CEC IEPR Workshop

Renewable Integration in California

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CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

CESA – Strength Through Diversity & Collaboration

Steering Committee

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- SAMSUNG SDI
- SUMITOMO ELECTRIC
- TAS – economic. clean. energy.
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Role for All Storage Technologies on the Grid

Technology Classes	Energy Storage Examples
Chemical Storage	**Advanced Lead Acid Battery** •Electrical energy is stored for later use in chemical form. Existing battery technologies are being improved, and new battery technologies are becoming available. •Example: 1.5MW Advanced Lead Acid Battery – Kaheawa, Hawaii Wind Farm 
Thermal Storage	**Chilled Water Storage** •Combustion turbines' efficiency is dependent upon the temperature of the air taken into the turbine. Water chilled during off-peak hours can greatly increase their efficiency by pre-cooling the air before intake. •Example: 23,700 tons of chilled water for a 1300MW Warren County, Virginia CCCT 
Mechanical Storage	**High Speed Flywheel** •Flywheels convert electrical energy to kinetic energy, then back again very rapidly. Flywheels are ideal for power conditioning and short-term storage. •Example: 3 MW Mechanical Storage for Ancillary Services — NE ISO (Beacon Power) 
Bulk Mechanical Storage	**Below Ground Compressed Air** •Electricity is used to compress air into small or large modular storage tanks or a large underground cavern. The compressed air is used to spin turbines when electricity is needed. •Example: 115 MW Compressed Air Energy Storage — McIntosh, Alabama 
Bulk Gravitational Storage	**Pumped Hydro** •Excess electricity is used to pump water uphill into a reservoir. When power is needed, the water can run down through turbines, much like a traditional hydroelectric dam. •Example: 1,532 MW Pumped Hydro — TVA's Raccoon Mountain 

Storage for Bulk Renewable Generation Integration

- » Manage output and demand mismatch
  - ✓ capacity firming
    - ☞ especially solar, during peak
  - ✓ energy time-shift
    - ☞ especially wind generation and baseload REs, at night
  - ✓ energy balancing
- » Manage regional generation variability
  - ✓ ramping
    - ☞ avoid use of thermal or hydro generation
  - ✓ frequency regulation
    - ☞ much faster, more efficient than thermal generation
- » Manage RE power quality impacts

Storage for Distributed Renewable Energy Integration

☞ Assume that distributed renewables are mostly PV
  - i.e., expect limited distribution-level wind generation

» Manage RE output and demand mismatch
  - energy time-shift and capacity firming

» Manage localized ramping-related challenges
  - voltage, momentary excess production

» Manage voltage and reactive power

» Manage harmonics

» Avoid current backflow (low voltage to high voltage)

» Enable islanded/microgrid operation

32 Storage Benefits

Benefit	Central Storage	Distributed[1] Storage	Location-specific Storage[2]
Electric Supply			
1. Time-shift	✓	✓	
2. Supply Capacity	✓	✓	
Grid Operations (a.k.a. Ancillary Services)			
3. Energy Balancing	✓	✓	
4. Load Following	✓	✓	
5. Area Regulation	✓	✓	
6. Fast Area Regulation	✓	✓	
7. Frequency Response	✓	✓	
8. Ramping	✓	✓	✓
9. Reserve Capacity	✓	✓	
10. Voltage Support	✓	✓	✓[3]
11. Black Start	✓	✓	
Grid Infrastructure			
12. Transmission Support			✓
13. Transmission Congestion Management			✓[4,5]
14. T&D Upgrade Deferral			✓[4,5]
15. Substation On-site Power			✓
End User			
16. Time-of-use Energy Cost Management			✓
17. Demand Charge Management			✓
18. Electric Service Reliability			✓
19. Electric Service Power Quality			✓

32 Storage Benefits

Benefit	Central Storage	Distributed[1] Storage	Location-specific Storage[2]
Renewable Integration			
20. Renewable Energy Time-shift	✓	✓	✓
21. Renewable Generation Capacity Firming	✓	✓	✓
22. Variable Renewables Grid Integration			✓
Incidental Benefits			
23. Generation Dynamic Operating Benefits	✓	✓	✓
24. Reduced Generation Fossil Fuel Use	✓	✓	
25. Reduced Generation Air Emissions	✓	✓	
26. Increased GT&D Asset Utilization	✓	✓	✓[4]
27. Reduced T&D I^2R Energy Losses	✓	✓	✓[4,5]
28. Avoided Transmission Access Charges	✓	✓	✓
29. Reduce T&D Investment Risk	✓	✓	✓[4]
30. Power Factor Correction	✓	✓	✓[5]
31. Flexibility	✓	✓	✓[5]
32. Real Options	✓	✓	✓[5]

1. Deployment at a specific location is not necessary.
2. Location matters.
3. Best if located near the most troublesome loads during voltage emergencies.
4. Must be located (elecrically) downstream from "hot spots."
5. Value is somewhat to very situation-specific.

The Application Matrix – A Logical Analytical Framework

Benefit streams

Applications and applicable benefits

Primary Benefit	●
Secondary Benefit	◎
Tertiary Benefit	○

	Benefit	Sort Order	Duration	Bulk Flexible Peaker	Flexible Peaker (Bulk) plus Transmission Congestion Relief	Bulk Renewables Integration	Fast Frequency Regulation	Flexible Ramping	Enhanced Reserves Management	Merchant Supply Only	Merchant Supply Plus Transmission[1]	Transmission (Electrical) Support[1]	In Lieu of Transmission Capacity[1]	Stationary T&D* Deferral and/or Life Extension[1]	Transportable T&D* Deferral and/or Life Extension[1]	Distributed Modular Flexible Peaker	Community Energy Storage (CES)[2]	Electric Service Bill Management[1]	Distributed PV Integration	Bulk Wind Generation to Distributed Storage	Air Conditioning Load Management	Fast EV Charging
1	Frequency Regulation	1	Short	◎	◎			◎	◎	◎	◎		◎	◎	◎	◎	◎		◎	◎	◎	
2	Fast Frequency Regulation	1	Short	◎	◎	◎	●	◎	◎	◎	◎		◎	◎	◎	◎	◎		◎	◎	◎	
3	Frequency Response	1	Short	◎	◎			◎	◎	◎	◎		◎	◎	◎	◎	◎	○	◎	◎	◎	◎
4	Ramping	1	Short	◎	◎	◎		●	◎	◎	◎		◎	◎	◎	◎	◎		◎	◎	◎	
5	Transmission Support[1]	1	Short									●										
6	Electric Energy Timeshift	2	Long	●	●	●				●	●		◎	◎	◎	●	●		●	●	●	●
7	Electric Supply Capacity	2	Long	●	●	●				●	●		◎	◎	◎	●	●		●	●	●	●
8	Transmission Congestion Relief/Capacity[1]	2	Long		●						●			◎	◎	◎	◎		◎	◎	◎	◎
9	T&D* Deferral and Life Extension[1]	2	Long										●	●	●	◎	◎		◎	◎	◎	◎
10	Time-of-use Energy Cost Management[1]	2	Long															●				
11	Demand Charge Management[1]	2	Long															●				
12	Spinning Reserves	3	Inter	◎	◎			○	●	◎	◎		◎	◎	◎	◎	◎	○	◎	◎	◎	◎
13	Contingency Reserves	3	Inter	◎	◎			○	●	◎	◎		◎	◎	◎	◎	◎	○	◎	◎	◎	◎
14	Voltage Support[2]	3	Inter	○	○					○	○		○	◎	◎	◎	◎	○	◎	◎	●	○
15	Black Start	3	Inter	○	○						◎			○	○		○					
16	Local Electric Service Reliability[1]	3	Inter											◎	◎	◎	●	◎	◎	◎	◎	
17	Local Electric Service Power Quality[1]	3	Inter											◎	◎	◎	●	◎	◎	◎	◎	
18	Reduced T&D Energy Losses[1]	4		○	○					○	○		○	○	○	○	○	○	○	○	○	○
19	Increased T and/or D Asset Utilization[1]	4		○	○					○	○		○	○	○	○	○	○	○	○	●	●
20	Reduced Air Emissions and/or Fuel Use[3]	4		○	○					○	○		○	○	○	○	○	○	○	○	○	◎
21	Location Types: Supply	5		✓	✓	✓	✓	✓	✓	✓												
22	Location Types: Transmission	5		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓							
23	Location Types: Distribution	5						✓	✓					✓	✓	✓	✓		✓	✓	✓	
24	Location Types: Behind-the-meter	5							✓	✓	✓					✓		✓	✓		✓	✓
25	Location Types: VER Co-located	5				✓		✓											✓			
26	Location Types: Transportable	5			✓			✓							✓	✓						

[1] Location is critical.

[2] Location matters.

[3] Per kWh. Depends on generation used to produce charging energy, avoided generation on-peak, storage round-trip efficiency.

* Subtransmission and Distribution.

Possible Renewables Integration Values: Financeable Cash Flows are Key!

Value	Description
Curtailment Avoidance	Mitigating the risk of over-generation that would result in curtailment by the grid operator.
Ramping Service	Smoothing of 5-15 minute fluctuations in generation output.
Regulation Services	Management of moment-to-moment fluctuations in power that occur on timescales from milliseconds to minutes
Penalty Avoidance	Using storage to avoid grid operator-imposed penalties for intermittency, ramping rates, capacity factor, etc.
Self-Scheduling	Revenue gained from the service of giving up the right to self-schedule, thereby making the storage asset dispatchable by the grid operator for a specific application during a specific time.
Capacity Payment	Revenue earned for being fully available to provide a certain amount of energy capacity to the grid.
Resource Adequacy Payments	Revenue Earned from providing baseline energy so that the grid operator can achieve adequate resources for the grid.
Ease of Interconnection	It can be significantly easier to complete the interconnection process when a variable generation resource is coupled with storage so as to guarantee flexibility and reliability.
Time Shifting	Storing excess energy produced and discharging it later when it is needed.
Capacity Firming	The specific use of balancing the fluctuations in wind generation to maintain a constant output.
PPA Bonus	In certain situations, a bonus payment may be negotiated in a PPA for variable generation energy that is firmed or time shifted.

Ownership can also ‘define’ an application …

Example: Behind the meter storage that is utility owned is very different from customer owned!

Owner	Regulatory Considerations	Technical Considerations
Investor-owned Utility	» “Permission” and rationale for rate basing » Guaranteed cost recovery	» Established performance track record of storage systems » Reliable control and dispatch software » Assessment and design standard practices (e.g. Rule 21)
Electricity End-user	» Consistent electric service pricing “Rules” for aggregation » Ability to participate in A/S markets » Standard interconnection rules	» Reliable control and dispatch software » Reasonable interconnection and protection requirements.
Third Party	» Long term financeable cash flows » Pay-for-performance and/or “efficient” pricing » Resource-type-neutral PPA terms.	» Financeable performance track record » Reliable control and dispatch software » Reasonable interconnection and protection requirements.

Conclusions

- » Storage is technically ready, comes in diverse forms and is getting better.
- » Innovation and more demonstration is still needed for effective adoption and accommodation of storage in grid applications
  - – System solutions (software/optimization of dispatch)
  - – Market design (structure, rules, access, long term contracting, pricing)
  - – Ownership models
- » CPUC making good progress with applications-based framework & framework for Phase 2 of OIR

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Possible CEC Roles

» Key historic CEC role: risk sharing
  – Enable public interest innovation
    • System solutions that are optimized within the grid
    • Overcome immaturity of markets (no long term cash flows for storage … yet)
    • Encouraging/ demonstrating new applications <u>*and*</u> business models
  – Fund demonstrations of new *applications* – learn by doing!

Possible CEC Roles

- » Provide analytical and technical support for CPUC storage rule making
  - – Benefit quantification for cost effectiveness
  - – How to value flexibility of storage (portfolio, timing, geographic)
- » Recognition of storage value in decisions regarding traditional and renewable generation
- » Encourage inclusion of storage in California's resource loading order at the same level as demand response.
- » Consider following the precedent set for distributed generation, which included the creation of a inter-agency coordinating group

Questions?

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www.storagealliance.org

Appendix

CESA's Top 2012 Policy Priorities

- Build a Robust Market Foundation *(CPUC)*
  - Implement AB 2514 - Comprehensive Storage Rulemaking *(CPUC)*: appropriate procurement targets, applications, priorities, cost-effectiveness
  - Achieve multi-year procurement – Resource Adequacy Rulemaking
- Behind the Meter Incentives and Value Proposition *(CPUC)*
  - Implement Self-Generation Incentive Program ~$400M budget
  - Implement Permanent Load Shifting Program ~$32M budget
  - Access Ancillary Services markets *(with CAISO)*
- Comparable Treatment in Wholesale Markets *(CAISO)*
  - Implement Pay for Performance robust implementation of FERC Order 755
  - Various Flexible Dispatch Initiatives - REM, flexible dispatch, FERC Order 745 demand response
- Promote Energy Storage as a Mainstream Energy Resource *(all)*: educate policymakers and stakeholders in all relevant proceedings, legislation:
  - 33% RPS implementation
  - AB32 GHG rules
  - Federal ITC*
  - Calif. Loading Order
  - Flexible dispatch rules
  - FERC proceedings*

* with ESA Advocacy Council