DESIGNING THE 21ST CENTURY ELECTRICITY SYSTEM

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EXECUTIVE SUMMARY

Power system operation and planning approaches were designed for the resource mix of the 20th century. The utility and regulatory structure we inherited was designed for baseload, intermediate, and peak load-serving conventional power plants. The resource mix of the 21st century looks very different from the past. Its characteristics in both the short-term day-to-day operations time frame and the long-term investment and planning time frame will require different methods and institutions.

Decarbonizing 90 percent of the power system can be accomplished reliably and affordably with today's technologies if best practice operating and planning institutions and methods are put in place. How to decarbonize the last 10 percent of the power system at a low cost is less clear at the present time. Innovation and research and development (R&D) will be important to develop "clean firm" sources.

Given cost trends, it is almost certain that a majority of electricity production will be from wind and solar energy. Wind and solar plants have variable output, can only be dispatched when their resource is available, and tend to be located remotely from population centers requiring new approaches to grid planning and management.

The question for short-term operations is how to run a reliable power system with a majority of the energy coming from variable renewable energy. Wind and solar plants tend to produce at different times and places than system load. Studies and experiences from around the world show that power systems can be operated with high-penetrations of renewable energy by moving energy to where and when it is needed. Power can be moved across time with battery energy storage and controllable demand, and potentially with longer duration storage in the future. Power can be moved across space with transmission infrastructure and large regional power markets. There is always renewable output somewhere and at some time of day in a large, interconnected grid. Studies and experiences show a significant role for storage, demand response, and transmission to move power to where and when it is needed. Each of these resources play a unique and complementary role in this 21st century electricity portfolio. Placing these changes into short-term operations will require changes to system operations policies and institutions.

A key question for the long-term planning and investment time frame in a system relying predominantly on wind and solar energy that has zero marginal costs is how investors can invest in markets with low power prices and still recoup enough revenue to justify the investments. This challenge exists both for carbon-free sources and the other sources needed to balance the system r when renewable output is low. This conundrum can be solved with more and better long-term contracting for the various electricity products, including flexibility, energy at all times, and environmental attributes. Improving long-term contracting will require changes to planning and investment institutions and policies. States will need to assign clear responsibility for resource procurement and forward contracting. To mitigate exposure to too much price or reliability risk, some states should ensure that retail customers, especially small customers, are incorporated and considered by regulating entities. Other states may wish to provide choice options to some or all customer classes, enabling them to procure the type of power they choose. Those states will need to balance consumer choice with consumer protections and ensure fair allocation of costs between customer classes.

The 21st century electricity system will require certain changes to achieve climate targets and to benefit all users:

- Large regional transmission organizations (RTOs) with best practice market design, including fast dispatch and locational and value-based pricing along with hedging and a circuit-breaker mechanism to protect consumers.
- Well-functioning energy procurement structures, on a voluntary or mandatory basis, to facilitate long-term contracting, resource adequacy, and lower financing costs for the large amount of new generation needed.
- Transmission planning and cost allocation to expand regional and interregional capacity based on appropriate recognition of the future electricity portfolio and the resilience value of transmission.
- R&D in two principal areas to bring the costs down and improve the performance of (1) clean long-duration storage sources and (2) high voltage direct current (HVDC) converter stations.
- Resource adequacy assessments and stress testing of the integrated power, gas, water, and other infrastructure systems.
- Reliability and generation performance standards to ensure reliability and resilience.

RELIABILITY, MARKETS, AND CLEAN ENERGY

Threats to reliability from polar vortices, summer heat waves, and other events over the last decade highlight the important role electricity plays in ensuring public health and safety, and the interconnectedness of our water, fuel, electricity, and other infrastructure systems. Ensuring that the power system of the future meets high levels of reliability, resilience, affordability, and clean energy requires continuous long-term, whole-system planning. While market forces can benefit customers in certain sectors of the electric industry, the whole industry remains "affected with the public interest" in the words of the U.S. Supreme Court, and will continue to require public policy and regulations of various types to meet the ongoing needs of all electricity customers.

Reliability and resilience can be ensured for all electricity customers through full-system assessments of how each region can meet load in all reasonably foreseeable situations. Regulators can perform stress tests to evaluate threats that may be present in a given region, and what a reliable, resilient, and low emission portfolio may be for that region.

In order to ensure a sustainable power system that meets all objectives of forums and public policy there needs to be a balance of market forces and regulation. Market forces are not sufficient, in the case of the electricity sector, to drive efficient outcomes and enable choice and innovation. Therefore public policies will be needed to continue to ensure reliability and that other public policy objectives are met. Those sectors that remain natural monopolies or public goods as defined in economics, such as transmission, distribution, and system operation, will generally require a single entity that is fully regulated to perform the function. Structurally competitive sectors, such as generation, may benefit from allowing many participants rather than one entity with a legally enforced franchise monopoly. Expanding competition in generation and accelerating clean energy development will need to be paired with careful reviews, expansion of reliability regulations, and system planning as recent reliability incidents have reminded us.

ELECTRICITY CUSTOMER FOCUS

As changes are made to electric industry operations and planning methods and institutions, certain aspects of these changes will have particular impacts on large electricity customers. Relative to most other stakeholder sectors, large customers are uniquely concerned with reliability, cost, and emissions. Many customers are approaching 100 percent carbon-free purchasing of the megawatt-hours (MWhs) of energy they consume. It is not always feasible nor efficient for each customer to match their individual load and clean energy purchasing by time and location. The full power system must work together to enable all electricity customers to receive clean, reliable, and low-cost energy.

Large electricity customers can and should be involved in electricity policy along with the other stakeholder groups at the table in state, regional, and federal policy fora. Customers have the ability to drive demand for zero-carbon electricity sources through their procurement and goals, and can advocate for the market structure and design changes that enable a low-carbon, reliable, and cost-effective power system. They can focus on the features of particular importance to their sector as associated policies develop. Customers may also pursue direct investments in complementary sectors beyond renewable energy procurement.

Of the changes necessary to decarbonize the power system in a reliable and efficient way, the following features are of particular benefit to large electricity customers:

- New RTOs in regions where they do not yet exist. RTO governance reform so that the overall voting reflects equal weight from electricity customers and sellers. Market design that accommodates state policy and customer bilateral contracting rather than counteracting them.
- Hedging and price circuit-breaker mechanisms to protect consumers while enabling accurate price signals on the margin for flexible resources.
- Market design that includes non-discriminatory operations reliability services definitions that allow clean energy and customer-owned resources the opportunity to provide these services on a level playing field.
- Independent market monitoring and mitigation to keep wholesale power prices competitive and protect all electricity customers.
- Market design that is open to and better integrates distributed and energy-limited resources.
- Transmission planning and oversight by the Federal Energy Regulatory Commission (FERC) that achieves appropriate grid expansion while ensuring the benefits exceed costs, grid-enhancing technologies are appropriately deployed, and the replacement of old assets is done in a way that captures longer term and regional efficiencies.
- Utility and state reliance on full competition in the generation sector rather than providing any advantages to utility-owned generation in both the operations or planning time frame.
- New approaches to resource adequacy that appropriately allocate risks between electricity customers and sellers, and better reflect customer preferences.