August 11, 2014

The Honorable Ernest Moniz
Secretary, United States Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dr. John P. Holdren
Director, Office of Science and Technology Policy
The White House
1600 Pennsylvania Avenue, NW
Washington, DC 20500

Daniel G. Utech
Special Assistant to the President for Energy and Climate Change
The White House
1600 Pennsylvania Avenue, NW
Washington, DC 20500

Dear Secretary Moniz, Director Holdren and Mr. Utech:

On behalf of the GridWise Alliance, I am pleased to submit these comments on the first phase of the Quadrennial Energy Review.[1] The GridWise Alliance commends the Administration for undertaking this effort to look at our nation's transportation and electricity transmission and distribution infrastructure and storage in 2030.

Our comments focus on transmission, distribution, and storage pertaining to the electricity sector. They do not address the transportation sector, except with respect to electric vehicles and their projected impacts on the electric grid.

[1] The GridWise Alliance (GWA) consists of a unique cross-section of members, including electric utilities, information and communications technology equipment and service providers, national laboratories, academic institutions, Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs), and more.

These comments are submitted on behalf of GridWise members, with the exception of our RTO and ISO members.

GWA appreciates the opportunity to submit these comments and looks forward to continuing to work with the Administration on the Quadrennial Energy Review process going forward. For questions about this Submission, please contact: Lee Coogan, Executive Director, at: lcoogan@gridwise.org or Ladeene Freimuth, Policy Director, at: ladeene@freimuthgroup.com.

Sincerely,

Becky Harrison

Becky Harrison
CEO
GridWise Alliance

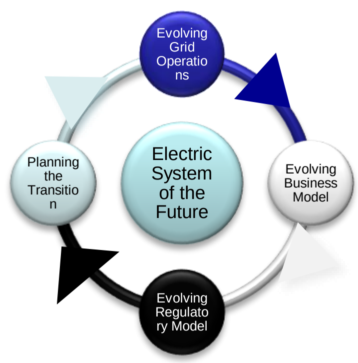
The GridWise Alliance's Comments for the First Phase of the Quadrennial Energy Review: Electric Transmission and Distribution Infrastructure and Storage

August 11, 2014

Executive Summary

Looking out to 2030, the electric utility industry will have undergone a transformation, but the ***electric grid is not going, and will not have gone, away.*** The "Grid of the Future," i.e., the Grid of 2030, likely will look very different than it does today and will be managed differently, but we will continue to need and, perhaps more importantly, will want a "wired" network to serve as the backbone of our electric power system.

GWA's framing of the discussion:



This new framework begins with a focus on the changing role of the grid as the "enabling platform" for the electric system of the future and to examine all related elements from this vantage point.

- Through this framework, one can examine the changes that will be needed to the existing ***utility business model***.
- One also can analyze necessary changes in ***regulatory models*** that must be considered and pursued.
- This new framework also must provide for greater **consumer engagement**.

None of these can be examined in isolation; rather, a holistic approach is required. GWA's findings and recommendations stem from this new and different perspective. The following vision and this frame of reference are premised on looking at where we need and want to be in 2030 and working backwards to achieve these goals, rather than looking solely in the near term.

Vision of the "Grid of the Future" in the Year 2030

The "Grid of the Future" must continue to provide abundant, affordable, reliable, power and will serve as the "backbone" of the nation's electric infrastructure. Thus, it will serve as the enabling platform to provide essential services to consumers. It also must be secure, resilient, and sustainable.

The "Grid of the Future" will consist of a two-way flow of electricity and information between central and distributed power generation sources – and other resources, including "smart" end devices – and consumers. More technically, it will serve as a fully-automated power delivery network that monitors and controls the system down to interactive end devices, of which consumers permit control. In other words, electricity and information will flow together in real time and in two (or multiple) directions, rather than the one-way flow of electrons from the utility to the consumer that historically has been the case.

The "Grid of the Future" will be able to integrate a wider array of intermittent, distributed energy resources, including microgrids. It will have advanced energy management systems and other "smart grid" technologies that provide end-to-end visibility. During extreme events, these technologies will allow for the isolation and continued service to limited portions of the grid, as needed, to prevent larger outages or provide for localized grid recovery from major weather events. The "Grid of the Future" also will possess storage capabilities. These broad capabilities will help reduce power outages and help restore power more quickly when outages do occur, and will mitigate the economic impacts from outages and power quality disturbances, as a result.

The transmission and distribution components of utilities change from being commodity providers to being "services" providers.

Central generation will continue to play an important role in the electric system of the future, however, it will not make up the entire generation mix.

- There will be more unregulated, distributed generation (e.g., rooftop solar, multi-customer and community microgrids, combined heat and power) and other distributed energy resources, such as electric vehicles (EVs) and energy storage.
- In addition, there will be more demand response, including more sophisticated responsive loads, and energy efficiency.
- In this future system, the grid operator, as well as microgrid operators, will leverage energy storage along with responsive loads and dispatchable (i.e., those that can be used or turned on, or "dispatched") generation sources in various circumstances (e.g., emergencies) to optimize the operation of the system.

While advances in energy storage will provide additional tools that that can be leveraged to manage the balancing of supply and demand, it will not replace the need to do so. In fact, with additional options for managing and optimizing the entire electric system, the complexity of this function will significantly increase.

Summary of Recommendations

I. The "Grid of the Future" as the Enabling Platform

Recommendations for this Section

1. The "Grid of the Future" is the enabling, central platform of the nation's electric infrastructure. Undertake a comprehensive approach to examine changes to the utility business model, regulatory model, and consumer engagement, using the "Grid of the Future" as the framework through which to do so.

2. Urge Congress to authorize accelerated depreciation for "smart grid" technologies, echoing NEMA's recommendation.

3. Incent microgrids and energy storage.

4. Cybersecurity: Continue the effective public-private efforts already underway on cyber security. GWA's cybersecurity principles outlined herein should underlie policy development in this area. Additional leadership and focus by industry are needed, according to GWA-DOE-OE June 2014 National Summit polling results.

5. Urge Congress to amend the Stafford Act to establish and ensure priority access for utilities and their equipment to public carrier networks during extreme events.

6. Interoperability: a) Enhance interoperability during extreme events; and, b) Support the utility industry's interest in gaining access, on an equal footing, to the Nationwide Public Safety Broadband Network and its advisory structures.

7. GWA wishes to associate itself with NEMA's recommendations to: a) Urge Congress to amend the Stafford Act to allow disaster assistance to be used to replace damaged equipment with more modern and resilient technologies, including on-site backup power; and b) Allow the use of Community Development Block Grant (CDBG) funds for the restoration – and *upgrading* of privately-owned electric utility infrastructure.

II. Changes in the Utility Business Model

Recommendations for this Section

Encourage a new utility business model such that grid owners and operators ultimately are compensated for that which will be valued in the future.

III. Changes in the Regulatory Model

Recommendations for this Section

As part of the development of a new regulatory model(s), regulators will need to compensate and reward utilities and consumers for services, rather than solely for providing kilowatt-hours (kWh), as has been the case historically.

1. State regulators should ensure processes are in place to accommodate and/or help establish rate structures for services and reward performance, taking into account a range of factors and options, aiming to help ensure that "costs incurred to transform to an integrated grid are allocated and recovered responsibly, efficiently, and equitably," as also noted by EPRI.[2]

2. State regulators should encourage utilities to develop and offer different rate structures for their consumers, based on a variety of factors and options.

3. Establish a voluntary model state regulatory framework(s).

4. Work with states to develop baseline, voluntary, output-based, model performance metrics to facilitate the "Grid of the Future."

5. States should develop new processes for reviewing and approving investments on a faster timeline.

6. The Federal Energy Regulatory Commission (FERC), National Association of Regulatory Utility Commissioners (NARUC), and other private and public sector stakeholders should work together, as needed, to enhance collaboration and coordination between state and federal entities to help better align the evolution of the transmission business model and of the distribution business model, respecting jurisdictional purviews.

7. Provide appropriate federal tax incentives and work with States and utilities to better synchronize the regulatory asset life with tax amortization periods.

IV. Changes in Consumer Engagement

Recommendations for this Section

The consumer must remain central to this transition process and the consumers' trust must be maintained.

1. Where appropriate, and respecting jurisdictional boundaries, assist in the development or expansion of state-based outreach efforts that increase consumer engagement.

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[2] Electric Power Research Institute (EPRI), *The Integrated Grid, Realizing the Full Value of Central and Distributed Energy Resources*, 2014, p. 5.

2. Relatedly, the federal government and/or state regulators should facilitate greater stakeholder understanding of the value of the modern grid and of the transition, and seek consumer engagement on a broad level along the way.

3. The DOE-OE should work with the National Ad Council to develop a consumer awareness "campaign" on the smart and resilient "Grid of the Future."

V. The Path Forward

To achieve the "Grid of the Future," i.e., the Grid of 2030, much needs to be accomplished and in a relatively short period of time.

Recommendations for this Section

1. Urge Congress to pass legislation that helps finance critical grid modernization infrastructure investments.

2. Develop and deploy an innovative suite of technologies to realize the benefits of a transformed grid.

3. Incorporate grid modernization into federal, state, regional, and local strategic and emergency planning efforts; and, identify measures that can be implemented in the near-to-medium term.

I. The "Grid of the Future" as the Enabling Platform

Background

For these comments, the term "electric system" refers to the entirety of generation, transmission, distribution, storage and end use. The term electric "grid" refers to the electricity infrastructure that lies between the generation sources and the consumer, i.e., transmission and distribution, or electricity delivery.

Today, our nation's electric system is one of the greatest "engineering achievements of the Twentieth Century," according to the National Academy of Engineering. The electric system certainly has served this Nation well in having provided accessible, abundant, and affordable electric power for decades. That said, as with any long-standing infrastructure, portions have become outdated. Outages and power quality issues result in billions of dollars of economic impacts each year. These impacts rise, as our digital economy becomes increasingly dependent on electricity.

Moreover, the electric system originally was designed to provide power in one direction: that is, from the utility to the consumer. And, although progress is being made in the area of energy storage, this capability is not yet sufficient. Thus, today's system requires that utilities match generation (i.e., supply) to demand in real time.

Consequently, our electricity infrastructure must be upgraded to ensure continued high levels of reliability, as well as to serve new loads or connect new generation sources. Over the past several years, we have experienced and, going forward, will continue to experience fundamental changes within the electricity industry on a scale we have not witnessed since the creation of the electric system more than 100 years ago.

To a certain extent, an analogy can be made to the transformation that occurred a few decades ago in the telecommunications industry.[3] The policy and regulatory changes that were enacted at that time revolutionized the telecommunications industry, the information technology (IT) industry/Internet, global communications, myriad consumer options, affordability, and much more. One should be aware that "wired" telecommunications networks (that used to connect all the way to the end device, i.e., a consumer's wired telephone line and telephone, otherwise referred to as a "land line") still exist. However, today, rather than connecting to end devices, these "wired lines" instead connect cellular towers to the larger network. This "backbone" infrastructure has been upgraded to handle these new capabilities that enable this digital world, without consumers needing to worry about how the complex telecommunications and information technologies behind it actually works.

Similarly, the electric system must undergo such a transformation to meet twenty-first century needs. As noted throughout this document, the electric system ***will retain the "grid" as the backbone or "central nervous system" of this infrastructure.*** Increasingly, however, the grid will be faced with the need to manage power flows in two (actually in multiple) directions, as well as to integrate renewable resources, electric vehicles, microgrids, storage, and much more, and its capabilities will need to be modernized to be able to do so; innovation will facilitate this transformation and create opportunities out of these challenges.

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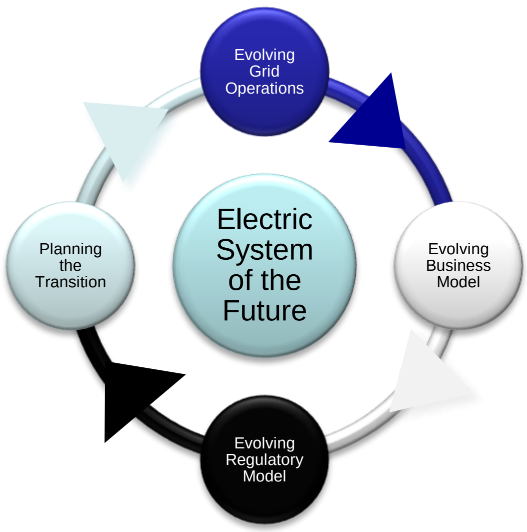
[3] Op-ed by Tony Earley, CEO, PG&E, and Edwin Hill, International President, IBEW, *Politico,* March 18, 2013.

GWA's Approach for Examining the "Grid of the Future"

Looking out to 2030, the electric utility industry will have undergone a transformation, but the ***electric grid is not going, and will not have gone, away.*** The "Grid of the Future," i.e., the Grid of 2030, likely will look very different than it does today and will be managed differently, but we will continue to need and, perhaps more importantly, will want a "wired" network to serve as the backbone of our electric power system.

The GridWise Alliance (GWA) worked with the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability (DOE-OE) to conduct four Regional Workshops and a National Summit looking at the "Future of the Electric Grid" to the year 2030 – and beyond. The insights we have gleaned from these events, has led us to frame the transformation of the nation's electric system and the "Grid of the Future" differently.

GWA's framing of the discussion:



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While advances in energy storage will provide additional tools that that can be leveraged to manage the balancing of supply and demand, it will not replace the need to do so. In fact, with additional options for managing and optimizing the entire electric system, the complexity of this function will significantly increase.

The “Grid of the Future” will need to be “agile and fractal,” meaning that it must be flexible, adaptable, and able to respond and operate as a single system or, as a coordinated set of sub-systems that each can operate individually and that also can operate in a coordinated manner, when interconnected.[4]

Recommendations for this Section

1. **The “Grid of the Future” is the enabling, central platform of the nation’s electric infrastructure. Undertake a comprehensive approach to examine changes to the utility business model, regulatory model, and consumer engagement, using the “Grid of the Future” as the framework through which to do so.**

   The “Grid of the Future” will serve as the “backbone” or “central nervous system” for the nation’s electric infrastructure. The electric grid is not going away. As the deployment of distributed resources and “smart” technologies expands, such resources will require a more robust, flexible grid that has greater, not fewer, capabilities. Distributed energy resources, such as rooftop solar, will require the grid to help provide “start-up” power for major loads, such as air conditioning, even on extremely sunny days. The grid also will be needed to supply power during extended weather periods when distributed solar cannot operate at normal output, and to supply backup power during emergencies.

   The “Grid of the Future” provides the holistic framework for examining the other changes that will be needed, i.e., changes to the utility business model, regulatory model, as well as to consumer engagement. Examining any of these elements in isolation could lead to unintended consequences.

2. **Urge Congress to authorize accelerated depreciation for “smart grid” technologies, echoing NEMA’s recommendation.**

   Urge Congress to authorize a five-year accelerated depreciation period to incentivize investment in “smart grid” technologies and equipment that help modernize the grid and increase resilience and reliability, by reducing outages, and expediting them, when they do occur. Much of this equipment is similar to computers and computer software that can become outdated in a relatively short period of time. Such technological changes should be reflected in the tax code. This provision should be voluntary, so that utilities would avail themselves of this incentive only if they wish to do so.

   The proposed tax incentive would help modernize the grid with technologies that could include, but would not be limited to: Advanced metering infrastructure (AMI), including smart meters; demand response technologies; grid-connected storage; fault location, isolation, and restoration

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[4] Fractal (Merriam-Webster): “any of various extremely irregular curves or shapes for which any suitably chosen part is similar in shape to a given larger or smaller part when magnified or reduced to the same size.” Oxford Dictionary: “A curve or geometric figure, each part of which has the same statistical character as the whole. Fractals are useful in modeling structures (such as eroded coastlines or snowflakes) in which similar patterns recur at progressively smaller scales, and in describing partly random or chaotic phenomena such as crystal growth, fluid turbulence, and galaxy formation.”

(FLIR) systems; wireless communications that enhance grid security; voltage/VAR management technologies capable of reducing overall distribution line losses; and technological improvements that enhance the ability of the grid to withstand cyber and/or physical threats,.

More specifically, the primary purpose of this incentive would be to enable the utility to flatten the demand curve, and increase the overall efficiency and resilience of the system by:
(1) Sensing, collecting, monitoring or controlling energy or data on an electric distribution grid;
(2) Providing real-time, two-way communications to monitor or manage the grid;
(3) Deploying such technologies to isolate and contain outages remotely, and restore partial power;
(4) Providing real-time analysis of data that can be used to improve electric distribution system reliability, quality, and performance;
(5) Enabling grid-connected renewable generation sources, distributed generation and energy storage capacity;
(6) Improving the safety, efficiency, quality and reliability of electrical transmission through enhanced control of voltage and power flow;
(7) Reducing peak demand through demand-response systems that remotely adjust power consumption thereby reducing the need for additional power generation capacity; or
(8) Enhancing the ability of the electric grid to withstand cyber or physical threats.

3. Incent microgrids and energy storage.

The Department of Energy and/or other appropriate federal and state agency(ies), or other key stakeholders, should incentivize microgrids and energy storage. These incentives should encourage non-rate based financing, including private financing, rate-based financing, and other incentives.

The Department of Energy should encourage Congress to authorize incentives along these lines, as appropriate, as well.

While microgrids and energy storage will offer the opportunity to enhance the resiliency of the electric system, without the proper policies, operating processes, and rules, as well as standard technical interfaces that provide ancillary services opportunities, this enhanced resiliency will not be achieved. Therefore, as incentives are implemented to encourage the development of microgrids and energy storage, States should develop policies to help ensure the successful implementation and integration of microgrids and energy storage into the larger electric system. In addition or as an alternative to such State efforts, DOE should consider using its convening powers to bring together States and the entire ecosystem of stakeholders to facilitate the development of a model policy framework(s) that will ensure the successful implementation and integration of microgrids and energy storage into the larger electric system.

In addition, the Department should facilitate the development and deployment of enhanced monitoring and control systems for the distribution grid, to accommodate small energy storage installations and other technologies/equipment. In addition, best practices for utility-based microgrids and storage should be developed, as well.

4. **Cybersecurity: Continue the effective public-private efforts already underway on cyber security. GWA's cybersecurity principles outlined herein should underlie policy development in this area. Additional leadership and focus by industry are needed, according to GWA-DOE-OE June 2014 National Summit polling results.**

   The electric sector has been working well with senior government officials from relevant federal agencies to address cyber, physical, and other threats and should continue these effective public-private partnership efforts. Innovative efforts the U.S. Department of Defense is undertaking in cybersecurity as well as cybersecurity research and development (R&D) efforts within DOE-OE and in other areas of the government should continue as should collaborative efforts with the private sector and technology transfer activities.

   GWA's has developed the following cybersecurity priorities/principles that cybersecurity policies should:

   - Facilitate secure, relevant information sharing between the government and private sector, including with vendors who supply critical systems, and should facilitate coordination and cooperation.
   - Information which private sector entities share with the government or which is appropriately collected by the government must be used solely for the express purpose(s) for which it was shared or collected.
   - They should enhance liability protections, including privacy and civil liberty protections.
   - They should consist of flexible regulations that are integrated with, and not duplicative of, existing applicable standards.
   - They also should not inhibit innovation.
   - Several of our members also emphasize the importance of establishing industry relationships that are on "equal footing" with governmental partners.

   In the National Summit on the "Future of the Grid" that the GridWise Alliance conducted in partnership with the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability (DOE-OE) in June 2014, audience polling found the following:

   - Thirty-five percent of those polled indicated that additional leadership and focus are needed by industry in this area, twenty-seven percent reflected that current industry-government efforts are sufficient, and twenty-four percent indicated that additional policy and regulation are needed at the federal level. Smaller utilities/businesses, in particular, likely need more assistance in this area. (The question that was posed was: "[w]here does the industry stand in addressing cyber security?")

   - In a separate polling question, twenty-two percent of those surveyed indicated that cybersecurity across the entire grid would be the "most challenging element of evolving regulation at the federal level" (versus twenty-five percent who indicated the most challenging element would be grid reliability and twenty-four percent that indicated dealing with emerging retail market exchanges would be the most challenging issue in this regard).

5. **Urge Congress to amend the Stafford Act to establish and ensure priority access for utilities and their equipment to public carrier networks during extreme events.**

   Urge Congress to amend the Stafford Act to ensure that utilities have priority access during extreme events, particularly to ensure that field personnel have immediate priority access for their communications and critical grid equipment that leverage public carrier networks to communicate status and receive control signals, and to prevent any potential hindrances to such access.

   This change will not only help local utilities, it also will help ensure that mutual assistance crews and resources from different states and/or regions of the U.S. will have access to public communications networks, so they and their equipment will be able to communicate during restoration efforts following extreme weather events and other emergencies.

6. **Interoperability:**
   a) Enhance interoperability during extreme events.

   > *Voluntary* interoperability guidelines should be developed to better integrate and manage mutual assistance resources during extreme events. A truly interoperable platform for mutual assistance would offer two-way, real-time communication to crews and utilities, allowing each to receive and update work orders in real time, and set up and track mutual assistance crews across a common platform with an integrated process available for all utilities.

   The Department of Energy, within the context of the existing NIST Framework, and working through the Smart Grid Interoperability Panel (SGIP), should establish a stakeholder process to advance and expedite the development of interoperability guidelines. This process should include the National Association of Regulatory Utility Commissioners (NARUC – and/or its appropriate Committee(s) or Subcommittee(s)) and should coordinate with the SGIP, the GridWise Architecture Council, the GridWise Alliance, and other key stakeholders.

   Guidelines should provide not only the types of coordination and communications mechanisms and interoperable technologies needed in emergencies but also the minimum level of shared functionalities that are both interoperable and non-proprietary for utilities to effectively and openly transfer critical mission data across multiple jurisdictions. Any necessary regulatory changes would need to be considered by NARUC and associated stakeholders.

   b) DOE should support the utility industry's interest in gaining access, on an equal footing, to the Nationwide Public Safety Broadband Network and its advisory structures.

   This should include support for industry participation in the Commerce Spectrum Management Advisory Committee on federal spectrum sharing, and with the FirstNet partnership.

7. **GWA wishes to associate itself with NEMA's recommendations to: a) Urge Congress to amend the Stafford Act to allow disaster assistance to be used to replace damaged equipment with more modern and resilient technologies, including on-site backup power; and b) Allow the use of Community Development Block Grant (CDBG) funds for the restoration – and, again, the**

upgrading **(not just replacing the equipment with likely-outdated equipment) – of privately-owned electric utility infrastructure.**

II. Changes in the Utility Business Model

Viewed through the lens of this new and different "framework" for the role of the grid and grid operator in 2030, and taking into account the range of technological and policy drivers, and "threats," facing the electric industry, including energy efficiency, distributed energy resources (DERs), net metering policies, and more, the traditional utility business model, and regulatory model, whereby utilities earn a return on equity (ROE) based on capital investments and recover costs based on the amount of electricity a consumer uses, will need to change going forward, to ensure the long-term viability of the "Grid of the Future."

Innovation must be incented on both ends of the electric system value chain – meaning central generation/wholesale markets and distributed energy resources/retail markets – while enhancing the reliability, resiliency, safety, security, and affordability of electricity to support our nation's economy and security and keeping grid operators financially viable to make the needed investments to support this innovation.

By 2030, the transmission and distribution (T&D) components of the utility will have shifted from that of a commodity provider to a services provider in many jurisdictions; and, costs will need to have been disaggregated into logical components to enable a services-oriented fee structure.

Other characteristics of this new system could include:

- Suppliers competing in open, unregulated, competitive markets;
- Consumers that buy and sell services;
- Locational marginal pricing (LMP) for ancillary services based on the location on the distribution grid;
- Coordination of retail and wholesale markets to optimize the entire energy value chain;
- The grid could become "an energy marketplace platform:"
    - Enabling wholesale to retail transactions; and
    - Enabling retail to wholesale transactions.

Therefore, the way in which utilities are compensated will have changed by 2030, in many jurisdictions. In many jurisdictions, T&D utilities will not be compensated for pushing more kilowatt-hours (kWh) through their system but, rather, for providing services and the types of elements itemized just below.

Recommendations for this Section

Encourage a new utility business model such that grid owners and operators ultimately are compensated for that which will be valued in the future.

Looking out to 2030, the "Grid of the Future" likely will have changed in large part from providing not only a commodity, i.e., kilowatt-hours (kWh) of electricity, but also to providing a range of services. That is, many more utilities will have changed from being a commodity provider to a services provider – but certainly could accomplish both (as elaborated upon below, as well as in the following ***Section on Changes in the Regulatory Model***), and their rate structures will not be based strictly on volume.

Thus, it will be important to compensate and reward utilities differently; and to adopt a more results-oriented approach. That is, utilities will be compensated, i.e., will charge consumers, *not* for volume-based transactions – in part or at all – but for providing services, deploying appropriate-scale advanced technologies, and for building and maintaining the "Grid of the Future" as the enabling platform and the "Electric System of the Future," such that all regulated and unregulated stakeholders thereof are made "whole" (i.e., do not lose revenues in this transition, as a result of changes in the business model(s)). In other words, costs incurred to transform to an integrated grid should be "allocated and recovered responsibly, efficiently, and equitably" -- and policy and regulatory frameworks should be developed to achieve these objectives.[5] Such models should take market structure, regulatory barriers, and other such key considerations into account.

The value propositions for this different business (and regulatory) model could include:

- Maintaining an increasingly safe, reliable, resilient, and secure grid;
- Being agnostic about supply;
- Being able to integrate all types of generation;
- Increasing and rewarding grid efficiency and innovation;
- Enabling consumers to provide benefits (back) to the grid and being appropriately compensated for these benefits;
- Operating the system to optimize asset utilization;
- Providing highly reliable and resilient energy services to end consumers; and,
- Identifying the most cost-effective ways of achieving such results.

The federal government should encourage and facilitate, where appropriate, new business models.

III. Changes in the Regulatory Model

The regulatory structure must be achieved to enable this "Grid of the Future" as well as the value proposition outlined above: that is, rules must be established to help value the grid and ensure that utilities recover costs for building and maintaining this "Grid of the Future."

- To attract the needed investments, it is essential that investor-owned utilities (IOUs) have regulatory certainty on how these investments will be recovered, and to help utilities plan and undergo this transition.
- Establishing these new rules and having clarity on how the utilities' performance will be measured is required by shareholders and creditors in this highly regulated industry, otherwise

[5] Electric Power Research Institute (EPRI), *The Integrated Grid, Realizing the Full Value of Central and Distributed Energy Resources*, 2014, p. 5.

the risk/reward dynamics will reduce access to, and increase the costs of, financing to the utilities and ultimately the consumers.

Recommendations for this Section

Regulators will need to consider a range of factors to create and/or maintain regulatory flexibility, as well as to help maximize investor confidence and long-term policy and economic certainty, and to regulate for an optimized, modernized grid, including, the best ways in which to accomplish the following:

- Enable consumer choice;
- Develop transparent methods by which consumers can buy and sell services; and,
- Establish rules for dealing with market-based, unregulated components, such as:
  - Consumer protections;
  - Community microgrids; and,
  - Multi-customer microgrids.

1. **State regulators should ensure processes are in place to accommodate and/or help establish rate structures for services and reward performance, taking into account a range of factors and options, aiming to help ensure that "costs incurred to transform to an integrated grid are allocated and recovered responsibly, efficiently, and equitably," as also noted by EPRI.[6]**

   Recognizing that ensuring regulatory flexibility is difficult, it is important to maintain such flexibility, nevertheless, and for regulations to move toward incorporating output-based incentives that reward results and performance based on value delivered **as well as to reflect the real costs of the energy consumed, while recognizing the future grid infrastructure costs that tend to be more fixed.** To be clear, in doing so, regulators, policy makers, and utilities should work to help ensure that "costs incurred to transform an integrated grid are allocated and recovered responsibly, efficiently, and equitably."[7]

   In addition, dynamic prices, and/or other pricing schemes, should be among the options considered, in that they could similarly foster and reward efficiencies and innovation.

   Prices should be transparent to allow consumers to understand what they are paying for and their options. The "transactive energy" component should provide clear and direct pricing signals to consumers and devices.[8] Consumers also should understand the grid services they

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[6] Electric Power Research Institute (EPRI), *The Integrated Grid, Realizing the Full Value of Central and Distributed Energy Resources*, 2014, p. 5.

[7] Ibid.

[8] "The term "transactive energy" is used here to refer to techniques for managing the generation, consumption or flow of electric power within an electric power system through the use of economic or market based constructs, while considering grid reliability constraints. The term "transactive" comes from considering that decisions are made based on a value. These decisions may be analogous to or [actually consist of] economic transactions . . . . Transactive energy techniques may be localized to managing a specific part of the power system, for example, residential demand response. They may also be proposed for managing activity within the electric power system from end to end (generation to consumption) such as the transactive control technique being developed for the Pacific Northwest Smart Grid Demonstration project. An extreme

require from the transmission and distribution infrastructure, independent of energy supply, per se, and the tariffs for those grid services. Consumers then will be able to evaluate short- and long-term decisions, such as installing distributed generation or storage, adding home energy management systems or services, or selecting a given energy supply pricing plan.

- Hawaii might serve as a good model. This model incentivizes utilities by rewarding them with a portion of cost savings as well as providing a means by which to share a portion of these savings with consumers. In other words, if the utility has cost savings, it can share in those savings, in addition to passing some of the savings on to consumers. This model is an attempt to get away from a pure cost recovery model. Sales and volumes do not affect revenue, because they are disaggregated; Hawaii is looking at performance metrics to provide for a better outcome-oriented focus and reward system. *(See also recommendation below regarding performance metrics.)*

- Many states are examining models focused on process outputs, similar to the United Kingdom's "Revenue set to deliver strong Incentives, Innovation and Outputs" (UK RIIO) model. For a regulatory contract, certain outputs are required; the utilities are measured on how well the outputs are produced, and they are compensated as such, i.e., obtaining value for their money.

States that have restructured their wholesale and retail markets and have unbundled the grid role (i.e., poles and wires) from end-use energy sales and wholesale generation may need to pursue other advanced ratemaking methods that better match those market constructs.

Performance-based ratemaking is another option worth considering, i.e., establishing rates based on performance or results. Performance-based ratemaking should ensure the following, at a minimum:

- Establish a realistic timeline.
  - Realistic time frames (such as eight years, as is the case in the UK) promote investor confidence and are generally immune from election cycles.

- Align performance metrics.
  - The metrics for utility performance (and network investments) should be aligned with the energy policies of the local, state, regional, and national levels. This forces Inter-Agency coordination and helps quantify policy outcomes for monitoring.

- Use both carrots and sticks within incentive schemes.
  - Simply offering increased financial returns is not sufficient to guarantee a positive outcome for all stakeholders. Regulations must have both carrots and sticks in order to be effective. Rewards must be matched with risks.

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example would be a literal implementation of "prices-to-devices" in which appliances respond to a real-time price signal. [Currently,] dynamic pricing is widely used in the wholesale power markets. Balancing authorities and other operations . . . routinely trade on the spot market to buy or sell power for very near term needs. In addition, dynamic pricing tariffs are being tried in a number of retail markets, for example, the PowerCentsDC dynamic pricing pilot." *Source:* GridWise Architecture Council, available at: http://www.gridwiseac.org/about/transactive_energy.aspx.

- In addition, regulators should seek to produce results comparable to those that would emerge from an efficient, competitive market, were such a market feasible. (Regulating distribution with the aim of achieving a competitive market (like the competitive wholesale markets)).

- The current rules pertaining to "obligation to serve" might deserve future examination, as meters and other "smart grid" technologies become more widely deployed.

- Regulators – and the business models -- also should facilitate the grid as the enabling platform to deliver new types of services to cities, i.e., to foster "smart" and resilient cities.

- Incent the building/development and deployment of proper networks to maximize AMI operationally.

- Regulators and utilities must do their best to plan for distributed resources that will be incorporated in unknown quantities, to a large extent, and influenced by market forces. Such planning could help prevent the over-building of major capital/infrastructure assets, as well as help prevent revenue losses.

2. State regulators should encourage utilities to develop and offer different rate structures for their consumers, based on a variety of factors and options.

Utilities likely should offer rate structures, again, based on a variety of factors and options, ranging, for example, from:

- Providing a minimum level of power to those who only want to keep the lights and heating/cooling on, to:
- Additional levels of service that could reflect the ability to deliver greater reliability in portions of the grid for consumers needing or wanting this; or, to provide service to consumers wanting to connect rooftop solar to the grid, and would charge accordingly, to help pay for these services and to help maintain the integrity of the grid and of the utility going forward.

The ways in which these costs will be allocated and recovered will require additional analysis, but could involve some fixed charges for grid services, such as those required to start up appliances, even on sunny days, and back-up power during emergencies, and a disaggregation of these charges from sales, or cost recovery by other means (as also proposed in an article entitled, *Results-Based Regulation: A Modern Approach to Modernize the Grid,* by David Malkin, GE Digital Energy (and GridWise member) and Paul Centolella, The Analysis Group).

The flip side of this is that: utilities also could benefit in the future from such resources that help maintain grid reliability (e.g., solar resources, especially solar PV with "smart inverters," and electric vehicles). Utilities also might be able to maintain service to a portion of the grid (in other words, "island" part of the grid) with the help of such resources, so the value to utilities, therefore, must be taken into account by the utility, regulators, and consumers.

The notion of enabling consumers to sell services to the grid also will be important, as is ensuring that the owners of these systems be fairly compensated for the value to deliver to the overall electric system, such as helping support the stability and reliability of the grid. It is extremely important to get these financial rules right to ensure that consumers understand the long term business case for their investments as well as the requirements for operating these systems.

As noted in the prior recommendation in this Section, ultimately the goal is to help ensure that costs incurred to transform an integrated grid are allocated and recovered responsibly, efficiently, and equitably (as also reflected by EPRI).

3. Establish a voluntary model state regulatory framework(s).

The Department of Energy should facilitate the establishment of a *voluntary* model state regulatory framework(s) that accomplishes the items highlighted below. This is intended to provide regulators with options to be considered, and as much state flexibility as possible; it is not at all meant to result in a one-size-fits-all approach. The Department should establish a public-private Model Framework Task Force to help develop this model framework. In addition, the Department should provide financial assistance, as needed, to help States, Tribes, and/or local governments implement such a framework. This model framework should:

- Provide a standardized approach to the electric system;
- Facilitate the modernization of the electric grid;
- Ensure a reliable, resilient, affordable, safe, and secure electric system; and,
- Acknowledge and provide for the different priorities, electric systems, and rate structures across States and regions. Along these lines, this framework also should facilitate:
  - Near real-time situational awareness of the electric system;
  - Data visualization;
  - Analytics-driven decision making;
  - Advanced monitoring and control of the electric grid;
  - Grid resilience;
  - Improved interoperability of the electric system, and predictive modeling and capital allocation;
  - Greater certainty for private investment in the electric system;
  - Increased innovation; and,
  - Increased consumer empowerment.

4. Work with states to develop baseline, voluntary, output-based, model performance metrics to facilitate the "Grid of the Future."

The Department of Energy should work with the appropriate federal and state entities to develop baseline, voluntary, output-based, model performance metrics to facilitate the grid of 2030. That is, such metrics should facilitate and promote the adoption of best practices and processes for electricity infrastructure providers to design, build, and implement a twenty-first century electric grid and maximize opportunities to enhance progress in the areas of: consumer engagement, grid technologies and capabilities, and more.

Quantify the potential performance improvements that can be achieved through deployment of new grid technologies and systems and report through standard channels (e.g., Energy Information Administration, Federal Energy Regulatory Commission).

There should be a method that allows for national benchmarking for these key performance metrics, as well as standard methodologies for calculating performance improvements or deteriorations to the metric, such as reliability, grid efficiency, power quality, consumer value and satisfaction, environmental performance, and financial incentives.

With respect to States that have retail choice, the role of the grid operator in enabling electric utilities to remain financially viable and make investments that ensure a reliable, secure, and resilient grid should be reflected.

With respect to States that have net metering, identify metrics that reflect ways in which to encourage the adoption of renewable resources that maintain financially viable electric grid operations, fairly allocate costs to all consumers connected to the grid, and ensure affordable rates for all income levels of electric consumers. This could consist of reflecting ways in which to reform net metering policies and adopt new approaches for designing rates for distributed generation.

5. States should develop new processes for reviewing and approving investments on a faster timeline.

States should develop and facilitate the implementation of new regulatory processes to review and approve utility investments on a more rapid time scale that reflects the speed of change and technological innovation. Federal technical assistance should be provided, as needed and/or appropriate, respecting jurisdictional boundaries. Currently, the typical State regulator is in office for an average of approximately three years. And, the time to approve utility investments in the grid and in grid modernization equipment can take two years or more. Utilities must have greater certainty and greater speed for investment approvals to modernize the grid to the extent needed going forward.

Regulatory models also must adapt and evolve to allow utilities flexibility to provide consumers the services and products they want, while still remaining economically solvent. More clarity is needed around innovative opportunities for utilities and businesses.

Consideration should be given to the following, to help achieve these goals:

- Point to potential solutions by developing a range of regulatory options and comprehensive supporting analyses.
- Identify and explore regulatory issues and barriers through open, multi-stakeholder forums.
- Communicate options by actively engaging a broad, yet manageable, range of stakeholders and decision makers.
- Engage and provide educational opportunities to consumer advocates on the value of grid modernization investments and regulatory changes.

6. **The Federal Energy Regulatory Commission (FERC), National Association of Regulatory Utility Commissioners (NARUC), and other private and public sector stakeholders should work together, as needed, to enhance collaboration and coordination between state and federal entities to help better align the evolution of the transmission business model and of the distribution business model, respecting jurisdictional purviews.**

   The range of stakeholders should work together, as appropriate, to facilitate better coordination between federal and state regulatory entities, particularly to help align the evolution of the transmission and distribution business models. This should help reduce risks and enhance regulatory certainty. This approach likely would help ensure that regulations and policies align with technologies and capabilities, which is important.

7. **Provide appropriate federal tax incentives and work with States and utilities to better synchronize the regulatory asset life with tax amortization periods.**

   Currently, the depreciation period for the majority of grid modernization or "smart grid" equipment and technology typically is ten years or longer. The depreciation period should be shortened to reflect the rapid changes in technology (as is the case with computers and other digital technology) and shorter asset lives. Additional federal tax incentives also should be provided to encourage investment in grid modernization technology and equipment, such as sensors, as well as control equipment, and more.

   Moreover, it is important to better synchronize or align the regulatory asset life of such equipment with tax amortization periods.

IV. Changes in Consumer Engagement

The consumer must remain central throughout the process of this transition to the "Grid of the Future" and beyond, as this role changes from historically being the recipient of a monthly electricity bill to having more capabilities to manage and control one's electricity consumption – and, in many cases, to having greater production capabilities, as well. That is, ensuring that the changing needs of consumers are addressed is essential. In addition, consumers' trust must be maintained throughout the transition, as well. Such changing needs also present opportunities for innovation, and more.

In addition, it will be important to actively engage with consumers, to the extent they want such engagement. To date, most consumers have very little knowledge of how the electric system works and what it takes to have the lights come on when they flip a switch. For some consumers, this will not change. They have no interest in the technical or technological occurrences transpiring behind the light switch and no desire to engage in being producers of power or providers of ancillary services (e.g., providing excess capacity back to the grid from solar panels on their roofs, etc.). They may be interested in options to manage their energy usage, but only if it is easy and can be done automatically in a "set and forget" mode of operation. Most consumers will not want to extensively manage their electricity usage.

To this end, while internally sophisticated and complex, the grid must be outwardly simple for consumers to interface with it (that is, the grid's interface must be outwardly simple for consumers) – i.e., "deconstructing the complexity of the grid."

However, for those consumers who wish to engage more actively, they will need more information and the utilities will need greater "situational awareness" of consumer activity and behavior on the other side of the meter. The utility will need this information in order to operate and optimize this new grid or, "central nervous system," to provide reliable services and meet the goals of supporting supply diversity objectives as well as optimizing operations.

More specifically, as we make the transition to a two-way, interactive electrical system, consumers are becoming both consumers and producers of electricity: in other words, a "prosumer" (discussed more elsewhere). That is, consumers will be empowered to buy and sell services and make choices, manage their energy consumption, and more. ***Currently, we lack the infrastructure and systems to manage a "transactive" energy world (please see footnote at bottom of page 17 for this definition) enabling these new "prosumers" of tomorrow.***

Recommendations for this Section

1. **Where appropriate, and respecting jurisdictional boundaries, assist in the development or expansion of state-based outreach efforts that increase consumer engagement.**

   Where appropriate, and respecting jurisdictional boundaries, the federal government should facilitate state-based outreach efforts that increase consumer engagement.

2. **Relatedly, the federal government and/or state regulators should facilitate greater stakeholder understanding of the value of the modern grid and of the transition, and seek consumer engagement on a broad level along the way.**

   Regulators, for example, could hold informal sessions with a range of stakeholders to seek input. State energy offices, governors, and other policy makers could also help fill this need and role.

   At a minimum, in addition to utilities, consumer advocates must be included, as this process evolves, as well as Public Utility Commissions and specific consumer groups (e.g., low/fixed income).

Because consumer education and outreach are so essential to their understanding of the transition and positioning them to influence the transition in a constructive manner, another recommendation includes the following:

3. **The DOE-OE should work with the National Ad Council to develop a consumer awareness "campaign" on the smart and resilient "Grid of the Future**."

   The DOE-OE should work with the National Ad Council to develop a Consumer Information/Awareness "campaign" on the Smart (and Resilient) Grid of the Future, (similar to the public awareness effort that was conducted for "standby power" (otherwise referred to as "vampire devices" by former President George Bush)) that consists of television, print, social media and other public service announcements.

The point made earlier in this Section regarding “deconstructing the complexity of the grid” is critical for consumer education and awareness.

V. The Path Forward

To achieve the “Grid of the Future,” i.e., the Grid of 2030, much needs to be accomplished and in a relatively short period of time.

In addition to the new and different framework provided herein through which the GridWise Alliance (GWA) recommends examining and analyzing the “Grid of the Future,” and the changes already discussed herein needed to achieve this end goal, financing is an essential component to achieving this future vision. Billions of dollars in grid infrastructure investments, upgrades, modernization, and more are needed to achieve a twenty-first century grid (though, as noted at the outset, outages cost billions of dollars today in lost productivity and more).

Recommendations for this Section

1. **Urge Congress to pass legislation that helps finance critical grid modernization infrastructure investments.**

   Urge Congress to pass legislation to help finance critical grid infrastructure investments on the scale needed. This could take substantial political will and leadership. For example, Congress could pass a grid infrastructure funding program that establishes a grid infrastructure investment fund, similar to the Highway Trust Fund, which funds ongoing highway infrastructure investment needs (e.g., Senator Hirono has drafted legislation along these lines) or other infrastructure financing program, such as that developed by Rep. Delaney that has bi-partisan support. Care should be taken to ensure that any such legislation clearly specifies that: as grid infrastructure is replaced, that it is modernized or upgraded (not just “like-for-like” replacements) and made as resilient as possible. S*ee also Stafford Act and CDBG recommendations in “Grid” Recommendations Section above on this latter point.*

   Some of these types of programs would be particularly beneficial for municipal utilities and rural electric cooperatives.

2. **Develop and deploy an innovative suite of technologies to realize the benefits of a transformed grid.**

   The Department should continually advance the technology frontier by creating and maintaining a visionary technology strategic and research and development (R&D) plan, which should include identifying technology gaps and potential ways in which to fill these.

   The Department also should help demonstrate the benefits of open, interoperable systems by facilitating partnerships that exhibit these characteristics.

3. **Incorporate grid modernization into federal, state, regional, and local strategic and emergency planning efforts; and, identify measures that can be implemented in the near-to-medium term.**

   The table below highlights some of GWA's recommended near-to-medium-term measures and their rationales.

Such measures could include but are not limited to:

Measure or Technology	Driver	Comments
Getting the grid ready………		
Upgrade Geographic Information System (GIS) Data Models	Must have the right data to drive the models. The data needed for the advanced modeling of the distribution system exceed the data that have been needed to drive Outage Management Systems (OMS) and load flow analyses that have been utilized to date.	Utilities that have undertaken new Advanced Distribution Management Systems (ADMS) have found that they need additional data to drive their models.
Distribution Supervisory Control And Data Assess (DSCADA)	Must have visibility and control to key components on the distribution grid.	Many utilities do not have DSCADA systems deployed, or have only limited capabilities with the systems deployed today. These systems must be upgraded to give the utilities the visibility and control not only to the feeder breakers, but to key distributed automation on their feeders.
Advanced Distribution Management Systems (ADMS)	Must be able to model the distribution feeders in near real time and on a continual basis, with feedback control points to validate the model.	To enable two-way power flows on the distribution grid, the grid operator will need this advanced modeling capability. Additional modules or systems will be needed to perform functions such as Volt/VAR Optimization (VVO) and Distributed Energy Resource Management (DERM). As increasing levels of DERs are added to the system, these additional capabilities will be required to effectively manage system stability and reliability.
Distributed Energy Resource Management (DERM)	DERM systems will be needed when penetration levels of DERs reach a level at which they are affecting system reliability and stability.	State policies and objectives that incent consumers and third parties to install DERs will have significant impacts on the speed of adoption within a given state. Consideration should be given to how this DERM functionality will be incorporated during the

		design phase of ADMS. This functionality could be provided as an add-on module to the ADMS, or could be a stand-alone system that is integrated for operational purposes. Timing to install DERM will depend on the penetration levels of DERs.
Volt/VAR Optimization (VVO)	To improve grid efficiency and ensure power quality, as new complex resources are integrated into the grid.	VVO could be a module of the ADMS or a stand-alone system but, at a minimum, will need to be integrated for operational purposes to ADMS.
Distribution Feeder Balancing Program	To better manage and leverage voltage management capabilities to maintain power quality on the grid.	To reduce losses and better manage the voltage and VARs on the distribution grid, the distribution feeders will need to be balanced as far out on the feeders as is economically and practically feasible. This may require increasing conductor size or pulling in additional conductor phases in some areas. As part of the design and analysis phases of the ADMS and VVO, utilities should consider how much feeder balancing would be needed.
Advanced Sensing Capabilities on Distribution Feeders	To increase situational awareness of grid conditions.	To support the ADMS models and enable the optimization of grid operations, additional sensing components will be needed. Advanced meters could comprise one component of this sensor network, particularly when looking at VVO functionality.
Asset Management Systems (AMS)	To track and enable more condition-based maintenance on the distribution grid.	Given the increase in sophisticated assets on the distribution grid, tracking and understanding the condition of these assets will become increasingly important to control maintenance costs and ensure the reliability of the system and its assets.
Getting the exchange and settlement infrastructure in place:		
Meter Data Management Systems (MDMS)	To establish the foundation for managing consumer usage data. Enables the utility to gain a better understanding of the ways in which consumers are using electricity.	An MDMS will allow the utility to gather and analyze their consumers' usage data, giving them a deeper understanding of how consumers are currently using electricity. An MDMS is a critical component of any advanced metering system. By establishing an MDMS in advance of an advanced meter deployment, the utility will be positioned to more quickly leverage data/information from advanced meters, and to offer immediate value to the

		consumer, once the deployment has occurred. In addition, by leveraging MDMS with current metering information, the utility can perform additional analytics on this usage information. This analysis will be useful in developing new programs for consumers as well as providing insights they can use in planning an advance meter deployment. These data or information also will provide the utility with an understanding of the impacts of DERs as they are installed on the system.
Advanced Metering Infrastructure (AMI) *(Adopting a Phased Approach from Targeted Through Complete Deployment)*	Positions utilities and consumers to have the ability to purchase or supply services to the grid, in association with the implementation of DERs. This is a critical component need to establish the platform for transaction management, including the buying and selling of services as well as measurement and verification of transactions for settlement purposes.	AMI capabilities will be needed for consumers who wish to participate in a DER market to sell and receive new services. This same infrastructure can provide numerous operational benefits as well as serve as sensors on the network to enhance situational awareness and allow the grid operator to optimize network operations. All of the value streams should be considered in the planning for and deployment of these systems to maximize their value, including by state regulators.
Infrastructure that supports both:		
Communications Infrastructure	Foundational in nature. Planning should incorporate all new requirements for managing the grid as well as enabling the AMI that will be required to support the robust buying and selling of services via the grid as the "enabling platform."	Communications infrastructure varies in size, etc., and lacks uniformity of structure. Taking into account a given utility's topology and the availability of public telecommunications infrastructure, an optimal design then can be developed. Communications infrastructure that overlays the electric grid infrastructure is the foundational capability that enables situational awareness and remote management. It should not be planned for in a "siloed" manner but, rather, should be done holistically. Planning for this infrastructure needs to incorporate all communications requirements, both immediate or emergency, and planned, and should remain flexible and

		agile to accommodate emerging requirements as much as possible.
Data Analytics	Turning data into "actionable" information will require a focus on developing and deploying data analytics capabilities.	By their very nature, the modernization of the distribution grid and the deployment of AMI will result in utilities having more data, i.e., "big data." Data analytics are required to turn these data into "actionable" information and to ensure these data are leveraged for their maximum value to consumers and utility operations.

The timing and pace of the transition to this future grid are important and, at least in part, will determine whether we successfully achieve this "Grid of the Future." That is, many of the system and business process changes as well as changes in workforce development needed to support this Vision will take four years or more to plan, design, build, and implement. These are complex projects that will drive significant changes in utility operations. Such efforts should be iterative in nature, with review and course corrections built into these processes.

We also must recognize that the transition to the "Grid of the Future" will not be perfect. Business and regulatory models and frameworks will need to incorporate flexibility and adaptability, so they can be modified, if they are not working as intended.

As noted at the outset of this document, as we look out to 2030, the electric industry is faced with a significant transformation, similar to the one that we witnessed with the telecommunications industry, enabled by innovation that creates new challenges, but also new opportunities and optionality. How the electric sector stakeholders choose to respond (including utilities, regulators, policy makers, service providers and third parties) will determine whether these changes are viewed as opportunities or threats to addressing our ever-increasing needs for a reliable, resilient, affordable "Grid of the Future."