demand-side management
EAMS	Enterprise asset management system
EEI	Edison Electric Institute
EIA	Energy Information Administration
EPRI	Electric Power Research Institute
EM&V	Evaluation, measurement, and verification
EV	Electric vehicle
FAN	Field area network
FLISR	Fault location, isolation and service restoration
GIS	Geographic information system
GT Plan	Grid Transformation Plan
GTSA	Grid Transformation and Security Act of 2018
HID	High intensity discharge
ICE	Interruption Cost Estimate
IDP	Integrated distribution planning
IGDs	Intelligent grid devices

Acronym	Meaning
IOCs	Indicators of compromise
IT	Information technology
KPIs	Key performance indicators
kV	Kilovolt
LED	Light-emitting diode
MDMS	Meter data management system
MPLS	Multi-protocol label switching
NERC	North American Electric Reliability Corporation
NIC	Network interface card
NPV	Net present value
NREL	National Renewable Energy Laboratory
NWA	Non-wires alternatives
O&M	Operations and maintenance
OACS	Operations and Automated Control Systems
OMS	Outage Management System
OT	Operational technology
Phase IA	Grid transformation projects for 2019, 2020, and 2021 approved in Case No. PUR-2018-00100
Phase IB	Grid transformation projects for 2019, 2020, and 2021 proposed in this proceeding

Acronym	Meaning
PII	Personal-identifying information
PTR	Peak-time rebate
QoS	Quality of Service
RAC	Rate adjustment clause
RFP	Request for proposals
ROW	Right-of-way
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SCADA	Supervisory Control and Data Acquisition
SLAs	Service level agreements
SLMS	Streetlight management system
STATCOMs	Static compensators
SUP	Strategic Undergrounding Program
TB	Terabyte
Va. Code	Code of Virginia
VEE	Validation / estimation / editing
TB	Terabyte
Va. Code	Code of Virginia
VEE	Validation / estimation / editing


KING STREET
OYSTER BAR
The Other Kind Of
Jewelry Store
AHT
SIDE BAR

I. Introduction

Fundamental changes in the energy industry have prompted the need for utilities across the country to modernize their distribution grids. The 2018 Virginia Energy Plan recognizes these needs and drivers:

> The energy industry is a vital economic driver that serves as the foundation for the Commonwealth's ability to grow and thrive. Homes and businesses rely upon stable, reliable, and affordable energy systems. At the same time, there are a number of market and policy shifts that are transforming the industry in ways that cannot and should not be ignored. These include technological advances that are unlocking new opportunities in both the electricity and transportation sectors, customer preferences that are driving the expansion of new business models, a shift toward a reduction in carbon emissions, and a growing focus on the reliability and resiliency of our electric system.[1]

With the passage of the Grid Transformation and Security Act of 2018 ("GTSA"), the Commonwealth declared electric distribution grid transformation to be in the public interest, and mandated that utilities file a plan for grid transformation. The GTSA required that any such plan "shall include both measures to facilitate integration of distributed energy resources and measures to enhance physical electric distribution grid reliability and security."

Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company") fully endorses the need for transformation and fully supports these policy objectives of the Commonwealth. These policy objectives align with the four goals for grid transformation identified by a group of the Company's stakeholders:

Optionality: Enable all customers with accessible, affordable electric service and engage customers with programs, education, and data access.

Sustainability: Evolve to a clean and decentralized grid that integrates distributed energy resources, such as solar and wind, and electric vehicles.

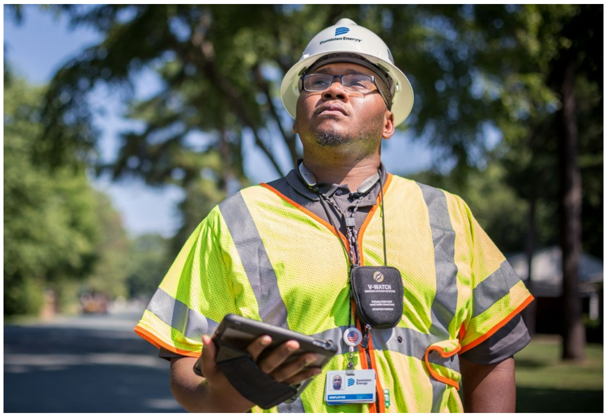
Resiliency: Build a more resilient energy grid that will reduce the effects of outages with automation and advanced asset management.

Affordability: Deliver value for customers by optimizing demand and seeking to reduce system and customer costs.

This document presents the Company's plan to transform its distribution grid ("Grid Transformation Plan," "GT Plan," or "Plan").

[1] VIRGINIA ENERGY PLAN (Oct. 2018), available at https://www.governor.virginia.gov/media/governorvirginiagov/secretary-of-commerce-and-trade/2018-Virginia-Energy-Plan.pdf [hereinafter VIRGINIA ENERGY PLAN].

II. Need for a Modern Distribution Grid



Electricity has become a basic need, vital to our economy, public safety and way of life. Critical services and infrastructure increasingly rely on electricity, including homeland security, large medical facilities, public safety agencies, state and local governments, telecommunications, transportation, and water treatment and pump facilities. As society has grown more dependent on electricity, customers expect highly reliable service as well as easy access to their energy usage information so that they can make informed decisions about their consumption. Another fundamental change is the emerging shift within the transportation industry as it continues toward electrification of personal vehicles, fleets, and mass transit, with the Edison Electric Institute ("EEI") projecting the number of electric vehicles ("EVs") to reach approximately 18.7 million in 2030, up from approximately 1 million EVs on the road at the end of 2018. Another vital resource powered by electricity is the internet, which drives commerce and everyday life. Even a brief interruption or power quality anomaly at, for example, a data center can be catastrophic for both the data center itself and the businesses that rely on that data center. While service interruptions have always been an inconvenience, the safe, reliable, and consistent delivery of power has never been more important than it is today.

Customers agree on the importance of reliable electric service and ensuring a quick recovery when outages do occur. In a recent survey of Dominion Energy Virginia customers, customers expressed that experiencing power outages is their primary source of frustration with the Company. Similarly, a survey of social media activity shows over nine times the comment volume appearing on major outage days.

A. Context for Distribution Grid Transformation

The electric grid was originally designed for the one-way flow of electricity, with electricity moving from large, centralized generators through high-voltage transmission lines to the distribution system. On the distribution system, electricity flowed from the substation to the customer. While originally limited to cities, the electric power grid eventually reached even the most remote areas of the country as a result of the incentives provided in the Rural Electrification Act of 1936 for the installation of distribution systems in isolated rural areas of the United States.

As reliance on electricity grew, focus shifted to the transmission system as vital to reliability of the electric grid as designed (i.e., the one-way flow of electricity). The Northeast Blackout of 2003 drove new standards and investments into the transmission grid. NERC became the national electric reliability organization responsible for the reliability of the transmission system, and instituted mandatory minimum standards to which transmission owners had to plan.

In the current day, focus has now shifted to distributed energy resources ("DERs"), such as solar and wind. DERs are resources connected to the distribution system, many of which are generation resources using renewable energy, such as solar photovoltaic ("PV") and wind generation. According to the Energy Information Administration ("EIA"), the nationwide growth of clean DERs from 2009 through 2017 has been approximately 23%[2]. The

[2] Edison Electric Institute, Report: ELECTRIC VEHICLE SALES FORECAST AND THE CHARGING INFRASTRUCTURE REQUIRED THROUGH 2030 (Nov. 2018), available at http://www.edisonfoundation.net/iei/publications/Documents/IEI_EEI%20EV%20Forecast%20Report_Nov2018.pdf.

Company has experienced an approximately 43% DER growth rate on its system during that same timeframe, mostly in the form of solar PV.

The rise of DERs requires a fundamental change to the electric grid. With DERs, electricity is now flowing onto the distribution system from multiple points. The distribution system that was designed for the one-way flow of electricity must now accommodate the two-way flow of electricity. In addition, the intermittent nature of some of these resources resulting from weather variability creates power fluctuations not typical of traditional generation resources. Propagated in an arbitrary manner, DERs are independent nodes that can disrupt traditional grid power quality and reliability. But when paired with investments to increase visibility on and control of the distribution system, DERs can transform into a system resource that can be equitably managed to maximize the value of other available resources, and potentially offset the need for future "traditional" generating assets or grid upgrades, and maintain reliable service to customers. As the Electric Power Research Institute ("EPRI") has outlined, the distribution grid benefits DER through (i) reliability; (ii) startup power; (iii) voltage quality; (iv) efficiency; and (v) energy transaction.[3]

In addition, because DERs rely on the distribution system to deliver the electricity they produce, a resilient distribution system is vital to maximizing the value of DERs. Day to day outages as well as major weather events not only cause prolonged outages for customers, but also prevent DERs from delivering electricity. The distribution system must be reliable and resilient so that it can operate for DERs like the transmission system operates for large, centralized generators.

Aside from DERs, and as the Commonwealth has recognized, "there are a number of market and policy shifts that are transforming the industry in ways that cannot and should not be ignored."[4] These shifts include "technological advances that are unlocking new opportunities in both the electricity and transportation sectors, customer preferences that are driving the expansion of new business models, a shift toward a reduction in carbon emissions, and a growing focus on the reliability and resiliency of our electric system."[5] And throughout, severe weather events continue as a reality in the mid-Atlantic, with two storms from 2016 and two storms from 2018 ranking among those most affecting customers over the past twenty years. Peer utilities have demonstrated the value of resiliency investments in response to such events, enabling timely restoration and economic recovery when damage does occur.

These foundational shifts prompt the need to transform the distribution grid, as utilities across the country have recognized. GridWise Alliance recognized as much in the preparation of its Grid Modernization Index 2018:

> Concepts that we discussed back in 2003 as long-term goals are now a reality in many parts of the country. Customers have access to data and tools that allow them to manage their energy use and cost while supporting more effective grid operations. Power is typically restored to customers much more quickly after an outage occurs thanks to faster and more accurate data, along with [grid] equipment that automatically responds to these interruptions. Customers are increasingly choosing to install their own energy systems and connect them to the grid and grid operators are modifying their own systems to accommodate these distributed resources, creating a more flexible and resilient grid.[6]

GridWise ranked Virginia as a "beginner" in its grid modernization efforts—25th among states and the District of Columbia based upon progress in modernizing the state's electric grid—noting many "leaders," "movers," and "believers" that can inform the effort as the Commonwealth moves to transform the electric distribution grid.[7]

[3] American Public Power Association, THE VALUE OF THE GRID (Jul. 2018), available at https://www.publicpower.org/system/files/documents/Value%20of%20the%20Grid_1.pdf.

[4] VIRGINIA ENERGY PLAN. [5] VIRGINIA ENERGY PLAN.

[6] GridWise Alliance, GRID MODERNIZATION INDEX 2018: KEY INDICATORS FOR A CHANGING ELECTRIC GRID, available at https://www.gridwise.org/resource-downloads/GWA_18_GMI-2018_FinalReport_12_17_18.pdf [hereinafter GRID MODERNIZATION INDEX 2018].

[7] GRID MODERNIZATION INDEX 2018.

B. Value of a Transformed Distribution Grid to Customers

Foundational investments to transform the distribution grid will allow the Company to use the distribution system differently than it does today, all for the benefit of customers. Transformational investments in advanced metering infrastructure ("AMI"), customer information platform ("CIP"), intelligent grid devices, automated control systems, and Advanced Analytics will enable the Company to improve operations (e.g., reducing truck rolls, more predictive and efficient maintenance, and increased visibility to help reduce outages and down time), better forecast load shape, and predict future behaviors (e.g., identifying and fixing grid problems before an outage occurs and overall savings and cost management of DSM programs), resulting in a better, more informed customer experience. This value of a transformed distribution grid can be seen from the view of different types of customers.

Today, all customers must take specific action to report outages and then wait for the Company to deploy resources to bring the power back on. With transformational investments in AMI, CIP, intelligent grid devices, automated control systems, and resilience, customers will experience fewer outages and will not need to take action to report outages when they do occur. Instead, when outages do occur on the more connected and resilient grid, the outages reported through smart meters and other intelligent grid devices will prompt the dynamic system to automatically restore power to as many customers as possible, narrowing the scope of the outage and focusing effort on issues that require manual intervention. Additionally, grid visibility provided by the transformed grid will allow customers to receive proactive outage and restoration alerts—and more accurate information on expected restoration times, including detailed outage maps—allowing the fewer customers that are impacted to better adapt to the situation. By targeting over 1,000 miles of mainfeeders for hardening over the full 10 years of the GT Plan, Dominion Energy Virginia's distribution system and the customers it serves will experience fewer customer interruptions and outage minutes each year, as discussed in detail in Section VI.A.3 below.

Today, most residential customers receive monthly energy usage data at a summary level through their bills. With transformational investments in AMI and the CIP, all residential customers can receive detailed interval energy usage data through convenient communication channels. The corresponding education will inform customers on how to take control of and manage their energy usage, if desired. These customers will also have the opportunity to participate in time-varying rates and innovative demand-side management ("DSM") programs that these investments will enable the Company to broadly offer. Such rate options and DSM programs can prompt behavioral changes that benefit customers through bill savings and reduced system costs.

Today, multi-family complex customers (e.g., apartment complexes) have meters that limit the efficiency of the move-in / move-out process, a process that happens more frequently than for single-family homes. With transformational investments in AMI and the CIP, customers can change accounts the same day, leading to more efficient relocation, easier owner / tenant billing, and lower costs.

Today, DER net metering customers must engage in a largely manual application process, and then wait for a meter exchange. The meter exchange process alone can take up to 10 business days to schedule and complete, leading to potential interconnection delays for the customer. With transformational investments in AMI, CIP, intelligent grid devices, automated control systems, and resilience, DER customers will experience a much faster and seamless interconnection process, will no longer need a meter exchange, and will receive detailed information on how their DERs interact with the grid. Further, customers will maximize the value of their DERs through the connection with a resilient grid, and can choose to offer grid support functions for the local distribution grid as an alternative to traditional grid upgrades. In addition, transformational grid investments will enable a dynamic hosting capacity map, allowing customers, and even localities, to evaluate optimal locations to interconnect DERs. By empowering customers with the information to optimally locate DER, customers can realize reduced interconnection costs and potentially contribute to the deferral of other system investments.

Today, the majority of EV customers do not have attractive options to encourage them to charge their vehicles during times when the demand for electricity is low. With transformational investments in AMI, CIP, and smart charging infrastructure, EV customers will have access to more innovative programs and advanced rate options that could lead to bill savings and reduced system costs.

Today, business customers are subject to sudden voltage fluctuations when outage events occur on the distribution grid. Even when a customer does not experience a sustained outage, these voltage fluctuations have the potential to impact operational processes and facility production. The intermittency and changing power flows related to renewable generation introduce new dynamics to grid operation that, if not managed properly, have the potential to similarly impact these customers. Transformational investments in reliability and resiliency will eliminate certain outage events and the associated voltage fluctuations that ripple across the distribution grid, while also ensuring power is restored more quickly when it does go out. With transformational investments in AMI, intelligent grid devices, and automated control systems, the Company will have the situational awareness and control capabilities to manage grid operation so business customers can rely on voltage stability to ensure minimal disruption to their operations.

Today, vital community resources are more dependent on grid reliability than ever before. Health and safety services, such as hospitals, water, and emergency services, carry the highest priority day-to-day and in a restoration event, closely followed by commerce and education, including internet services for home and work. More and more grid availability translates to availability for DER to contribute to system resources in the form of capacity factor. With transformation investments in resilient grid architecture, customers will have confidence that their growing reliance will be served.

Dominion Energy Virginia values the experience of its customers and believes that the Grid Transformation Plan will enable the Company to meet their changing needs and expectations.

III. Existing Distribution Grid

As discussed in Section II.A, the electric grid was originally designed for one-way flow of electricity to meet customers' demand—from the generator, through the transmission system, to the distribution system and the end-use customer. In the traditional distribution system design, electricity typically flows from a substation, through mainfeeders, to tap lines and then service lines that are connected to the end-use customer.

Dominion Energy Virginia's over 2.5 million customer accounts in the Commonwealth power the business economy and serve over 5 million residents. The Company's existing distribution system in Virginia consists of more than 53,000 miles of overhead and underground cable, and over 400 substations. The distribution system utilizes a variety of devices for functions from voltage control to power flow management, and relies on multiple operating systems for various functions from customer billing to outage management. The following sections provide a detailed description of the Company's existing distribution system.

A. Substations

The primary function of a distribution substation is to transfer power from the higher voltage transmission system, which ranges from 69 kilovolt ("kV") to 230 kV on the Company's system, to the lower voltage distribution system, which typically ranges from 4 kV to 35 kV. Once this power is "stepped down," it is placed on the distribution system for delivery to the end use customer.

There are many pieces of equipment and devices that help to facilitate this transfer of power, including the following:

Substation Transformers. Equipment that handles the stepping down of higher voltages to lower voltages.

Substation circuit breakers. Devices that enable the flow of power into and out of the substation and serve to isolate faults.

Voltage regulation devices. Devices that help keep voltage within the desired bandwidth.

B. Wires

Within the distribution system, the wires—also known as conductors—transmit electricity from substations to end-use customers. A system of conductors is referred to as either a circuit or a feeder. The Company will use the term "feeder" in this document. The Company operates approximately 1,700 feeders in Virginia. There are three parts to feeders, the mainfeeders, the tap lines, and the service lines. Figure 1 provides an illustration.

1. Mainfeeders

Mainfeeders are the three-phase portion of the distribution system that carries electricity from substations to tap lines and end-use customers. Larger customers, such as certain businesses and public services, are often served directly from the mainfeeders. Mainfeeders on the Company's distribution system typically serve hundreds or thousands of customers along many miles of conductor. The Company's distribution system in its Virginia service territory has approximately 10,000 miles of overhead mainfeeders and 1,800 miles of underground mainfeeders on its approximately 1,700 feeders.

2. Tap Lines

Tap lines are the portion of the distribution system that carry electricity from the mainfeeders to neighborhoods and individual end-use customers. The Company's distribution system in its Virginia service territory includes approximately 18,000 miles of overhead tap lines and approximately 22,000 miles of underground tap lines.

Separate from, but complementary to, its plan to transform the distribution grid is the Company's Strategic Undergrounding Program ("SUP"). This program focuses on undergrounding tap lines to decrease downed wires and work repair locations, enabling crew redeployment to other outage locations and allowing a faster recovery after severe weather events. In contrast, the focus of the grid transformation efforts is the mainfeeder portion of the distribution system.

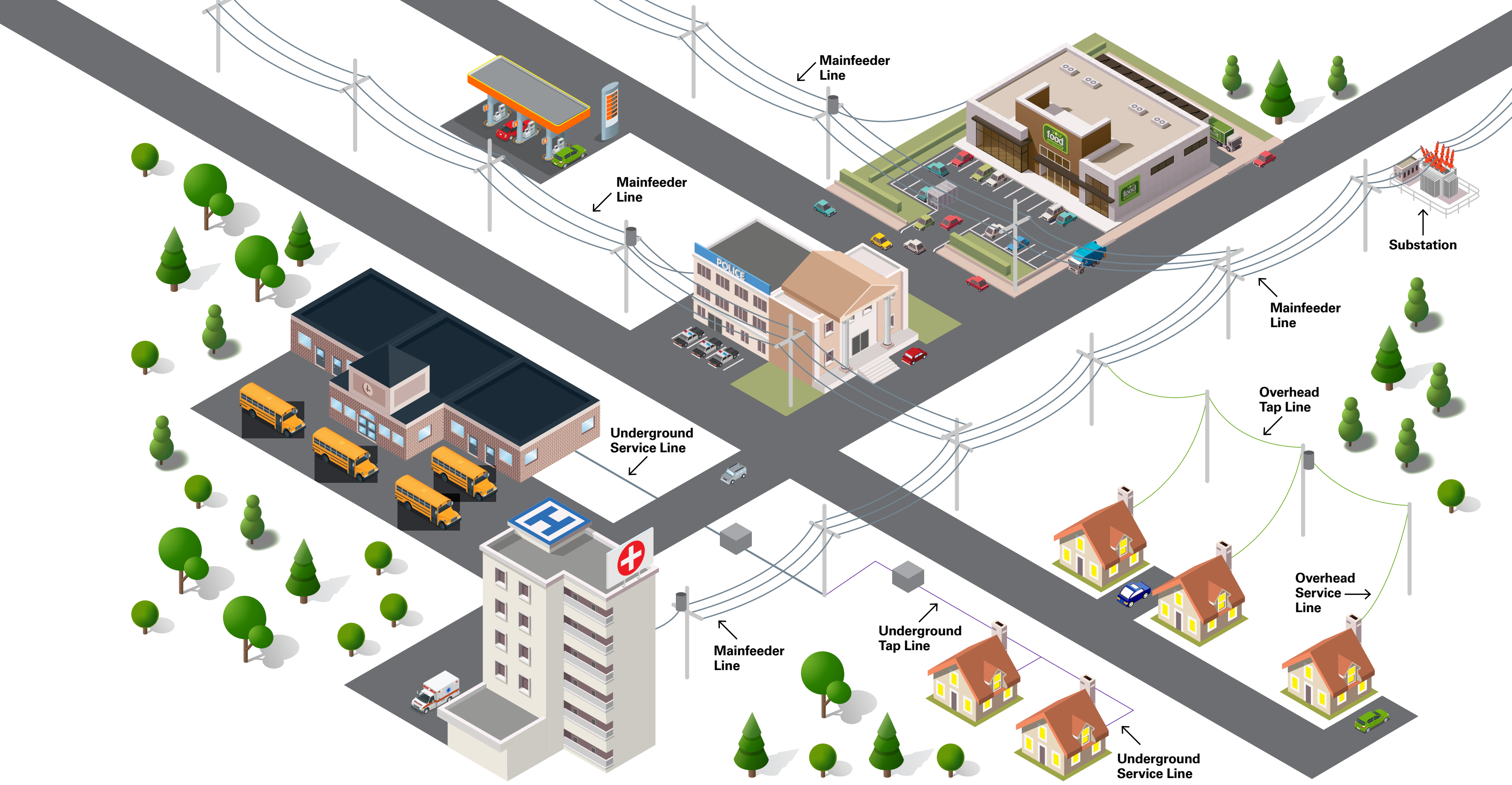


Figure 1: Distribution System Illustration

3. Service Lines

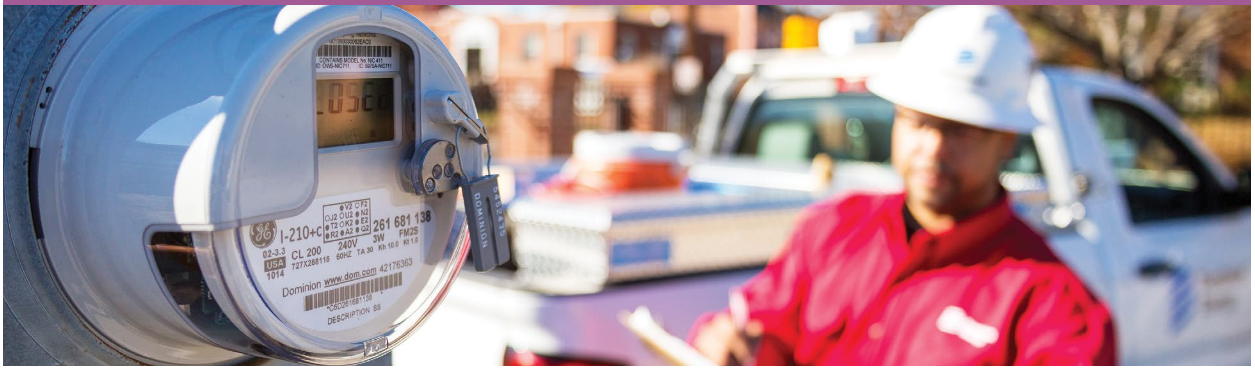
Service lines are the low voltage portion of the distribution grid that carries electricity from service transformers to customers. For residential customers, these lines typically operate at 120/240V while commercial and industrial customers may have service lines that deliver a variety of voltages, including 120/208V, 120/240V, and 277/480V. Service lines typically connect to the service transformer on one end and the meter on the other end. In some instances, one service line can be used to serve multiple customers by connecting additional service lines to it along the route from the transformer to the meter.

C. Devices

Voltage Control Devices. Voltage control devices are used to manage grid voltage to ensure customers receive adequate voltage at the meter. The most common voltage control devices on the distribution grid are voltage regulators and capacitors. Voltage regulators monitor and adjust the voltage at the substation or along the feeder based on control programming that is loaded by Company engineers. The programming typically uses loading and specific electrical information based on the location of the equipment. Capacitors are used to manage power flow efficiency on the distribution grid. As customers use electricity, the equipment along the grid that delivers the power, such as transformers and conductors, consume additional electricity and cause electrical losses to occur, causing voltage to decrease. Capacitors are used to provide a portion of that additional electricity and reduce the losses, which in turn improves voltage.

Service Transformers. Service transformers connect to the grid and serve to lower the voltage from distribution voltages used on the mainfeeders and tap lines, typically 4 kV to 35 kV, to the service voltage used by customers. For residential customers, the most common service voltage is 120/240 volt ("V"), meaning appliances and devices using electricity can be connected to either a 120V or a 240V outlet from customers' electrical panels. Commercial and industrial service transformers deliver a variety of service voltages, including 120/208V, 120/240V, and 277/480V. The Company has approximately 540,000 service transformers in Virginia.

Protective Devices. Protection devices perform several different functions on the distribution grid, including monitoring power flows and voltages, providing switching points to reconfigure power flows, automatically disconnecting a grid segment when a problem is detected, and providing the associated communications functions to allow protection activities to occur. Electronically controlled line devices, fuses, line sensors, relays and communications gateways are examples of protection devices.



D. Meters

Dominion Energy Virginia customers primarily have one of three types of meters: automated meter reading ("AMR") meters, smart (i.e., AMI) meters, or manually read meters. As of July 1, 2019, approximately 78% of Virginia customer meters are AMR meters, approximately 17% are smart meters, and approximately 5% are manually read meters.

AMR Meters. The Company began deploying AMR meters throughout the service territory over 20 years ago. Usage data from AMR meters is collected through drive-by readings. Specially equipped trucks drive throughout the service territory daily, covering approximately 450 different meter route cycles throughout each month. The Company uses meter readers to drive these routes. The equipment collects a meter reading from the AMR meters within range, which the Company then uses for monthly billing. AMR meters cannot be remotely controlled or operated, meaning that the Company must send a field representative for common requests like connecting or disconnecting service. The Company utilizes meter servicers to execute these and other requests.

Smart Meters. Smart meters are electric meters that enable two-way communications, digitally gathering energy usage data in specified increments (i.e., interval data) and other related information. Smart meters are equipped with a network interface card ("NIC") and communicate with each other, creating what is referred to as a mesh network. A system of field telecommunications devices—comprised of devices called repeaters and collectors—gathers meter data from the mesh network and transmits the data gathered back to the utility through a backhaul network. Together, the mesh and backhaul networks are called the field area network. A back office system, also called a head-end system, receives and processes the data and serves as an operating platform for the back office team responsible for operation and maintenance. The term AMI, or "advanced metering infrastructure," refers to the over-arching metering system, which includes smart meters, a field area network, and a back office system.

In 2008, the Company began to deploy AMI in a targeted fashion based on specific operational and customer needs. Taking a measured pace over the course of several years, the Company continued to deploy smart meters in larger quantities and densities in diverse geographical areas of the service territory to validate deployment and operational strategies. The Company used the knowledge gained from this initial deployment of AMI to develop its strategy for full deployment across the service territory. The Company currently has approximately 435,000 smart meters deployed across its service territory, primarily in the Alexandria, Herndon, and Charlottesville offices.

Manually Read Meters. As of July 1, 2019, approximately 130,000 customers have manually read meters, primarily to gather energy usage data in specified increments (i.e., interval data) or monthly peak energy demand. To obtain this data, meter readers visit the customer premises and must walk up to the meter to record energy usage via an electronic "probe" approximately once per month. The meter readers that drive the AMR routes also complete these visits. The Company has deployed manually read meters to support offering time-varying rates to customers that do not have smart meters. The Company has also deployed manually read meters to provide additional information to net metering customers that do not have smart meters. Eliminating these manual meter reads with the implementation of AMI will not only provide operational benefits through reduced components of cost of service, but will also enable the Company to provide detailed energy usage data to customers and to more widely deploy time-varying rates in an efficient and cost effective manner.

E. Operating Systems

1. Customer Experience Systems

Customer Information System ("CIS"). Deployed about 23 years ago, the CIS is the core system delivering business functions such as customer service, account management, credit and collections, service orders, meter inventory, usage, billing, service address management, portfolio management, and rates and financial based activities. The CIS is an employee-facing system, and is also referred to internally as customer business management system ("CBMS").

CBMS is built on a mainframe platform using the programming language COBOL. Users use what is referred to as a "green screen" to view information. The system lacks a logical workflow, requiring users to memorize a series of four letter commands to navigate through screens. The system is not Windows based; nor is it compatible with using a mouse or cursor for simple navigation. The vendor no longer supports the system, and service providers do not routinely hire or train COBOL programmers. The limited services that are available for CBMS come at an increasingly higher cost.

Manage Accounts. Deployed in 2003, Manage Accounts is the customer-facing web self-service platform for residential and small commercial customers.

Key Customer. Deployed in 2006, Key Customer is the customer-facing web self-service system for large customers that are assigned an account representative.

Property Manager Portal. Deployed in 2013, the Property Manager Portal is the customer-facing web self-service tool for property management companies to manage landlord agreements and turn on / turn off service for their properties.

Agency Web Access ("AWA"). Deployed in 2006, Agency Web Access is the customer-facing web self-service application for charities and third-party agencies (e.g., Salvation Army) to make energy assistance payments on behalf of customers.

Meter Data Management System ("MDMS"). Deployed in 2009, the meter data management system is the employee-facing system that processes and stores interval data used for billing and calculates billable consumption for interval meter data.

Gateway. Deployed in 2013, Gateway is the employee-facing web-based front end system to CBMS and other systems used in the contact center. Gateway is the primary tool for customer service representatives to interact with customers.

Knowledge. Deployed in 2016, Knowledge is the employee-facing system that allows for systematically capturing, describing, organizing, and sharing information including alerts, work processes, and policies across customer service.

E-Gain. Deployed in 2010, E-Gain is the employee-facing system that imports and sorts emails and work tickets, creating a queue for response. E-Gain includes auto replies and templates for responses.

LanBill. Deployed in 1996, LanBill is the employee-facing system that allows back office personnel to manually edit and print bills flagged for special handling. LanBill is used to process large complex bills that are not fully automated in CBMS.

Bill Image. Deployed in 2003, Bill Image is the employee-facing software used to render an image of the bill on demand in Manage Account and Gateway.

Agiloft. Deployed in 2011, Agiloft is the employee-facing record keeping system used to track elevated customer issues and inquiries.

2. Grid Operation Systems

AMI and AMR head-end systems. The system that receives and processes the data and serves as an operating platform for the back office team responsible for operating and maintaining AMI and AMR, respectively.

Advanced distribution management system ("ADMS"). A software platform that supports a full range of distribution management and optimization tools, such as supervisory control and data acquisition ("SCADA"), fault location, isolation and service restoration ("FLISR"), voltage optimization, and distributed energy resource management ("DERMS"). The Company implemented the first phase of ADMS in 2019, which provides the basic data acquisition and control functionality.

Outage management system ("OMS"). A system that provides tools and information to efficiently restore power to customers by providing outage analysis and prediction functionality. The system enhances public and worker safety, and serves as the Company's system of record for outage history. The existing OMS was deployed in 1994. It does not have the capability to maintain a dynamic hierarchy of how each customer is being served based on the configuration of the feeder ties at any point in time.

Data Analytics System ("DAS"). A system that stores and quickly processes large amounts of data to create Advanced Analytics solutions. The existing DAS was deployed in 2017. It does not have the capability to process the amount of data that the Company will obtain from full deployment of smart meters and other intelligent grid devices.

F. Telecommunications

Dominion Energy Virginia currently has a telecommunications ("telecom") transport portfolio that consist of Company-owned fiber, leased lines, copper cables, and public carrier solutions. Approximately 6% of the distribution substations have fiber, approximately 40% use leased circuits, and approximately 10% use copper cables. The remaining approximately 44% of substation have no communications.

G. Security

The existing distribution system is protected by a comprehensive security program designed to provide adequate and cost-effective security control measures that manage the growing threat to the energy sector and that protect the Company and its customers from cyber and physical attacks. The Company's security program has been subjected to multiple third-party vulnerability assessments and penetration tests (announced and unannounced); peer reviews; and numerous internal and external audits. Results from those engagements have informed continuous improvements to both cyber and physical security.

H. Electric Vehicle Infrastructure

Electric vehicles ("EVs") are typically charged by plugging the EV into a charger that is connected to the electric grid. There are three major categories of chargers that are distinguishable by the amount of power the charger can provide, which results in different speeds of charging:

- Level 1 refers to use of a standard 120-volt ("V") outlet, which charges three to five miles of range per hour. Level 1 charging is ideal for overnight charging for EV owners that travel about 30 miles or fewer per day.

- Level 2 chargers require a higher voltage at 240V, which charges 10 to 20 miles of range per hour. Level 2 charging is ideal for workplaces, multi-family dwellings, and locations with the potential for more electric vehicles than chargers.

- Level 3—also known as direct current fast charging ("DC Fast Charge" or "DCFC")—can charge an EV battery to approximately 80% of capacity in 20 to 30 minutes. DCFC requires three-phase electric service and significant capacity. It is ideal for public locations to support travel over long distances.

As of August 15, 2019, there were approximately 595 Level 2 (i.e., 240 volt) and direct current fast charging ("DCFC") charging stations in Virginia available for public use. However, not all of these stations are available to all EV drivers, and some are only available during limited hours.

IV. Distribution Grid Planning

The fundamental changes in the energy industry discussed in Section I drive not only the need to transform the distribution grid, but also to transform how distribution grid planning occurs. Appendix B provides a detailed overview of the Company's current distribution planning process, the limitations of the current process, and the integrated distribution planning ("IDP") process that the Company plans to implement going forward (the "IDP White Paper"). The IDP White Paper also details how the proposed Grid Transformation Plan investments are foundational to enabling true integrated distribution planning. This section provides an overview of the IDP White Paper.

A. Current Distribution Planning Process

The Company's current distribution planning occurs through three separate processes: (i) distribution capacity planning, (ii) distribution reliability planning, and (iii) DER interconnection.

The purpose of distribution capacity planning is to evaluate grid utilization during seasonal peak loading conditions based on projected load growth, identifying any necessary improvements to the distribution system needed to satisfy thermal and voltage criteria as the demands placed on the distribution infrastructure change over time. Generally, load growth forecasting is not location specific beyond information regarding block load additions that are known in the short term. There are no inputs related to customer-level usage patterns or DER and emerging technology penetration growth included in this current forecasting process. Traditional static planning focuses on the system's summer and winter peak conditions, studying the traditional "worst case scenarios." Based on this focus, the current load growth forecasting utilizes only peak customer usage and removes DER to ensure the grid will remain reliable under these conditions.

The purpose of distribution reliability planning is to identify causes of service interruptions and risks to the grid, and to develop cost-effective and prudent solutions to improve overall grid performance and customer experience. Reliability planning is based on data analytics of service outage information.

The DER interconnection process identifies the impact to the grid of interconnecting DER. Which interconnection process DER customers must follow depends upon (i) whether the DER customer opts to sell its output wholesale to PJM Interconnection, LLC ("PJM") or to the Company; and (ii) whether the DER customer elects to interconnect directly to distribution infrastructure as a small electrical generator or behind the customer's meter via net energy metering.

Current distribution planning methodologies and processes were designed for a distribution grid in a world of centralized large-scale generation and a one-way power flow. In the evolving paradigm where DERs and other emerging technologies are increasing on the distribution grid causing two-way power flows, the Company's distribution planning process must also evolve.

B. Future Integrated Distribution Planning

The Company defines integrated distribution planning as a process to address capacity, reliability, and DER integration, accounting for uncertainties introduced by factors such as increasing DER penetration, changing usage patterns, and increasing use of new technologies such as high energy electric vehicle charging infrastructure. True IDP requires people, technologies, and processes. Throughout, trained professionals are vital to fully leverage the technologies and optimize the processes and emerging tool sets. Technologies and communications that provide visibility into the grid to the customer premises level are foundational to enable integrated distribution planning. The processes and tools must then be developed that incorporate the data gathered by the foundational technologies, including advanced distribution modeling and analysis tools that consider a range of possible futures where varying levels of DER and emerging technologies are adopted on the distribution system.

Achieving true integrated distribution planning requires both a thorough understanding of how the grid is performing in all respects, and tools that can process information from the grid and inform or take actions. This is only possible with a full implementation of the equipment and systems that are proposed in the Company's Grid Transformation Plan. Namely, AMI; intelligent grid devices and operations and control systems; a robust and secure telecommunications network; and Advanced Analytics tools are all required to perform integrated distribution planning. Without a full deployment of the devices and systems that the Company is proposing in its Grid Transformation Plan to achieve situational awareness and control capabilities, true integrated distribution planning is not possible.

These proposed investments will enable a deep examination of the current distributed pathways and a detailed analysis of feeder segments for long-term planning purposes. With this baseline view, the Company can encourage DER in a manner that supports customer demands, improves grid reliability and resiliency, and ensures reasonable costs. This process will ultimately allow the Company to utilize DER in its generation planning.

The Company plans to implement an IDP process that will evolve the current planning processes to adapt to the increasing proliferation of customer-owned DERs and other changes relevant to the modern grid. The IDP White Paper, attached as Appendix B, describes the Company's proposed evolution of integrated distribution planning over time as enabling technologies are deployed.

V. Development of Grid Transformation Plan

The Company has engaged in an iterative process to develop the Grid Transformation Plan presented in this document. Guided by the policy objectives of the Commonwealth to facilitate the integration of DER and enhance distribution grid reliability and security, the Company incorporated its experience-based knowledge with input from customers and stakeholders; with lessons from the experiences of peer utilities; and with guidance provided by the State Corporation Commission of Virginia ("Commission") in prior orders.

A. Internal Process

The Company consistently tracks developments in the energy industry and challenges for its distribution system. As shown in the Grid Modernization Index 2018, GridWise Alliance ranked Virginia as 25th among states and the District of Columbia based upon progress in modernizing the state's electric grid, noting many "leaders," "movers," and "believers" that the Company could learn from as the Commonwealth moves to transform the electric distribution grid. The Company has talked to its peer utilities and has learned from their experiences. The Company has kept current with information published by various industry groups, and has engaged with these industry groups to gain additional knowledge and perspective. The Company also engaged an industry expert, West Monroe Partners, as a knowledgeable partner in the development of a plan to modernize the distribution grid. Additionally, the Company has tested certain components of the GT Plan on a smaller scale, such as AMI. All of this knowledge coalesced to create the framework for the Grid Transformation Plan.

B. Customer Engagement

Dominion Energy Virginia strives to meet its customers' energy needs while providing a seamless customer experience. To that end, the Company frequently seeks feedback from its customers in various forms and forums. The Company has also sought specific feedback to assist in the development of the Grid Transformation Plan. The Company intends to continue this customer engagement to assess the priorities included in the GT Plan.

1. Ongoing Feedback

Dominion Energy Virginia receives customer feedback on a daily basis. The Company strives not only to quickly and justly resolve any customer issue, but also to identify trends and possible process improvements.

The Company also meets directly with customers. For example, from January 2017 to May 2019, the Company conducted nearly two dozen community meetings at the request of customers to discuss grid performance and to provide information on activities to improve service. The Company will continue to engage with customers on an ongoing basis in its efforts to meet customer needs and expectations.

2. Virginia-Based Voice of the Customer Survey

The Company recently contracted with Maslansky + Partners ("Maslansky") to conduct Virginia-based research to evaluate customer priorities related to the Grid Transformation Plan. Maslansky based this effort on a nationwide survey fielded by Edison Electric Institute ("EEI") on the "Voice of the Customer," and, where applicable, compared the results of the Virginia survey and the national study.

Survey questions tested 35 attributes across a range of eight areas: (i) bills and payment; (ii) customer service; (iii) digital/digital privacy; (iv) environment/carbon/energy efficiency; (v) operational performance; (vi) outage communications; (vii) rewards; and (viii) smarter energy infrastructure. Customers expressed that experiencing power outages is their primary source of frustration followed closely by the ability (or inability) to control their electricity bills. Above all other categories, customers value reliability and affordability the most, and they expressed their desire to save on their bills and / or conserve energy. Appendix C provides the full results of the Maslansky Survey.

3. Social Media Analysis

Social media is a channel through which the Company communicates with and receives feedback from its customers. Dominion Energy Virginia recently prepared a Social Media Analysis that reviewed social media comments and sentiment to gather insights about customers' impressions of Dominion Energy Virginia, their reactions regarding power outages, and other aspects of the power delivery service they receive from the Company. West Cary Group completed the analysis, and assessed more than 28,500 social media comments identified as related to the Company over the last three and a half years.

Although only a limited number of customers use social media channels as a way to communicate with the Company or voice their concerns, the analysis clearly shows customers are frustrated during outages, as evidenced by over nine times the comment volume appearing on major outage days. While some comments share their appreciation after restoration, many customers do express frustration. The comments also illustrate an erosion of patience as time ticks by during multi-day outages. Notably, reliability and resiliency are major concerns for customers on all days—major storm or not. Appendix D provides the full results of the Social Media Analysis.

C. Stakeholder Engagement

In furtherance and development of the Company's GT Plan and related initiatives, the Company began a series of stakeholder sessions in mid-2019 to inform and develop goals for a modern grid and the customer experience. In two distinct session topics, the Company sought feedback and alignment regarding stakeholders' vision for prioritized capabilities of the grid, and how enabling infrastructure and technology can support new time-varying rates and customer programs. Each stakeholder process is further summarized below.

1. GT Plan Stakeholder Process

To facilitate stakeholder engagement surrounding the Company's plan for grid transformation, the Company engaged an industry expert, Navigant, to facilitate an external stakeholder process. Attendees included a range of stakeholders with varying interests, from environmental advocates to municipality representatives to low income advocates. Commission Staff also attended the stakeholder process.

Navigant facilitated a series of workshops that guided the conversation on the stakeholders' vision and objectives for grid transformation. Through collaborative conversations, a group of the stakeholders identified four goals for grid transformation:

Optionality: Enable all customers with accessible, affordable electric service and engage customers with programs, education, and data access.

Sustainability: Evolve to a clean and decentralized grid that integrates distributed energy resources, such as solar and wind, and electric vehicles.

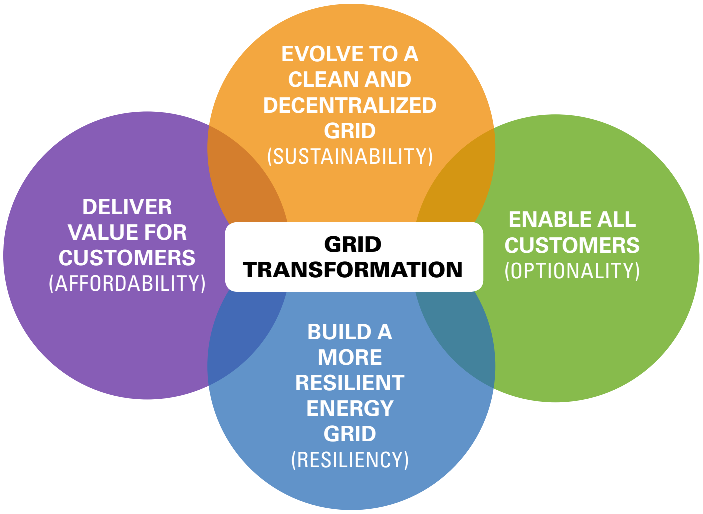
Resiliency: Build a more resilient energy grid that will reduce the effects of outages with automation and advanced asset management.

Affordability: Deliver value for customers by optimizing demand and seeking to reduce system and customer costs.

Using these goals as a guide, Navigant led an exercise for stakeholder groups to prioritize grid capabilities that any plan for grid transformation should enable. Consistent across all stakeholder groups were investments that enabled two capabilities: (i) integrate and optimize DERs and (ii) provide relevant, data-enabled options that enable customers to meet their goals. In addition, highly prioritized by at least one stakeholder group were investments that enabled the following capabilities: (iii) increase monitoring and visibility; (iv) accommodate two-way power flows; (v) enable voltage monitoring and control, supporting load management and peak shifting; (vi) simplify interconnection for residential customers; and (vii) harden for resiliency and security. Figure 2 below shows the results of a grid capabilities exercise conducted by Navigant with the stakeholders mapping the four goals of grid transformation to the customer-facing and value-enabling capabilities.

Navigant then facilitated a discussion that mapped high-priority capabilities to key grid modernization technologies. At the final workshop, the Company presented the Grid Transformation Plan and received stakeholder feedback. Appendix E is Navigant's final report on the stakeholder process.

The Company intends to continue engagement with stakeholders as its grid transformation efforts proceed.



Customer-Facing Capabilities	
🟣 🔵 🟠 🟢	Equitability of Service Offerings
🔵 🟠	Grid Resiliency
🟣 🔵 🟠 🟢	Integration & Optimization of DER
🟠 🟢	Streamlined DER Interconnections
🟠 🟢	Transportation Electrification Enablement
Value-Enabling Capabilities	
🟣 🔵 🟠 🟢	Data Collection & Communication
🟣 🔵 🟠	Distributed Intelligence
🟣 🔵 🟠	Grid Automation
🟣 🔵 🟠	Modern System Planning
🟣 🔵 🟠 🟢	System Visibility and Monitoring
🟣 🔵 🟠 🟢	Voltage Management

2. Time-Varying Rate Stakeholder Processs

In 2019, the General Assembly passed legislation—HB 2547—requiring the Company to convene a stakeholder process to make recommendations concerning the development of time-varying rates and other related initiatives. After consultation with the stakeholder group, the Company engaged Navigant as an independent facilitator to conduct the process. Attendees included a range of stakeholders with varying interests, from environmental advocates to municipality representatives to low income advocates. Commission Staff also attended the stakeholder process.

Initial sessions and collaborative discussions with the stakeholder group identified two key goals of an effective time-varying rate:

- To have a rate that empowers a large number of satisfied and engaged customers to regularly manage their load for maximum benefit to the electric system; and
- The rate offering should send as accurate of price signals as possible, but with design elements that minimize negative impacts for certain customer segments.

With these goals clearly identified, Navigant facilitated a review of common rate design options, leveraging Company supplied load information to analyze various rate structures and associated customer behavioral changes and system benefits that could result.

By the third session, stakeholders aligned on a preferred rate structure and associated on/off peak periods to target and began focusing on refining the new time-varying rate structure through discussions around specific pricing differentials / signals within the rate. Current technology limitations were also discussed at length with the group to highlight the need for AMI and CIP deployment to achieve targeted rate design and goal realization.

Stakeholders acknowledged the existing systems, specifically those running on mainframe systems, do not support the functionality they seek. Stakeholders specified a need for customer data tools, easy access to view data, and customer empowerment. The feedback from the Stakeholder group along with other customer feedback provides the basis for the customer experience goals of the CIP: modernize the customer relationship, provide better information and provide value.

As the process continues, the Company is working with stakeholders to finalize the new rate structure to inform a potential filing in the future and begin crafting a customer outreach and education plan to ensure the rate empowers customers to effectively manage their load for maximum benefit to the electric system in an effort to lower peak usage.

VI. Grid Transformation Plan

The 10-year Grid Transformation Plan focuses on the overarching goals of optionality, sustainability, resiliency, and affordability, as described in Section I. Similarly, Virginia Code § 56-585.1 A 6 requires that any plan for electric distribution grid transformation projects "shall include both measures to facilitate integration of distributed energy resources and measures to enhance physical electric distribution grid reliability and security."

Based on the development process described in Section V, the Company presents a comprehensive plan designed to achieve all of the goals and objectives for grid transformation in a reasonable, prudent, and cost-effective manner. Specifically, Phase IB of the Grid Transformation Plan includes six components: (i) AMI; (ii) CIP; (iii) grid improvements; (iv) telecommunications infrastructure; (v) cyber security; and (vi) the Smart Charging Infrastructure Pilot Program.

A. Components

1. AMI

Dominion Energy Virginia proposes to fully deploy AMI across the service territory. Through this technology, the Company can remotely read data gathered by smart meters and send commands, inquiries, and upgrades to individual smart meters. The full deployment of AMI is a foundational component of the Grid Transformation Plan, effectively enabling all other Plan components, and is needed to unlock the capabilities that customers, stakeholders, and the Commonwealth are demanding. Simply put, without the full and timely deployment of AMI technology across the service territory, the Company cannot transform the distribution grid.

The Company expects to complete deployment of AMI over a six-year period beginning in 2019. During this time, a total of approximately 2.1 million meters and 3,100 network devices will be deployed in a structured manner across the Virginia service territory within each of the geographic areas by region and field office. The Company plans to use the AMI head-end system currently in place for the full deployment of AMI, upgrading the system as needed as the deployment of smart meters progresses and as the Company enables additional AMI capabilities.

With the plan for full deployment, the Company proposes a revenue-neutral opt-out policy for residential customers including a one-time fee and ongoing monthly fees intended to only recover the costs of a customer opting out of smart meter installation.

2. CIP

The Company proposes to implement a new CIP that will replace 12 current systems supporting different aspects of the customer experience, including the outdated CIS, described above. The CIP will integrate with other critical operational systems that either currently exist or that the Company plans to upgrade as part of the GT Plan. The proposed CIP is needed to replace antiquated systems with a platform that will provide the foundation for an enhanced customer experience and desired grid capabilities. Without the foundational investment in the CIP, the value of the transformed grid will not be widely accessible to customers in a manner that is user-friendly (e.g., web self-service, smartphone apps, proactive communications). For example, time-varying rates, high bill alerts, and receipt of push notifications regarding billing would not be broadly accessible to customers without a new CIP.

The Company plans to implement the CIP beginning in 2019. The foundation of CIP implementation is the replacement of the CIS. The Company has collaborated with an industry expert to assist with bid management, including the competitive process to select a system integrator. The system integrator is responsible for leading the Company through design of the new system, configuration of the new system to meet the design, integration of other applications and systems to the new system, testing of the new system to ensure that it meets all requirements, and conversion of required data from the existing system. During the replacement of the CIS, the Company will deliver customer functionality through early releases of technology within the CIP, such as notification preference, which will allow customers to choose the communication channels through which they prefer to engage with the Company, and an outage center app for outage communications. After the CIS replacement, the Company will continue the CIP and leverage the new technology for additional functionality, specifically redesigning the bill to make it more understandable and easy to read.

3. Grid Improvements

The Company proposes grid improvement projects over the 10-year period of the GT Plan. Proposed projects fall into two categories: (i) grid technologies and (ii) grid hardening. The grid improvement projects are needed to adapt to fundamental changes in the energy industry described in Section I, facilitating the integration of DER and enhancing system reliability and resiliency.

Grid Technologies. Within the category of grid technologies, the Company proposes: (a) building a self-healing grid; (b) conducting and publishing hosting capacity analysis; (c) implementing a DERMS; (d) enabling Advanced Analytics; (e) implementing voltage optimization; (f) demonstrating microgrid capabilities at the Locks Campus; (g) implementing an enterprise asset management system ("EAMS"); and (h) replacing the OMS.

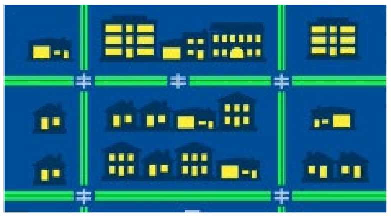
Self-Healing Grid. The Company proposes to build a self-healing grid. A self-healing grid refers to a distribution network that uses smart grid devices such as switches, reclosers, and line sensors; a communications network; and a control system to automatically isolate outages to the smallest possible group of customers and reroute power to restore most customers in a matter of seconds or minutes. This type of system also provides details about the specific location of the fault, allowing crews to arrive and assess repair needs faster, speeding the restoration time for the remaining customers. This concept is also known as distribution automation or fault location, isolation, and service restoration ("FLISR"). Additionally, these smart grid devices provide situational awareness that is necessary to manage grid voltages and power flows related to DER. Figure 3 illustrates the self-healing grid.

To build a self-healing grid, the Company will install electronic devices on selected feeders and associated substations, and add a FLISR software module to the Company's recently installed ADMS. The electronic devices to be installed include the following:

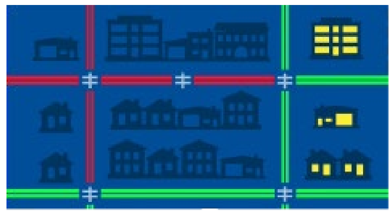
- <u>Electronically-controlled line reclosers.</u> Devices that can sense grid problems and take action to de-energize and isolate line sections turn off power where necessary, and that can also receive control commands from the ADMS using a secure telecommunications network.
- <u>Line sensors.</u> Devices installed at select locations along the feeder that provide situational awareness regarding normal loading and voltage as well as fault related information that can be used by the ADMS to further narrow the potential outage location.
- <u>Digital relays.</u> Devices that provide advanced protection and control functionality, and detailed grid performance information including near real-time situational awareness about grid operation.
- <u>Communication gateway</u>s. Devices that facilitate secure communications and function as a central data hub, sending and receiving all data and control functionality between substations and the ADMS.

To maximize the benefit of investments in a self-healing grid, the Company selected feeders that have the largest number of customers and most critical services affected when outages occur based on historical outage information from 2014 to 2018. The Company has completed detailed engineering for the feeders it intends to target in 2020 and 2021 to determine the number and types of devices to deploy on each feeder.

Figure 3: Self-Healing Grid

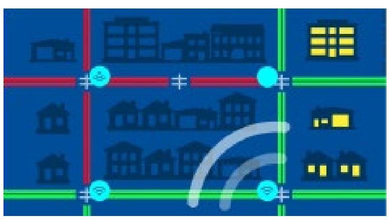


Majority of customers today do not have a smart meter

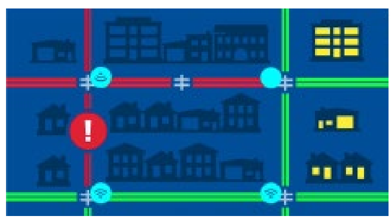


Rely on customers to notify us during outages

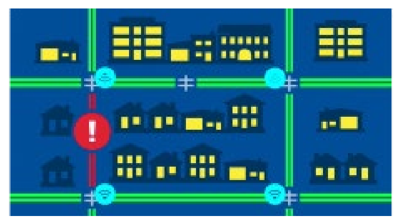
Smart meters and self-healing grid technologies use a secure network to provide visibility to the grid



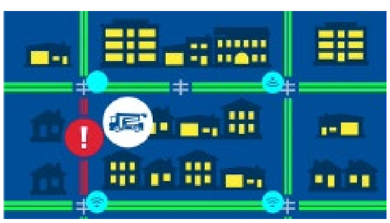
Intelligent grid devices provide data to control systems



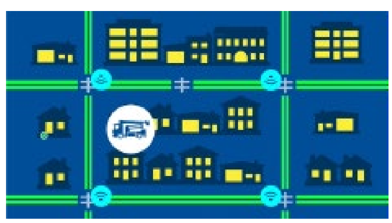
The location of the fault is identified and isolated



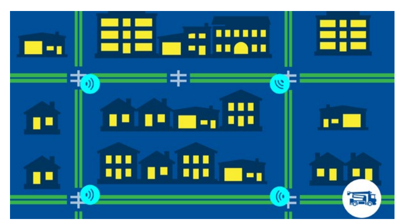
Most customers restored automatically in minutes



Crews have more precise location of fault



Remaining customers' power restored more efficiently



Crews available to move onto next outage location

Hosting Capacity Analysis. The Company proposes to complete and publish a hosting capacity analysis, and to refresh this analysis on a regular basis. Hosting capacity analysis uses computer simulations to determine how much generation can be placed at each point on the distribution grid without causing voltage or loading problems. Hosting capacity results are typically communicated using online interactive maps, with colored line segments indicating the hosting capacity of each part of the circuit. This type of analysis helps customers and localities to determine the potential contribution of DERs on the distribution feeder.

The Company plans to publish initial hosting capacity maps of its system by the end of 2020. The Company will update these maps periodically. Notably, AMI and the intelligent grid devices that the Company plans to install as part of the self-healing grid will enable more advanced and dynamic hosting capacity analysis in the future.

DERMS. The Company proposes to implement DERMS to leverage the full capabilities of DERs by managing grid performance and maximizing customer benefits. The proposed DERMS will aggregate performance and status information from DERs, analyze the need for control actions (e.g., charging and discharging battery energy storage systems), and issue the appropriate commands to DERs to maintain a safe and reliable energy grid. As equipment capabilities continue to mature and industry standards evolve, DERMS will also enable the use of smart inverters. In addition to the basic inverter function of converting direct current to alternating current, smart inverters enable DERs to provide grid support capabilities, such as voltage regulation, frequency support, and ride through capabilities. All of these capabilities help to achieve greater grid efficiencies and provide greater customer benefits.

Advanced Analytics. The Company proposes to expand its Advanced Analytics capabilities to maximize the data collected from smart meters and intelligent grid devices. Advanced Analytics uses mathematical and statistical formulas and algorithms to generate new information, to recognize patterns, to predict outcomes, and to determine the respective probabilities of those outcomes. To expand its Advanced Analytics capabilities, the Company proposes to upgrade its DAS and to create an Analytics Center of Excellence ("ACE"), a support organization responsible for Advanced Analytics.

Voltage Optimization. In conjunction with the installation of AMI, the Company proposes to implement a voltage control system in 2022 that uses near real-time voltage data from smart meters and issues control commands to voltage control devices to manage grid voltage more precisely. These more precise settings would result in generally lower voltage control settings, which would also lower energy consumption for most customers without a noticeable difference in service level.

Locks Microgrid. The Company proposes to study microgrids by installing one at its Locks Campus near Petersburg, Virginia. A microgrid is a small power grid consisting of interconnected loads and DERs with clearly defined electrical boundaries. A microgrid can operate both when connected to the larger electric grid and continue to operate as an "island" when there is an interruption or other grid disturbance.

Through the Locks Microgrid, the Company will obtain real-world data, better understand DER performance characteristics, perform testing of DER grid support and islanding capabilities, vet new technology integration into the distribution grid, and evaluate microgrid operations architecture for potential future applications.

EAMS. The Company proposes to implement EAMS beginning in 2020. The EAMS will enable the Company to improve asset management practices by assessing the health and performance of grid components and driving predictive maintenance activities, leading to more effective grid operation activities. The EAMS will also assist the Company with managing the procurement, deployment, and retirement of equipment and devices through improved equipment attribute analyses and planning capabilities. Once implemented, information and analytics from the proposed EAMS will drive a large part of the identification and prioritization of component upgrades included in future phases of the GT Plan.

OMS. The Company proposes to replace its OMS with a new OMS that will operate effectively with the self-healing grid. The self-healing grid will create constant changes in grid connectivity as feeders are reconfigured to restore customers or manage power flows from DER. The result is a dynamic electric distribution grid that requires an OMS capable of maintaining the hierarchy of how each customer is being served based on the configuration of the feeder ties at any point in time. The Company plan to begin implementation of a new OMS after Phase IB in 2024.

Grid Hardening. Within the category of grid hardening, the Company proposes: (a) hardening mainfeeders; (b) deploying targeted corridor improvement activities; (c) upgrading components proactively; and (d) mitigating voltage islands.

Hardening Mainfeeders. The Company proposes to complete hardening work on a targeted population of mainfeeders. Hardening projects will improve reliability by focusing on physically strengthening infrastructure using newly implemented stronger standards when rebuilding, relocating, or undergrounding targeted mainfeeder segments, as well as improving distribution system architecture and connectivity to provide feeder tie capabilities.

The Company selected mainfeeders for hardening by evaluating historical reliability information to identify segments of customers with the most outage interruptions each year excluding major events. The Company identified 312,000 customers with the worst reliability based on annual outage time between 2014 and 2018. This group of customers—approximately 12% of the Company's total customers—account for 41% of all outage minutes. While the average Dominion Energy Virginia customer averages 127 minutes of outage time annually, these customers average 421 outage minutes.

The Company has completed the detailed engineering analysis for the 11 mainfeeders it intends to target in Phase IB, serving 12,578 customers and 61 critical services. Two of the 11 proposed Phase IB projects will improve service for customers located in economically distressed Opportunity Zones as certified by the Internal Revenue Service. Engineering undertaken for these projects determined the amount and type of hardening work to perform on each mainfeeder. Of the approximately 63 miles of mainfeeder hardening work that is proposed for 2020 and 2021, 61 miles involve rebuilding or relocating the mainfeeder, while only approximately 2 miles include undergrounding of the mainfeeder. The Company views mainfeeder undergrounding as a last resort for hardening given the costs and complexities associated with this work.

Targeted Corridor Improvement. The Company proposes several new vegetation management programs to improve grid reliability and resiliency while minimizing environmental impacts. Specifically, the Company proposes to remediate ash tree mortality and implement an herbicide program for ground floor maintenance.

Proactive Asset Upgrade. The Company proposes to proactively upgrade (i) substation transformers with poor health and high customer impact and (ii) service transformers that are overloaded or not providing voltage within the proper bandwidth. In 2020 and 2021, the Company proposes to replace 5 substation transformers and 1,589 service transformers.

Voltage Island Mitigation. The Company plans to mitigate voltage islands, which are single substation transformers that serve a population of customers without the support of available load transfer capability within the substation or through field tie switches to adjacent feeders. Voltage islands expose customers to the risk of an extended outage if the single substation transformer fails. The Company plans to address 18 of the 26 voltage islands through the GT Plan, including two in 2020 and 2021. To address the voltage islands, the Company will typically install a second transformer at each location and reconfigure feeder architecture both to provide the capacity to restore all customers in the event of a failure of the existing transformer and to improve day-to-day service reliability.

4. Telecommunications

Dominion Energy Virginia proposes to deploy a comprehensive telecommunications strategy requiring multiple components specifically designed and deployed as an integrated solution to meet the wide-range needs of a transformed distribution grid. The strategy envisions three tiers of communication: (i) Tier 1, a high-speed broadband with very low latency and redundancy; (ii) Tier 2, a broadband network without redundancy; and (iii) Tier 3, a field area network ("FAN") to support distribution automation equipment. The telecommunications investments are a foundational component of the Grid Transformation Plan and are needed to enable the secure communication required for a transformed grid.

The Commission approved Tier 1 and Tier 2 in Case No. PUR-2018-00100, and the Company has begun implementation of these telecommunications solutions. For Tier 3, beginning in 2020, the Company plans to deploy field device hardware, FAN base station hardware, and a FAN management system, and plans to acquire licensed spectrum for the FAN. Tier 3 supports the proposed self-healing grid by facilitating secure, real-time communications to the intelligent grid devices via wireless communications on the distribution system not directly serviced by Tiers 1 and 2.

5. Security

The Company will continue to protect the distribution grid by providing adequate and cost-effective security control measures to manage the growing threat to the energy sector and to protect Dominion Energy Virginia from cyber and physical attacks. The Company's security strategy includes both physical and cyber security at key substations and cyber security to protect the investments proposed in the GT Plan. The security investments are a foundational component of the Grid Transformation Plan, and are needed to protect the distribution grid from internal and external threats, protecting the Company and its customers.

The Commission approved investments in physical and cyber security at key substations in Case No. PUR-2018-00100, and the Company has begun assessment at 10 substations. The Company proposes to implement cyber security solutions as the Company deploys its other proposed GT Plan investments, including AMI, CIP, and grid improvements. The majority of cyber security solutions are extensions or separate rollouts of existing solutions, but the Company will evaluate additional cyber security solutions as needed to close any security gaps and address any new or emerging threats.

6. Smart Charging Infrastructure Pilot Program

Dominion Energy Virginia takes a proactive approach to understanding the trends, innovations, and progress related to new technologies in the electric utility landscape. As part of the GT Plan, the Company is proposing initiatives related to electric transportation, including the Smart Charging Infrastructure Pilot Program. The Company will continue to monitor other emerging technologies for possible inclusion in future GT Plan filings.

Through this Pilot Program, the Company proposes to offer rebates for the electrical infrastructure and upgrades at EV charging sites and rebates for the smart charging equipment that enables managed charging. The Company plans to offer a set number of rebates to four different segments: multi-family; workplace; DCFC; and transit. The Company is also proposing to own a limited number of DCFC stations in an effort to study and support electrification in the rideshare segment.

Industry experts agree that EV adoption will continue to increase across the nation and in the Commonwealth. In the Company's service territory, EV adoption is expected to increase to approximately 169,000 EVs by 2030. With increased adoption comes increased demand for electricity. The proposed Smart Charging Infrastructure Pilot Program aims to provide the Company with the data and tools necessary to understand and manage future EV charging load in furtherance of additional pilots, programs, or rate designs that will support EV adoption while minimizing the impact of EV charging on the distribution grid.

7. Customer Education

The Company is committed to improving the customer experience by incorporating education into various Plan components and including general energy education. Key to achieving this goal is educating customers about their energy consumption and how to manage their costs and empowering them to take advantage of the numerous enhanced customer capabilities enabled by the GT Plan. The Company will develop and provide concise, consistent, easy-to-understand content via multiple external communications channels, including but not limited to website content, social media, digital and direct mail, bill inserts and newsletters, presentations and public events, video and display signage, and interactions with the customer service organization.

The Company's comprehensive approach for customer education addresses: (1) foundational education, (2) smart meters and detailed energy usage data, (3) customer information platform and engagement, (4) customer energy management programs, (5) electric transportation benefits, and (6) grid improvement projects to improve reliability. Appendix F includes the full details of the customer education plan. While this customer education plan will focus on enhanced capabilities enabled by GT Plan, it supplements the Company's overall efforts to educate its customers on topics ranging from available rate schedules to general energy education.

The Dominion Energy Virginia website will be a main hub for public education. The Company has already launched a webpage at DominionEnergy.com (https://www.dominionenergy.com/next) which provides links to factsheets, informational videos, and other informative documents. A landing page specific to the GT Plan will be launched and all materials (print and digital) will provide or include the link back to the webpage for further information. In addition, there will be a wide variety of community opportunities for customers to speak face-to-face with subject matter experts and employees about the GT Plan through the Company's "speaker's bureau" events and presentations.

The Company's consistent implementation of the customer education approach and plan will improve the customer experience. Utilizing this education approach, the Company will ensure outreach is efficient and effective in achieving the goals of educating customers, keeping them informed, and empowering them to take advantage of the numerous enhanced customer capabilities provided by the GT Plan.

B. Environmental Justice Considerations

In developing the GT Plan, Dominion Energy Virginia sought to ensure that the benefits of these investments reach all customers. For example, the Smart Charging Infrastructure Pilot Program targets the multi-family residential, transit, and rideshare segments to ensure that low income customers may benefit from transportation electrification. Upon full deployment of AMI and CIP, the Company has committed to programs including prepay, peak time rebate, and time-varying rates, all of which will be "opt-in" and available to interested customers. The corresponding education with these programs will provide information so each customer can determine whether the options will be beneficial to them. Additionally, the foundational telecommunications investments proposed as part of the Grid Transformation Plan will provide the opportunity to support expanded deployment of broadband in the Commonwealth through a Rural Broadband Program Pilot.

Further, the deployment plans for AMI and grid improvements were evaluated to ensure that minority and low income communities were considered when identifying areas and timing of those investments.

C. Alignment with Customer and Stakeholder Feedback

As discussed in Section V.B, the Company received customer feedback on a range of priorities associated with the Grid Transformation Plan as part of the recent Maslansky Survey. Figure 4 notes the top findings on what customers rank with highest importance.

Figure 4: Customer Feedback Priorities

	Customer Priorities
1	Completes scheduled work when they say they will
2	Has knowledgeable customer service representatives
3	Invests in technology to help it prevent outages and respond to outages faster when they occur
4	Keeps my energy usage data private and doesn't make any personally identifiable information available
5	Alerts me when power is out, how long it will take to restore, and when it is restored
6	Invests in a stronger energy grid that can withstand extreme weather and cyberattacks
7	Completes work without needing follow up
8	Has easy to understand bills that explain charges clearly
9	Takes the time to listen to my issues and actually help me
10	Has an outage map that includes accurate estimates of outage time and progress in restoring power

As shown in Figure 4, among attributes tested, those relating to outage communications and smarter energy infrastructure rise to the top as priority areas of focus. These findings support the proposed GT Plan investments and make clear that they will provide the types of benefits the Company's customers value most—enhanced reliability and accurate information.

As discussed in Section V.C, the Company initiated a series of stakeholder sessions to inform and develop goals for a modern grid and the customer experience. Through the GT Plan stakeholder process, four goals were identified: (i) enable all customers with accessible, affordable electric service and engage customers with programs, education, and data access (Optionality); (ii) evolve to a clean and decentralized grid that integrates distributed energy resources, such as solar and wind, and electric vehicles (Sustainability); (iii) build a more resilient energy grid that will reduce the effects of outages with automation and advanced asset management (Resiliency); and (iv) deliver value for customers by optimizing demand and seeking to reduce system and customer costs (Affordability). GT Plan investments directly support each of these four goals, through deployment of technology to empower customers to make informed decisions about their energy usage, enabling increased adoption of DERs in a responsible manner, and delivering better reliability and fewer outages for customers.

D. Costs

As shown in Figure 4, among attributes tested, those relating to outage communications and smarter energy infrastructure rise to the top as priority areas of focus. These findings support the proposed GT Plan investments and make clear that they will provide the types of benefits the Company's customers value most—enhanced reliability and accurate information.

As discussed in Section V.C, the Company initiated a series of stakeholder sessions to inform and develop goals for a modern grid and the customer experience. Through the GT Plan stakeholder process, four goals were identified: (i) enable all customers with accessible, affordable electric service and engage customers with programs, education, and data access (Optionality); (ii) evolve to a clean and decentralized grid that integrates distributed energy resources, such as solar and wind, and electric vehicles (Sustainability); (iii) build a more resilient energy grid that will reduce the effects of outages with automation and advanced asset management (Resiliency); and (iv) deliver value for customers by optimizing demand and seeking to reduce system and customer costs (Affordability). GT Plan investments directly support each of these four goals, through deployment of technology to empower customers to make informed decisions about their energy usage, enabling increased adoption of DERs in a responsible manner, and delivering better reliability and fewer outages for customers.

The Company determined these projected costs primarily using competitively-negotiated contracts and responses to competitive requests for proposals ("RFPs") and requests for information ("RFIs"), informed by prior experience. The Company's filing provides detailed information used to determine costs, and includes the relevant contracts or RFP/RFI summaries with its filing.

The Company has committed that the costs of the Plan associated with the deployment of AMI and the CIP in Phase IB will not be the subject of a rate adjustment clause petition. Instead, these costs will be recovered through the Company's existing rates for generation and distribution services ("base rates"). As to other phases and components of the Plan, the Company has not yet determined its plans for cost recovery.

Figure 6 summarizes the estimated Phase I revenue requirements for the GT Plan and provides an estimated revenue requirement for Phase IA and Phase IB of the GT Plan for the components that could be subject of a rate adjustment clause petition (i.e., excluding Phase IB AMI and CIP costs). Notably, these calculations are high-level estimates based on the preliminary costs of the Plan, but do not contain the level of precision or detail contained in similar calculations typically provided with the Company's rate proceedings.

Figure 5: Phase I Costs ($M)

Nominal $, in Millions	2019 Year 1	2020 Year 2	2021 Year 3	3-year Total
Phase IA	$8.5	$17.9	$37.0	$63.3
Capital	$7.3	$17.7	$36.5	$61.4
O&M	$1.2	$0.2	$0.5	$1.9
Phase IB	$39.4	$246.8	$307.3	$593.4
Capital	$26.8	$218.4	$265.4	$510.5
O&M	$12.6	$28.4	$41.9	$83.0

Figure 6: Phase I Costs ($M)

(millions)	Phase IA	Phase IB
Capital Spend (2019-2021)	$61.4	$232.8
O&M Spend (2019-2021)	$2.1	$50.2
Annual Revenue Requirement (2021)	$6.4	$50.4

The estimated revenue requirements shown above encompass all components of the GT Plan. However, the Company has committed that Phase IB costs of AMI and the CIP will not be the subject of a rate adjustment clause. Therefore, in evaluating rate impact, the Company focused only on those investments that could be subject to a rate adjustment clause in the future. Based on 1,000 kWh usage per month, the implementation of these Phase IA and Phase IB estimated annual revenue requirements in the year 2021, would increase the typical residential customer's monthly bill by $0.12 and $1.03, respectively.

E. Benefits

The proposed Grid Transformation Plan unlocks benefits for the Company, its customers, and the Commonwealth. The Company engaged a third-party industry expert, West Monroe Partners, to generate a cost-benefit analysis ("CBA") for the GT Plan. Figure 7 presents the results of the CBA.

As can be seen, the CBA represents a positive business case from a financial perspective, providing over $3 billion of benefits, which represents net benefit to customers of approximately $322.5 million all on a net present value basis.

The CBA focuses on quantifiable benefits, but the Grid Transformation Plan produces other qualitative, non-quantifiable benefits. For example, there are benefits that are difficult to quantify, like avoiding a cyberattack; providing resilient service to military bases, hospitals and communities; and providing customers with accurate and timely information that have implications for their daily lives.

The following sections highlight certain GT Plan benefits important to the Company and various stakeholders.

1. Time-Varying Rates

Transformational investments in AMI and CIP, when coupled with customer education and communication, enable the Company to broadly offer time-varying rates. Time-varying rates better reflect the true cost of electricity, where customer energy prices vary over time and different prices are in effect for different hours on different days.

Time-varying rates provide more accurate price signals to customers that are better aligned with cost causation than traditional rates not based on time of use. Time-varying rates can provide incentives for behavioral changes that may cause customers taking service under such rates to reduce usage during peak demand periods and enable the system to avoid incurring higher variable operating expenses (e.g., fuel) and to avoid future capacity costs. These behavioral changes can benefit customers directly through bill savings and reduced system costs.

The Company anticipates proposing new time-varying rates later this year upon conclusion of the recently-initiated, legislatively-directed stakeholder process. Currently, the Company anticipates proposing a new residential time-varying rate available to customers with a smart meter, which will include a basic customer charge and energy charges, differentiated by season and by time periods within each season. This rate will be experimental and voluntary, and will initially be limited in the number of customers that can participate as AMI and CIP are being deployed. Once AMI and CIP are fully deployed, the Company can more broadly offer time-varying rates with Commission approval. The Company is planning for the new time-varying rate to be voluntary or opt-in at first.

Figure 7: CBA Summary (Revised October 25, 2019)

Cost Benefit/Summary (Revenue Requirement Basis)
(in Millions)

BENEFITS & COSTS	PV[1]
BENEFITS (Asset Life):	
Customer	**$2,972.3**
Avoided/Deferred Capital	$375.6
O&M Savings	$265.9
Energy & Demand Savings	$237.5
Improved Reliability	$1,974.3
Reduction of Bad Debt & Energy Diversion	$118.9
COSTS (Revenue Requirement):	**$2,703.6**
Total Net Benefit (Cost):	**$268.7**
Total Benefit/Cost Ratio:	**1.1**

[1]Presented Value (NPV) calculated using Weighted Average Cost of Capital (WACC) of 7.62%

	PV[1]
Additional Benefits	**$85.3**
Reduced GHG	$4.1
EV Ownership Savings[2]	$81.2
Economic Impact[3]	$2,829.0
Total + Additional Net Benefit (Cost):	**$354.0**
Total + Additional Benefit/Cost Ratio:	**1.1**

[2]Adjusted to apply 7.2% benefits correlation factor to reduction associated with GTP
[3]Economic Benefits are neither included in the Total + Additional Net Benefit nor in the Total + Additional Benefit/Cost Ratio

Job Creation[4]	
Indirect Jobs	17,228
Direct Jobs	4,540

[4]Jobs creation is calculated using a multiplier applied to Millions of $ in Capital Spend (PV)

2. Demand-Side Management Initiatives

The foundational and transformational investments proposed as part of the Grid Transformation Plan will enable enhanced and targeted DSM initiatives. With the data provided by AMI, the Company can more effectively target the most appropriate customers for specific programs and would provide better recommendations for energy savings within any programs that involve a behavioral or educational component. AMI also provides a significant benefit to the evaluation, measurement, and verification ("EM&V") requirements of DSM programs by providing detailed energy usage data from each customer endpoint where smart meters are deployed.

Future DSM programs enabled by AMI—in conjunction with implementation of the CIP—include peak-time rebates ("PTR"). PTR is a customer program designed to target and reduce the Company's coincident peak period. The Company would call a certain number of PTR events per year, each lasting for a certain number of hours. For example, the Company could call 10 events per year to cover projected coincident peak periods. Once called, enrolled customers would receive a notification of the opportunity to reduce usage, and would earn a rebate if they reduced usage during the PTR event. Customers would not be penalized if they did not reduce usage during the event.

3. Prepay

Full AMI deployment combined with the new CIP will enable the Company to develop a prepay program. Prepay is a program that allows customers to make an up-front payment of their energy bill that will then be reduced over time based on their ongoing usage. Customers will receive alerts as their balance is depleted, and can take action accordingly. In other words, prepay allows customers to manage their energy usage within their budget. In the industry, prepay programs have also been shown to result in energy savings.


Dominion Energy

4. Load Forecasting

The data obtained from AMI can also enhance the Company's load forecasting process. AMI data will permit the Company to examine consumption patterns on an hourly basis. This data can then be used to create consumption forecast models at various segment levels, for example, at the neighborhood level, the zip code level, and the feeder circuit level. These localized forecasts can then be rolled up to a system level and compared against the Company's current forecasting methods. Having this ability will allow the Company to modify its forecasting process, which will likely lead to more accurate peak demand and energy forecasts.

5. Broadband Pilot Program

The foundational telecommunications investments proposed as part of the Grid Transformation Plan will provide the opportunity to support expanded deployment of broadband in the Commonwealth through a Rural Broadband Program Pilot. Under this Pilot, the Company could use a portion of the fiber capacity to meet its own distribution system needs, including as the supporting communications backbone for intelligent grid technologies. The Company would lease another portion to an internet service provider, which would use the fiber infrastructure to deliver high-speed Internet access to unserved residences and business.

F. Regulatory Process

The GTSA mandated that the Company petition the Commission for approval of a plan for electric distribution grid transformation projects. The GTSA also set forth the applicable standard for reviewing such petitions:

> In ruling upon such a petition, the Commission shall consider whether the utility's plan for such projects, and the projected costs associated therewith, are reasonable and prudent. Such petition shall be considered on a stand-alone basis without regard to the other costs, revenues, investments, or earnings of the utility; without regard to whether the costs associated with such projects will be recovered through a rate adjustment clause under this subdivision or through the utility's rates for generation and distribution services; and without regard to whether such costs will be the subject of a customer credit offset, as applicable, pursuant to subdivision 8 d.[8]

The Commission must rule on any petition not more than six months after the date of filing.

In 2018, the Company submitted its first petition for approval of its GT Plan in Case No. PUR-2018-00100 ("2018 Final Order"). The Commission issued its 2018 Final Order on January 17, 2019.

As part of the regulatory process, the Company proposes performance metrics in consultation with Commission Staff to track the success of the Plan. The Company proposes to submit an annual report on the progress of the Grid Transformation Plan by April 30 of each year for the prior calendar year. The Company also plans to continue stakeholder engagement on the GT Plan in the future. The Company intends to work with stakeholders to determine the best structure, process, and cadence going forward.

[8] Va. Code § 56-585.1 A 6.

VII Future Technologies

Dominion Energy Virginia takes an active approach to understanding the trends, innovations, and progress related to new technologies in the electric utility landscape. The following section describes future technologies that the Company will continue to monitor as its pilot and demonstration programs progress.

A. Battery Energy Storage Systems

Battery energy storage systems ("BESS") offer a variety of support options for the distribution grid. While BESS technologies are still in the early stages of utility-scaled deployment, the Company is piloting this technology in several proof of concept applications.

On August 2, 2019, the Company submitted its first application to participate in the pilot program for electric power storage batteries established by the Commission pursuant to the GTSA. The application presents three projects for deployment, including two for applications on the distribution system. Through BESS-1, the Company proposes to deploy a 2 MW / 4 MWh AC lithium-ion BESS that will study the prevention of solar backfeeding onto the transmission grid at a specific distribution substation. Through BESS-2, the Company proposes to deploy a 2 MW / 4 MWh AC lithium-ion BESS that will study BESS as a non-wires alternative to reduce transformer loading at a specific substation. The Company may seek approval of additional BESS in future applications. For example, the Company is evaluating a potential project to study battery storage paired with DCFC infrastructure for electric vehicles.

Separately, on August 29, 2019, the Company announced an innovative electric school bus initiative to replace diesel school buses with electric school buses, and then leverage the batteries using vehicle-to-grid technology.

B. MicroGrids and NanoGrids

A microgrid is a small power grid consisting of interconnected loads and DERs with clearly defined electrical boundaries. A microgrid can operate both when connected to the larger electric grid and continue to operate as an "island" when there is an interruption or other grid disturbance.

A nanogrid is a small microgrid typically consisting of a single building or primary load, and the generation needed to supply that load without a connection to a centralized grid. A nanogrid is fully capable of operating independent of the grid through a combination of sustainable generation, storage, and smart devices, all digitally connected and controlled to optimize the balance of load with available power. A nanogrid gives the individual consumer the ability to manage its own generation sources, demand, and usage independent of both the microgrid that they may be a part of and the centralized utility grid.

Microgrids offer promising solutions for critical loads, such as military installations, hospitals, and water treatment plants. At this time, microgrids are not economic to deploy on a large-scale basis. A report by the National Renewable Energy Laboratory ("NREL") reported a microgrid cost per megawatt at $2.1 million per megawatt of DERs installed.[9] Nevertheless, the Company proposes to study microgrids by installing one at its Locks Campus near Petersburg, Virginia, as discussed in Section VI.A.3.

[9] National Renewable Energy Laboratory, PHASE I MICROGRID COST STUDY: DATA COLLECTION AND ANALYSIS OF MICROGRID COSTS IN THE UNITED STATES (Oct. 2018), available at https://www.nrel.gov/docs/fy19osti/67821.pdf.


ALL ELECTRIC

Glossary

ACE (Analytics Center of Excellence): An analytics team consisting of system administrators, data scientists, data engineers, business analysts, user interface developers (i.e., people who develop visualizations like dashboards and reports), and other IT and business professionals responsible for identification, prioritization, business case evaluation, testing, and implementation of Advanced Analytics-driven business use cases.

ADMS (Advanced Distribution Management System): A software platform that supports and manages the full suite of distribution grid management and optimization technologies employed by the Company.

Advanced Analytics: Broadly classified as artificial intelligence, combining many technologies and methods, and is often referred to as predictive analytics (one of its salient capabilities) or Big Data (the platform used for processing analytics).

AMI (Advanced Metering Infrastructure): Another term for Smart Meters – electric meters that automatically measure and record usage data at regular intervals and provide that data to consumers and energy companies at least once daily- and the systems that use that data and communicate with the meters including the field area network and the back office system.

AMI Back Office System: Also called a "head-end "system, this system receives and processes the data recorded by the "field area network" and assists the operation and maintenance team.

AMR (Automated Meter Reading): A technology that records usage data and transmits it to the Company one-way. The Company reads these meters through drive-by readings using specially equipped trucks that receive the data through radio signals.

Automated Control Systems: Technology that allows for near real-time adjustment of the grid to changing energy loads, distributed generation or feeder fault conditions without or with limited operator intervention.

Backfeed: The flow of electric power from the distribution grid to the transmission grid. Also represents the flow of electric power from a net metering distributed energy resource to the distribution grid during periods where distributed generation exceeds consumption at the premises.

Backhaul Network: The backhaul portion of the network comprises the intermediate links between the core network and the small subnetworks at the edge of the network.

BESS (Battery Energy Storage System): A rechargeable resource that stores energy from a generating source for later discharge to the electrical grid.

Big Data: An accumulation of data that is too large and complex for processing by traditional database management tools.

CBMS (Customer Business Management System)/CIS (Customer Information System): Core system delivering business functions such as customer service, account management, credit and collections, service orders, meter inventory, usage, billing, service address management, portfolio management, rates and financial based activities.

CCRO (Customer Credit Reinvestment offset): A provision of the law allowing for overearnings to be reinvested into certain renewable generation projects or grid transformation investments rather than credited back to customers.

CIP (Customer Information Platform): A combination of technologies, applications and projects at the core of the customer experience, consisting primarily of the Customer Information System (CIS), Meter Data Management System (MDMS), Customer Portals, and other customer experience applications.

Collector: A device deployed as a component of AMI designed to enable two-way communications to and from meters within range of the device. The device captures meter data and transmits via a dedicated backhaul communications network to the AMI head-end system to drive business processes.

Cyber Security: Programs, techniques and technology to protect the Company's network, devices, and programs from cyberattack.

DAS (Data Analytics System): A system that stores and quickly processes large amounts of data to support advanced analytics solutions.

DCFC (Direct Current Fast Charging): Electric vehicle charging technology capable of charging batteries to a 60 to 80 mile range state of charge within 20 minutes.

Decentralization: [two-way energy flow] A concept that involves moving the electric grid away from relying solely on large centralized generating plants that supply power via the transmission grid to the distribution grid and ultimately end users, to a power grid where large generating plants and smaller distributed resources supply the grid simultaneously from two directions: the large generators through transmission lines and the smaller resources supplying from the distribution grid.

DER (Distributed Energy Resource): A generation resource or controllable load that is interconnected to the distribution grid or connected to a host facility within the distribution grid.

DERMS (Distributed Energy Resource Management System): A system that monitors and analyzes performance and status data from multiple distributed energy resources and has the ability to control those resources to maintain safety and reliability on the energy grid while maximizing benefits of the resources.

Distribution Grid: The portion of the electrical utility system that delivers electrical power from the transmission grid through a substation transformer to end-use customers- typical distribution grid operating voltages range from 4 kV to 46 kV.

DSM (Demand Side Management): Programs that encourage customers to modify their behavior in order to save on energy costs.

Earned Media: Publicity gained through promotional efforts other than paid media advertising or owned media, like branding, such as TV news segments, social media, customer reviews and word of mouth.

EAMS (Enterprise Asset Management System): A system that aggregates data and attributes of grid assets and provides capabilities to manage grid assets at all points in their life cycle, including procurement, deployment, and retirement. The system allows for collection of information related to the health and performance of grid components and analysis to drive life cycle decision making.

EM&V (Evaluation, Measurement and Verification): The collection of methods and processes used to assess the performance of demand-side management activities so that planned results can be achieved with greater certainty and future activities can be more effective.

Fault: An abnormal electrical condition caused by a short circuit on a feeder section.

Feeder: An electric distribution subsystem that begins at a substation and distributes electrical power within a localized service area. Feeders are comprised of mainfeeders, tap lines and service lines.

FLISR (Fault Location, Isolation, and Service Restoration): A distribution network system that works with intelligent grid devices such as switches, reclosers, line sensors, and a secure communications network to automatically isolate faulted feeder sections and reroute power to restore most customers in a matter of seconds or minutes.

Generation/Generator: A machine or system that converts an energy source (solar irradiance, wind, fossil fuel etc.) to electric energy.

GIS (Geographic Information System): A system designed to capture, store, analyze, and present spatial or geographic data, herein referring to distribution grid assets.

Green Screen: Common name for the user view of the existing CIS, which is a non-Windows based view of the mainframe system.

Grid Hardening: Physical grid improvements that improve reliability and resiliency by rebuilding portions of the grid to eliminate outages and reduce damage for faster restoration, and proactively upgrade assets at or near end of life with components that provide increased functionality or higher reliability.

Grid Modernization/Transformation: These are blanket terms for efforts to improve and modernize the grid.

Hosting Capacity: The estimated amount of DER that can be connected to each segment of the distribution grid without causing voltage or loading issues as determined by engineering analysis.

IGD (Intelligent Grid Devices): Various devices that provide situational awareness and control capability of the grid and enable two-way communication and centralized control of the power system.

Integrated Distribution Planning: A process to address the capacity, reliability, and DER integration needs of the distribution grid using traditional solutions as well as new solutions offered by customer-owned DER and other non-traditional technologies.

Intermittent Generation: Also known as variable energy resources, these generating types do not produce continuously available electricity due to external factors that cannot be controlled, such as solar and wind power. The power from them is non-dispatchable, meaning that they cannot be called upon at all times, only at times when the conditions for their power are present (Sun or wind) and the amount of power varies depending on those conditions.

Kilovolt (kV): Unit of measure for electric equipment and facilities representing 1000 volts.

KPI (Key Performance Indicators): The critical measurements of progress toward an intended result. KPIs provides a focus for strategic and operational improvement and create an analytical basis for decision making.

Latency (Telecomm): The amount of time it takes for a packet of data to get from one designated point to another.

LED (Light Emitting Diodes): These are semiconductor light sources that emit light when an electrical current flows through it, without emitting an arc of electricity.

Locks Campus Microgrid: A testbed microgrid site at the Company's Locks Campus focused on gaining an understanding of distributed energy resource performance characteristics, vetting new technology integration into the distribution grid, and evaluating microgrid architecture and operational requirements.

Machine Learning: A subset of artificial intelligence that allows computers to use algorithms and statistical models to perform certain tasks without needing explicit instructions from an operator, rather relying on patterns and inferences from data instead.

Mainfeeder Hardening: Activities directed at improving reliability and resiliency of mainfeeder sections through a combination of: rebuilding to newly implemented stronger design and material standards ("new standards"), relocating, converting to underground, or constructing feeder ties.

Mainfeeder: The three phase sections of a feeder that distribute electrical power from substations to tap lines and individual customers.

MDMS (Meter Data Management System): System that processes and stores interval data used for billing; calculates billable consumption for interval meter data.

Mesh network: The information network created from smart meters communicating with each other.

Microgrid: A group of interconnected loads and distributed energy resources that act as a small power grid, able to operate when connected to the larger distribution grid and also able to continue to operate as an "island" when there is an interruption or other grid disturbance that affects normal power flow from the grid.

Microgrid Controller: A device that enables the establishment of a microgrid by controlling distributed energy resources and loads in a predetermined electrical system to maintain acceptable frequency and voltage while the microgrid is disconnected from the distribution grid.

MPLS (Multi-Protocol Label Switching): A mechanism for the routing of communications within a network as data travels across network nodes.

Multifamily residential charging: Electric vehicle charging located in common areas of multifamily housing communities for use by residents

Nanogrid: A very small power grid of interconnected loads and DERs that may serve only one or a few customers within its boundaries.

NIC (Network Interface Card): A hardware component, typically a circuit board or chip, embedded within a meter so that it can connect to a network.

One-way Energy: Power flow from a centralized location, such as a substation, along a distribution feeder, to end users.

Outage Management System ("OMS"): A system that provides tools and information to efficiently restore power and communicate status updates to customers by providing outage analysis and prediction functionality, while enhancing public and worker safety.

Glossary

PTR (Peak Time Rebate): Programs that reward customers who reduce electricity consumption during periods of high-cost electricity with monetary rebates. Those who do not reduce usage during peak events are simply charged the normal rate.

Physical Security: Enhancing the physical structures on the grid through hardening as well as increased security personnel at key locations with enhanced telecommunication and surveillance technology.

Predictive Analytics: The use of historical data to understand what will happen.

Proactive asset upgrades: Replacement of assets at or near end of life with components that provide increased functionality and higher reliability.

RAC (Rate Adjustment Clause): A mechanism to recover certain investment costs outside of the normal rate case regulatory framework.

Redundancy (Telecomm): Network redundancy is a process through which additional or alternate instances of network devices, equipment and communication mediums are installed within network infrastructure. It is a method for ensuring network availability in case of a network device or path failure and unavailability

Reliability: As used in this document, it is the ability of the distribution system to deliver uninterrupted power service to customers.

Repeater: A repeater is an electronic device that receives a signal and retransmits it. Repeaters are used to extend transmissions so that the signal can cover longer distances or be received on the other side of an obstruction.

Resiliency: The ability of the power grid to withstand outages and maintain service to customers and recover from outages to restore service to customers.

Revenue Requirement: The revenue that a regulated utility needs to earn in a test year in order to provide adequate service to its customers and a fair return for its shareholders.

RFP (Request for Proposals): This is often a competitive bidding process where vendors and contractors offer to provide a service, asset, or good for a certain cost.

SCADA (Supervisory Control and Data Acquisition): A computer system that monitors and provides control of distribution assets, primarily located at substations.

Security Information Event and Management (SIEM): A system to provide analysis of collected security events and logs to identify and detect potential security incidents as well as support incident response.

Self-healing Grid: A distribution network that uses smart grid devices such as switches, reclosers, line sensors, a secure communications network, and a control system to automatically isolate outages and reroute power to restore most customers in a matter of seconds or minutes.

Single-Phase: A segment of a power system consisting of one primary voltage conductor and one neutral conductor.

Situational Awareness: Real-time perception of the grid and its environment that allows operators to project future outcomes as well as deal with present events.

Smart Inverter: An inverter capable of modifying aspects of its output to provide grid support. Such support can include lowering or raising the voltage or shutting down when its contribution to the grid may lead to negative outcomes. Such grid support can also be executed upon receipt of communication from the grid operator to do so.

Speaker's Bureau: Consists of an experienced group of employee volunteers who share company and industry information with customers and community organization.

System Integrator: This vendor is responsible for leading the Company through design of the CIP, configuration of the new system to meet the design, integration of other applications and systems to the new system, testing of the new system to ensure that it meets all requirements, and conversion of required data from the existing system.

Tier 1: High Speed Broadband internet with very low latency and redundancy.

Tier 2: High Speed Broadband without redundancy.

Tier 3: A field area network (FAN).

Time-Varying Rates: Time-varying rates vary according to the time of day, season, and day type (weekday or weekend/holiday). Higher rates are charged during the peak demand hours and lower rates during off-peak (low) demand hours. This rate structure provides price signals to energy users to shift energy use from peak hours to off-peak hours.

Transmission Grid: The high voltage part of the electrical grid that carries bulk power directly from large generating facilities to substations throughout the Company's service territory. Typical transmission grid operating voltages range from 69 kV to 500 kV.

Three-Phase: A segment of a power system consisting of three primary voltage conductors and one neutral conductor.

Visibility (on the grid): Real-time awareness of the grid's operating conditions.

Voltage Optimization: The more precise control of distribution grid voltage that is possible with information from smart meters and a voltage control system.

Voltage Island: A single substation transformer that serves a population of customers without the support of available load transfer capability within the substation or adjacent feeders. If a single transformer fails, all customers served by the substation could face an extended outage.

Workplace Charging: Electric vehicle charging located at workplaces for use by employees.

Appendix List

A. Sponsoring Witness Chart

B. Dominion Energy Virginia's IDP White Paper

C. Maslansky Partners Survey

D. Social Media Analysis

E. Navigant Report on Stakeholder Process

F. Customer Education Approach and Plan

Note: Appendix documents available online at **DominionEnergy.com/SmartEnergy**, refer to Grid Transformation Plan SCC Filing, "Volume One."

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