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on
Electric Transmission, Storage and Distribution -- West
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Good morning Deputy Secretary Poneman and members of the Quadrennial Energy Review Task Force (QER Task Force). My name is Geisha Williams, and I am the Executive Vice President of Electric Operations at Pacific Gas and Electric Company (PG&E).

I am pleased to appear before the QER Task Force on the issue of electric transmission, storage and distribution.

PG&E appreciates the time and consideration the Administration is giving to the need to invest in and modernize our nation's electric and natural gas infrastructure to make it more reliable, more resilient and better able to support the 21st century economy. The issues being explored today – electric transmission, storage and distribution – are fundamental to enabling a future electric grid that can seamlessly integrate new power generation and end-use technologies, thereby providing customers with more options and information and facilitating the deployment of clean energy technologies.

As background, PG&E is one of the largest combined natural gas and electric utilities in the United States (U.S.). Headquartered in San Francisco, California, with more than 22,000 employees, the company provides natural gas and electric service to more than 15 million people throughout a 70,000-square-mile service area in northern and central California.

With a service area that stretches from Eureka in the north to Bakersfield in the south, and from the Pacific Ocean in the west to the Sierra Nevada in the east, PG&E owns and operates more than 160,000 circuit miles of electric lines in California. In order to meet our commitment to deliver safe, reliable and affordable service, we are implementing a multi-year, strategic plan aimed at modernizing our electric operations to better serve our customers.

Over the next three years, PG&E plans to invest more than eight billion dollars to make the grid smarter, more resilient and better able to help California realize its vision for a low-carbon, clean-energy future. And, PG&E is not alone. We are part of a nationwide effort to modernize the electric grid, which will ultimately result in more efficient, cleaner and more reliable energy services. These modernization efforts are occurring at the transmission, distribution and customer levels and include the deployment of smart meters, intelligent switches, synchrophasers, and other technologies that provide better visibility, greater automation and more information. In fact, over the next decade, the utility industry is poised to invest nearly a trillion dollars to upgrade, expand and enhance our infrastructure.

As a result, this newer, modernized grid will benefit customers by:

- Improving electric reliability;
- Facilitating the deployment of new end-use technologies, like smart appliances, electric vehicles and energy management tools;
- Enhancing efficiency in electric generation, transmission and distribution; and
- Supporting the integration of renewable resources, such as wind, solar and distributed generation.

The Changing Power Grid and Role of Energy Storage

One of the most unique aspects about the operation of the electric grid is the real-time nature of its functions. From production, to transmission, to delivery, it takes an entire integrated network that can withstand the elements and adapt to changing supply and demand dynamics in a split second. Unlike other commodities, electricity is essentially produced and used in real time. The amount of electricity put into the grid must always balance with the electricity being consumed. The ability to balance these supply and demand dynamics will become more challenging as more-and-more intermittent resources come online. This is because these intermittent resources operate differently than those the grid was originally designed to accommodate.

According to the U.S. Energy Information Administration (EIA), renewable energy sources accounted for approximately 14.2 percent of the nation's electricity production during the first half of 2013, which was approximately a four percent increase over the same period in 2012. EIA also found that renewable resources (excluding hydro) more than tripled their output during the past decade. The greatest area of growth during this period has come from solar thermal and photovoltaics (PV) – which, combined, have grown nearly 95 percent. In addition, significant levels of solar capacity are coming from smaller applications - e.g., rooftop solar PV. In our service area alone, PG&E has connected more than 120,000 solar rooftops to the grid, and we expect to connect another 3,000 per month in 2014.

Given this transition, the National Renewable Energy Laboratory (NREL) indicated that increased electric system flexibility is needed to enable electricity supply and demand balance with increasing levels of intermittent renewable generation. It identified a variety of supply- and demand-side options, including flexible conventional generation, energy storage, new transmission, more responsive loads and changes in power system operations.

A smarter, modernized grid that successfully incorporates technologies like energy storage can, therefore, provide grid operators with tools to react to rapid changes in consumer demand by adjusting the electricity on the grid to match usage. Today's electric grid was designed to move energy in one direction from a central place – e.g., larger and predictable baseload resources -- to the places where the power is needed – e.g., load centers with predictable usage patterns. Instead, what is needed for the future is a dynamic grid that can process and send out huge amounts of information to coordinate power flows among millions of contact points in multiple directions throughout the day.

The upshot of this transformation is that we have to make huge new investments in basic infrastructure – and in the digital and other supporting technologies that allow for this integration. Energy storage will play an important role in future grid operations and management, along with the other tec hnologies and operational changes identified by NREL.

Energy Storage – Technologies, Uses and Integrating Renewable Energy

Currently, in the U. S., the bulk of energy storage is comprised of a relatively small number of hydroelectric pumped storage projects, including PG&E's Helms facility located near Fresno, California. As highlighted in the above section, with the steadily increasing penetration of intermittent renewables onto the electric grid, coupled with changing customer usage patterns, utility-scale energy storage and ancillary services will become more important for stable grid operations.

Prior to recent years, much of the discussion around renewable energy resources has focused on a "static" view of their contribution to the overall resource mix – i.e., a simple accounting of the energy or total kilowatt-hours (kW-hrs) produced – with less focus on the time of day when the energy is produced. This simple kW-hr accounting of supply and demand does not consider the challenge of aligning actual demand with supply on a real-time basis. One example of this static accounting is a residential rooftop PV installation that allows the homeowner to match consumption with production on an accounting basis, say monthly, even though the homeowner depends on the grid for supply when the PV system is not capable of matching real-time consumption – e.g., at night.

The benefits of energy storage technologies to this type of system is that they can store excess energy produced during low-demand periods and deliver it during high-demand periods or when, for example, solar PV output is reduced or non-existent. There are a wide range of storage technologies that can provide solutions to this real-time supply-demand dynamic. However, there is no "one size fits all" application. Rather, some applications need high-power, short-discharge durations provided by technologies like capacitors, flywheels, batteries and superconducting magnetic energy storage devices. These devices can be used within fractions of a second to improve reliability and power quality in localized, small grid applications. Large grid applications benefit from high-energy, long-discharge durations provided by technologies like hydro pumped storage and compressed air energy storage (CAES).

Generally speaking, the smaller, localized storage applications consisting of batteries are currently not yet cost competitive and have not been widely implemented. From a large grid perspective, hydroelectric pumped storage has demonstrated its ability to provide substantial energy storage functionality for bulk electric system support. With approximately 22,000 megawatts (MW) installed and operated in the U.S. over the past 25 years, hydro pumped storage is the only commercially-proven bulk energy storage resource available today.

In addition to pure capacity and energy shifting, energy storage, depending on technology type, provides additional value when it is able to deliver grid stabilizing products like regulation, spinning reserve, non-spinning reserve and fast ramping. As more intermittent renewable generation depends upon power electronics (inverters) in the production of power, there is increased awareness on the value of spinning generation resources where the rotating mass of the turbine-generator system provides inertial benefits to the grid. These capabilities become more critical as additional intermittent renewables -- like wind and solar (PV in particular) -- are added to the grid.

Consequently, as intermittent renewable penetration increases, utility-scale regional grids will need to increasingly rely on fast-acting, dispatchable, rotating generating resources – like gas combustion turbines, hydro and hydro pumped storage generation – to provide operational flexibility and stability to offset the impact of intermittent renewable operation. A fundamental question is to what extent storage technologies will become economically viable to address these needs in the near term.

Energy Storage in California

California is truly leading the way on energy storage. The California Public Utilities Commission (CPUC) has adopted the first energy storage mandate in the U.S., requiring the state's three major investor-owned utilities to have 1,325 MW of cost-effective electricity storage capacity in place by the end of 2024. This mandate will allow the most promising and cost-effective energy storage projects to be developed, and PG&E is taking all steps necessary to implement the first solicitation cycle of the CPUC's energy storage program.

Separate from the CPUC mandate, PG&E has been active in the energy storage space through its participation in several other programs:

- *Helms*: PG&E has owned and operated this large, pumped hydro facility since 1984. Located high in the Sierra Mountains, about 50 miles east of Fresno, the Helms Pumped Storage Plant is a 1,212 MW facility carved into a tunnel in a mountain between two reservoirs at different elevations. Helms moves water between Courtright Lake at the higher elevation (8,200 feet) and Lake Wishon at the lower elevation (6,500 feet), using three turbine generators to pump water uphill when electricity prices and demand are low. Then, when prices and demand are higher, the water is released downhill to regenerate electricity.

- *Battery Storage:* PG&E is operating and testing two battery projects:
    - Yerba Buena: In partnership with the California Energy Commission, we initiated a battery energy storage system pilot project to better balance power needs of the electric grid. The Yerba Buena Battery Energy Storage System Pilot Project, located in San Jose, California, charges batteries when prices and demand for power is lower and then sends stored power to the grid when prices and demand are higher. The system is located next to a customer site, allowing us to understand the potential for the system to improve power quality and reliability for customers. This smart grid project uses a 4 MW sodium-sulfur battery that can store more than six hours of energy. We are working in close coordination with the Electric Power Research Institute (EPRI) to study how sodium-sulfur battery energy storage can improve power quality and reliability, and support greater integration of intermittent renewable power. EPRI's reports will be made available to the public in 2015.
    - Vaca-Dixon: This 2 MW battery storage project is located at PG&E's electric substation adjacent to the company's Vaca-Dixon solar PV facility. This battery facility is ideal for testing the use of energy storage at the substation level to manage this intermittent resource. The battery will also be used to provide the grid ancillary services and energy dispatch/storage, depending on customer demand.
- *Compressed Air Energy Storage (CAES)*: In 2009, the U.S. Department of Energy (DOE) awarded PG& E a $25 million grant to fund initial work on a CAES project to support our increased use of intermittent renewable energy. The grant was awarded under the American Recovery and Reinvestment Act (ARRA). In January 2010, the CPUC approved PG& E's request for matching funds of $25 million for the project. The CPUC found that a CAES technical feasibility assessment will provide PG&E with a better understanding of this energy storage technology, which has the potential to lower costs for customer s and reduce greenhouse gas (GHG) emissions through greater integration of renewable energy sources. Located near Lodi, California, t he CAES project could provide up to 300 MW for up to 10 hours of storage. The technology would use lower-cost energy during periods of lower demand to compress air and inject it into a depleted natural gas reservoir and then use the compressed air to help power a generator during higher energy cost and demand periods, when the energy has the most value. PG&E is in the process of permitting and readying the project site for air injection testing.

In addition to these stationary technologies, PG&E is also working with VIA Motors on developing and deploying mobile energy storage systems through the VIA eREV vehicle. In 2008, PG&E partnered with VIA Motors to develop the first eREV pick-up truck. The eREV pick-up trucks are designed to not only function as dependable, zero-/low-emitting work trucks, but also to provide exportable power to shorten unplanned outages, provide back-up power for scheduled outages and boost the electric grid when needed. Still in the testing phase, the first generation eREV trucks have 15-kilowatt (kW) capacity, which is the equivalent of a generator for a small- or medium-sized house. Going forward, a utility-grade output module, now in development, will provide 50 kW of mobile emergency power to keep critical facilities online.

Challenges and Policy Needs

Energy storage has the potential to provide significant benefits for the electric grid and our customers, but there are several challenges that must be addressed to help its viability match its potential. These challenges include:

- *Cost Competitiveness*: Among the reasons that energy storage has not been more widely deployed is cost relative to value. It is possible that some level of mandated procurement (such as in California) or tax incentives could facilitate enough investment to lead to large cost reductions for various technologies. While energy storage can contribute to a reduction in the amount of curtailment of non-dispatchable renewable resources, it is not clear to what extent the costs of implementing additional storage will outweigh the costs of curtailment and other avenues for GHG reduction.

- *Environmental*: Some energy storage technologies can present unique environmental issues that ideally should be addressed early in the process to facilitate projects being financed and built. For example, many battery technologies may contain hazardous materials during operation and after the facility is decommissioned. Clear, upfront rules for managing any hazardous materials associated with a project are important so that parties can better manage costs and risks.

- *Permitting and siting*: Depending on the technology and space requirements, long lead times may be necessary to develop, permit and construct projects, such as large pumped hydro facilities and CAES. Similar to many other renewable projects in California, there should be continued efforts to reduce the time it takes to permit and site projects. For example, aligning agency schedules, allowing permitting processes to run concurrently, as opposed to sequentially, and ensuring that all agencies are using the same basic data sets and assumptions for analytic purposes can help to reduce permitting timelines and the potential for permit challenges.

- *Grid Integration Research*: More research is needed to determine energy storage requirements and the best way to integrate and operate those resources in day-to-day grid operations. PG&E's testing of small battery storage devices has identified a number of questions about how much energy storage is needed for certain applications and what the capabilities of these energy storage technologies are. PG&E has also found a lack of commercially-available tools to allow transmission and distribution system operators to manage and control these devices efficiently. The potential proliferation of small energy storage installations, particularly on the distribution system, will require development and commercialization of enhanced monitoring and control systems.

Conclusion

Through PG&E's work to utilize proven storage methods, such as pumped storage, while also piloting new technologies with strong potential, including battery storage and CAES, we are proud to play a role in facilitating the development and deployment of energy storage technologies on a larger scale.

With careful steps to encourage the continued growth and integration of storage technologies, along with a focus on cost competitiveness to help keep energy affordable for our customers, we believe that storage holds considerable potential. Electric utilities are in a strong position to integrate storage technologies onto the grid to help deliver safe, reliable and affordable service to our customers.

Thank you again for the opportunity to participate in today's outreach session. We appreciate the Administration's focus on this critical component of energy delivery.