On-Site Renewables With Storage

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1. Overview Section

In the near future, distribution grid operation and maintenance costs are expected to increase along with the growing popularity of net-energy metered solar generation and electric vehicles where adoption is being driven from the customer side of the meter. By encouraging adoption of customer sited Distributed Energy Storage (DES) systems through a variety of utility rate-based applications and demand response type programs, strategically deployed DES systems can help load-serving entities be better aware of interconnected generation, electrical grid conditions, and provide control strategies to help defer network upgrades and prolong asset life. In exchange, customers and third-party service vendors also gain more control over when and how much energy is used from the grid to reduce bill costs through real-time energy management.

2. Use Case Description

A customer sited Distributed Energy Storage System (DESS) combines electricity storage, power systems, and real-time remote accessibility to manage two sets of benefits for two parties: 1) load-serving entities such as **utilities**, **and** 2) utility residential and business **customers**.

Utility Customer

The utility customer owns the DESS or purchases on-site DESS services from a utility or third-party system owner. Each system is sized according to the specific needs of the customer and the site, minimizing component and installation costs under existing safety and communications standards. The customer receives value from displacing peak-time priced energy consumption that is reflective of utility unbundled energy and delivery costs. Generation and storage are controlled based on when and where energy should be delivered to ensure the greatest possible return on investment. The DESS is a virtual hub for customer sited power systems to connect and interact with the grid:

- variable energy resources (photovoltaic solar, wind, fuel cells)
- electric vehicle chargers
- building energy management systems
- programmable control thermostats
- critical load panels (back-up power)

Load Serving Entity (Utility)

Storage appliances can be deployed on the distribution grid at or near locations where variable energy resources and electric vehicle charging systems cause problems for aging and undersized circuits. Utilities gain access to almost instant power quality and demand information about customer usage and distribution grid operational conditions. In addition to supplying a reliable set of services to utility customers, any number of DESS can be remotely operated to control regional circuit power quality and circuit health during periods of high demand variability. Storage supply can be incrementally added or subtracted to permanent DESS as grid conditions demand.

Rate-Payer/Utility Interface

The modularity and virtual divisibility of Li-ion DESS allow for customers and utilities to divide ownership of a DESS in ways not previously imagined. As a function of a competitive market, both parties have measurable opportunities where a DESS can produce economic and societal benefits by facilitating a more efficient and reliable power delivery system while reducing green-house gas emissions. Policy mechanisms such as technology incentives, tariff options, and peak-load reduction programs serve as the interface between the customer and utility value propositions. Control of DESS from the cloud means individual DESS resources can be virtually divided between utility and customer using software-as-a-service platforms. Such discrete partitioning, much like a computer hard-drive, allows for new ownership models where a utility may rate-base only a portion of the DESS like additional DESS storage cells, for example. It is at the rate-payer/utility interface that all DESS value streams are measured and harvested.

2.1 Objectives

- Reduce distributed scale (<1MW generation/storage capacity) project installation costs.
- Defer distribution system maintenance while improving grid operability for utilities using consumer sited distributed renewables installed parallel with responsive, co-operative battery storage.
- Target residential, multi-family, institutional, and commercial consumer market segments with tariff options, incentives, and demand management programs that **encourage customer investment** of highly optimized, utility deployable resources that can be used to manage a grid with increasingly variable utility customer power needs (electric vehicle, renewable power, reliability, consumer appliances)
- Mitigate the negative impacts of intermittent/variable wind and solar generation on the distribution grid by firming at the source of generation
- Reduce load management costs by intelligent and optimized peak load shifting
- Accelerate the deployment of Electric Vehicles while mitigating increased demand variability

- Enhance effectiveness of demand response by guaranteed targeted dispatch upon command
- Improved grid reliability and efficiency by improving power quality at the edges of the distribution network
- Enhance accuracy of grid analytics with real-time visibility into distributed resources

2.2 Actors

In this Use Case, the DESS may be owned by 1) the utility, 2) the utility customer, 3) a third-party aggregator of customer storage resources, 4) a third party system owner that operates the facility under a under a long-term power purchase agreement with the utility and/or host customer, and 5) a DESS system operator that operates and maintains DESS hardware and software.

Name	*Role description*
Utility	Rate-based ownership of consumer oriented appliances, distribution system operator, energy supplier, power procurement
Electric Utility Customer, Host	Property owner, electric customer
Third-Party Aggregator	Vendor offering short-term energy services to utilities and utility customers
Third-Party System Owner	Supply distribution services to utility through long-term power agreements
System Operator	Operates and maintains DESS hardware and software

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

<u>Rules Affected:</u>

NEM, FiT, RESBCT, other emerging tech utility tariffs

Self-Generation Incentive Program

California Solar Initiative

Demand Response Programs

PLS

LTPP

Applies to Market:

All IOU GRCs

Residential, Commercial utility customers

Distribution level voltages

CAISO

Wholesale Distribution Capacity (aggregated)

2.4 Location

The DESS interconnects to the distribution grid at or near electric customer service delivery points. It charges from on-site renewable energy generation or the grid and discharges to customer load or the grid. The DESS is located at a single site and aggregated over multiple smaller sites.

2.5 Operational Requirements

Participating DESS products must meet minimum communication and operational thresholds to be eligible for special purposed utility tariffs, demand response programs, and real-time ancillary services (Regulation, Power Quality) to the utility.

Software and power electronics aggregate systems together in a secure, real-time network for the delivery of both energy and information to customers and utilities alike. Software services pool and dynamically scale energy resources across the grid upon demand. Multiple applications are delivered to multiple parties from each DESS.

- Respond to Demand Response events with guaranteed dispatch of power to the grid. DR events can either be scheduled in advance or sent in real-time.
- Respond to needs for voltage and reactive power control by injecting or absorbing power
- Respond to regulation signals on a per-second basis
- Supplement the intermittent nature of renewable generation with the stored energy in its battery, each appliance can “smooth” the energy provided to the grid, making it more reliable, more predictable, and more stable.
- In the event of a loss of power, the appliance automatically isolates itself from the grid, and then delivers its own power to the site without any interruption in service or loss in power quality.
- "time-shift" energy generated from PV and/or drawn from grid to maximize peak load reduction for a home or business

- Optimize the amount of load reduced during the peak load period by dispatching energy (effectively "offsetting" energy consumption at the site)
- Limit the export of solar generation to the grid by storing solar generation that is produced in excess of site demand

2.6 Applicable Storage Technologies

Storage Type	*Storage capacity*	*Discharge Characteristics*
Li-ion Battery	Suited to short duration (<=2hrs)	Real-time response
Compressed-air		
Advanced lead-acid		

2.7 Non-Storage Alternatives for Addressing this Objective

- Distribution system upgrades to accommodate bi-directional flow and high load variability
- Customer sited combustion generators (peakers and back-up)
- Customer sited SCADA
- Third party Demand response programs

3. Cost/Benefit Analysis

3.1 Direct Benefits

End Use	*Primary/ Secondary*	*Benefits/Comments*
1. Frequency regulation	P	Real-time response Li-ion is well suited to this use
2. Spin		
3. Ramp		
4. Black start		

5. Real-time energy balancing		
6. Energy arbitrage		
7. Resource Adequacy		
8. VER[1] / wind ramp/volt support,		
9. VER/ PV shifting, Voltage sag, rapid demand support	P	Real-time response Li-ion with extra power monitoring
10. Supply firming		
11. Peak shaving: load shift	P	Li-ion for 2 hr or less duration, other technologies for longer periods
12. Transmission peak capacity support (deferral)		
13. Transmission operation (short duration performance, inertia, system reliability)		
14. Transmission congestion relief		
15. Distribution peak capacity support (deferral)	P	Storage can mitigate the need for distribution grid upgrades due to growing customer loads and age.
16. Distribution operation (volt/VAR support)	P	Real-time response Li-ion well suited
17. Outage mitigation: microgrid	P	Li-ion can be used to improve short-term reliability until back-up generators come on-line. DESS can be used to control the shedding of loads and PCTs
18. TOU energy mgt	P	High-resolution and real-time Li-ion response are terrific demand cost management tools and peak shaving
19. Power quality	P	
20. Back-up power	P	

[1] VER = Variable Energy Resource

3.2 Other Beneficial Attributes

Benefit Stream	*Y/N*	*Assumptions*
Distribution level scalability	Y	Distributed at customer sites and virtually aggregated to scale resource
Rapid build time	Y	Customer focused deployment minimizes DESS footprint and build time.
Data monitoring and analysis	Y	Built in SCADA
Multi-site aggregation	Y	Real-time communication and response
Optionality	Y	
Procurement flexibility	Y	Devices can respond in real-time and offers a niche of functionality to short-duration power needs
Grid/communications reliability	Y	Can be used to keep communication infrastructure reliable during outages

3.3 Costs

Cost Type	*Description*
Installation	Modular design allows for standard product solutions (turn-key).
O&M	Typically includes software-as-a-service platform and monitoring

3.4 Cost-effectiveness Considerations

In cases where storage and renewable generation are installed behind a single inverter, special consideration must be made to not encumber efficiently designed systems with added inverter and metering costs as is currently required by some utilities to be eligible for Net Energy

Metering (NEM) tariffs. A new storage-centric tariff similar to NEM but designed for renewable generation (solar, wind, fuel cells) optimally paired with storage to firm variable generation as a way to reduce both utility interconnection study costs and project installation costs.

4. Barriers Analysis & Policy Options

4.1 Barrier Resolution

Barriers Identified	*Y/N*	Policy Options / Comments
System Need		
Cohesive Regulatory Framework	Y	
Evolving Markets	Y	
Resource Adequacy Value		
Cost Effectiveness Analysis	Y	
Cost Recovery Policies	Y	
Cost Transparency & Price Signals	Y	Real-time pricing, unbundled costs, storage tariffs
Commercial Operating Experience	Y	
Interconnection Processes	Y	Create a fast track for storage paired renewables
Customer usage awareness	Y	Putting devices behind the meter will increase awareness

4.2 Other Considerations

Combinations of energy storage devices installed in concert with renewables for mid-to-large commercial customers could have beneficial synergies. For example, compressed air to satisfy permanent peak load shifting paired with lithium-ion batteries used for ramping up to the compressed air, firming solar renewables, and reducing customer bill costs through demand management.

5. Real World Example

5.1 Project Description

The project consists of two discrete types of power system co-existing on four separate multi-family properties. One system type is a virtually net-metered photovoltaic generation supplying tenant loads. The second system type is photovoltaic generation paired with a Li-ion DESS optimized to common area meter loads. The DESS is designed prevent solar energy exports, firm solar generation, and reduce customer demand costs as solar generation begins to wane below consumption. All four sites are within a single utility territory and could provide additional value to the load serving entity under a short or long-term DESS distribution services contract.

- Four separate multi-family properties in southern California.
- 2 MWac photovoltaic solar, 90% of which is serving multiple tenant loads
- 180kWac / 350kWh of Li-ion DESS
- 150kWac of the 2MWac solar is tied into the DESS on the DC buss, serving common area loads
- Project online by Summer 2013

Location	Comment
Operational Status	In development
Ownership	PPA
Primary Benefit Streams	Virtual Net Energy Metering, Bill Cost Management
Secondary Benefits	Storage available for demand response or other utility grid cost reduction strategies
Available Cost Information	Project cost on par with conventional solar-only systems (<$7/Wac installed)

5.2 Outstanding Issues

Description	*Source*
Net energy metering eligibility and interconnection process	

5.3 Contact/Reference Materials

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6. Conclusion and Recommendations

Is ES commercially ready to meet this use?

Is ES operationally viable for this use?

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

Can these benefits be monetized through existing mechanisms?

If not, how should they be valued?

Is ES cost-effective for this use?

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?

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