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Electricity Transmission, Storage and Distribution – West

July 11, 2014

Written Comments of the
Sacramento Municipal Utility District

The Sacramento Municipal Utility District (SMUD) appreciates the opportunity to provide its written comments in connection with the July 11, 2014 public meeting conducted by the Department of Energy (DOE) addressing "Electricity Transmission, Storage and Distribution in the West."

SUMMARY

SMUD is a political subdivision of the state of California formed pursuant to the Municipal Utility District Act (California Public Utility Code §811501 *et seq*.) to acquire, generate, transmit, and distribute electric energy. SMUD currently serves 1.4 million residents in its 900 square miles service area, which includes most of Sacramento County (including the City of Sacramento) and a portion of Placer County.

SMUD has developed an integrated generation portfolio that includes renewable energy sources such as hydro, photovoltaic, and wind, as well as natural gas-fired cogeneration. In a typical year, this portfolio provides about one-half of the power demand of SMUD's customer-owners. Other power is provided for through long- and short-term power contracts for both renewable energy and natural gas-fired generation.

SMUD's Integrated Resource Plan (IRP) objectives include maintaining affordable power and continuing local and regional environmental leadership toward a low carbon future, and providing reliable, clean and high quality energy for its customers.

The IRP remains flexible and adaptable to changing SMUD customer needs as well as state and federal regulations. For example, we recently broadened our focus from wind and biogas to encompass solar and geothermal resources. This was a necessary adaptation recognizing reductions in wind and biogas resource availabilities due to environmental and state policy concerns.

As power generation shifts away from carbon emitting resources, integration of variable renewable energy sources will create significant challenges, requiring flexible supplies, responsive demands and energy storage. The long-term IRP strategy addresses this need to support the transition toward the low carbon future while maintaining reliable, affordable clean power. Toward this end, we are engaged in several clean capacity resource initiatives including a pumped hydro storage project in the Upper American River Project, demand response (DR)

and pricing initiatives, and significant planning and R&D efforts including distributed storage pilot projects funded in part by DOE.

SMUD's IRP plan is an important planning framework for us to ensure that our long-term resource needs are met in a way that is consistent with the direction California's policy makers are pushing. The state has adopted long-term carbon reduction goals that will reduce emissions by 80% below 1990 levels. Legislation for RPS requirements of 33% by 2020 was adopted in 2011, and draft legislation has been introduced that proposes a 51% renewable supply (not counting large-hydro) by the year 2030.

In this context, SMUD along with the other 4 large utilities in California funded modeling by E3 to examine the impacts of a 50% RPS on the electricity system in 2030[1]. The report found that there would be substantial amounts of over-generation of solar energy, primarily during spring and fall days, totaling as much as 23% of the hours of the year. These findings indicate the need for flexible generation, DR, and energy storage to accommodate more variable generation without curtailing its output.

With an installed capacity of 688 MW, the Upper American River Project (UARP) is an important component in SMUD's integrated generation portfolio. The UARP provides low-cost power, operational flexibility, and overall system reliability to SMUD's customer-owners. Additionally, the UARP's storage capability, coupled with its operational flexibility, provides a much-needed level of protection to SMUD's customer-owners from unexpected increases in the price of electricity on the open market.

The Iowa Hill Pumped Storage Project is planned to enhance the overall operation of SMUD's generation portfolio by enabling our utility to bridge the gap from intermittent renewable energy to dispatchable capacity. The proposed Iowa Hill project would allow SMUD to move large quantities of electricity onto and off of the electrical grid at any time of the day, which is becoming essential to reliably meet electricity demands in a carbon-constrained world.

Upper American River Project

The UARP is the only hydroelectric project owned by SMUD. The 688 MW hydro system plays a significant role in energy management, contributing value in three primary areas: (1) operational flexibility, (2) economic power generation, and (3) overall system reliability.

One of the primary aspects of operational flexibility lies in the ability of the UARP to store water on a seasonal basis. The combined 400,000 ac-ft gross capacity afforded by the three storage reservoirs (Loon Lake, Ice House and Union Valley reservoirs) enables SMUD to manage the water, within physical, safety and regulatory constraints, to generate electricity when power is most valued throughout the year.

Generally, power is most valued when a deficit exists for electricity supply in the western United States (west of the Rocky Mountains), and particularly in northern California. An imbalance

[1] 'Investigating a Higher Renewables Portfolio Standard in California' January 2014, Energy + Environmental Economics https://ethree.com/documents/E3_Final_RPS_Report_2014_01_06_with_appendices.pdf

between energy supply and demand is driven by a number of factors, including but not limited to: (1) high daily temperature, (2) low precipitation and snowmelt in the Pacific Northwest and/or California, (3) an unexpected generating plant and/or transmission outage, and (4) constrained natural gas supplies. For example, on a hot summer day, when customer demand for electricity is high, SMUD will generally release water from storage to generate electricity at near full capacity. This operation occurs most often during peak load hours of the day such as the later afternoon and early evening. Alternatively, when local demand for power is low or when the western power supply is abundant, water is held in the storage reservoirs, and the UARP generates at reduced capacity for shorter periods of time.

The UARP is also operated to ensure reliability of the electric generation and transmission systems within SMUD's service area and in northern California. The UARP is operated in a manner to instantaneously provide electricity during emergency and other limited (e.g., peak load) situations, and to provide regulation services to the California Independent System Operator (CAISO). The Project is also capable of providing "black start" power to help in quickly putting base-load generation plants back on line in the event of a system-wide blackout. This helps to ensure integrated system reliability in California and other western states.

Iowa Hill

The SMUD Board of Directors have set the dual goals of achieving a 33 percent renewable contribution to SMUD's 2020 energy budget and reducing GHG emissions by 2050 to a level equivalent to 10% of emissions released in 1990. The GHG reduction goal is the cornerstone of SMUD's Sustainable Energy Policy.

With these goals, the amount of renewable energy added to SMUD's Balancing Authority area, and the California electric grid as a whole, will increase substantially. The majority of this energy is expected to come in the form of wind and solar energy, both intermittent and non-dispatchable resources. As more intermittent energy sources are added to the grid, additional forms of flexible generation will be needed to smoothly integrate the intermittent contribution. Currently, the majority of flexible generation, providing fast start-up capability, rapid ramping and regulation services, comes from gas-fired generation. As more renewable energy comes on-line and gas-fired generation declines, a growing divide appears likely to develop between renewable and sustainable energy goals. Pumped hydro storage technology is uniquely qualified to bridge this divide. Iowa Hill can provide the flexibility to integrate renewable resources into the grid under a scenario of decreasing gas-fired generation, in essence transforming renewable energy into sustainable energy.

Pumped storage technology previously was characterized by large plants (> 1,000 MW) that absorbed nighttime generation from base loaded nuclear power plants, and is re-emerging in response to a different set of needs. These include load following, load shifting, regulation, renewable resource integration, capacity services, system reliability, grid stability, and voltage control. In this new environment, pumped storage projects must be targeted to these special needs. SMUD believes that creative technologies focused on these needs should be developed and demonstrated to guide the hydroelectric industry into the next generation of pumped storage

projects. One such technology is adjustable-speed turbines that provide significant value in regulating and efficiently dispatching intermittent renewable energy supplies, providing ancillary services to the grid, and supporting the integration of Smart Grid technologies.

Iowa Hill is planned to be a 400MW facility with three adjustable-speed pump generators. The facility would be integrated into the existing UARP system. The existing Slab Creek Reservoir will serve as the lower reservoir and a new reservoir will be constructed atop Iowa Hill, 1,200 feet above the lower reservoir. Electricity will flow in and out of the underground facilities via a short gen-tie line connected to the existing UARP transmission line.

In 2011, SMUD received a $5M grant from the DOE Wind and Water Power Program, lending support to geotechnical and value modeling studies of Iowa Hill. Many of the grid management services described above were quantified in the modeling exercise. The model also demonstrated improved UARP efficiency due to better use of water storage and powerhouse operations leading to less water spillage at UARP dams. The value of improved water storage at UARP reservoirs will be adequately demonstrated under a global warming scenario of water runoff patterns that have transitioned from predictable snowmelt-driven hydrology to more volatile rain-driven hydrology.

Statewide Energy Policy Context and the 50% RPS Study

California has adopted long-term carbon reduction goals through Executive Order and legislative action to address climate change. In 2005, the state adopted an 80% carbon reduction below 1990 levels by the year 2050, and in 2006, the state legislature passed legislation bill to reduce statewide emissions back to 1990 levels by the year 2020. These overarching policies are being accomplished in the state through a variety of specific policies including renewable energy, rooftop solar, zero-emissions vehicles, low carbon fuels, cap and trade, energy efficiency and other efforts. One of the biggest drivers for the electricity sector is the renewable portfolio standard, which reached 20% in 2010, will reach 33% by 2020, and has been proposed in draft legislation to reach as high as 51% by 2030.

To better understand the impacts of future increases in the state RPS policy, the five largest utilities in California funded a modeling effort by Environmental + Energy Economics in 2013 to examine the operational reliability and cost implications of a 50% RPS by 2030. The study examined seasonal operational impacts of high penetrations of renewables, focused in particular on scenarios with significant amounts of solar generation. More than any other resource, solar generation has become a preferred renewable resource based on its now low cost and relatively easy accessibility throughout the state. The scenarios examined indicated that even with the contracts in place to meet the 33% RPS by 2020, overgeneration situations were going to be increasingly likely, and that by 2030, at a 50% RPS, overgeneration could occur as frequently as 23% of the hours of the year in certain scenarios. Such outcomes could have profound implications for asset owners, market participants, and our customers.

Energy storage, combined with dispatchable or controllable loads such as water heaters and/or EV's could provide an opportunity for a lower societal cost of renewables integration as

distributed storage costs are reduced. In this context, storage for both bulk as well as distribution systems presents an increased opportunity to capture value and enhance reliability.

Distributed Storage Research

Distributed energy storage holds promise as a mitigation strategy for dealing with intermittency of PV and wind. It can also help deal with increased loading of distribution system from EV charging. For example, storage can be sited with commercial, public opportunity charging systems. If EV charging is needed during peak load periods for the utility, the storage can be dispatched to offset the EV charging load and thus lessen stress on the distribution system. Further, it can help customers manage costs and improve their reliability. Customers can use the storage to better manage super peak energy costs or demand charges by using off-peak stored energy to offset energy and demand during super peak periods. Storage can also be used by customers to serve their load during utility outages, like an uninterruptible power supply. And, it can help SMUD and SMUD customers reduce peak load. Off-peak stored power can be used during utility peak periods when the distribution system is stressed and energy losses are highest.

However, the industry is still emerging. There are many startup companies operating on venture capital investments. While a number of large industry players such as GE, Bosch, Toshiba, and Mitsubishi are operating this space, the total MWs of installed distributed energy storage systems is still small. Storage technologies remain cost-prohibitive for general consumer use. Many of these new storage systems have little or no track record of performance.

SMUD has developed a portfolio of storage research and demonstration projects to better understand the different technologies, how well they perform, how durable they are, and how those technologies interact within our system. These projects are also helping our utility understand how to integrate, view, and manage storage in our system operations. From the customer perspective, some of these projects are helping SMUD and SMUD customers understand how storage can benefit them, i.e., reduce energy and demand costs and improve reliability.

SMUD's current distributed storage projects are assessing bulk energy storage such as compressed energy storage, distribution substation/feeder scale storage to help firm intermittent megawatt class PV projects (Kost Road 3MW PV plant), firming commercial customer sized PV plants (80kW PV array at SMUD HQ), and helping firm customer sited PV and reduce their energy costs. These research projects are revealing the challenges of communicating with and controlling these storage systems. For example at the Anatolia demonstration site, the customer broadband communication with the Residential Energy Storage was much less reliable and more problematic than the wireless communication solution used for the Community Energy Storage. SMUD has ongoing research to leverage SMUD's Smart Grid investment in Automated Metering Infrastructure, its Distribution Automation networks, and Demand Response Management System to communicate and control distributed storage devices that can help address this.

Conclusion

Based on SMUD's R&D, IRP planning, and experience implementing our integrated generation portfolio, we are actively exploring approaches to make utility-scale energy storage a reality. SMUD greatly appreciates the funding provided by DOE for our research and development of these energy solutions and the opportunity to provide input on issues affecting our customers through the Quadrennial Energy Review process.