Distribution Storage

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1. Overview Section

2. Use Case Description

This Use Case describes a hypothetical 1 MW/ 4 MWh energy storage system (ESS) functioning effectively as a "distributed storage" plant, referred to here as a "distributed storage" that connects to and charges from the transmission or distribution grid to primarily service local loads.

It is assumed that the resource has successfully connected to the transmission grid under California ISO interconnection rules and processes and includes CAISO-approved telemetry that allows for remote monitoring of the resource and related factors (i.e., generation output, availability, meteorological data, and circuit-breaker status).

2.1 Objectives

A "distributed storage" plant offers dispatchable capacity and energy in peak hours to defer T&D upgrades including wires, transformers, circuit breakers and other equipment or defer construction of new substations or power lines.

In addition, distributed storage may act as a storage peaker that provides several additional benefits including: better operational flexibility, emissions reduction, renewable integration (including over generation), procurement flexibility, and risk mitigation. Additionally, use of storage as a peaker, instead of a conventional combustion turbine (CT), may potentially avoid curtailment because of oversupply situations.

2.2 Actors

In this Use Case, the storage facility is owned by the utility.

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

	Description	*Applies to*

CPUC	Long-term Procurement Proceeding	Utility
CPUC	Resource Adequacy	Utility
CAISO	GIP	Project developer/owner

2.4 Location

The storage peaker plant is located at or near a transmission or distribution substation. It charges from the grid and discharges into the grid.

2.5 Operational Requirements

The "capacity" of distributed storage typically ranges from 1 MW to 5 MW x 4-6 hours.

A key feature of distributed storage is operational flexibility and ability to fulfill multiple purposes. A variety of requirements could be considered for operational flexibility that may need to be satisfied by distributed storage, especially multi-purpose storage. These include ramp rate, start/stop times, re-starts, minimum run times, dynamic range, emissions limits, hours of availability, etc.

If utility owned distributed storage is allowed to participate in the ancillary services market, the ISO may dispatch energy from its 5-minute market (aka, Balancing Energy Ex-Post Pricing, or BEEP-stack) which represents a real-time market for ancillary services. Distributed storage can participate in this real-time market and supply incremental energy in the same manner as traditional generators.

2.6 Applicable Storage Technologies

The distributed storage is most likely to be based on some form of battery system of various chemistries, such as Redox Flow Batteries (RFB), Sodium Sulfur (NAS) or Lithium Ion (Li-Ion).

Storage Type	*Storage capacity*	*Discharge Characteristics*
Redox Flow Batteries (RFB)	1 - 5 MW / 4 to 6 Hrs	Long 100% DOD cycle life

Sodium Sulfur (NaS)		
Lithium Ion (li-Ion)	50KW to MultiMW/1 to 4 hours	High speed, long cycle life

Redox Flow Batteries (RFB) are especially suited for large capacity energy storage.

The decoupled power and energy of RFB provides the maximum flexibility in sizing system power and energy appropriately for the target application from common building blocks. System power is tailored via integrating groups of electrochemical stacks with power electronics. Optimizing system energy is achieved by adjusting the volume of liquid electrolytes and tank sizes. As result, RFB cost per kWh decreases with increased duration.

An additional major benefit of the decoupled power and energy in RFB technology is a high degree of safety as only the electrolytes contained in the stacks can release energy. This characteristic limits the risk of unintended energy release to a small fraction of the system's total energy as there is no mechanism for electrolytes contained in the separate storage tanks to react. This provides increased location flexibility and accelerates the permitting process.

2.7 Non-Storage Options for Addressing this Objective

Alternatives available to address functions:

- Upgrade Substations
- New Substations
- Demand Response

3. Cost-Effectiveness Analysis

3.1 End Uses / Benefits

End Use	*Primary/ Secondary*	*Benefits/Comments*
1. Frequency regulation	S	If allowed
2. Spin	S	If allowed
3. Ramp	S	If allowed
4. Black start		

5. Real-time energy balancing	S	If allowed
6. Energy arbitrage	S	If allowed
7. Resource Adequacy		
8. VER[1] / wind ramp/volt support,	S	
9. VER/ PV shifting, Voltage sag, rapid demand support	S	
10. Supply firming	S	
11. Peak shaving: load shift	P	
12. Transmission peak capacity support (deferral)	P	
13. Transmission operation (short duration performance, inertia, system reliability)	P	
14. Transmission congestion relief	P	
15. Distribution peak capacity support (deferral)	P	
16. Distribution operation (volt/VAR support)	P	
17. Outage mitigation: microgrid		
18. TOU energy mgt		
19. Power quality		
20. Back-up power		

[1] VER = Variable Energy Resource

3.2 Other Beneficial Attributes

Attribute	*Benefits/Comments*
Modularity/Incremental build	Highly dependent on choice of technology
Faster build time	Choice of technology and chemistry influences permitting time
Locational flexibility	Highly dependent on storage technology and chemistry
Safety and Environmental Impact	Highly dependent on storage technology and chemistry
Mobility	Greatly improves cost-effectiveness
Multi-site aggregation	Enabled by modularity and locational flexibility
Optionality	Not sure what this means
Procurement flexibility	
Other?	

3.3 Costs

Cost Type	*Description*
Installation	
O&M	

3.4 Cost-effectiveness Considerations

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Since practical T&D deferral periods (typically 2 to3 years) are much shorter than a battery storage plant life (typically longer than 20 years), battery systems can be designed into easily transportable modular systems that can be redeployed multiple times at future substations or for different applications. This capability can greatly improve cost effectiveness.

Furthermore, allowing utility owned distributed storage to participate in the energy and ancillary services markets will play a major role in enhancing cost effectiveness,

4. Barriers Analysis & Policy Options

4.1 Barrier Resolution

Barriers Identified	*Y/N*	Policy Options / Comments
System Need	Y	Incorporate flexibility requirements into need authorization
Cohesive Regulatory Framework		
Evolving Markets	Y	

Resource Adequacy Value	Y	Higher valuation for flexible resources
Cost Effectiveness Analysis	Y	
Cost Recovery Policies		
Cost Transparency & Price Signals		
Commercial Operating Experience	?	
Interconnection Processes		
Issues with RFO design and offer evaluation process	Y	Develop a more comprehensive design & evaluation to consider more attributes
Operational flexibility requirements unclear	Y	
Value of operational flexibility unclear	Y	
Value of portfolio/procurement flexibility undefined	Y	
		Consider designating storage-based generators as "preferred"
		Consider portfolio approach to procurement

4.2 Other Considerations

5. Real World Example

6. Conclusion and Recommendations

Is ES commercially ready to meet this use?

Yes, See Section 5

Is ES operationally viable for this use?

Yes, See Section 5

What are the non-conventional benefits of storage in this use?

Refer to section 3.2

Can these benefits be monetized through existing mechanisms?

If not, how should they be valued?

No. A project-specific scoring system for non-monetized benefits should be considered and included in evaluating ES solutions.

Is ES cost-effective for this use?

Yes, but higher volumes are needed to improve cost-effectiveness.

What are the most important barriers preventing or slowing deployment of ES in this use?

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

Refer to Section 4

Should procurement target or other policies to encourage ES deployment be considered for this use?

Yes. Targets with incentives are needed to accelerate adoption leading to higher volumes that will greatly improve cost-effectiveness