Virginia Smart Grid and Advanced Metering Infrastructure
Providing Reliable, Safe, and economically viable sources of energy to meet and encourage economic growth

Innovation has always been important in Virginia. The electric industry builds its business through innovation. Adding new technologies into energy business models can help the industry meet mounting challenges faced across economic sectors. Virginia depends on reliable, safe, and economically viable sources of energy to serve growing customer needs and businesses in the state. The smart grid addresses not only the entire electric infrastructure, but also new technologies, customer interaction, legal, and regulatory issues.

A smart grid holds the promise of transforming traditional electric delivery systems into a more efficient and secure system that is able to better integrate variable supply resources while giving the customer greater options for energy consumption. Some of the largest challenges and opportunities are on the utility side of the meter. With new technological advances and management tools available, the smart grid depends on regulators, policy-makers, customers, companies, and stakeholders to consider the potential challenges that make it fair and balanced.

There are substantial benefits to moving to a more intelligent grid, not only for utilities and grid operators, but also for consumers and society as a whole. A smart grid also holds the promise of enhanced reliability and security of the power system. Virginia looks to improve the grid from a reliability stand-point that is secure, progressive and sustainable. From an economic standpoint, the smart grid can enable reduced energy consumption through consumer education and participation in energy efficiency and demand response or load control programs.

The U.S. Department of Energy defines a smart grid as the digital technology that allows for two-way communications between the utility and its customers. Sensing along the transmission (high voltage) line is what makes the grid smarter. It represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability, and efficiency that will contribute to the country's overall economic and environmental health.

Smart grid technologies can detect and isolate outages, enabling the utility to contain them before they become large-scale blackouts. New technologies can help ensure that electricity restoration resumes as soon as possible. The smart grid will also take greater advantage of customer-owned power generators to produce power when it is not available by the utility. By moving to a smart grid, Virginia can change the industry's relationship with all stakeholders, including utilities, regulators, energy service providers, technology and automation vendors as well as consumers.

Smart Grid Policy Development

The policy of the United States supports the modernization of transmission and distribution of the nation's electric system. The policy also works to ensure that the system is maintained so that future demand growth can be easily transformed. The federal government is responsible for the nation's smart grid strategy via its national energy policy. Some aspects of that policy are performed at the state, regional, local and municipal governing levels. Together these groups are pooling resources to collaborate and develop the smart grid. A smarter grid can keep the lights on as it equips the system to meet increasing demand. It decreases brownouts, blackouts and surges, gives consumers better control over monthly bills, facilitates real-time trouble-shooting, and reduces expenses to energy producers.

The first federal law concerning the smart grid was enacted by Congress in 2007. The primary smart grid focus of the Energy Independence Act of 2007(EISA) is found in Title 13 which is directed towards the goal of modernizing the nation's electricity transmission and distribution system. For this goal, 10 topic areas are included in the law:

- ❖ Increased use of digital information and control technology to improve reliability, security, and efficiency of the electric grid.
- ❖ The dynamic optimization of grid operations and resources, with full cyber-security.
- ❖ The deployment and integration of distributed resources and generation, including renewable resources.
- ❖ Development and incorporation of demand response, demand-side resources, and energy-efficiency resources.
- ❖ Deployment of ''smart'' technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.
- ❖ Integration of ''smart'' appliances and consumer devices.
- ❖ Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.
- ❖ Provision to consumers of timely information and control options.
- ❖ Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
- ❖ The identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices and services.[1]

In 2008, the Department of Energy - Office of Electricity Delivery and Energy Reliability (OE) produced a report outlining a national vision of the smart grid and the positioning of its primary stakeholder groups. The report outlines 6 key objectives for smart grid development:

- ❖ Ensuring the Electrical Grid's reliability to degrees never before possible.
- ❖ Maintaining the Electrical Grid's affordability.
- ❖ Reinforcing the United State's global competitiveness.
- ❖ Fully accommodating renewable and traditional energy sources.
- ❖ Potentially reducing the United State's carbon footprint and Green House Gases (GHG).
- ❖ Introducing advancements and efficiencies to the Electrical Grid yet to be envisioned.

Finally the OE smart grid report identifies 6 strategic opportunities from which the United States wishes to use the smart grid to realize:

- ❖ Enablement of nationwide use of plug-in hybrid electric vehicles.

[1] "Energy Independence and Security Act of 2007" **http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf**

- ❖ Deployment of large-scale energy storage.
- ❖ Seamless integration of renewable energy sources.
- ❖ Flexible consumer choice regarding electrical energy source and consumption.
- ❖ Exploit the use of green building standards to help lessen electrical load requirements.
- ❖ Making use of solar energy 24 hours a day. [2]

The American Recovery and Reinvestment Act of 2009 (ARRA) was passed in Congress initiating laws regarding funding and policy direction concerning the smart grid. The law further extended funding activities such as:

1. Smart Grid Investment Grants – served as catalyst and seed programs to enable commercial development in smart grid technologies for retail and wholesale electricity markets which included central and distributed generation and storage options, power quality diversification, asset utilization and operating efficiency of the electric power systems, etc.

2. Smart Grid Demonstration Program funding initiatives of ARRA were designed to enable the validation and verification of smart grid technologies for costs versus benefits, replications, pilot programs and new business model implementation. These programs enable customers, electricity distributors, and electricity generators to change their behavior in order to reduce electric power system demands and costs, increase energy efficiency, match electricity demand and resources and increase grid reliability.

3. Smart Grid Workforce training and development programs that help to provide for training and education of a new generation of electric power professionals. This program provided funding to train 30,000 people in a series of smart grid workforce training programs.

4. The Smart Grid Maturity Model is funding the building of a management model to help utilities track progress towards smart grid technologies implementation through the analysis of a set of criteria that includes, strategy, management and regulatory; organization and structure; grid operations; work and asset management; technology; customer; value chain integration; and societal and environmental.

In April 2013, the U.S. Department of Energy analyzed the economic impacts of ARRA funding for smart grid project deployment in the United States. The report found that many industrial sectors benefit from smart grid investments. It also noted that economic and labor impacts are substantially broader than the first line of organizations and companies receiving funds for program starts.[3]

Since the Energy Independence and Security Act of 2007, it has been the policy of the United States to modernize its electricity infrastructure for the economic well-being and security of the nation. There are many smart grid technology programs available for use - Advanced Metering

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[2] IEEE Smart grid Toolkit - **http://smartgrid.ieee.org/resources/smart-grid-news/12-resources**

[3] Smart grid Investment Grant Program – April 2012
http://www.smartgrid.gov/sites/default/files/doc/files/Smart%20Grid%20Economic%20Report.pdf

Infrastructure (AMI) is the most widely used because of the broad benefits available for the utility companies and its customers.

Smart Meters and Advanced Metering Infrastructure (AMI)

A smart meter is a digital electronic device that measures and records usage data in intervals of an hour or less and communicates that information back to the utility. Advanced Metering Infrastructure (AMI) technology features two-way communications between the utility and the meter, providing interval and time-of-use data to measure residential, commercial, and industrial customer usage.

The U.S. Energy Information Administration (EIA) notes that 493 U.S. electric utilities had 37,290,374 smart metering installations in 2011. Approximately 77 percent were installed by investor owned utilities and about 90 percent were residential customer installations. Also, in 2011 more than 23 percent of all U.S. electric customers had smart meters. The meters support demand response and distributed generation, can improve reliability, and also provide information that consumers can use to save money by managing their use of electricity.[4]

Advanced Metering Infrastructure (AMI) includes smart meters or digital versions of the traditional electrical meter attached to the outside of homes. These meters can measure and record electricity usage at a minimum of one minute intervals and have the ability to provide data to both the utility and the utility customer on a daily basis. AMI meters can also be queried to provide real-time data using on demand read features.

The possibilities of the smart grid are bringing many changes to the way electricity is produced, transmitted, distributed and metered. These active components of the utility communications network are used more widely across the states to send and receive information securely and accurately. In fact, the transformation underway is directly related to the American Recovery and Reinvestment Act. The Department of Energy has funded projects helping the electricity industry implement smart technologies and systems designed to increase grid flexibility, reliability, efficiency, affordability and resiliency.

Virginia Advanced Metering Infrastructure (AMI)

During hot summer months, the region has experienced some of the warmest days seen in the United States in recent years. These conditions pose a real challenge for electric utilities operating in these states. Dominion Virginia Power, Rappahannock Electric Cooperative, Appalachian Power Co. (American Electric Power) and Northern Virginia Electric Cooperative are four companies leading the effort in Virginia. With a smart meter in place, consumers can become more informed about energy consumption and how much it costs to use individual appliances. Advanced technologies, tools and processes are working together across the Commonwealth to respond digitally to the changing demand for electricity in an increasingly complex environment. As the state moves forward, Virginians can experience fewer outages, more efficient operations, faster power restoration, and cost savings. System operators are more aware of abnormal conditions on the systems that provide electricity across the state. Better

[4] U.S. Energy Information Administration – "How many smart meters are installed in the U.S. and who has them?" **http://www.eia.gov/tools/faqs/faq.cfm?id=108&t=3**

awareness can lead to improved reliability, less possibility for outages, and less time needed to restore power.

Dominion Virginia Power is the largest electric utility in the state. Dominion's Powering Virginia Plan began in 2008. The plan provides a jump-start toward meeting the 10 percent conservation goal enacted by the Virginia General Assembly and the governor. This enables the state to be within one-third of its goal within a five year period. The smart grid would allow energy to be delivered more efficiently, resulting in significant savings, by allowing precise control over its flow. According to an IEE smart meter survey completed in May 2012, Dominion has installed over 100,000 smart meters across Virginia in an effort to demonstrate the technology and customer benefits.[5]

Rappahannock Electric Cooperative has a Smart Grid Enabled Consumer Participation Initiative involving the deployment of AMI meters, its distribution system infrastructure and a communications network to support the new smart grid assets. The project is focused on a portion of the utility's service territory acquired from Allegheny Power. The deployment of smart meters throughout the service territory allows the cooperative to introduce and test advanced pricing programs for meter data management and distribution automation equipment including supervisory control and data acquisition (SCADA), and automated controls on distribution voltage regulators to improve power quality, reduce line losses, and reduce operations and maintenance costs through monitoring and control of the distribution voltage. Rappahannock received a federal grant totaling $15,694,097 to help implement this program in Virginia.[6]

Northern Virginia Electric Cooperative (NOVEC) has engaged in a distribution system automation program to deploy digital devices to expand automation and control systems to cover a majority of its substations and distribution circuits. The project also deploys a new communications network to compliment the distribution system upgrades and producing better monitoring of grid operations. The project aims to improve system efficiencies, reduce line losses, and enhance situational awareness of the system and critical components to improve reliability and lower operating costs. NOVEC also received a federal grant to help implement its program in its service territory in Virginia. According to IEE's September 2011 update, the U.S. Government has subsidized utilities with at least $10 billion to interface power plants, substations transformers, transmission lines, and home wiring. The Obama administration provided $1 billion in matching funds in the 2009 stimulus bill, to assist companies in deployment of new innovation for energy efficiency.[7]

AEP is committed to installing smart meters for all its customers by 2015. AEP's utility units operate as AEP Ohio, AEP Texas, Appalachian Power (APCo Virginia and West Virginia), AEP Tennessee, Indiana Michigan Power (I&M), Kentucky Power (KPCo), Public Service Company of Oklahoma (PSO), and Southwestern Electric Power Company (SWEPCo) in Arkansas, Louisiana and east Texas. Appalachian Power offers programmable thermostats that can be

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[5] IEE May 2012 "Utility Scale-smart meter deployments, plans, & proposals" **http://www.edisonfoundation.net/iee/Documents/IEE_SmartMeterRollouts_0512.pdf**

[6] SmartGrid.Gov – Virginia **http://www.smartgrid.gov/project/rappahannock_electric_cooperative_smart_grid_initiative**

[7] SmartGrid.Gov-Virginia **http://www.smartgrid.gov/project/northern_virginia_electric_cooperative_electric_distribution_system_automation_program**

reconfigured for consumer use in Virginia. The Ecobee thermostat includes touch screen interface and internet control from a mobile device. The Nest programs continuously adjust to the needs of the consumer by automatically creating a personalized schedule to optimize energy efficiency. The program includes real-time wireless control that adjusts to the needs of the consumer.[8]

AMI smart meters and communications capabilities, combined with special rate plans, allow customers to better understand energy consumption and respond to various pricing signals, to reduce electricity use.

Customer Savings and Economic Benefits

The smart grid can deliver many benefits at individual, community and statewide levels. The smart grid helps to keep the lights on, lowers energy costs, and secures energy independence. Smart grid-AMI deployments positively impact employment and labor income throughout the economy.

The bulk of the benefits from the smart grid will come from the operational side. Benefits associated with AMI deployment can be broadly categorized as:

- ❖ System Operation Benefits
- ❖ Customer Service Benefits
- ❖ Financial Benefits

System Operation Benefits - primarily associated with reduction in meter reads and associated management and administrative support, increased meter reading accuracy, and improved utility asset management, easier energy theft detection, and easier outage management.

Customer Service Benefits - primarily associated with early detection of meter failures, billing accuracy improvements, faster service restoration, flexible billing cycles, providing a variety of time-based rate options to customers, and creating customer energy profiles for targeting energy efficiency/demand response programs.

Financial Benefits – according to the National Energy Technology Laboratory (NETL), individual financial benefits to the largest consumer group, the residential class, although positive, may not prove large enough in some cases. Consumers who bear the cost of the smart grid are concerned that the expected benefits may not materialize. Potential bill savings depend on a number of factors. Recent pricing experiments suggest that a range of 10–15 percent savings in a consumer's electricity bill is realistic. An average savings of $10–$15 per month can be expected for the average residential customer with an electricity bill of $100 per month. This does not consider the increased cost to pay for new smart grid technologies. For an assumed cost of $5–$10 per month to cover the cost of new smart grid technologies, the value proposition for residential consumers reduces to $0–$10 per month.[9]

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[8] American Electric Power Company, Inc. Smart Technologies
https://www.appalachianpower.com/save/eNewsletter/ViewStory.aspx?StoryID=171

[9] **NETL Smart grid Implementation Strategy – Understanding the Benefits of the Smart grid v1.0 -2010 –**
http://www.netl.doe.gov/smartgrid/referenceshelf/whitepapers/06.18.2010_Understanding%20Smart%20Grid%20Benefits.pdf

Industrial sectors include computer system design, technical and scientific services and consulting, and electrical/wireless equipment and component manufacturing. Industrial sectors that experience indirect and induced benefits include real estate, wholesale trade, financial services, restaurants, and health care. Advanced metering benefits both utilities and consumers by offering extensive and up-to-date information about energy efficiency. Advanced metering is also considered to represent a starting point for a broader set of smart grid initiatives and is fundamental to the modernization of today's energy networks.

Global Investments and Savings

In a report released in March, 2013 by the Worldwatch Institute, global investment in smart grid technologies totaled $13.9 billion worldwide in 2012. The report states the U.S. invested about $4.3 billion in smart technologies in 2012.[10]

Smart meters are globally replacing traditional meters for electricity, gas and water. Deployment of smart meters have become commonplace across the United States. The deployment drivers include lower meter-reading costs, improved outage and restoration management and reduced time in the field. The savings have been well documented and proven, even with the issues regarding customer benefits. The choice to use real-time data that once was only available in substations is providing the means for more efficient grid applications.

Conservation Voltage Reduction (CVR) is one of the first grid efficiency applications that leverages the new data provided through smart meters. CVR is a technique used by utilities to lower their system voltage to levels that are supported in the bottom part of the voltage range.

In the United States, voltage at every household outlet is a nominal 120 volts. The utility industry is allowed to operate the system in a band that ranges from 114 to 126 volts returning results of significant savings, mostly for the consumer.[11] According to the Energy Information Administration, the average consumer would save $80-180 per year once the grid is completed. The Department of Energy estimates a 15 percent reduction in annual energy consumption in areas where smart meters are installed.

Security and Interoperability

Security issues associated with meter data transmission from customer meters to AMI host systems have advanced to further ensure that only authorized devices provide and receive meter data. Innovators of the smart grid look for regulatory certainty before entering the marketplace with new tools, technology and deployment plans. Meanwhile, regulators look for assurance of mature interoperability and security before they can convey certainty.

AMI systems offered by different innovators and vendors are required to conform to standards established by the American National Standards Institute (ANSI). Also, additional standards have been set that interface between systems, such as between the host AMI system and Meter Data Management Systems (MDMS), between MDMS and other utility data systems, as well as

[10] **"Smart grid technologies gained $13.9 billion in investments in 2012" March 2013 – http://www.esewindandsolar.com/profiles/blogs/smart-grid-technologies-gained-13-9-billion-in-investments-in**

interfaces with Demand Response networks and systems further ensuring that data is stored and shared securely. With widespread deployment of large-scale AMI systems, utilities must address the task of managing the alarms and events that are generated by the meters. AMI systems do not easily integrate into Security Information and Event Management (SIEM) systems and Intrusion Detection Systems (IDSs) due to the fact that all AMI vendors do not use standard data objects for representing the alarms and events that are generated by the meters. According to EPRI, standardization will help electric utilities enhance interoperability in their operations and more quickly integrate AMI systems with their intrusion detection systems and security information and event management systems. [12]

In February 2012, The U.S. Department of Commerce, National Institute of Standards and Technology (NIST) noted that much of the traditional electricity infrastructure has changed little from the design and form of the electric grid as envisioned by Thomas Edison and George Westinghouse at the end of the 19th century. President Obama, in State of the Union Addresses early in his presidency, spoke of his vision for a clean energy economy[13] and the Administration's commitment in the "Blueprint for a Secure Energy Future."[14] The "Blueprint for a Secure Energy Future" serves as a guide for the country to upgrade and move into the 21st century, still ahead of other nations in making the necessary changes to the infrastructure. In June 2011, the White House released a report by NIST "A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future," [15] which advocates for the development and adoption of standards to ensure investment in the smart grid and that the charge set-out by the President would remain valuable in the future; to catalyze innovations; to support consumer choice; to create economies of scale to reduce costs; to highlight best practices; and to open global markets for smart grid devices and systems.

NIST has taken on the role of coordinating the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems which includes acceleration of the identification and consensus of smart grid standards; establishing a robust Smart Grid Interoperability Panel (SGIP) that sustains the development of many additional standards that will be needed; and creating conformity testing and certification. The results of NIST's ongoing work on standards for the smart grid provide input to industry utilities, vendors, academia, regulators, integrators and developers, and other smart grid stakeholders that will continue to evolve for many years into the future. Ensuring that technology adds value for generators and consumers of electricity in the most efficient and economical manner possible further ensures that everyone involved can benefit.

The Future of Smart Grid in Virginia

The utility industry is in the midst of grid modernization efforts to ensure a more secure, cost effective, environmentally safe power grid. The next generation of metering and data exchange technology or AMI technologies are the basis and most viable elements of the smart grid.

[12] "Smart grid R&D Opportunities Outlined in Two New NIST Reports" April 3, 2013. **http://www.nist.gov/el/smartgrid-040313.cfm**

[13] The White House, Office of the Press Secretary, "Remarks by the President in State of the Union Address." January 25, 2011 and January 24, 2012. See http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address and **http://www.whitehouse.gov/the-press-office/2012/01/24/remarks-president-state-union-address**

[14] The White House, "Blueprint for a Secure Energy Future." March 30, 2011. See **http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf**

[15] National Science and Technology Council, "A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future," **http://www.whitehuse.gov/sites/defalt/files/microsites/ostp/nstc-smart-grid-june2011.pdf**.

Promoting investment in smart meter deployment along with education can be beneficial in the state. The Commonwealth has an energy reduction target for 2022 of reducing the consumption of electric energy by retail customers by 10 percent of the amount they consumed in 2006.

Even with conservation, Virginia's demand for electricity is expected to continue growing by an estimated 4,600 megawatts by 2019.[16] In addition to improving the infrastructure for transmitting power, utility companies can meet growth demands by pursuing a balanced mix of new generating facilities, including wind, biomass and other forms of renewable energy, emissions-free nuclear, natural gas and clean coal technology.

The smart grid is still in its infancy stage. There is still much work to be done at the state and federal levels. Smart metering is a breakthrough technology that enables many applications and value streams to connect. Electric utilities are making progress in upgrading customers with digital access that if implemented properly, in combination with grid-side efficiency programs, both the utility and its customers will see benefits beyond expectation.

There is always potential for new technology. Virginia is in place to meet the challenges of a smarter gird where there maybe few roadblocks to restrict its development. It is also just one state among many that is overdue for game-changing policies. Like any other successful transformation, progress will be measured by the goals set during implementation.

The future of the grid will depend on an all of the above approach in regulatory schemes, technological advancement and customer education. As the country embraces renewables, a smarter grid can motivate movement toward creating a more efficient system. Today's technology provides for real opportunities to transform shared thoughts of clean energy into reality. If Virginia is successful, its leadership is one that should be followed.

Some policy trends to watch in 2013 include:

- Regulators with forward-thinking influence on utilities allowing them to consider distribution load and new sources without affecting reliability or resiliency.
- A statewide and industry focus on transactive energy, which can conceptualize the impacts of widely distributed energy sources on utility business models, technologies/services, markets, and consumers.
- The connection between water and energy which could be a dominant part of project and technology management in the future.
- Finally, some consensus in Congress allowing for Master Limited Partnerships (MLPs) for renewable energy, which is currently limited to oil and gas investments.[17]

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[16] Electric Energy online – "Charlottesville to be First City in Dominion Virginia Power's Smart grid' Network" June 2009. **http://www.electricenergyonline.com/?page=show_news&id=113924**

[17] "Smart grid Policy Trends to Watch in 2013" by Christine Hertzog; The Energy Collective; January 2013 **http://theenergycollective.com/christine-hertzog/167991/smart-grid-policy-trends-watch-2013**

Micro-Grid
A microgrid is a localized group of electricity generation, energy storage, and loads that normally operate connected to traditional centralized grids. Generation and loads in a microgrid are usually interconnected at low voltage. A connected microgrid can be controlled as if it was one entity and can include fuel cells, wind, solar, or other energy sources.[18]

Many people believe traditional energy generation resources are diminishing and policy makers are beginning to look for new roadmaps to increase energy efficiency and sustainability as well as major modes of modernization of energy distribution grid infrastructure. While each microgrid has to satisfy its own localized constraints and objectives, limitations and objectives enforced by the whole smart grid and/or other microgrids impose extended and more conservative constraints.

A well designed microgrid can provide an efficient and economic way to manage and deliver electricity to local users. Economic and environmental benefits to smart grid users are also maximized while minimizing energy loss through transmission over long distances. Other savings can be seen through smart use of power and more distributed generation. Smart microgrids are reliable and can help consumers and businesses save substantially each year in costs lost due to power outages. Local generation can minimize peak power costs and the microgrid allows users to procure power in real-time at lower costs. Local generation is more efficient and reduces transmission line losses. Smart microgrid technology empowers consumers, stimulates future electricity innovations and activates entrepreneurial free-market funding.

There are consumer benefits to using a smart microgrid including increases in reliability, revenue, and economic growth. A microgrid is also more adaptable to future changes, reduces the utility carbon footprint, and maximizes the use of clean, renewable energy. Microgrids can also back up the bulk power grid when power demand and cost are high. A well designed microgrid can produce enough energy to meet the power needs of its users within the grid and stimulate future electricity innovation and free market funding.

Vehicle-to-Grid-Power
Many Virginians may decide to replace their traditional automobile with an electric vehicle. The change will require a reliable, low-cost way to recharge the vehicle at convenient locations at anytime. Millions of owners plug in to charge their electric vehicles. States that take advantage of smart grid technologies will be ready to handle the new demand, seamlessly. A smarter grid can safeguard Virginia consumers' position at the forefront of the world's transition toward a clean energy future. Vehicles-to-grid technology can be used with BEVs and PHEV plug-ins and provide extra grid capacity. Since most vehicles are parked an average of 95 percent of the time, EV batteries could be used to let electricity flow from the car to the power lines and back, with a value to the utilities of up to $4,000 per year per car according the Idaho National Laboratories.[19]

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[18] The Economics of Distributed Generation June 30, 2011 by John Farrell; **http://www.ilsr.org/economics-distributed-generation/**

[19] Vehicle-to-Grid-(V2G) Power Flow Regulations and building Codes Review by the AVTA. September 2012; Executive summary. **http://www.1.eere.energy.gov/veiclesandfuels/avta/pdfs/evse/v2g_power_flow_rpt.pdf**.

There is regulatory uncertainty with the new market transformation to electric transportation. Electric utilities must communicate on both the threats and opportunities going forward. The past structure of the electricity markets, based on stable and long-term planned traditional generation matched against predictable growth in consumer demand, is beginning to change. The drivers for this change are based on many worldwide views such as the recession, renewable energy portfolio standards, availability of electric cars, instability in oil rich regions, unstable petroleum prices, and the promotion of demand response programs. Regulators must stay abreast of development in the market adoption of PEVs and collect as much information from the industry as possible.

Virginia has adopted a pilot program to evaluate various EV programs. The State Corporation Commission (SCC) is in an information gathering stage and will likely phase in additional programs to provide useful data that may influence proposed policy changes. The SCC has approved a recharging pilot designed to test whether electric vehicle owners will choose to recharge vehicles during off-peak hours in exchange for lower electricity costs. Virginia has been identified by industry experts as potentially one of the most active markets for plug-in-vehicles. The benefits for having one of these vehicles can include fast response to energy storage, improvements in reliability and improved viability without too many technological changes.

Energy Storage

Energy storage is a very important part of the smart grids being built today. These grids are made to improve the reliability of electricity transmission and distribution, facilitate the integration of renewable energy generators, and allow long-distance trading of electricity supplies. All of these functions depend on the grid to offer safeguards where electricity can be stored locally.

Grid-scale energy storage is rapidly changing. Regionally, grids have incorporated storage through the use of conventional batteries or through major projects like compressed air storage. Energy storage in Virginia could help resolve the variability in power demand in the Regional Transmission Organization. PJM has noted that combining wind and solar with storage provides greater benefits to grid operations and the potential to achieve economic value. In Arlington, Virginia AES Energy Storage has plans to bring an additional 40 megawatts (MW) of advanced energy storage resources to the region that will provide frequency regulation service to the market. In addition, these plans will establish a new energy technology that is safe and reliable, which does not require water or have direct emissions. The new technology operates in the PJM region and serves customers in the United States and South America.

Solar and wind are great sources of clean, renewable energy, but integration will become a challenge. Some of the new just in time technological advances match demand to maintain stability. Pumped hydro storage is efficient as well as building large-scale lithium-ions however, both technologies remain expensive and ultra-capacitors and flow batteries have specific uses. Jesse Berst, founder of Smart Grid News.com, forecasts that grid-scale energy storage markets will grow nearly 4,000 percent by 2017.[20] Demand for grid energy storage will see nearly a

[20] Jesse Berst, Smart grid News.com **http://www.smartgridnews.com/artman/publish/Technologies_Storage/Is-this-for-real-Market-researcher-claims-grid-scale-energy-storage-will-jump-4-000-in-four-years-5705.html**

3,954 percent increase from $2.8 billion to $113.5 billion in 2017 and could reach 185.4 gigawatt-hours (GWh) of capacity compared to 3.2 GWh in 2012. As partnerships form and smaller players exit the business, technology developers will seek higher profile corporate partners to develop and market their products.[21] Partnerships are essential to the success of new technology. A key aspect of the technology is that it can aggregate power from multiple electric vehicles to create one larger power resource, rather than individual, smaller ones.

For grid operators, new technology can be innovative and energy storage achievable as it shows potential to balance the power provided by intermittent renewable resources such as wind and solar. Energy storage could also take wind power generated at night and store it for use when demand is higher. As electric cars become more popular, it is believed that a network of thousands of plug-in cars may help to stabilize the grid.

Smart grid On-site Distributed Generation

Distributed generation allows for the collection of energy from many sources, providing lower environmental impacts as well as improved security of supply. Distributed generation plants are produced in bulk but are small, and less site-specific. Their development came about with concern over externalized costs of central plant generation and environmental concerns. The aging U.S. electric grid infrastructure and higher costs for energy were also of concern.

Distributed generation can reduce the amount of energy lost in transmitting electricity because the electricity is generated in proximity to where it is used, thereby reducing the size and number of power lines that have to be constructed. Typically distributed energy resources range from 3 kW to 10,000 kW and are used to provide an alternative to or an enhancement of the traditional electric power system.

One of the more popular sources of distributed generation is solar panels. The costs to install and operate are comparable to coal power plant costs.[22] Another source is small wind turbines. These have low maintenance, and low pollution however, construction costs are high. Wind also tends to be complementary to solar; on days there is no sun there maybe wind and vice versa.

For reasons of reliability, distributed generation resources would be interconnected to the same transmission grid as central stations. There are technical and economic issues that occur in the integration of these resources into a grid. A large scale deployment may affect grid-wide functions such as frequency control and allocation of reserves.

Benefits of Distributed Generation

Consumer benefits of distributed generation include: selling surplus power to the grid, which can yield significant income during times of peak demand. Distributed technologies may also provide benefits in power reliability for facilities that require uninterrupted service. Because the power is produced locally, they can help the entire grid by reducing demand during peak times and minimizing congestion on the network.

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[21] PRNewswire April 18, 2013; **http://www.prnewswire.com/news-releases/how-to-find-high-profile-corporate-partners-in-the-global-grid-storage-market-leaders-in-grid-scale-battery-storage-203595821.html**

[22] Solar Panel Installation cost; **www.http://solarpanelinstallationcost.com/solar-cost-debate.html**

In Virginia, distributed generation is a key element in the state's energy future. The elements include large electric power that is localized, increased power stability, availability and reliability, increased facility wattage, and growth of a dedicated power system. Statewide, the promise of distributed generation is very interesting for policymakers and regulators. Its role in Virginia's energy future is bright. With more than 4,500 high technology firms, the role and potential of distributed power is important, both in maintaining the existing infrastructure, and attracting new high-tech companies to the state.

The implications of distributed generation for Virginia's high-tech industries include, improving industry power quality and reliability, streamlined permitting to generate power while serving thermal and cooling loads, and providing a power solution for the states ozone non-attainment area due to low emissions. Distributed generation represents a viable long-term strategy in Virginia and interconnection has become easier as well. Virginia is on track to being one of the nation's most technological savvy states. The state continues to develop all of Virginia's energy resources and encourages the development of renewable energy. This work also supports Governor McDonnell's pledge to be the first state to produce energy offshore.

AABE Principles

In November 2012, the American Association of Blacks in Energy (AABE) set an agenda to publish a set of principles to guide U.S leaders in making decisions on several issues of importance in the energy industry. To enhance and participate in discussions on smart grid policy, AABE believes the technologies are generally seen as improvements for the modernization of the electric grid. The advocacy group is taking steps to educate and communicate on issues of importance in this country that are important in the states and in Congress.

The Virginia Chapter of AABE is active and engaged in the energy policies of this state. We take great pride in communicating and educating others in the community about energy policy. We believe smart grid technologies can play a key role in reducing the cost of energy by deferring the addition of new power generation facilities through improved demand response programs, and strategic voltage reduction. As smart grids evolve and the presence of consumers increases, some experiences from the early growth of groups like AABE can be expected to be informative and important.

AABE Smart grid Principles

The American Association of Blacks in Energy (AABE) recognizes the need for increased Participation in the discussion on smart grid policy by historically underserved communities. To that end, AABE supports the following Smart grid principles.

- AABE believes that smart grid technologies are generally seen as improvements for the modernization of the electric grid, which can potentially provide benefits to underserved communities.

- AABE believes that support for smart grid technologies through tax credits and other incentives (e.g., loan guarantees and research programs) is desirable to the extent that these tools will help provide options that can potentially reduce consumer costs and enhance electric system reliability.

- AABE believes that smart grid technologies training and deployment can potentially spur economic growth and job creation in underserved communities. Where practical, procurement of smart grid products and services from minority business enterprises is encouraged.

- AABE believes that adoption of smart grid technologies is not without risks, as these new technologies may be more susceptible to cybersecurity attacks and intrusions. Providers of Smart grid systems should seek to evaluate and protect the grid from all legitimate cybersecurity threats.

- AABE believes that smart grid technologies can provide greater flexibility for underserved communities to help control and potentially reduce energy costs. Greater awareness is needed for underserved communities to understand the costs of deploying smart grid technologies and the expected benefits.

- AABE believes that smart grid technologies are generally seen as lower-risk technologies which enhance the performance of existing generation, transmission, and distribution facilities. Much of the smart grid would be deployed on distribution level systems, enhancing existing services and enabling new consumer services.

- AABE believes that smart grid technologies can potentially enable consumers to better control their consumption of electricity in order to facilitate consumer-friendly participation in conservation and load management.

- AABE believes that smart grid technology operators should protect the privacy of customer data by integrating privacy requirements and customer consent into smart grid planning and design from an early stage. Details of an individual customer's energy usage should remain private.

- AABE believes that the benefits of smart grid technologies could be enhanced through the use of voluntary pricing approaches made available to the customer, and through expected improvements in a utility's ability to maximize system performance.

- AABE believes that the safe and cost-effective adoption of smart grid technologies can help improve the nation's electric power infrastructure making the system more efficient and reliable, thus reducing power outages. Smart grid technologies can also play a key role in reducing the cost of energy by deferring the addition of new power generation facilities through improved demand response programs, and strategic voltage reduction.