Distributed Peaker

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1. Overview Section

Although energy storage systems can be built at the transmission, multi-megawatt scale to provide bulk energy storage applications, this Use Case investigates smaller, distributed energy storage systems (DESS) placed on the distribution circuits. This type of energy storage product offers several specific advantages that cannot be met with large bulk storage products or more traditional industry solutions. First, a DESS unit can be sited locally with minimum permitting as installations do not require a gas line, water for cooling, or additional transmission lines and have no direct emissions or significant operation noise. This ability to be sited at a substation can help improve service reliability by discharging to serve the load of a specific distribution substation for multiple hours. This provides utilities a defined window of time to fix an outage at a substation without their customers seeing any power interruption or loss of service. Additionally, DESS can help solve local voltage and reactive power problems that can occur at the substation and thus improve the stability and efficiency of the distribution equipment for the utility. Finally, although some of DESS's distinct advantages are derived from its ability to be sited and sized for location specific challenges, a network of DESS across a utility's service area can provide a coordinate response to shave peak demand and shift energy similar to the large, transmission level bulk energy storage product.

2. Use Case Description

This Use Case describes a hypothetical network of distributed energy storage systems (DESS) sized to be anywhere from 20 kW up to 1 MW in capacity and capable of providing 2-4 hours of energy functioning effectively as both a solution for local substation specific problems and a distributed peaker plant that connects to and charges off the distribution system to deliver local capacity, ancillary services, and energy to congested nodes in the distribution network.

It is assumed that the resource has successfully connected to the distribution grid under California ISO interconnection rules and processes and includes CAISO-approved telemetry that allows for remote monitoring of the resource and related factors.

2.1 Objectives

Although the challenges and needs of distribution system is similar to those of the larger, system wide transmission system, the distribution problems are much more location-dependent and thus must be solved at the local level. DESS offers a solution that can both help solve local distribution level needs and provide a coordinated response to alleviate system level load.

While being located at the distribution level, a DESS could still participate in wholesale markets by offering dispatchable capacity and energy in peak hours with little to no direct emissions, and ancillary services for balancing and reliability. These applications in addition to the localized benefits help make DESS a more economically viable option for utilities today.

In comparison to conventional, gas-fired peaker plants, a storage peaker may offer several advantages, including: better operational flexibility, emissions reduction, renewable integration (including over generation), procurement flexibility, and risk mitigation,

2.2 Actors

In this Use Case, the storage facility will be owned by a utility which could be defined as a distribution service provider, cooperative, municipality, or fully vertically integrated utility.

Name	*Role description*
Energy Storage Device	These are devices that can quickly store or discharge energy for grid operation and control such as batteries, flywheels, compressed air energy storage 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.
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	If providing power quality services, this will be needed to 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 and Markets for This Use

	Description	*Applies to*
		California IOU's
CPUC	General Order 85- Overhead	
CPUC	Long-term Procurement Proceeding	Utility
CPUC	Resource Adequacy	Utility
CPUC	Energy Storage OIR - R.10-12-007	California IOU's
CPUC	Rule 2- Rules of Service	California IOU's
CPUC	Rule 21- Interconnection	California IOU's
CAISO	GIP	Project developer/owner
IEEE	IEEE1547	California IOU's
CA	AB2514	California IOU's

2.4 Location

The individual DESS units are connected to the distribution grid and can be located at a substation or even further downstream next to residential level transformers for the smaller (< 100 kW) capacity systems. The DESS would charge and discharge from the distribution grid directly. The multiple DESS can be aggregated into a local controller, and multiple local controllers can be aggregated into a single master controller. This tiered control architecture enables a utility to command an integrated response and monitor performance of an entire fleet of DESS located throughout a utility's service area all from the utility's operation center.

2.5 Operational Requirements

DESS capacity can range from 20 kW per module for residential level systems to 500 kW for substation level systems. In order to provide peak shaving and time shifting, DESS must have 2 to 4 hours of duration at rated capacity per module. Minimal footprint, easy installation, and low maintenance are all design features that should be optimized to make implementation and operation as cost effective and simple as possible for the utilities.

From a software and control perspective, DESS must be able to perform multiple applications including power factor correction, voltage support, frequency response, automatic peak shaving, scheduled time shifting, AGC response, and market based dispatch services. In addition, DESS control must be available both at the local individual module level and at an aggregated service area wide level. This drastically increases operational flexibility by offering the utility solutions for local constraints by controlling individual DESS modules and system level challenges by commanding a coordinated response to provide capacity on demand to reduce peak load similar to a bulk storage peaker.

Specifications Table	
Module Capacity	20 kW to 500 kW
Discharge Duration	2 h to 4 h
Footprint	Minimal

2.6 Applicable Storage Technologies

The operational requirements combined with space limitations for likely siting lends battery based storage as the most appropriate technology for DESS. Depending on the expected operational requirements of a specific DESS installation, several battery chemistries could be utilized in the design including various lithium ion chemistries, advanced lead acid, and sodium nickel chloride.

Storage Type	*Storage capacity*	*Discharge Characteristics*
Battery Lithium-ion	Durations of 30 mins-4 hours	High power discharge and able to operate efficiently at a partial state of charge
Battery: Advanced Lead Acid	Durations of 5 mins-4 hours	High power discharge and able to operate efficiently at a high state of charge
Battery: Sodium Nickel Chloride	Durations of 2 hours-4 hours	Ideal is deep cycle discharge and able to operate efficiently at a partial state of charge

2.7 Non-Storage Options for Addressing this Objective

Of the non-storage alternatives available today, none of them offer the same range of diverse solutions from a single source. Fuel cell technology may be able to provide a subset (on peak energy) of applications in a distributed format. In addition, utilities have many existing options to solve problems related to growing demand, overloaded distribution circuits, and voltage stability concerns. These existing solutions include upgrading distribution level equipment such as transformers, switchgear, and electrical lines to increase the available capacity of the distribution network; capacitor banks and static VAR compensators to aid in power factor and voltage stability challenges; automatic demand response programs; and procuring additional energy from the ISO during peak demand periods to serve growing loads.

3. Cost-Effectiveness Analysis

3.1 End Uses / Benefits

End Use	***Primary/ Secondary***	***Benefits/Comments***

1. Frequency regulation	S	Earn revenues in Fast Acting Regulation market
2. Spin	S	If it can qualify
3. Ramp	S	Adds flexible supply capacity in milliseconds at nameplate.
4. Black start	S	
5. Real-time energy balancing	S	Discharge energy in the real-time energy markets
6. Energy arbitrage	S	Earn revenues from discharging during periods of peak demand and charging when prices are low
7. Resource Adequacy	S	If it can provide on a firm basis.
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	Automatically discharge energy when local distribution lines reach capacity to reduce peak load
12. Transmission peak capacity support (deferral)	N/A	
13. Transmission operation (short duration performance, inertia, system reliability)	N/A	
14. Transmission congestion relief	N/A	
15. Distribution peak capacity support (deferral)	P	Defer expensive distribution infrastructure upgrades by increasing efficiency and reducing peak demand of distribution system
16. Distribution operation		Instantly improve local power quality by providing

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[1] VER = Variable Energy Resource

(volt/VAR support)		reactive power and responding to voltage fluctuations
17. Outage mitigation: micro-grid	S	They are currently doing this now on a micro-grid.
18. TOU energy mgt	S	Ex. Non-utility owned: peak shaving for Industrial /Commercial customers to manage demand charges.
19. Power quality	S	Inject or absorb real or reactive power instantly and accurately to help with local power quality issues
20. Back-up power	P	Immediately discharge to continue supplying energy to loads in the event of an outage

3.2 Other Beneficial Attributes

Along with the applications outlined in the table above, a DESS acting as a distributed peaker provides unprecedented flexibility in its design, procurement, installation, and operation. An outline of these beneficial attributes is provided in the table below.

Attribute	*Benefits/Comments*
Modularity/Incremental build	Improve system upgrade efficiencies by purchasing only the capacity needed
Faster build time	Reduce project logistics and project financing costs
Locational flexibility / Mobility	Site systems at source of grid challenge
Multi-site aggregation	Command transmission level capacity from network of locally sited systems
Optionality	Solve multiple grid challenges with one solution; Adapt services to needs

3.3 Costs

The costs of Distributed Energy Storage Systems vary widely as a function of duration, type of storage technology employed, and operational duty cycle. Longer duration systems require more energy storage while keeping the capacity rating (kW) constant which effectively increases the normalized $/kW installation cost of a system. Operation and Maintenance (O&M) costs are generally fairly immaterial, but can increase with low efficiencies or if the DESS design requires more moving parts such as pumps and fans for cooling. Finally the operational duty cycle can affect the expected battery replacement interval which impacts the total cost of ownership of the system. Different battery storage technologies have different cycle life capabilities and limitations and the properly selected technology will have to balance $/kWh cost, cycle life, energy density, and power delivery capabilities. An overview of these three major cost categories is outlined in the following table.

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

3.4 Cost-effectiveness Considerations

[Still need to work through this section – have some initial modeling completed though]

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	Y	
Evolving Markets	Y	Need to value flexible, fast and accurate ramping

		capabilities of resources that have little to no direct emissions.
Resource Adequacy Value	Y	Still needs addressed. Higher valuation for flexible resources
Cost Effectiveness Analysis	Y	
Cost Recovery Policies	Y	Rate base mechanism for energy storage needs to be finalized
Cost Transparency & Price Signals	Y	Absent appropriate rate design no driver for installation
Commercial Operating Experience		
Interconnection Processes	Y	Simplify process
Issues with RFO design and offer evaluation process	Y	Develop a more comprehensive design & evaluation RFP/RFO process toconsider of storage
Operational flexibility requirements unclear	Y	More demand side and distributed resources penetrating the system.
Value of operational flexibility unclear	Y	Need to the systems needs for flexibility and ramping under the 33% RPS framework.
Value of portfolio/procurement flexibility undefined	Y	Consider portfolio approach to procurement
Other:		Consider designating storage-based generators as “preferred”

4.2 Other Considerations

5. Real World Example

5.1 Project Description

5.1.1 Ohio Smart Grid CES Demonstration Project[3]

AEP Ohio is currently conducting a CES (Community Energy Storage) demonstration project in Columbus, Ohio, which is part of the larger federally funded AEP Ohio gridSMART Demonstration Project. The CES project will install 80 S&C 25-kW/25-kWh CES units along a distribution feeder serving 1,742 customers with a peak load of 6.3 MVA. The CES units will cover approximately 20% of customers on this circuit. The aggregated capacity of these 80 units is 2 MW and 2 MWh. All 80 units will be controlled by one CES control hub, acting as a virtual substation battery. The prototype CES units were under construction in June 2010. The first 20 units are scheduled to be installed in April 2011. The remaining 60 units were scheduled to be installed in October 2011. Monitoring of these systems will continue through December 2013.

5.1.2 Detroit Edison CES Project[3]

Detroit Edison (DTE) is conducting a CES (Community Energy Storage) demonstration as part of its Advanced Implementation of A123's Community Energy Storage Systems for Grid Support project. The project is funded in part by the Energy Storage Systems Program of the U.S. Department of Energy. DTE's CES project will install twenty 25 kW / 50 kWh CES units along a residential distribution feeder in Northville near Detroit, Mich. The aggregated capacity of these 20 units will be 500 kW and 1 MWh. The 20 units will be controlled by DTE's Distributed Resources System Operations Center. A123 Systems will be providing CES units to the project comprised of their own batteries along with S&C's inverter and power electronics enclosure. The CES units are expected to be installed and tested between mid-2011 and mid-2013. A second phase of testing incorporating used plug-in electric vehicle (PEV) batteries, provided by Chrysler, will be conducted between mid-2013 and mid-2014.[2]

5.2 Outstanding Issues

Description	Source
Accepted/vetted benefits calculation	CPUC, EPRI

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[2] Advanced Energy's Community Energy Storage Report dated January 14th, 2011

5.3 Contact/Reference Materials

6. Conclusion and Recommendations

Is ES commercially ready to meet this use?

Yes

Is ES operationally viable for this use?

Yes

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

1. Supply is emission free.

2. Modularity/Incremental build: Energy Storage is modular in nature so that the utility only builds what they need and has the option to add more capacity if need be.

3. Siting: Can be sited in or near load centers.

4 Timing: Can be sited & built very quickly. Permitting process in minimal compared to a conventional peaker plant.

5. Transportability: Storage can be moved if it is determined that another location is ideal.

6. Optionality: Solve for multiple grid challenges with one solution.

Can these benefits be monetized through existing mechanisms?

Not currently.

If not, how should they be valued?

Could be valued against what the current/conventional solution is.

Is ES cost-effective for this use?

Yes, it is more cost-effective than building out conventional peakers to meet incremental system needs. Distributed storage peakers provide little to no direct emissions supply capacity and can be sited quickly near load centers.

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

- Inability to monetize non-conventional benefits.
- Regulatory framework.
- Utilities' inability to properly evaluate energy storage via current RFO/RFP processes.

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

1. Allow for a rate recovery mechanism.

2. Allow for Storage to seriously be considered through utility RFO/RFP processes.

3. Standard model for evaluating energy storage benefits.

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

Yes