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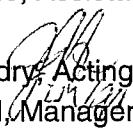

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MEMORANDUM

DATE: March 14, 2017 Commission Meeting

TO: Commissioner Anson Moran, President
 Commissioner Ike Kwon, Vice-President
 Commissioner Ann Moller Caen
 Commissioner Francesca Vietor
 Commissioner Vince Courtney

THROUGH: Harlan L. Kelly, General Manager 
 Barbara Hale, Assistant General Manager, Power

FROM: James Hendry, Acting Manager, Regulatory & Legislative Affairs 
 Lori Mitchell, Manager, Renewable Energy Generation 

SUBJECT: Update on Power Enterprise's Electric Storage Activities
 as Required by Resolution 14-0147

Summary

Assembly Bill (AB)2514¹ required that by October 1, 2014 “the governing board of each local publicly owned electric utility (POU) shall determine appropriate targets, if any, for the utility to procure viable and cost-effective energy storage systems to be achieved by December 31, 2016, and December 31, 2020.” Energy storage systems are defined in AB2514 as a “commercially available technology that is capable of absorbing energy, storing it for a period of time, and thereafter dispatching the energy” using “either mechanical, chemical or thermal processes.” A rechargeable electric battery is a common example of an energy storage system, although a variety of other technologies are also in use.²

In Resolution 14-0147 (September 23, 2014) the Commission approved staff's conclusion “that it is not cost-effective for the SFPUC to adopt an electric storage procurement target at this time” as well as directing that the General Manager should annually report back to the Commission “on the state of the market and the viability of energy storage as a resource for the SFPUC.”³

Edwin M. Lee
Mayor

Anson Moran
President

Ike Kwon
Vice President

Ann Moller Caen
Commissioner

Francesca Vietor
Commissioner

Vince Courtney
Commissioner

Harlan L. Kelly, Jr.
General Manager

¹ Stats. 2010, Ch. 469

² Appendix A provides a brief summary of these technologies. A more thorough description of each technology can be found in the SFPUC's Energy Storage Report.

³ Resolution 14-0147, p. 1,2.



Annual Update of SFPUC
Electric Storage Activities

This annual update identifies the following issues.

- Energy storage continues to not be a cost-effective option to meet the SFPUC's electric needs. The Hetch Hetchy system currently provides the same benefits that electric storage would provide.
- Power Enterprise is developing, in conjunction with other agencies, an electric storage facility at Thurgood Marshall High School, as part of the "Solar+Storage for Resiliency" program, as well as working with Water and Wastewater to identify opportunities for electric storage.
- Senate Bill(SB)350,⁴ passed in 2016, directs California's largest POU's, including San Francisco, to prepare an Integrated Resource Plan (IRP) by January 1, 2019. An IRP seeks to identify the most cost-effective and environmentally-sensitive portfolio of energy resources to meet a utility's forecasted demand. SB350 requires that electric storage be evaluated as part of this process.
- Power Enterprise is finalizing its IRP and will present its results to the Commission later this year. Based on the preliminary results of the IRP modeling, storage is still not a cost-effective option to meet the SFPUC's future energy needs.
- AB2514 also requires that the governing board of a POU shall reevaluate its storage targets "not less than once every three years." Power Enterprise staff will be preparing a Resolution, incorporating results from the IRP, on the SFPUC's needs (or lack thereof) for electric storage for the Commission's consideration prior to October, 2017.⁵

These points are discussed further below.

Energy storage is not a cost-effective option to meet the SFPUC's electric needs

Since the Commission's adoption of Resolution 14-0147 in September, 2014 costs for electric storage technology (although declining) are still significantly above the cost of either the SFPUC's own Hetch Hetchy generation or purchasing energy on the open market.

One of the main reasons that storage (at least on the wholesale energy level) is not cost-effective for the SFPUC is that the Hetch Hetchy system currently provides the same benefits that electric storage would provide. Among the benefits of electric storage are: the opportunity to defer the construction of new

⁴ Stats. 2016, Ch. 677, Sec. 9. Effective January 1, 2017.

⁵ This is three years after the initial October 1, 2014 filing date for setting initial storage targets. (Public Utilities Code 2836(b)(2) and (3).)

power plants to meet peak demand; the ability to ramp up and down over the course of a day to better match generation with load; and the ability to quickly ramp up or down to meet fluctuations in the electric system and maintain the reliability of the system (ancillary services). Since the capacity of the Hetch Hetchy system (385 MW) is significantly greater than the SFPUC's current peak demand (150 MW) the SFPUC is fully resourced and does not need additional capacity at this time. Consistent with the "water first" policy, there is still significant flexibility for the SFPUC to schedule water deliveries (and hence electric generation) to better match load and resources over the course of the day. The Hetch Hetchy system also provides almost all of the SFPUC's ancillary service needs.⁶

Identify opportunities to use electric storage for critical infrastructure as a source of back-up generation or in areas not accessible to the electric grid

As the 2014 Energy Storage Report concluded:

An additional benefit of an energy storage system is that it could provide power to customers during a utility outage. This may be of particular value to certain critical municipal loads, particularly in the event of a natural disaster that causes an extended outage.⁷

Over the past year, Power has assisted the Water Enterprise in evaluating and designing electric storage for use in critical infrastructure such as emergency cut-off valves for the major pipelines delivering water to the San Francisco Bay Area. This infrastructure is generally remote from the electric grid thus requiring its own source of power. The proposed configuration consists of solar photovoltaics (solar PV) combined with electric batteries. As the facilities provide critical operations, they also generally require generator back-up. The location and status of these projects are shown in Attachment C. Four projects have completed design review and are awaiting contracts for construction.

Over the last year, Power Enterprise worked with Wastewater to examine the feasibility of electric storage for the proposed re-build of the Southeast Wastewater Treatment Plant. It was decided that the use of electric storage, while feasible, was not cost-effective given the large amount of electric demand needed to be met. Wastewater continues to study upgraded co-generation facilities for this site.

Power staff is also supporting San Francisco Environment's (SFE's) efforts to develop energy storage paired with solar PV as a tool to improve post-emergency resiliency. San Francisco was awarded a two-year \$1.3 million

⁶ Appendix B provides a more detailed comparison of the energy services offered by storage compared to the Hetch Hetchy system.

⁷ 2014 Energy Storage Report, p. 15.

grant from the US Department of Energy to develop a roadmap for “Solar + Storage for Resiliency” projects in San Francisco neighborhoods.

As described in the grant:

The goal of the project is to expand the solar market by serving as a national model for integrating solar and energy storage into an existing Emergency Response Plan (ERP)....San Francisco’s experience will shorten the timeframe for other cities integrating renewables into their ERPs.⁸

Power Enterprise is actively managing a solar + energy storage resiliency pilot that will be located at Thurgood Marshall High School, since the location is listed as a Community Refuge Site. San Francisco Unified School District (SFUSD) has approved this location and Power Enterprise is currently working with SFUSD, SFE, the Department of Emergency Management, HSA and the Mayor’s Office to finalize the scope and goals of this project.

Power Enterprise has begun the design and engineering phase, selected the battery technology, and will conduct a site visit in early March to confirm design before plans are submitted to Division of State Architect (DSA) for permitting. Construction of the project will be done by the Department of Public Works that previously installed, under a SFPUC work order, the 87 kW solar electric system that will be incorporated into the combined Solar + Storage system.

SB350 directs the SFPUC to prepare an Integrated Resource Plan (IRP) by January 1, 2019 that includes the evaluation of electric storage

In addition to raising California’s Renewable Portfolio Standard (RPS) to 50% by 2030, SB350 also directed that California’s largest POUs, including San Francisco,⁹ prepare an Integrated Resource Plan (IRP) by January 1, 2019. An IRP seeks to identify the most cost-effective and environmentally-sensitive portfolio of energy resources to meet a utility’s forecasted demand. SB350 requires that electric storage be evaluated as part of this process.¹⁰

In response to this requirement, Power Enterprise has retained consultants and is in the process of finalizing the SFPUC’s IRP. Power Enterprise will present its results to the Commission later this year. Based on the preliminary results of the IRP modeling, storage is still not a cost-effective option to meet the SFPUC’s future energy needs.

⁸ “Solar + Storage for Resiliency” Technical Volume, p. 3 (US Department of Energy Solar Pathways Grant DE-FOA-0001071).

⁹ A large POU is defined as having sales of greater than 700,000 MWh per year for years 2013 through 2015. (Public Utilities Code 9621(a)). The SFPUC’s retail sales are approximately 1 million MWh per year over this time period.

¹⁰ Public Utilities Code 9621(c)(1)(B).

Power Enterprise will be preparing a Resolution for the Commission's Consideration prior to October, 2017 Updating (if needed) the SFPUC's Electric Storage Targets

AB2514, which required the SFPUC to evaluate setting a target for electric storage procurement, also requires that the governing board of a POU reevaluate this target "not less than once every three years."¹¹ To meet this requirement, Power Enterprise will be preparing a Resolution, incorporating results from the IRP, on the SFPUC's needs (or lack thereof) for electric storage, for the Commission's consideration prior to October, 2017.

APPENDICES

- A **TYPES OF ELECTRIC STORAGE TECHNOLOGIES**
(excerpted from 2014 Energy Storage Report)

- B **SFPUC ENERGY STORAGE NEED EVALUATION**
(2014 Energy Storage Report, Table 3)

- C. **SFPUC WASTEWATER PROJECTS USING/EVALUATING
ELECTRIC STORAGE**

¹¹ Public Utilities Code 2836(b)(2) and (3).

APPENDIX A
TYPES OF ELECTRIC STORAGE TECHNOLOGIES
(excerpted from 2014 Energy Storage Report)

Battery Storage: This category covers a wide range of electro-chemical devices that convert electrical energy into chemical energy for storage. There are three categories of batteries including conventional (lead-acid and lithium-ion), high temperature (sodium-sulfur and sodium-nickel-chloride) and flow batteries (vanadium redox and zinc-bromine).

Pumped Storage Hydroelectric: Pumped hydro is the world's most mature and abundant form of electric energy storage.¹² Pumped hydro systems use low-cost off-peak electricity to pump water from a lower reservoir into an upper reservoir for storage (gravitational potential energy). When the stored energy is needed, the water is released and passed through a turbine used to generate electricity. Pumped hydro is best used for large scale storage that has the ability to both store and discharge energy over long periods of time.

Compressed Air Energy Storage (CAES): CAES technology is a relatively mature form of energy storage with some new applications under development. CAES uses low-cost off-peak electricity to compress air inside an air-tight vessel (underground caverns or above ground pipes or bladders). The energy contained in the compressed air is then converted back to electricity by reheating and mixing the cool pressurized air with fuel, which is then passed through an expansion turbine where the fuel (natural gas, hydrogen, gasified biomass and oil) is combusted to drive an electric generator.

Thermal Energy Storage (TES): TES is a technology that stores thermal energy by heating or cooling a storage medium so that the stored energy can be used at a later time for heating and cooling applications and for power generation. TES systems can be either centralized (providing bulk or wholesale services) or distributed (providing services to end use customers). Centralized applications can be used in district heating or cooling systems, large industrial plants, combined heat and power plants, or in renewable power plants (Concentrating Solar Plants).

Flywheel Energy Storage (FES): FES systems convert electricity to rotational kinetic energy in the form of the momentum of a spinning mass. The spinning mass, or rotor, rests on bearings that facilitate its rotation. FES systems charge using electricity to power a motor-generator, which spins a shaft connected to the rotor to store energy. To discharge energy, the kinetic energy in the rotor is used to power a motor-generator to produce electricity.

¹² There is approximately 22,000 MW of installed pumped hydro in the United States and 127,000 MW worldwide.

APPENDIX B
SFPUC ENERGY STORAGE NEED EVALUATION
(2014 Energy Storage Report, Table 3)

Table 3: SFPUC Energy Storage Need Evaluation

Energy Storage Service	Service Description	Fulfills SFPUC Procurement Need?
<i>Bulk Energy Service</i>		
Energy Time-Shift or Arbitrage	Energy time-shift/arbitrage involves purchasing or generating electricity during periods when prices are low and storing that energy to be used or sold at a later time when prices are high. Storage can also time-shift or balance energy production by storing excess energy, which might otherwise be curtailed for use at a later time (e.g., from renewable sources such as wind or solar).	<i>Not At This Time</i> The SFPUC does not have an intra-day balancing need at this time as its generation supply is more than adequate to cover hourly loads. The ability to control water flows (and hence electric generation) from the Hetch Hetchy system (subject to meeting the requirements of the City's "water first" policy) already provides the SFPUC with sufficient flexibility to adjust electric output over the course of a day to better match electric demand. Additionally, considering the uncertainty in future differentials in intra-day prices, it would be purely speculative to invest in/commit to energy storage for this purpose.
Resource Adequacy Capacity	Energy storage could be used to defer or reduce the need to buy or build new central station generating capacity. Storage can be used to satisfy CAISO Resource Adequacy requirements (i.e., System, Local and Flexible).	<i>Energy Storage Could Satisfy Local Capacity Requirements</i> The Hetch Hetchy system has sufficient capacity for San Francisco to meet its System-wide and Flexible Capacity obligations. However, since this resource is neither located within the Greater Bay Area nor currently within any of the Local Capacity Requirement (LCR) zones established by the CAISO, the SFPUC might need additional local capacity. SFPUC could count energy storage capacity that meets LCR operating criteria and that is located in a CAISO designated Local Capacity Area toward its Local RA obligations.

Wholesale Ancillary Services		
Regulation Services	Regulation resources reconcile momentary differences caused by fluctuations in energy production and demand. Regulation helps maintain the proper grid frequency and ensure that the control area (e.g., CAISO) is compliant with reliability standards.	<p><i>Not At This Time</i></p> <p>The SFPUC currently has no need for any of these ancillary services as it either self-provides using the Hetch Hetchy system or acquires these services through the CAISO. In the future, depending on the system location and technology type, an SFPUC-owned energy storage system might be able to provide ancillary services to the CAISO and get paid for those services. The CAISO is currently working on addressing interconnection procedures for energy storage systems participating in its markets.</p>
Spinning/Non-spinning Reserves	Operation of the electric grid requires reserve capacity that can be called upon when some portion of the normal electric supply becomes unavailable or if there is large demand forecast error.	
Voltage Support	Grid operators must maintain system voltage within specified limits to ensure system stability. This requires the management of reactance, which is typically done using power plants to generate reactive power. Strategically sited energy storage can also provide system voltage support.	
Black Start Support	If suitably located, energy storage can be used to energize transmission and distribution lines and provide station power to help bring power plants on-line after a black-out.	
Transmission Infrastructure Services		
Transmission Upgrade Deferral	The delay or avoidance of otherwise required utility transmission capacity (expansion) investments can be achieved through strategic siting and sizing of energy storage.	<p><i>Not at This Time</i></p> <p>The SFPUC's transmission system is not facing capacity constraints, but as new needs arise, we will evaluate storage options alongside other available technologies. The CAISO is still developing policies and procedures for considering energy storage as an alternative to transmission investment.</p>

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<p>Transmission Congestion Relief</p>	<p>Transmission congestion occurs when the flow limit of a transmission line reaches its capacity, increasing the cost of energy on the congested side of the transmission line (where the demand is). Storage can be used to alleviate transmission constraints and avoid congestion-related costs and charges if it is located on the congested side of the transmission line. Energy is stored when there is no congestion (when demand is low) and discharged during peak periods to reduce congestion.</p>	<p><i>Not at This Time</i> Beginning July 2015, with the expiration of the City's Existing Transmission Contract rights, the SFPUC will face an estimated increase of \$100,000 to \$200,000/year (\$0.15 per MWh) in unhedged transmission congestion costs. The SFPUC plans to mitigate this exposure by participating in the CAISO's Congestion Revenue Rights allocation process. Energy storage may also help the SFPUC further mitigate its transmission congestion costs. However, the expected congestion exposure is not significant and any benefits energy storage may provide in this regard are estimated to be minor.</p>
<p><i>Distribution Infrastructure Services</i></p>		
<p>Distribution Upgrade Deferral</p>	<p>The delay or avoidance of an otherwise required investment to maintain adequate distribution capacity. Energy storage can defer the need to replace or expand the capacity of an existing transformer and/or reconductor existing lines with heavier wire.</p>	
<p>Distribution Voltage Support</p>	<p>Like the transmission system, utilities must regulate voltage on distribution lines within specified limits. Properly sited energy storage can help regulate voltage on distribution systems as well.</p>	<p><i>Not at This Time</i> SFPUC does not have a distribution capacity investment that could be deferred or a distribution voltage issue that could be addressed with a storage application at this time, but as new needs arise, staff will evaluate storage options alongside other available technologies.</p>

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Electric Storage Activities

Customer Energy Management		
Power Reliability	Energy storage can provide customers with uninterrupted power supply during a black out.	<p><i>Not at This Time</i></p> <p>SFPUC rate schedules, which include demand charges (\$/kW) and time-of-use rates (\$/kWh) for medium and large commercial customers, provide a price signal that allows these customers to evaluate the potential benefits energy storage may provide. However, while customer use of energy storage to avoid or reduce their demand or peak energy charges will provide bill reduction benefits to the customer, it will result in lost revenue to the SFPUC. In some cases, there may be off-setting avoided costs to the SFPUC in the form of reduced transmission and distribution charges or purchased power costs, but those reductions will be case specific.</p> <p>Many of the SFPUC's customers provide critical public services such as police, fire, hospital, airport, and water/waste-water operations. Almost all of the facilities providing this service currently have emergency back-up generation (natural gas or diesel) which might be candidates for electric storage.</p> <p>SFPUC policy to promote customer-side energy storage would benefit from further research to better understand the value of energy storage applications on the SFPUC customer's side of the meter. Staff believes that Customer Energy Management services could be an excellent area for demonstrating new energy storage technologies, particularly small or medium scale battery storage.</p>
Retail Electric Energy Time-Shift	Customers on time-of-use rates can avoid peak period energy prices by charging energy storage system during off-peak periods and discharging during peak periods. This is similar to the energy time-shift noted above, except at the retail level.	
Demand Charge Management	Medium and large commercial customers with energy storage can reduce or avoid maximum demand charges by charging their energy storage system during off-peak periods and discharging their energy storage during peak, high demand charge periods, typically between 12:00 p.m. and 5:00 p.m.	
Power Quality	Energy storage can help protect customer loads against poor power quality events, including voltage variations, frequency variations, lower power factor, harmonics, and momentary service interruptions.	

**APPENDIX C
WATER PROJECTS UTILIZING ELECTRIC STORAGE**

PROJECT	LOCATION	BATTERY SIZE	STATUS	COMMENT
Oakdale Valve Lot	Oakdale, CA.	77KWh	Design Complete. Awaiting Contracts.	PV+Battery for HHWP Water Pipeline
Tie-In Vault	Oakdale, CA.	38KWh		PV+Battery for HHWP Water Pipeline
Throttling Station #3 & 4	Oakdale, CA.	38KWh		PV+Battery for HHWP Water Pipeline
Alameda Creek Diversion Dam/Fish Passage	Alameda County, CA.	86KWh		PV+Battery plus On-Site Generation (2) per final design. (Off-Grid).