Appendix B

CPUC Energy Storage Use Case Analysis

[Application]

[Distributed Energy Storage - Community Energy Storage]

Version 0.1

Contents

1. Overview Section

In December ,2010, the California Public Utility Commission (CPUC) opened Rulemaking (R.) 10-12-007 (Storage OIR) to implement the provisions of Assembly Bill (AB) 2514 (Stats. 2010, Ch. 469). AB2514 directs the CPUC to determine appropriate targets, if any, for each load-serving entity as defined by Public Utility Code § 380(j) to procure viable and cost-effective energy storage systems and sets dates for any targets deemed appropriate to be achieved. In April, 2012, the CPUC issued a staff report titled "*Energy Storage Framework Staff Proposal*". The report provides an overview of the existing barriers for energy storage systems identified during a stakeholder public review process and identifies a proposed framework for analysis of energy storage systems. The report also highlights a list of prioritized use cases for energy storage systems.

The energy storage system identified in this use case is within the scope of the definition included in AB2514, which defines energy storage systems as follows:

(1) "Energy storage system" means commercially available technology that is capable of absorbing energy, storing it for a period of time, and thereafter dispatching the energy. An energy storage system:
  - may have any of the characteristics in paragraph (2)
  - shall accomplish one of the purposes in paragraph (3), and
  - shall meet at least one of the characteristics in paragraph (4)

(2) An "energy storage system" may have any of the following characteristics:
  - (A) Be either centralized or distributed.
  - (B) Be either owned by
    - a load-serving entity or local publicly owned electric utility,
    - a customer of a load-serving entity or local publicly owned electric utility,
    - a third party, or
    - is jointly owned by two of more of the above.

(3) An "energy storage system" shall be cost effective and either
  - reduce emissions of greenhouse gases,
  - reduce demand for peak electrical generation,
  - defer or substitute for an investment in generation, transmission, or distribution assets, or
  - improve the reliable operation of the electrical transmission or distribution grid.

(4) An "energy storage system" shall do one or more of the following:
  - (A) Use mechanical, chemical, or thermal processes to store energy that was generated at one time for use at a later time.
  - (B) Store thermal energy for direct use for heating or cooling at a later time in a manner that avoids the need to use electricity at a later time.
  - (C) Use mechanical, chemical, or thermal processes to store energy generated from renewable resources for use at a later time.
  - (D) Use mechanical, chemical, or thermal processes to store energy generated from mechanical processes that would otherwise be wasted for delivery at a later time.

As California moves towards achieving the objectives of the California Solar Initiative, Utility-Side (Wholesale) Distributed Generation Programs and Governor Brown's Clean Energy Plan, thousands of Photovoltaic (PV) systems are being installed every month in the State of California. A potential negative impact of these systems is a decrease in power quality and reliability due to the intermittency nature of PV power output. Energy storage systems may be able to help resolve these issues and achieve the levels of penetration targeted in the existing state policy.

2. Use Case Description

This Use Case describes energy storage system associated with a hypothetical 25 kW/50kWh Lithium-ion batteries that are connected to the distribution grid on the secondary side of distribution transformers. These Community Energy Storage (CES) devices are owned and operated by a load-serving entity. This Use Case will describe how using energy storage for grid operations and control for mitigating intermittency associated with distributed energy resources; primarily PV systems connected to the distribution system, and protect the transmission system from distribution system disturbances. CES devices may provide benefits at the individual-transformer level or at the feeder level if they are operated as a fleet.

2.1 Objectives

The objective of this Use Case is to integrate the targeted levels of penetration for PV systems at the distribution level and achieve the following primary functions:

- Power leveling/regulation on distribution grid with connected variable, renewable energy sources, primarily PV systems
- Power quality

The energy storage system included in this Use Case may have the potential to provide additional secondary functions to the extent that they do not interfere with the primary functions. In order to achieve these secondary functions additional systems, cost and benefits and potential changes to existing regulatory framework might be required. Below are some of the secondary functions identified:

- Peak load shifting/shaving:
    - As needed
    - Daily
- Distribution capacity deferral
- Grid operation to islanded system operation
    - Smoothing electrical transition
- Energy regulation and ancillary services related to CAISO operations, if units are operated as a fleet
- Energy storage for off-peak/on peak energy arbitrage
- Develop accurate cost forecast as a function of PV development for power quality services

As a result, the primary benefit of the energy storage system included in this Use Case is expected to be the mitigation of intermittency associated with PV systems connected at the distribution level. The energy storage system would provide smoothing characteristics to the highly-variable power output of the PV system, while providing voltage support.

2.2 Actors

In this Use Case, the energy storage device is owned and operated by the load-serving entity. The Use Case assumes full cost recovery of the investment by the load-serving entity under existing ratemaking methodologies.

Name	*Role description*

Energy Storage Device	These are devices that can quickly store or discharge energy for grid operation and control such as batteries and aggregated plug-in electric vehicles.
Storage Provider	Entity that operates the energy storage system. This use case assumes that the load-serving entity is the owner and operator of the energy storage system.
PV System	PV systems installed operated parallel to the distribution grid
Distribution Management System	Application(s) use by the storage provider to monitor, control, and optimize the performance of the distribution system.
Distributed Energy Resource Management System (DERMS)	DERMS is an advance software application that optimizes resource utilization in response to system operational events, environmental and equipment conditions, and market conditions. DERMS includes several different, but integrated, software components that incorporate advanced optimization algorithms to dispatch demand and supply side resources.
Measurement Device	These are devices that can measure voltage or other power quality indicators that would provide information about the condition of the distribution system

2.3 Proceedings and Rules that Govern Procurement Policies and Markets for This Use

Agency	Description	Applies to
CPUC	General Order 128 – Rules for Construction of Underground Electric Supply and Communication Systems	Utility
CPUC	General Order 95 – Rules for Overhead Electric Line Construction	Utility
CPUC	Rule 21 – Interconnection Standards for Non-Utility Owned Generation	Utility
CPUC	Rule 2 – Description of Service	Utility
IEEE	IEEE1547 – Standard for Interconnecting Distributed Resources with Electric Power Systems	Utility
California Statues	AB2514 – Energy Storage Systems	Utility
CPUC	R.10-12-007 – OIR Pursuant to Assembly Bill 2514 to Consider the Adoption of Procurement Targets for Viable and Cost-Effective Energy Storage Systems	Utility

2.4 Location

The energy storage system in this Use Case is located at various locations along a distribution feeder, coinciding with the areas of high concentration of PV systems. The units will be connected to individual distribution transformers.

2.5 Operational Requirements

The operational requirements for this Use Case are the following:

- Measurement device detects fluctuations in power output of the PV array and sends a signal to the battery controller.
- Battery controller charges or discharges the energy storage device in response to the signal.
- The energy storage device can supply and absorb both Watts and VARS, as required
- Charge/discharge cycle is determined by the desired daily operational needs to mitigate the power output fluctuations of the PV array.
- Energy storage device can operate autonomously or via DERMS control system.
- Discharge capacity will be based on the durations of the power output fluctuations of the PV array.

2.6 Applicable Storage Technologies

Storage Type	Storage capacity	Discharge Characteristics
Batteries	Driven by operations with a typical minimum size of 25 kW/50kWh	Driven by operations. Response time varies based on system requirements. For example, these devices given the power electronics interface to the grid can start to operate when given a signal within cycles.

2.7 Non-Storage Alternatives for Addressing this Objective

Name	Role description
Dynamic VAr Device	Power electronics based VAr device
Increase circuit capacity	Conventional alternative
Voltage Regulators	Autotransformers with power electronics interface. Not commercially available today.
Line Capacitors	Capacitors with power electronics interface. Conceptual today.
Smart Inverters	PV inverters with two quadrant operation capabilities

3. Cost/Benefit Analysis

3.1 Direct Benefits

The primary benefits identified below are those related to the objectives of this Use Case. Secondary benefits identified in this Use Case correspond to additional functionality that may be achieved by the energy storage devices but outside the scope of this Use Case. In order to achieve these secondary benefits additional systems, costs and potential changes to existing regulatory framework might be required.

End Use	***Primary/ Secondar y***	***Benefits/Comments***
1. Frequency regulation	Secondary	Aggregation of energy storage devices to provide regulation services to CAISO
2. Spin		
3. Ramp	Secondary	Aggregation of energy storage devices to provide fast ramping services to CAISO
4. Black start	Secondary	Aggregation of energy storage devices to provide fast ramping services to CAISO
5. Real-time energy balancing		
6. Energy arbitrage	Secondary	Charge energy storage device during off-peak hours and discharge the energy storage device during on peak hours
7. Resource Adequacy		
8. VER[1] / wind ramp/volt support,	Secondary	Providing voltage support to mitigate fluctuations of power output
9. VER/ PV shifting, Voltage sag, rapid demand support	Primary	Mitigate intermittency associated power output of PV systems
10. Supply firming	Secondary	Firming the power output from intermittent renewable energy generation such as wind and solar
11. Peak shaving: load shift	Secondary	Reduce feeder peak load by charging the energy storage device during off-peak hours and discharging the energy storage device during peak hours
12. Transmission peak capacity support (deferral)		
13. Transmission operation (short duration performance, inertia, system reliability)	Secondary	Provide support by aggregating energy storage devices
14. Transmission congestion relief		
15. Distribution peak capacity support (deferral)	Secondary	Economic value associated with deferring circuit upgrades by discharging battery during peak load hours, thereby keeping circuit load within the feeder rating
16. Distribution operation (volt/VAR support)	Secondary	Supply or absorb VARs as needed to support voltage regulation
17. Outage mitigation: microgrid	Secondary	Smooth transition to islanded operation and provide energy supply for the microgrid
18. TOU energy mgt		
19. Power quality	Primary	Maintain voltage, flicker and harmonic content within limits
20. Back-up power	Secondary	Provide black start or energy supply

[1] VER = Variable Energy Resource

3.2 Other Beneficial Attributes

Benefit Stream	Y/N	Assumptions
Energy Policy	Y	Support state policy related to deployment of PV systems

3.3 Costs

Cost Type	Description
Installation	• Equipment (battery, PCS) • Associated equipment (switches, transformers, cable) • Communications and metering equipment • Infrastructure (pads, trench/conduit) • Electrical construction • Measuring equipment
O&M	• Maintenance (inspection, repairs) • Training • Spare parts

3.4 Cost-effectiveness Considerations

TBD

4. Barriers Analysis & Policy Options

4.1 Barrier Resolution

Barriers Identified	Y/N	Policy Options / Comments
System Need	N	
Cohesive Regulatory Framework	N	
Evolving Markets	N	
Resource Adequacy Value	N	
Cost Effectiveness Analysis	Y	Phase 2 of R.10-12-007 will establish the cost-effectiveness methodology for this Use Case
Cost Recovery Policies	Y	Rate base cost recovery and cost allocation mechanisms for energy storage devices
Cost Transparency & Price Signals	Y	Absent appropriate rate design no driver for new investments in distributed energy storage devices

Commercial Operating Experience	Y	Limited operating experience by utilities
Interconnection Processes	N	
Commercial Readiness	Y	Devices still in the early product cycle. Not ready for plug-and-play

4.2 Other Considerations.

None

5. Real World Example

San Diego Gas & Electric (SDG&E)

5.1 Project Description

SDG&E is installing advanced energy storage devices that will mitigate the impact of intermittent renewables, as well as provide SDG&E with experience developing, implementing and operating new energy storage. The scope of the project includes developing utility scale size energy storage devices at substations, and distributed energy storage systems (typically 25kw/ 50 kWhr) on distribution feeders. The scope of this Use Case only covers energy storage devices on distribution feeders.

The current projects that are in progress will contain the following:

- Installations targeting circuits that have high penetration levels of PV systems and high loading levels
- Energy storage device sites will be based on the available space near the circuits and where the device would assist the circuit the most.
- Installation will occur once the device locations are confirmed and any necessary permits are granted.

The benefits identified for the current project are the following:

Primary Benefits:

- VER/PV Smoothing
- Power Quality

Secondary benefits:

Distribution Peak Capacity Support (Deferral)

- Peak Shaving
- VAR Support
- Frequency Regulation
- Arbitrage
- Cost Forecasting

Based on the recent SDG&E 2012 Smart Grid Annual Report, one distribution battery has been installed as of June 30, 2012 in the service territory with two more in construction.

5.2 Outstanding Issues

Description	*Source*
Pending Approval of SDG&E 2012 GRC Application	CPUC

Any benefits beyond primary function might require additional cost, systems and proper regulatory framework	Various

5.3 Contact/Reference Materials

Thomas O. Bialek, PhD., P.E.
Chief Engineer
tbialek@semprautilities.com

6. Conclusion and Recommendations

Is ES commercially ready to meet this use? Commercially available but not plug-and-play ready

Is ES operationally viable for this use? Yes

What are the non-conventional benefits of storage in this use? Complying with targeted penetration levels of PV systems established in state policy

Can these benefits be monetized through existing mechanisms? If not, how should they be valued? There are some evaluation tools available, but require further analysis

Is ES cost-effective for this use?. Existing deployments of energy storage devices under this Use Case are being analyzed on a the least cost, best fit approach as these devices are supporting the levels of penetration of PV systems established by state policy.

What are the most important barriers preventing or slowing deployment of ES in this use case? Plug-and-Play systems designed to meet a solution, regulatory certainty and lack of price signals.

What policy options should be pursued to address the identified barriers? TBD

Should procurement target or other policies to encourage ES deployment be considered for this use? No