The Future of the Grid

Evolving to Meet America's Needs

National Summit

Pre-read Materials

Hosted By

June 26, 2014

Dear Summit Participant:

Thank you for participating in the U.S. Department of Energy's (DOE's) Office of Electricity Delivery and Energy Reliability (OE) and GridWise Alliance's (GWA) *The Future of the Grid – Evolving to Meet America's Needs National Summit*. Over the past six months, DOE OE and the GridWise Alliance have facilitated four regional workshops across the country to obtain stakeholder views on the ways in which the grid must evolve to meet America's energy needs and customer expectations by the year 2030. This National Summit is the culmination of these workshops, during which panelists will discuss and debate the key themes that emerged from the regional discussions and participants will ask questions, contribute ideas and recommend actions to move the industry forward.

To assist attendees in preparing for the meeting, we have consolidated key findings from the regional workshops to provide an overview of the vision that is emerging. So we can have richer, more informative, and productive discussions, please take a few minute to become familiar with these materials. Your participation and insight are critical to the success of this effort.

We will be soliciting your input on the action steps to move our industry forward. The Summit intends to develop both a vision of and a framework for achieving a sustainable and modernized electric grid. To achieve this desired future electric grid, the Summit seeks to identify key barriers and a recommended range of actions to overcome them including both regulatory changes and R&D efforts.

Sincerely,

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Background

The U.S. electricity system is undergoing a major transformation that will continue for the next 25 to 30 years. The rapid evolution of electricity supply and end use will have major implications for reliability, transmission and distribution, customer engagement, security, and integration.

The GridWise Alliance (GWA) and the U.S. Department of Energy's (DOE's) Office of Electricity Delivery and Energy Reliability (OE) hosted four regional workshops across the country to develop an industry-driven vision of the nation's future electricity grid. The regional workshops brought together members of key stakeholder groups including utilities, regulators, state government officials, renewable energy providers, suppliers, and industry innovators. These thought-leaders provided input on the changing role of grid operators and the needed capabilities including new technologies and financial models to drive investment, as well as the policy and regulatory barriers that must be overcome to realize this vision.

Figure 1. Workshop region designations

The region designations for the workshops are identified in Figure 1 and align along Independent System Operator (ISO)/Regional Transmission Organization (RTO) markets.[1] California, due to its unique blend of characteristics, was included in both the Western and Central Region workshops.[2]

Each of the four regional workshops began with a visioning exercise, and then participants split into breakout groups to discuss the future state of the grid based on one of five different scenarios that were provided. The scenarios served to guide the discussion of "2030 grid operations" from important and somewhat different perspectives. These scenarios were based on key factors anticipated to have a significant impact on the grid but were not intended to be an exhaustive examination of what is possible in 2030.

The scenarios discussed at each workshop were:

- Balancing Supply and Demand as Grid Complexity Grows

[1] While not pictured, Hawaii and Alaska were included in the Central Region workshop.
[2] California is geographically aligned with the Western Region and shares many renewable energy and environmental drivers common to other Western Region states. California is also aligned with the Central Region in terms of its use of an ISO to regulate its wholesale market and the nature of the utility-customer relationship.

- Involving Customers and Their Loads in Grid Operations
- Higher Local Reliability through Multi-Customer Microgrids
- Transitioning Central Generation to Clean Energy Sources—Large Wind, Large Solar, and Large Gas
- Planning for Empowered Customers[3]

Prior to each workshop, participants were given an extensive set of pre-read materials describing the scenarios and highlighting factors to consider. These materials set the stage for the workshop and provided context for the discussions. Reports summarizing the regional meeting discussions and highlighting the key findings, the messages to policy makers, and recommended actions were developed. The pre-read materials and summary reports can be found online at http://www.gridwise.org/.

[3] For the Southeast and Northeast Regions this scenario was combined with the second one, *Involving Customers and Their Loads in Grid Operations*.

National Summit Approach

This National Summit will be structured in a panel format. The panels will be comprised of industry thought-leaders. A moderator will engage participants and panelists in discussions about the industry's transition in critical focus areas. The critical focus areas and titles for each of the panels are:

- **Evolution of Grid Operations (Innovation on the Edge)**
- **Evolution of the Business Model**
- **Evolution of the Regulatory Model**
- **Path Forward: Transitioning to the Future Grid**

This document consolidates key findings captured in the regional summary reports as they pertain to the different panels. While reviewing this document consider the most compelling finding and ponder what issues need to be addressed first. Participants will have an opportunity to ask questions of the panelists and provide input on these topics. In addition, polling will take place during the Summit to obtain participants' opinion on important transition topics.

Panel #1: Evolution of Grid Operations (Innovation on the Edge)

Across all scenarios and regions, participants asserted that the grid of the future would operate differently and play a different role in the electricity value chain than the grid of today. Distribution will no longer be just load and the electric flows on the grid will be more complex. The panel and participants should consider the workshop findings below when debating the *Evolution of Grid Operations (Innovation on the Edge):*

- **The role of the grid is significantly changing and grid operations will be more complex.** The grid will no longer be a "pipe" to deliver "kWh" from central generation to distributed loads. The grid will enable a "two-way" flow of energy and services with customers being both consumers and producers. It will become the enabling platform for a dynamic energy network. **While inwardly complex, the grid's interface must be outwardly simple for customers.**
- **The grid must be more flexible and responsive.** With the increasing penetration of intermittent renewable energy resources, the grid will need to be able to respond to wide fluctuations in supply both from central and distributed generation.
- **The future distribution grid will more closely resemble today's transmission grid.** The distribution grid will be an enabler for a new "retail market" where customers can be both consumers and producers of energy services. ISO, transmission, and distribution operations must be tightly integrated to insure grid stability and to optimize the use of all available resources.
- **There should be a transactive energy component that provides clear and direct pricing signals to customers and devices.** Pricing signals will need to be transparent so customers can evaluate short and long-term energy decisions such as installing PV or other distributed generation or selecting a given pricing plan.

- **Visibility will be needed to the edges of the grid.** Real-time, automated communications to distributed energy resources/devices will be needed.
- **Real-time knowledge of operational conditions across the entire grid will be required to manage two-way power flow from end customers.** Real-time monitoring and analytics of the distribution systems will be needed; these capabilities will allow for more efficient dispatch and system balancing of the distribution and transmission systems.
- **Operations will be more predictive, rather than reactive** due to cognitive computing and near real-time communications with devices on the system. Operations will feature more decentralized decision-making.
- **High-bandwidth, low-latency, cost-effective, interoperable communications systems** will overlay the grid. The communications systems will have to process more data and will enable access to and analysis of real-time data, allowing energy providers and automated systems to act on it in near real-time. Data will need to move from source to operation systems within distribution, transmission, and ISO/RTOs in near real-time. Communications systems will need to enable a "plug and play" capability for end devices to communicate to grid operation systems.
- **New analytic capabilities will be required.** Better tools will be needed to analyze the huge amounts of data and support automated operations.
- **Some customers will expect greater choice and control over their electric generation.** Some customers will want to install distributed generation whether they hire someone or do the work themselves. Utilities will need to develop capabilities and services that meet the needs of all customers—from very interested buyers to customers who do not want to worry about their electricity usage or may just want to select a "set-it and forget-it" option.
- **To maintain grid stability, a mechanism must be in place to control the interface with the grid,** as well as provide signals to end devices to produce the desired outcome by customers or other entities participating in the grid.
- **Microgrids will have a place in the future grid.**
    - **There could be both physical and virtual microgrids, as well as utility-owned, community-owned and privately-owned microgrids.**
    - **Multi-customer and single customer microgrid operation could be complementary to the grid system and increase resiliency**.
    - **Aggregating distributed generation into microgrids could offer benefits** for managing significant concentrations of distributed generation and customer-owned renewables.
- **Energy storage will aid in mitigating intermittency**. Energy storage will be a critical component because it will provide flexibility for managing and operating the grid. It will allow opportunities for mitigating the variability in solar photovoltaic (PV) and wind energy systems, as well as some spinning reserve requirements. Energy storage could also be an important microgrid component for this reason and could improve the technical and economic feasibility of these systems.

- **Balancing authority will be complex.** There are varying views on whether more or fewer balancing authorities will be needed. Some participants believe that a new balancing authority will have to be established at the distribution operator level to focus on balancing supply and demand at the distribution level. Some participants believed that all this could be handled by the transmission operator/ISO. There was debate over whether transmission-level balancing authorities will be consolidated into larger regional authorities.
- **Workforce education will be necessary**. Employees will need new skills and training. A combination of operational technology (OT) and information technology (IT) skills will be key to operating these new complex systems. Dispatch/control center operators will also need increased skill sets.

Panel #2: Evolution of the Business Model

Across all scenarios and regions, participants noted that utilities would need to be incentivized and compensated differently in the future to ensure that the grid has the capabilities needed and that utilities remain financially viable. Given the changing industry landscape, the traditional model of recovering investments over a 30-year capital asset life is increasing the risk of stranded investments which in turn is limiting necessary grid investments. Below is a summary of the regional workshop findings to consider when discussing the *Evolution of the Business Model:*

- **Grid owners and operators will need to be compensated for the value they provide.** The values of the grid that workshop participants highlighted are:
    - Providing safe, reliable, and affordable electric service to customers;
    - Integrating all generation types and being agnostic as to origin of supply;
    - Increasing operational efficiency;
    - Engaging customers and providing them a mechanism to participate and provide services back to grid;
    - Enabling and facilitating a two-way retail market ;
    - Managing the system to optimize assets including customer response options; and
    - Supporting/implementing public policies
- **The role of the Transmission and Distribution (T&D) utility will shift from commodity provider to customized consumer services provider (all-premise management).** A modernized grid will enable additional services and products that are not possible today. Revenue for T&D should be based on services provided, not on capital asset investments.
- **Costs will need to be disaggregated.** The cost for electricity needs to be broken down into its components in order to develop new service pricing structures. Pricing will need to be transparent so customers can make fully informed decisions.
- **Utilities could offer a portfolio of selectable services including ancillary services, reliability, microgrids, and backup power. New pricing plans should be created for these services. Pricing must be flexible and the regulatory model must change to allow for this flexibility.** The pricing plan design will need to accommodate customers' desires, as well as include considerations for

socializing some costs to protect low-income customers. Services will provide consumers options related to what they care about (e.g., the environment, cost, and cutting-edge technology).

- **Pricing models should consider the following:**
  - The question of energy equality, namely, whether access to electricity is a basic right;
  - The implications of large numbers of customers disconnecting from the grid;
  - The value to customers of new services and programs;
  - The total cost of electricity including externalities; and
  - The barriers that exist around rate structures that prevent utilities from offering the services customers want.
- **Pricing plans must adapt to allow for new technologies and the associated capabilities they deliver**. To make the required infrastructure and maintenance investments, utilities will need a reasonable and established method for recovering the costs incurred, particularly for providing grid backup service to "net zero" customers. There will also need to be a method for recovering the capital and the operations and maintenance (O&M) costs associated with maintaining the grid infrastructure.
- **Utilities need to be incentivized to invest in innovation now.** Utilities as a group tend to delegate innovation to third parties. Utilities need to invest (and be approved to invest) in research for innovative products and services.

Panel #3: Evolution of the Regulatory Model

Across all scenarios and regions, participants stated that regulatory clarity was crucial to developing a modernized grid. The speed of the regulatory process will need to be aligned with that of technology development in order for the grid to capitalize on existing and upcoming innovation. The panel and participants should consider the workshop findings below when contemplating the *Evolution of the Regulatory Model:*

- **Regulatory clarity is needed to help utilities plan and transform.** Utilities and other players need certainty regarding the rules around cost recovery to make needed investments in grid modernization. Current rate cases are cumbersome and take too long to gain approval; they do not allow utilities to be nimble and react to changing market conditions or customer expectations. In addition, incentives are needed to encourage the right types of investments such as investments in innovation and efficiency.
- **Transparent, bidirectional, real-time, distribution-level markets for the buying and selling of services will need to be developed.** Utilities, policy makers, and regulators need to determine the additional services beyond electricity (i.e., kilowatt-hour) that utilities will be able to offer, as well as the type of services that utilities will purchase from consumers and other third parties. Once these services are determined, distribution-level markets will need to be established. Everyone should be allowed to participate in these markets.

- **Distribution utilities are positioned to coordinate and manage the retail market.** Underlying systems necessary to coordinate and manage the emerging retail market will also be vital to operate a distribution grid where end customers are both consumers and producers of services.
- **Allow for and ensure regulations and policies that provide consumer choices.** Residential, industrial and commercial customers must be kept at the forefront of decisions. Providing customers with choices and options must be balanced against the "physics" of operating the grid to the established standards.
- **Customers and third-party providers should bear the costs associated with the services they receive.** Capital investments were made and are still being paid for to build today's grid infrastructure. Customers who have their own generation but want to connect to the grid for reliability or other reasons must contribute to the building and the maintenance of the infrastructure that they use and benefit from. New third party providers of services or distributed energy resources should also bear the cost of any infrastructure and services they require from the grid and the grid operator. If customers and/or third parties want to use their own distributed generation but still connect to the grid as a backup service, they need to pay for the associated cost of this service.
- **Clearly define the obligation of utilities to serve the needs of new players (e.g., microgrids) entering the market.** If a new party provides services to customers and then leaves the market, there will be questions about how services to those customers are handled and who is accountable for providing those services. If the utility picks up the services, there will also be questions about how it will be compensated.
- **Clear and transparent public policies will need to be established regarding whether electricity is a basic right.** Policy makers will need to decide this issue in order to provide clarity and certainty about the goals for electricity delivery and help define basic infrastructure requirements. Once basic infrastructure and services are defined, policies will need to define how utilities will be financially compensated for implementing these basic services. In today's model, utilities have been tasked with implementing certain public policies through their rate structures. Current rate structures have socialized certain costs and subsidies are provided for some customer groups and programs. Uncertainty around policy and regulations could hamper future investments and may have unintended consequences. Greater direction will help utilities and new third party entrants into the market determine the business model and technology advancements that are needed.
- **Policies must be easy to implement, consistent, and supported through pricing of services.** Policies must allow for the integration of existing and emerging technologies including state-of-the-art forecasting tools. Pricing for the service rather than the asset should support policy.
- **Regulation and policy must be aligned with technology and capability.**
- **Constructive conversations are needed between regulators and other industry stakeholders to help advance the understanding about the realities and consequences of various technologies, pricing structures, and infrastructure investments.**

- **Federal and state jurisdictions will need to be refined and clarified, and better coordination between federal and state regulatory agencies is needed**.

Panel #4: Path Forward: Transitioning to the Future Grid

Across all scenarios and regions, participants agreed that a transition plan for modernizing the grid is critical to reduce the risk and cost of moving to this future vision. Stakeholders such as customers, providers, financial markets, and the workforce must understand and agree on the path forward to be successful. The panel and participants should consider the following proposed actions that emerged from the regional workshops when discussing the *Path Forward: Transitioning to the Future Grid:*

- **Define the vision for the entire electric system from generation to end use at the national, regional, and state levels.**
- **Establish priorities at the state and regional levels to align investments, the business model changes and the regulatory model changes with these priorities.**
- **Develop a national "reference architecture" from generation to end use to identify the critical components and how they interact to inform the policy and regulatory changes needed.**
- **Outline the "critical path" to the vision and align stakeholder plans to the path.**
- **Identify "no regrets" steps that will enable investments to be started while the vision is refined.**
- **Create frameworks that can be used to establish specific plans.**
- **Bring together industry stakeholders in a coordinated planning and education process similar to a task force to look closely at the various components of the transition plan.** Stakeholders should include utilities, grid operators, independent power producers, third parties, consumer advocates, trade organizations and regulators. The process should explore the role of the regulated utility of the future, how utilities make money and stay financially viable, how consumers are protected, and how social objectives are achieved.
- **Develop a stakeholder-driven transition plan/roadmap.** The transition plan/roadmap should be facilitated by a trustworthy, unbiased entity and should involve all stakeholder perspectives. The transition plan/roadmap should be stakeholder-driven and developed through frank, open discussions with all stakeholders to ensure all perspectives are taken into account. The transition plan/roadmap needs to provide enough detail to be useful; therefore, it should be completed at the regional, state, or company level. It should integrate policy pathways conducive to new business model formation. The transition plan/roadmap should provide clarity on the path forward and help facilitate an orderly evolution to the future grid.
- **Educate stakeholders.** Education of policy makers, regulators, businesses, shareholders, and customers will be critical throughout the transition to increase the understanding of all parties. Industry will need to proactively provide information to policy makers to help them remain informed and to help them understand the nuances of operations and how policies and

regulations will impact the business. Customers should be educated in their language, not in technical language.

- **Provide extensive and continuing customer education.** Customers have varying levels of understanding about electricity delivery. In the future customers will need to understand how electric services are priced and why changes to the services and pricing are needed. For those who choose to be more active participants by providing services back to the grid, additional education will be needed regarding how the electric system works, and what the costs are for the services they receive and provide.
- **Develop the future workforce**. Employees will need a combination of operational technology and information technology skills. Operators will need further education due to the increasingly high level of sophistication at the distribution level, which will require a different set of core competencies. The workforce is also in transition with a significant portion expected to retire in the next 5 to 10 years. It will be necessary for employees to know how all of the pieces fit together and to be able to deal with increasing grid complexity.
- **Leverage all the information that is being developed or is readily available in the public domain.** A continuing desire to have "a clearinghouse" of best practices, data, benchmarks, and case studies on grid investments was articulated by participants. While this has been tried before, the issue is not the lack of publicly available information (e.g. smartgrid.gov), but rather, how to effectively organize, promote, and make such information available to those who need it, when they need it.