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SMUD®

Mr. John Mathias
Energy Assessment Division
California Energy Commission
1516 Ninth Street, MS-20
Sacramento, CA 95814

December 28, 2016
LEG 2016-1001

Re: Energy Storage Compliance Report of the Sacramento Municipal Utility District (SMUD)

Mr. Mathias:

AB 2514 requires evaluation of appropriate targets, if any, for electric utilities to procure viable and cost-effective energy storage systems. Publicly owned electric utilities (POUs) were required to adopt these procurement targets by October 1, 2014, but only if they determined such targets to be appropriate after considering viability, cost-effectiveness, and "a variety of possible policies to encourage the cost-effective deployment of energy storage systems, including refinement of existing procurement methods to properly value energy storage systems." The POUs must report to the Energy Commission regarding their progress towards compliance with these energy storage procurement targets and policies by January 1, 2017. The following is SMUD's report to the Energy Commission demonstrating compliance with energy storage system procurement targets and policies adopted by SMUD's Board of Directors in 2014.

2014 Adopted Energy Storage Targets & Policies

1. Please indicate what, if any, energy storage targets your utility adopted in 2014 to be achieved by December 31, 2016.

In 2014, the SMUD Board of Directors chose not to adopt energy storage targets. This decision was based upon a significant body of research SMUD staff had conducted that found the storage technologies and applications available were not expected to be cost-effective by the timeframes in SB 2514. In addition to novel energy storage assessments and demonstrations, SMUD also devoted considerable resources to investigate the feasibility of pumped hydro storage at Iowa Hill. In early 2016, after evaluating considerable data from SMUD's energy storage research portfolio, the SMUD Board of Directors found that adoption of targets at that time would not be prudent. Nevertheless, SMUD has continued to investigate and test new technologies to identify

cost effective energy storage that meets the best interests of our ratepayers and of the environment.

2. If energy storage targets were adopted, provide an update on the progress of your utility towards meeting the energy storage targets:
What procurement mechanisms were used?

As indicated above, SMUD did not adopt energy storage targets in 2014.

3. If energy storage targets were NOT adopted, please discuss any efforts your utility has undertaken to evaluate or otherwise consider energy storage technologies either RD&D or pilot projects. If your utility has since procured energy storage, even in the absence of a formal target, please describe these projects as well.

While SMUD did not adopt storage targets in 2014, the *SMUD AB 2514 Storage Procurement Report* included the following recommendations about ongoing storage activities at SMUD:

1. Continue Investing In Energy Storage Technology Assessment, Demonstrations and Pilots.
2. Develop staff expertise in Customer Services to provide assistance to customers considering installation of energy storage systems.
3. Continue exploring the potential development of the Iowa Hill pumped hydro project.
4. Monitor ongoing developments with energy storage procurement by the IOUs in California.

The Energy Storage Program resides in SMUD's Energy Research and Development (ER&D) department. As industry leaders in research and development of energy innovations, ER&D contributes to achieving SMUD's vision - namely, to empower our customers with solutions and options that increase energy efficiency, protect the environment, reduce global warming, maintain high system reliability, and reduce the cost of serving our region.

ER&D supports SMUD's vision through:

- Research, analysis, development, and demonstration of emerging technologies that could benefit our customers and our community; and
- Support of energy and climate change policies, regulations, and programs at the federal, state, and local level, which promote SMUD's vision and the State's Climate Change policies.

The ER&D efforts focus on eight program areas, each with dedicated staff concentrating on specific research topics and how they all interrelate. ER&D research program areas include:

1. Climate Change
2. Demand Response
3. Distributed Generation
4. Energy Efficiency
5. Energy Storage
6. Electric Transportation
7. Grid Modernization
8. Large Scale Renewables

The Energy Storage Program conducts research into thermal, mechanical and electrical energy storage systems to reduce energy and demand costs. Such systems could increase the value of the existing distribution system without requiring upgrades by shifting peak demands at feeder and transformer levels, thereby improving overall system load factors. The Energy Storage Program is funded by SMUD, through partnerships with other agencies, and by grant funding.

SMUD is dedicated to identifying best-fit solutions for customers that optimize individual customer choice and benefits across the customer base. The Energy Storage Program works closely with other SMUD departments, such as Resource Planning, Distributed Energy Strategy, Grid Planning, Grid Assets, Rates, and Customer Strategy to ensure the research strategy is closely aligned with each business unit's vision and strategy. The program coordinates with SMUD's Legal and Legislative groups to ensure alignment with State policies and mandates.

SMUD is committed to identifying best-fit energy storage solutions and has established the following primary research areas for energy storage:

- Investigation of business concepts and shared-use scenarios
- Investigation of technical performance and value of storage use cases for grid products and distribution services
- Developing guidelines for interoperability with SMUD systems for customer- and utility-owned storage systems and control technologies

Because SMUD's energy storage procurements have resided solely within the ER&D Department, they are typically procured with the intention of decommissioning at the end of the research period. Energy storage technologies procured for investigation since October 2014 include:

Project Type	Technology	Status	# of Units	Capacity	Energy
Anatolia: PV and Utility- and customer-sited Storage Demonstration.	Lithium ion	Research completed. Decommissioned.	3 15	30 kW 5 kW	34 kWh 8.8 kWh
FIAMM: PV, EV and Utility-Sited Storage Demonstration	Sodium Nickel Chloride	Research completed. Decommissioned.	1	50 kW	130 kWh
Sunverge: Residential PV, EE, DR and Customer-Sited Storage Demonstration	Lithium ion	Research completed. Units remain installed and owned by customers.	33 1	4.5 kW 4.5 kW	11.64 kWh 12.3 kWh
Mitsubishi: PV and Utility-Sited Storage Firming Demonstration	Lithium ion	Research completed. Decommissioned.	1	500 kW	125 kWh
STEM: Commercial Customer-Sited Storage Demonstration	Lithium ion	M&V period. Unit remains installed and owned by customer.	1	36 kW	72 kWh
Iowa Hill: Utility Pumped Hydro Storage Assessment	Pumped Hydro	Siting and feasibility studies complete; cancelled	1	400 MW	6,400 MWh
Smart Grid Billing: Hotel EMS, EE, DR and Customer-Sited Storage Demonstration	Lithium ion	Scheduled for installation Q1 2017.	1	90 kW	135 kWh

Anatolia

SMUD led a DOE-funded project at the Anatolia housing subdivision to demonstrate residential and community storage in a SMUD SolarSmart Homes[SM] community. Partners included GridPoint, SunPower, Navigant, NREL, and SAFT. The project objectives included:

- Testing the ability to firm renewables, shift renewables and reduce peak load
- Understand the impacts of layers of TOU pricing with residential solar and storage
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

FIAMM

At our Headquarters campus, SMUD demonstrated a solar EV charge port coupled with an energy storage system. A sodium nickel chloride battery system was integrated with a PV array and 20 EV chargers, including a DC Fast Charger. The DC Fast Charger is open to the public and is in frequent use. The remaining EV chargers are primarily used by SMUD employees driving personal electric vehicles. This project evaluated how emerging, advanced, distributed energy storage can enhance and enable greater penetrations of intermittent PV onto SMUD's distribution system while maintaining system reliability, power quality, and operational control.

The project objectives included:

- Evaluation of the technological and commercial readiness of high temperature energy storage on SMUD's distribution system
- Demonstration of the ability of FIAMM's ESS to provide PV firming, peak load shaving, ramp rate control, mitigate the loading peaks associated with level 1, level 2, & level 3 electric vehicle charging
- Design, install, and successfully commission an energy storage system fully integrated with localized PV production and electric vehicle charging

Sunverge

SMUD partnered with Pacific Housing and Sunverge to demonstrate a smart community new construction project in 34 new highly energy efficient homes located in Midtown Sacramento at 2500 R Street. The project demonstrated solar PV integrated with lithium ion battery storage, demand response, programmable communicating thermostats and plug controls, and dynamic pricing.

The project tested the ability to:

- Reduce demand and TOU charges through demand response
- Respond to UPS events
- Minimize impact of PV variability, control ramp rates
- Shift peak load
- Provide real-time visibility and analytics of aggregated load for the utility

Mitsubishi

SMUD installed a lithium-ion battery system to augment a 3 MW solar PV plant within the service territory to evaluate the system's ability to mitigate PV variability, ramp rates, and voltage issues that result from PV arrays. The project assessed the ability to:

- Minimize impact of PV variability
- Control PV ramp rates
- Help regulation voltage and mitigate sags

STEM

SMUD partnered with Whole Foods to install a lithium-ion battery storage system from STEM behind their meter at their retail store to evaluate the following use cases;

- Peak Load Shifting – Charge the storage device when energy cost is lowest and discharge the storage device when energy costs are highest. This will allow the customer to arbitrage the expensive on-peak energy costs with cheaper energy from off-peak hours.
- Demand Charge Reduction – Demand charge is defined by the maximum kW delivered for a 15 minute period over 12 months. The project analyzed how the battery discharged power to serve customer peak loads, thus reducing the demand charge signal to the grid and enabling a lower maximum demand charge.

Iowa Hill

After many years of study and careful evaluation, SMUD has decided not to proceed with the proposed Iowa Hill project due to cost, financial risk and changes in the electric utility business. The latest engineering estimate put the total cost of the project at $1.45 billion. An updated cost-benefit analysis has led SMUD to conclude that other energy-storage technologies may provide more economical options for reducing peak demand, meeting our renewable-energy goals and reducing carbon emissions.

In 2010, a detailed study pegged the cost of construction at approximately $800 million. Last year, our engineering contractor updated the construction cost estimate to $900 million. Including the cost of financing and higher-than-expected costs to upgrade our transmission system, plus allowances for a contingency fund, the estimate for the total cost of the project rose to $1.45 billion.

In 2015, we also re-evaluated our need for the energy storage that would have been provided by the 400-megawatt pumped-storage project. Staff determined we would need only about half of the project's capacity until 2030 or later. After further analysis, we concluded in early 2016 that the project would be too risky from the financial standpoint. With recent advances in other energy-storage technologies, we recognized a growing likelihood that there will be more economical alternatives for satisfying Sacramento's energy storage needs in the long term.

Customer Service Progress on Interconnection Support

Customers interested in customer-sited energy storage are currently supported through SMUD's standard inverter interconnection process. In 2017, staff will review the customer touch points and interconnection guidelines to ensure that potential unique attributes of energy storage are considered and addressed by the interconnection process.

Overview of Energy Storage Portfolio

Smart Grid Billing
SMUD is currently partnering with Smart Grid Billing to demonstrate the performance of Smart Grid Billing's product GridRabbit™, a real time load management and dispatchable load control EMS platform. In 2017, SMUD and Smart Grid Billing plan to add commercial battery storage to the EMS package already in place at a local hotel to evaluate the ability to:

- Effectively and efficiently stack multiple storage use cases
- Shift loads off peak and enhance the customer's demand response capabilities
- Combine the benefits of integrating energy storage and real-time load control

Distributed Energy Strategy
In 2015, SMUD formed a Distributed Energy Strategy (DES) unit, focused on evaluating the market for Distributed Energy Resources (DER) and developing SMUD's DER strategies. This effort included examination of distributed storage applications, along with other DERs -- photovoltaic resources, energy efficiency programs, demand response programs, and electric vehicles. SMUD has considered the following planned or possible energy storage projects:

- Utility-sited storage for distribution deferral: SMUD intends to assess the cost effectiveness and technical ability of utilizing utility-owned and sited distributed storage to contribute toward the deferral of a traditional capital distribution project. The project is currently being scoped and assessed for feasibility and is planned to begin in 2017.
- Customer pilots: SMUD has planned to investigate the impacts of residential and commercial business models supporting the natural adoption of customer energy storage and to offer opportunities for shared use to provide the most cost-effective options for value stacking for both the customer and SMUD. The project is currently being scoped and is planned to begin in 2017.

Key Factors Impacting Energy Storage Procurement

1. *Please describe your utility's reasoning for procuring or not procuring energy storage to date.*

SMUD believes the following factors support procurement of energy storage resources in the future:

- Energy storage may provide a lower cost, modular alternative to large, long-term generation investments
- Increased penetration of renewables will require flexible resources for renewables firming and generation shifting

- Energy storage may provide alternatives to building traditional distribution projects or provide opportunities to delay projects by utilizing energy storage in combination with other distributed energy resources
- Energy storage may provide options for power generation operations with immediately responsive contingency reserves and black start capabilities
- The natural uptake of energy storage provides an opportunity to partner with customers on their energy management options, and may increase customer loyalty

2. *Please discuss barriers to your utility procuring energy storage.*

SMUD sees the following, potential barriers to deploying viable and cost-effective energy storage:

- Lack of visibility and control systems for bulk and distributed storage creates a liability in terms of unpredictable load impacts, inability to ensure the resources availability and response, and unknown impacts to revenue.
- Energy storage is not currently a cost effective alternative to traditional utility planning and operations.
- There is not currently an immediate need by the utility for energy storage, nor is there an influx of natural adoption by customers.
- Energy storage requires extensive systems integration and optimization to maximize both utility and customer benefits.

3. *Pursuant to Section 2836(b) of the Public Utilities Code, POUs are required, by or before October 1, 2017, to reevaluate adoption of energy storage procurement targets, if any, to be achieved by December 31, 2020. Please provide an update on your utility's re-evaluation process of energy storage technologies (i.e., the NCPA/SCPPA joint contract with DNV GL to provide an updated evaluation of energy storage technologies)*.

Energy storage procurement opportunities and strategies are currently being assessed by SMUD's Research and Development, Distributed Energy Strategy, Resource Planning, Distribution Planning, and Power Generation business units in collaboration with the Integrated Resource Planning team. Based on this work, SMUD will engage in a process to consider whether or not to recommend adoption of a specific storage target in 2017, to be achieved by December 31, 2020. This recommendation will be presented to the SMUD Governing Board of Directors for adoption prior to October 1, 2017.

/s/

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cc: Corporate Files (LEG 2016-1001)