PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

ENERGY DIVISION **RESOLUTION E-4355**
August 12, 2010

R E S O L U T I O N

Resolution E-4355. Southern California Edison Company (SCE) requests approval to recover up to $25,978,264 for SCE's cost share in the Tehachapi Wind Energy Storage Project (TSP). This cost share will be matched by $24,978,264 in federal stimulus funding awarded by the United States Department of Energy (US DOE) under the American Recovery and Reinvestment Act of 2009 (ARRA).

PROPOSED OUTCOME: This Resolution approves SCE's request for cost share recovery. The TSP will design, build, operate, and evaluate utility-scale lithium-ion battery technology for purposes of improving grid performance and integrating intermittent renewable resources.

ESTIMATED COST: The maximum cost to SCE ratepayers is $25,978,264, which is approximately 45 percent of $57,218,155, the total project cost.

By Advice Letter (AL) 2482-E filed on June 10, 2010.

SUMMARY

This resolution approves SCE's request to recover up to $25,978,264 for its cost share in the TSP. SCE's cost share will be matched by $24,978,264 in federal stimulus funding awarded by the US DOE under the Smart Grid Demonstration Program[1] as part of the ARRA.[2] This cost share will also be matched by $1,000,000 in co-funding awarded by the California Energy Commission (CEC),

[1] U.S. Department of Energy, *Financial Assistance Funding Opportunity Announcement: Smart Grid Demonstration Program* (DE-FOA-0000036), June 25, 2009.

[2] American Recovery and Reinvestment Act of 2009, Pub. L. 111-5 (H.R. 1).

and $5,261,627 in third-party vendor contribution. The total project cost is $57,218,155.

This resolution directs SCE to investigate the feasibility of continued operation and maintenance of the TSP facility beyond the projected five-year demonstration life. This investigation should ascertain the cost and benefit of continued operational and maintenance activities versus the cost and benefit of facility decommissioning.

BACKGROUND

On December 18, 2008, the Commission issued Order Instituting Rulemaking (R.)08-12-009 (Rulemaking) pursuant to federal legislation[3] as well as its own motion to guide policy in California's development of a Smart Grid system. Following the issuance of the Rulemaking, the federal government appropriated $4.5 billion to modernize the electric grid pursuant to the terms of ARRA. Pursuant to this appropriation, US DOE issued two Funding Opportunity Announcements, establishing a Smart Grid Investment Grant Program (DE-FOA-0000058) and a Smart Grid Demonstration Program (DE-FOA-0000036).[4]

Consequently, the May 29, 2009 Assigned Commissioner's Ruling amended the scope of the Rulemaking to address procedures for IOUs seeking ARRA funding through either of the Funding Opportunity Announcements.

Following extensive commentary by parties, the Commission adopted D.09-09-029 establishing Commission processes for review of projects and investments by IOUs seeking ARRA funding. These processes are "intended to align the timeline of the Commission's review of investor-owned utility Smart Grid projects with the [US DOE's] rapid timeline for reviewing and granting awards for projects."[5] Additionally, IOUs are directed to provide the same quarterly and final project reports they submit to the US DOE to the

[3] The Energy Independence and Security Act of 2007 (H.R. 6).

[4] DE-FOA-0000036 targeted two program areas of interest: advanced digital grid technologies and grid-scale energy storage installations.

[5] D.09-09-029 at 3.

Commission, and serve these reports to the R.08-12-009 service list pursuant to Ordering Paragraph 1 of D.09-09-029. These reports will include the status and progress of the project, achieved project milestones, any proposed changes in the project's schedule required to complete project milestones, and data analytical results.[6] Non-confidential portion of these reports will be posted on the Commission's website.

Pursuant to Ordering Paragraph 3 of D.09-09-029, an IOU Smart Grid project that has been reviewed and approved for US DOE funding and does not require a California Environmental Quality Act (CEQA) review, a Certificate of Public Convenience and Necessity, a Permit to Construct, and does not require ratepayer funding that exceeds $30 million and 50 percent of total project costs, would qualify for the Tier 3 advice letter process. The Commission's Energy Division shall review the advice letter consistent with Tier 3 advice letter procedures to determine whether:

1. The US DOE has selected the project to receive an award;
2. The project furthers one or more of the benefits to utility ratepayers identified in Section 5.2 of D.09-09-029;
3. The requested incremental ratepayer funding for the project does not exceed $30 million;
4. The utility attests that ratepayer funding does not exceed 50 percent of the total project costs;
5. The utility attests or otherwise demonstrates that it has sought third-party funding, in addition to US DOE funding, and indicates what third party co-funding it has received;
6. The utility has provided a detailed itemized budget for the project and included a reasonable explanation of how the budget was developed; and

[6] DE-FOA-0000036 at 32.

7. The utility attests or otherwise demonstrates that the costs are necessary for the project.

If the conditions above are met, the Energy Division shall prepare a resolution approving the project for consideration by the Commission. A party protesting the Advice Letter should demonstrate that the Advice Letter does not meet the conditions set forth above.

On August 26, 2009, SCE submitted an application to US DOE to receive ARRA funding for TSP under the Smart Grid Demonstration Program's Energy Storage Program Area of Interest. Projects selected under this category will "help establish [grid-scale storage] costs and benefits, verify technical performance, and validate system reliability and durability, at scales that can be readily adapted and replicated across the United States."[7] As a condition for receiving financial assistance under ARRA, the selected demonstration projects are required to make data available to the public via a smart grid information clearinghouse administered by US DOE.[8]

On October 9, 2009, SCE served a notice to the R.08-12-009 service list regarding its TSP proposal submission to US DOE. SCE proposes the TSP to be a five-year demonstration project to design, build, operate and evaluate a 32 MWh (8 MW for 4 hours) utility-scale lithium-ion battery system, with advanced inverter technology, for purposes of improving grid performance and integrating renewable generation resources into the electric grid.[9] SCE plans to construct the attery facility at SCE's existing Monolith substation on the Antelope-Bailey 66 V sub-transmission system near the Tehachapi Wind Resource Area. SCE, along with its project partners,[10] proposes to collect data and quantify the potential

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[7] *Id.* at 7.

[8] ARRA Section 405 requires US DOE to establish a smart grid information clearinghouse to make data from smart grid demonstration projects available to the public, available at: http://www.sgiclearinghouse.org/.

[9] AL 2482-E Appendix B, *Tehachapi Wind Energy Storage Project Narrative to DOE*, at 9.

[10] *Id.* at 28. These project partners include SCE's battery technology vendor, A123 Systems, Inc., Quanta Technology, California State Polytechnic University at Pomona, and the California Independent System Operator (CAISO).

transmission, distribution, generation, and environmental benefits of the grid-scale storage technology. SCE proposes to use these data to improve energy storage cost-benefit models, validate the performance of grid-scale lithium-ion technology, better determine how much storage may be required in SCE's grid in the future, and make these findings applicable to other regions. (See Appendix A for a summary of SCE's project proposal.)

On November 24, 2009, US DOE announced that it had preliminarily awarded SCE $24,978,264 for the project.

On January 29, 2010, Energy Division Director approved SCE AL 2389-E to establish the Smart Grid American Recovery and Reinvestment Act Memorandum Account (SGARRAMA) to record incremental Smart Grid project costs and funding amounts relating to projects proposed by SCE under the smart grid provisions of ARRA. Upon Commission review through a Tier 3 advice letter filing or separate application, SCE may transfer amounts recorded in SGARRAMA to the Distribution sub-account of the Base Revenue Requirement Balancing Account, consistent with Ordering Paragraphs 3, 4, and 5 of D.09-09-029. Costs associated with the TSP are currently being booked to SGARRAMA.

On June 10, 2010, SCE submitted AL 2482-E for approval to recover up to $25,978,267 for the TSP, which includes estimated project costs of $23,616,604 and a 10 percent contingency budget for unforeseen events. SCE states that it will use the contingency budget only if they are needed to successfully complete the project and only in compliance with the requirements of D.09-09-029. SCE also states that it received third-party funding including $1,000,000 from CEC and $5,261,627 from A123 Systems, Inc, SCE's battery technology vendor.

In AL 2482-E, SCE provided its justification for meeting the specified criteria in D.09-09-029 that govern Energy Division's review of the project. Additionally, SCE provide, as appendices to AL 2482-E, its Project Narrative to US DOE, Project Management Plan, and Project Budget Spreadsheets, and Letters of Award by the US DOE and CEC.

NOTICE

Notice of AL 2482-E was made by publication in the Commission's Daily Calendar. SCE states that a copy of the Advice Letter was mailed and distributed

in accordance with Section 3.14 of General Order 96-B. The advice letter was served to the R.08-12-009 service list.

PROTESTS

SCE's Advice Letter AL 2482-E was timely protested on July 30, 2010 by the Division of Ratepayer Advocates (DRA). DRA agrees with SCE that the proposed TSP meets the criteria set forth in D.09-09-029. DRA states that the TSP should benefit one or more of the following areas identified in D.09-029-029:

- Reliability of the electric power system;
- Electric power system costs and peak demand;
- Consumer electricity costs, bills, and environmental impacts;
- Clean energy development and GHG emissions; and
- Economic opportunities for business and new jobs for workers.

DRA, however, expresses concerns that the cost of this project is relatively high especially considering its short operating life. DRA proposes that (1) SCE ratepayers should receive all future revenues in proportion to their contribution to the project; and (2) SCE should investigate the feasibility of continued operation of the TSP facility to mitigate its high cost as long as it does not result in any added cost to the ratepayers.

SCE timely filed a reply to DRA's protest on July 8, 2010. In response to DRA's recommendations, SCE states that the (1) TSP is not designed to provide any revenue-generating service to the grid, and (2) extending the duration of the project would cause SCE to incur additional and unauthorized operational expenses. SCE also does not expect to generate any intellectual property revenue associated with the TSP. If SCE were to realize any intellectual property revenues, they would flow through via the established Gross Revenue Sharing Mechanism approved by the Commission.

SCE claims that DRA's recommended requirements are not pertinent to Energy Division's review of AL 2484-E, and requests the Commission reject DRA's protest.

DISCUSSION

Energy Division reviewed SCE's AL 2482-E and concludes that the TSP meets the requirement specified by Ordering Paragraph 3 of D.09-09-029.

The TSP does not require a CEQA review, Certificate of Public Convenience and Necessity, or Permit To Construct

The TSP is proposed to be built within SCE's existing Monolith Substation. It does not involve an activity that will increase the substation voltage rating, and does not involve expanding the fence line of the substation. Accordingly, the TSP constitutes a "substation modification" and not a "substation upgrade" under Section III.B of GO 131-D. Pursuant to D.94-06-014, as modified by D.95-08-038, and GO 131-D, no CPUC or local discretionary permits or approvals are required for SCE to construct the TSP facility within its Monolith Substation.

The incremental ratepayer contribution does not exceed the thresholds of the $30 Million and 50 percent of total project cost pursuant to Order Paragraph 3 of D.09-09-029

The incremental amount of ratepayer funding SCE requests for TSP, of up to $25,978,264, does not exceed the threshold limit of $30 million and constitutes under 50 percent of the $57,218,155 total project cost.

AL 2482-E satisfies the specified criteria of D.09-09-029 that govern Energy Division's review

1. ***The DOE has selected the project to receive an award.***

   As Appendix A to AL 2482-E, SCE provided a copy of the letter from US DOE's National Energy Technology Laboratory notifying SCE of an award for the TSP under the Smart Grid Demonstration Program.

2. ***The Project Furthers One or More of the Benefits to IOU ratepayers identified in Section 5.2 of D.09-09-029.***

   The TSP will further Commission and industry understanding of grid-scale energy storage technology's capability to provide the following benefits: (1) optimal allocation and matching of resources to meet demand; (2) increased reliability of the grid; and (3) reduced system demands and costs. The result of this demonstration and will provide measurable and quantifiable economic, reliability, power quality, and environmental benefits to inform future grid-scale storage projects.

   SCE identified grid operation benefit categories to be evaluated and quantified as part of the TSP. These benefit categories include: (1) voltage support and grid stabilization; (2) decreased transmission losses; (3) diminished congestion and reduced wind generation curtailment; (4) increased system reliability by reducing the number of load shedding events; (5) deferred transmission investment; (6) optimization of size and cost of renewable energy-related transmission; (7) deferred transmission investment; (8) provision of system capacity and resource adequacy; (9) renewable energy integration and smoothing of generation output; and (10) wind generation output shifting from off peak to on peak periods.

   SCE also identified four CAISO Market benefit categories to test as part of the TSP. These market benefit categories include: (1) frequency regulation; (2) spinning and non-spinning replacement reserves; (3) ability to provide ramping capability and follow ISO market signals; and (4) energy price arbitrage. (See Appendix A for more details on SCE's proposal for data collection and analysis.)

3. ***The Incremental Ratepayer funding for the project does not exceed $30 million.***

   SCE requests to recover up to $25,978,264 for TSP, which is under the $30 million threshold established by D.09-09-029.

4. ***The utility attests that ratepayer funding does not exceed 50 percent of the total project costs.***

SCE requests to recover up to $25,978,264 for TSP, which is approximately 45 percent of the total project costs and under the 50 percent threshold.

5. ***The utility attests or otherwise demonstrates that it has sought third-party funding, in addition to DOE funding, and indicates what third-party co-funding it has received.***

   As Appendix C to AL 2482-E, SCE provided a copy the CEC Notice of Proposed Awards to grant SCE $1,000,000 in co-funding under CEC's Public Interest Energy Research Program. SCE also provided its quotation from the battery technology vender, A123 Systems, Inc., to contribute $5,261,627 toward the TSP.

6. ***The utility has provided a detailed itemized budget for the project and included a reasonable explanation of how the budget was developed.***

   As Appendix D to AL 2482-E, SCE provided a detailed itemized budget for the TSP and included a reasonable explanation of how the budget was developed in Appendix E to AL 2482-E.

7. ***The utility attests or otherwise demonstrates that costs are necessary for the project.***

   As Appendix E to AL 2482-E, SCE provided its TSP Project Management Plan which attests that the project budget, as laid out in Appendix D, is necessary to complete the project.

The TSP is a demonstration project to generate data and not revenue

DRA raised the issue of the TSP's expected future revenue in its protest. Specifically, DRA recommends that SCE's ratepayers receive all future revenues in proportion to their contribution to the project.

As SCE states in its reply, the TSP is not expected to provide any revenue-generating service to the grid. SCE has already provided this explanation as part of the advice letter filing: "The energy service provided will be for testing and demonstration only, no actual financial transactions will move

through the CAISO's market clearing house."[11] We agree with SCE that this issue is already addressed by SCE's filing. The purpose of TSP is to generate measured and quantitative data to inform future Commission policy and actions regarding grid-scale storage options, and not to generate energy service revenue. However, in the case that any future market design or regulatory changes could allow the TSP to generate energy service or other revenues, such revenues shall be credited to the Distribution sub-account of the Base Revenue Requirement Balancing Account.

SCE further explains that it does not expect to generate any intellectual property revenue associated with the TSP. We agree with SCE that a key objective of the project is to make information widely available via publicly available reports to the DOE and the Commission. However, if SCE were to generate any intellectual property revenues, such revenues shall be credited to the Distribution sub-account of the Base Revenue Requirement Balancing Account, and not flow through via the Gross Revenue Sharing Mechanism as SCE proposes.

SCE should provide information regarding the feasibility of continued operation of TSP beyond its forecast demonstration life prior to decommissioning the TSP facility

SCE plans to decommission the TSP facility in the fifth and final year of the demonstration project in 2014. SCE estimates the cost to disassemble the energy storage system, recycle batteries, and refurbish the substation to be $541,000. One potential reason for SCE's plan to sunset the demonstration project appears to be the project's currently presumed negative net present value (NPV). SCE states:

> The project is to test the potential range of uses and quantify the benefits of system performance to develop a robust set of benefit streams that can be subsequently used in cost-benefit analysis… As such this project itself is not expected to be NPV positive… The energy service provided will be for testing and demonstration only,

[11] AL 2482-E Appendix B, *Tehachapi Wind Energy Storage Project Narrative to DOE*, at 35.

> no actual financial transactions will move through the CAISO's market clearing house.[12]

However, as noted by DRA in its protest, extending the operation of the storage facility for as long as possible may provide useful information regarding the capability of the lithium-ion battery technology. If the data collected by the TSP team show that the facility's quantitative benefit stream can offset the continued operational expenses for the TSP facility, it may be reasonable to defer project decommissioning until a date beyond the five-year demonstration period.

The Commission, however, does not have sufficient information at this time to determine whether and at what cost SCE should operate the TSP facility beyond 2014. Therefore, we direct SCE to investigate the feasibility of continued operation of the TSP facility beyond the projected five-year demonstration life. This investigation should ascertain the costs and benefits of continued operational activities versus the costs and benefits of facility decommissioning. SCE is hereby required to report to the Commission with the result of this investigation and a final recommendation on facility decommissioning via a Tier 3 Advice Letter filing 6 months prior to commencing project decommissioning.

COMMENTS

Public Utilities Code section 311(g)(1) provides that this resolution must be served on all parties and subject to at least 30 days public review and comment prior to a vote of the Commission. Section 311(g)(2) provides that this 30-day period may be reduced or waived upon the stipulation of all parties in the proceeding.

The 30-day comment period for the draft of this resolution was neither waived nor reduced. Accordingly, this draft resolution was mailed to parties for comments on July 13, 2010, and placed on the Commission's agenda for August 12, 2010. On July 26, 2010, SCE timely submitted comments in support of the draft resolution. No other party submitted comments.

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[12] *Id.* at 35.

FINDINGS AND CONCLUSIONS

1. D.09-09-029 directed SCE to file a Tier 3 Advice Letter to recover SCE's cost share for a Smart Grid project that has received US DOE funding under the Smart Grid provisions of ARRA.

2. The TSP does not require a California Environmental Quality Act review, Certificate of Public Convenience and Necessity, or Permit to Construct.

3. The TSP satisfies the criteria that govern Energy Division's review of AL-2482-E as set forth in D.09-09-029.

4. It is reasonable to authorize SCE to recover up to $25,978,267 for its cost share in the TSP.

5. SCE's cost share will be matched by $24,978,264 in federal stimulus funding awarded by US DOE under the Smart Grid Demonstration Program as part of ARRA.

6. SCE demonstrates that it has successfully sought third-party contribution of $1,000,000 from the California Energy Commission, and $5,261,627 in technology vendor contribution.

7. The total project cost for the TSP is $57,218,155.

8. The purpose of TSP is to generate measured and quantitative data to inform future Commission policy and actions regarding grid-scale storage options, and not to generate energy service revenue.

9. The TSP is not expected to generate any energy service, intellectual property, or other revenues associated with the TSP. However, if SCE were to generate any revenues associated with the TSP, it is reasonable to credit these revenues to the Distribution sub-account of the Base Revenue Requirement Balancing Account.

10. SCE shall submit reports to US DOE and to the Commission, pursuant to Ordering Paragraph 1 of D.09-09-029. These reports will include the status and progress of the project, achieved project milestones, any proposed changes in the project's schedule required to complete project milestones, and data analytical results on the lithium-ion battery technology's ability to integrate intermittent renewable generation output into the grid.

11. Although SCE plans to decommission the TSP facility in 2014, it is reasonable to direct SCE to investigate the feasibility of continued TSP facility operation beyond TSP's projected five-year demonstration life.

THEREFORE IT IS ORDERED THAT:

1. SCE's request to recover up to $25,978,267 for the TSP as requested in Advice Letter 2482-E is approved.

2. If SCE were to generate any energy service, intellectual property, or other revenues associated with the TSP, such revenues shall be credited to the Distribution sub-account of the Base Revenue Requirement Balancing Account.

3. SCE shall investigate the feasibility of continued operation of the TSP facility beyond the projected five-year demonstration life. SCE's investigation shall contain a comparison of the cost and benefit of continued operational activities versus the cost and benefit of facility decommissioning.

4. SCE shall provide the Commission with a report of this investigation and a final recommendation on facility decommissioning via a Tier 3 Advice Letter filing 6 month prior to commencing decommissioning.

This Resolution is effective today.

I certify that the foregoing resolution was duly introduced, passed and adopted at a conference of the Public Utilities Commission of the State of California held on August 12, 2010; the following Commissioners voting favorably thereon:

/s/ Paul Clanon
Paul Clanon
Executive Director

MICHAEL R. PEEVEY
PRESIDENT
DIAN M. GRUENEICH
JOHN A. BOHN
TIMOTHY ALAN SIMON
NANCY E. RYAN
Commissioners

Appendix A

Tehachapi Wind Energy Storage Project Summary

PROJECT HISTORY

As part of a smaller scale research project funded by CEC's Public Interest Energy Research (PIER) program, SCE has been assessing the impact of the variable wind resource on grid voltage stability and power transferability.[13] Through the TSP, SCE plans to extend this PIER-funded study into a 32 MWh (8 MW for 4 hours) utility-scale demonstration facility sited at the Monolith sub-transmission substation on the Antelope-Bailey 66 kV system near the Tehachapi Wind Resource Area.

SCE reports that the Antelope-Bailey system currently experiences poor frequency and voltage stability resulting from local wind generation, periodic curtailment of wind resources, and sub-transmission line congestion. SCE states that it had selected the site based on the presence of problems that could be resolved or mitigated by the operational uses that SCE will evaluate as part of TSP.

SCOPE AND OUTCOME

SCE intends to use the results from the TSP to inform potential future investments in grid-scale storage across its service area. SCE states the goals of the TSP are to (1) establish real-world data on the costs, benefits of energy storage, (2) improve energy storage cost-benefit models, (3) validate the effectiveness of grid-scale lithium-ion technology, and (4) determine how much energy storage is required in SCE's grid. SCE asserts that this demonstration will help establish industry "best practices" and commercialization strategies for deploying large scale storage via cost-benefit reports to be disseminated by the US DOE.

In its Funding Opportunity Announcement, US DOE provided specific guidelines on what types of quantitative estimates Smart Grid demonstration projects must provide as a condition for receiving federal stimulus funding.[14] In

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[13] On June 18, 2008, CEC approved $496,273 for SCE's *Storage Feasibility Analysis for Wind Interconnection Points on the SCE system* under the PIER Renewable Program Wind-Storage Enhanced Transmission Research and Development grant solicitation.

[14] DE-FOA-0000036 at 8.

Table 1 below, columns 1 indicates the benefit categories specified by US DOE. In response, SCE provided to US DOE its outlines on the benefit details of each benefit category (column 2) and proposed project metrics (column 3) on how to quantify those benefits.

Table 1. TSP Benefit Categories and Estimates

DOE-specified Benefit Category	Benefit Details	TSP-specific Metric
1. Lower electricity costs	• Reduced need for curtailment • Reduced need for excess capacity and firming sources • Supply shifted to compete in higher price periods	• Overall average market price of Tehachapi Wind Resource energy. Measurements include curtailment costs, potential for reducing excess firming, load shifting price differences
2. Lower T&D losses	• Optimized T&D network	• Cost of generation for lost energy • Pollutant emissions from lost energy
3. Lower O&M costs	• Reduced O&M activity • Lower equipment failure	• Capital cost of replacing equipment • O&M cost from repair • Cost efficiencies from automated operations and maintenance
4. Greater transmission capability	• Increasing transfer capability without building additional transmission capacity	• Avoided curtailment costs • Avoided costs of building additional transmission
5. Better power quality	• Fewer outages • Shorter outages	• Cost savings of avoided cascading outages
6. Lower GHG/carbon emissions	• Fewer momentary outages • Fewer severe sags	• Cost savings to customers or equipment associated with fewer disturbances

	and swells • Lower harmonic distortions	• Cost savings to utilities from longer equipment life due to less exposure to fault current
	• Lower T&D losses • Lower emissions from generation	• Cost of generation for lost energy • Pollutant emissions from lost energy • Cost of central generation avoided • Pollutant emissions from central generation and lost energy avoided • Cost of generation for lost energy • Cost of ancillary services avoided

DATA COLLECTION AND ANALYSIS

SCE and the project participants plan to start collecting baseline data on the effect of intermittent renewable generation on the Antelope-Bailey sub-transmission system in 2010.[15] The increasing level of intermittent renewable generation in the Tehachapi Wind Resource Area is expected to create congestion, system instability, and generation curtailment events when wind generation output cannot be matched by local demand. Through this baseline process, SCE plans to identify the timing and magnitude of these grid conditions, in absence of the battery system, and establish the control data necessary for comparison when the TSP facility is operation.

Once the energy storage system and monitoring equipment are installed, SCE plans to test the thirteen operational uses indicated in Table 2. During this testing period, SCE plans to continue gathering control data by leaving the battery system inactive for certain periods. When the battery system is in use,

[15] Project participants include Quanta Technology, California State Polytechnic University at Pomona, and the CAISO.

the project team will calculate the metrics identified in the third column of Table 2 and compare these measurements to the control data collected during the baseline and testing periods.

SCE expects that it can test each operational uses independently and, where facility design permits, simultaneously with other uses. The extent of an operator's ability to stack these operational uses could help determine the cost-effectiveness and potential revenue streams for future grid-scale storage deployment. For example, shifting wind generation output across hours of the day can be stacked with voltage support, which requires charge and discharge events measured in fractions of seconds. Results from such simultaneous operations could inform the extent of lithium-ion battery technology's ability to simultaneously provide energy arbitrage benefits and ancillary service value. SCE proposes to work with the CAISO to develop performance measurement methodologies to test the technology's ability to provide such grid services.[16]

Table 2. TSP Test Requirements and Metrics

Operational Uses	Required Conditions	Relevant Metrics	Energy Storage Charge/Discharge Timeframe
Transmission Uses			
1. Voltage support/grid stabilization	High wind generation and low local load	System voltage profile	20 ms to 1 min
2. Decreased transmission losses	High wind generation or high load	Real time transmission line loading	4 hours
3. Diminished congestion	Antelope-Bailey stability problems	Reduced wind generation curtailment or frequency of curtailment events	4 hours
4. Increased system	High load	Increased power flow into area and	4 hours

[16] AL 2482-E Appendix B, *Tehachapi Wind Energy Storage Project Narrative to DOE*, at 29.

reliability by load shed deferral		reduced number of load shedding events	
5. Deferred transmission investment	Successful demonstration of uses 1-4	Dollars saved through potential investment deferred	Not applicable
6. Optimized size and cost of renewable	Successful demonstration of uses 1-4	Projected cost differential between original and reduced	Not applicable
System Uses			
7. Provide system capacity / resource adequacy	Successful demonstration of uses 1-4	MW of reserves relative to total generation before and after installation	Not applicable
8. Renewable energy integration (smoothing)	High variability of wind output	Power output and voltage fluctuation pre and post installation	20 ms to 15 min
9. Wind generation output shifting	High off-peak wind generation	Output shifted from off peak to peak periods	4 hours
ISO Market Uses			
10. Frequency regulation	Functional communication with CAISO	CAISO frequency data variation to verify the storage system's ability to follow ISO market signal	20 ms to 15 min
11. Spin/non-spin replacement reserves	Functional communication with CAISO	Financial value of displaced spinning reserves pre and post installation	4 hours
12. Deliver ramp rate	Functional communication with CAISO	System output to verify the storage system ability to follow ISO market	15 min

		signal	
13. Energy price arbitrage	Functional communication with CAISO	Difference between cost of electricity during discharge and charge	4 hours

Once baseline, testing, and performance data have been collected, SCE and the project participants plan to conduct data analysis to translate these operational results into quantitative benefit estimates required by US DOE, as indicated in Table 1. SCE asserts that the project results can be applied to any region that has similar problems with wind generation intermittency. Since the project has a detailed list of metrics and data gathering approach, SCE expects to establish energy storage benefits based on real data and refine energy storage models both locally and nationally.

TECHNICAL DESCRIPTION

Energy Storage System Efficiency

The TSP system efficiency is expected to be in the range of 85 to 90 percent, depending on usage and environmental conditions.[17] Under the type of cycling expected for the proposed wind integration uses, SCE expects the A123 System battery cell efficiency to be over 99 percent on a stand-alone basis. However, the overall TSP system efficiency is estimated to be lower, at 85 to 90 percent, reflecting conversion losses, on-site thermal management load, and parasitic loads.

Advanced Inverter Technology

SCE plans to incorporate an advanced inverter technology in its TSP facility design. The inverter is designed to facilitate the battery system's grid-related operations. SCE asserts that this inverter technology will dynamically communicate with utility operations on voltage programming, frequency response, status reporting, and reprogramming based on grid conditions to inject or receive real and reactive power as needed to support grid stability. SCE asserts that, unlike capacitor banks which operate in discrete levels, this advanced inverter technology offers continuous levels of reactive power and the

[17] *Id.* at 56.

ability to follow random and rapid control signals to smooth intermittent renewable generation output.

Synchronized Phasor Measurement System
SCE plans to install synchronized phasor measurement systems as part of the data collection and analysis effort. SCE expects the application of phasor measurement unit technology to help in (1) monitoring location of system constraints, (2) acquiring necessary data for energy storage control algorithm, and (3) analyze data records to determine system voltage stability and power quality performance.

COST-EFFECTIVENESS

Pending analytical results, emerging market processes and industry-accepted cost-benefit methodologies, SCE does not expect this project have a positive net present value. SCE asserts that the TSP is a research and development project to test the potential range of uses and to develop a set of benefit streams for subsequent cost-benefit analyses. SCE projects that these quantified benefit estimates will be applicable to in future storage deployment for itself and other utilities. SCE asserts that there is not enough quantitative information available at this point to conduct a net present value assessment.

REPORTING AND INFORMATION SHARING

The DOE Funding Opportunity Announcement requires SCE to provide a task-by-task breakdown of the TSP, including project milestones.[18] SCE is required to report the milestone status as part of the quarterly progress reports to US DOE and the Commission,[19] including the actual status and progress of the project, required to complete project milestones. Final reports on analytical results are expected in 2014.

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[18] *Id.* at 49.

[19] DE-FOA-0000036, at 32.