Permanent Load Shifting

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1. Overview Section

California Utilities typically employee Time of Use (TOU) electricity rates for larger commercial customers. Along with paying for the energy they consume (assessed on a kWh basis), these commercial customers are also charged for demand (measured in kW). Demand charges are determined using the maximum demand (or peak demand) occurring during the monthly billing period. Demand charges can be a substantial cost component of a commercial customer's electric bill.

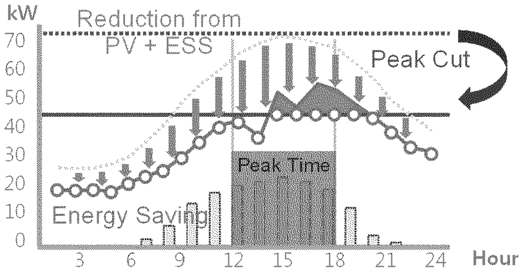
2. Use Case Description

This use case describes and energy storage asset located downstream or behind an end customers electric meter. There are several ownership models of behind the meter energy storage. Three are described here...

1. Commercial Ownership - The energy storage asset is located behind a commercial customer's electricity meter. The energy storage asset is owned by the commercial customer and is used to dispatch electricity to coincide with periods of peak demand. By utilizing energy storage in this fashion, the commercial customer can reduce or eliminate peak electricity demand. This action correlates to monetary savings on the commercial customer's electric bill. If the customer also employees onsite renewables generation, such as solar, the energy storage asset can boost self-consumption of energy generated at the site.
2. Residential Ownership – Similar to commercial ownership, only owned by a an individual as opposed to a commercial entity.
3. An alternative ownership model for behind the meter energy storage is also possible. Many municipal and cooperative utilities do not own generation assets but rather purchase capacity from generating partners. This purchase of electricity includes demand charges. In this example, the energy storage asset is not owned by the end customer but rather by a utility. A utility would pay for and install an energy storage asset at a customer location, behind the meter. The customer would principally receive backup power benefits while the municipal utility would use the energy storage units at multiple sites, aggregated, to reduce demand charges it must pay to its generating sources.

2.1 Objectives

Customer sited energy storage can be utilized to dispatch energy to coincide with periods of peak demand, thus helping reduce or eliminate a customers demand charge burden. In addition to the primary purpose of helping customers manage demand, customer sited behind the meter energy storage resources can also provide a number of other benefits such as backup power and / or power quality thereby protecting key equipment or processes from the effects of weather related electricity interruptions and outages, rolling blackouts, brownouts, and generation and / or transmission system failures upstream of the customer sited energy storage resource.



2.2 Actors

Name	*Role description*
Commercial Building Owner	Property Owner seeking to reduce electricity demand charges, secure against power fluctuations and outages
Residence Owner	Property Owner seeking to reduce electricity demand charges, secure against power fluctuations and outages
Utility	IOU / Municipal Utility

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

Agency	*Description*	*Applies to*

CPUC	Self-Generation Incentive Program	
Federal Tax	FITC	
Utility Tariffs	Utility TOU Tariffs	
CPUC	AB 2514	

2.4 Location

The energy storage resource is located behind the customer electric meter.

2.5 Operational Requirements

For the purposes of this use case, the energy storage asset should be able to dispatch energy to coincide with periods of peak load demand. This can be accomplished through a programmable interface to allow the system to discharge to coincide with peak load. Alternatively, the system could employ adaptive logic which would account for various factors such as weather, onsite renewable generation, utility tariffs structure, and other variables to automatically dispatch energy at appropriate levels to reduce or eliminate peak demand. The system must be fast responding. Ideally, the system would employ some fashion of battery management system to monitor the health and state of charge of the systems batteries.

For behind the meter energy storage assets owned by utility's seeking to aggregate multiple systems, the energy storage asset should employ some type of communication interface to allow the utility to remotely control the charge and discharge of the system.

2.6 Applicable Storage Technologies

The potential storage devices that are most applicable to this use case is some form of battery, sized to support the reduction of demand charges. Currently, the most common technologies are lead acid and li-ion. However, Redox Flow Batteries (RFB) are also suited for large capacity energy storage[1].

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[1] The decoupling of power and energy unique to RFBs provides maximum flexibility to size system power and energy appropriately for the target application from common building blocks.

Storage Type	*Storage capacity*	*Discharge Characteristics*
Li-ion Battery		
Lead Acid Battery		
Ice Thermal Energy Storage	120 to 160 kW / 4 to 6 Hrs	
Redox Flow Batteries (RFB)	250 kW to 2 MW / 4 to 8 Hrs	Long 100% DOD cycle life

2.7 Non-Storage Alternatives for Addressing this Objective

Among the non-storage options for meeting the reduction of demand and demand charges are.

- Demand Response programs that incentivize end-users to increase or decrease consumption under pre-specified conditions.
- Air Conditioning Cycling – Utility controlled switch which can cycle on and off an Air Conditioners compressor unit to use less power when needed.
- Diesel Generator – Limited applicability and environmental concerns
- Energy Efficiency
- Self generation (e.g. PV, CHP, Fuel Cells)

3. Cost/Benefit Analysis

3.1 Direct Benefits

End Use	*Primary/ Secondary*	*Benefits/Comments*
1. Frequency regulation	S	Aggregated Ancillary Services
2. Spin		
3. Ramp		
4. Black start		
5. Real-time energy balancing		
6. Energy arbitrage		
7. Resource Adequacy		
8. VER[2] / wind ramp/volt support,		
9. VER/ PV shifting, Voltage sag, rapid demand support		
10. Supply firming	P	If combined with onsite solar or wind.
11. Peak shaving: load shift	P	For utilities
12. Transmission peak capacity support (deferral)	S	For utilities
13. Transmission operation (short duration performance, inertia, system reliability)		

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[2] VER = Variable Energy Resource

14. Transmission congestion relief	S	For utilities
15. Distribution peak capacity support (deferral)	S	P, when utility-owned & dispatched
16. Distribution operation (volt/VAR support)		
17. Outage mitigation: microgrid	S	P For end-users
18. TOU energy mgt	P	Helps reduce peak demand charges
19. Power quality	S	For end-users
20. Back-up power	S	Can provide backup power to critical circuits; "P" for end-users

3.2 Other Beneficial Attributes

Benefit Stream	*Y/N*	*Assumptions*
Reduce energy use	Y	
Maximize self-consumption of renewable generation	Y	When paired with on-site renewable generation.
Reduced emissions	Y	
Modularity/Incremental build	Y	Highly dependent on choice of technology
Faster build time	Y	Choice of technology and chemistry influences permitting time
Locational flexibility	Y	Highly dependent on storage technology
Safety and Enviromental	Y	Highly dependent on storage technology

Impact		

With regard to Ice Thermal Energy Storage it is worth noting that systems designed for permanent customer load shifting can, with minimal modification to the control software, be converted to serve as demand response units answering utility dispatch signals. No mechanical adjustment of the system is necessary beyond installation of the signal equipment.[4]

3.3 Costs

Cost Type	*Description*
Installation	
O&M	

3.4 Cost-effectiveness Considerations

With regard to Redox Flow Batteries (RFBs), 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.

4. Barriers Analysis & Policy Options

4.1 Barrier Resolution

Barriers Identified	*Y/N*	*Policy Options / Comments*
System Need		
Cohesive Regulatory Framework		
Evolving Markets		
Resource Adequacy Value		
Cost Effectiveness Analysis		

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[4] Terry Andrews, CALMAC.

Cost Recovery Policies		
Cost Transparency & Price Signals		
Commercial Operating Experience		
Interconnection Processes		
Issues with RFO design and offer evaluation process		
Operational flexibility requirements unclear		
Value of operational flexibility unclear		
Value of portfolio/procurement flexibility undefined		
Other issues		

4.2 Other Considerations

5. Real World Example

5.1 Project Descriptions

Location	*Korea (Jeju Island)*
Company	Samsung SDI
Technology	Li-ion
Capacity	
Operational Status	Operational
Ownership	Residential
Primary Benefit Streams	Backup, solar shifting
Secondary Benefits	

Available Cost Information	
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Location	1500 Walnut Street, Philadelphia, PA
Company	CALMAC
Technology	Ice-Bank Thermal Energy Storage
Capacity	1,300 ton hours of cooling capacity; 4 hours 160 kW or 6 hours 120 kW of electrical energy shift
Operational Status	Operational
Ownership	Commercial
Primary Benefit Streams	Peak Shaving/Load Shift, Resource Adequacy, Transmission Operation
Secondary Benefits	Time Of Use Energy Management
Available Cost Information	
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Location	Almond farm in Turlock, CA
Company	EnerVault
Technology	Redox Flow Battery
Operational Status	In Construction
Ownership	Commercial
Primary Benefit Streams	Peak Shaving/Load Shift: • Shifts Helios dual tracker PV to peak hours to power 225 kW irrigation pump
Secondary Benefits	Time Of Use Energy Management
Available Information	Projected online by Q2 2013
Contact Information	Bret Adams Director of Business Development EnerVault Corporation 1244 Reamwood Avenue Sunnyvale, CA 94089 351 201 9139 BAdams@EnerVault.com

5.2 Outstanding Issues

Description	*Source*

5.3 Contact/Reference Materials

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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?

Demand Charge Reduction

Can these benefits be monetized through existing mechanisms?

Yes

If not, how should they be valued?

Is ES cost-effective for this use?

Yes

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

Limited track record of deployment. Access to additional revenue streams

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

Allow broader participation of behind the meter energy storage assets in electricity markets (for example – allow bidding for ancillary services)

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

Yes