Treatment of Storage Technologies in other Jurisdictions

MAC Meeting Presentation

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Economic Regulation Authority
WESTERN AUSTRALIA

Agenda

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Application of Storage Technologies - Grid

	Storage System	Operational Use
Transmission System	Large scale facility used to improve grid performance and assist integration of utility scale renewables.	Voltage support and grid stabilization, decrease transmission losses, diminish congestion, increase system reliability, support local grid during upstream outages, defer/substitute transmission investment, optimise renewable-related transmission.
Distribution System	Facility located at substation or distribution feeder, controlled by utility, integrated distribution into utility management systems	Substation - flexible peaking capacity while also mitigating stability problems Feeder – mitigate stability problems and enhance system reliability and resiliency

https://www.lazard.com/media/438042/lazard-levelized-cost-of-storage-v20.pdf

Application of Storage Technologies – Islands

	Storage System	Operational Use
Microgrid	Facility that supports small power systems that can 'island' eg. farm at edge of grid	Ramping support to enhance system stability and increase reliability. Smooth and firm customer-sited solar or wind. Support islanded microgrid operation for critical services during grid outage. Provides short term power output.
Island Grid	Facility that supports physically isolated electricity systems eg. isolated mining operation - scale can vary widely by use.	Supporting stability and reliability, in addition to smoothing and firming renewables. May provide balancing and fast ramping. Provides enduring output.

NB. Storage resources can be mobile.

https://www.lazard.com/media/438042/lazard-levelized-cost-of-storage-v20.pdf

Application of Storage Technologies – Market

	Storage System	Operational Use
Hybrid Generation	Large scale storage facility collocated with renewable energy	Wind and solar firming, smoothing and dispatch. Can shift renewable generation output to meet market needs and/or energy arbitrage. Capacity and resource adequacy.
Peaker replacement	Large-scale energy storage system designed to replace peaking gas turbine and other facilities. Fast and responsive	Capacity, energy sales (eg. time-shift/arbitrage), spinning reserve. Can be brought online quickly to meet rapidly increasing demand at peak and quickly taken offline as demand diminishes.
Frequency regulation	Energy storage system with parameters designed to reflect system requirements. Fast and responsive	Balances power by raising or lowering output to follow real time changes in load to maintain frequency to be held within a tolerance band.

https://www.lazard.com/media/438042/lazard-levelized-cost-of-storage-v20.pdf

Application of Storage Technologies – BTM

	Storage System	Operational Use
Residential	System for residential home use	Back-up power, power quality improvements eg. regulates power supply and smooths the quantity of electricity sold back to the grid from PV, and extends the utility of solar generation.
Commercial and Industrial	System sized to have sufficient power and energy to support multiple C&I energy management strategies	Behind the meter peak shaving and demand reduction ie. time shift energy from grid or from customer-sited solar, to manage energy use under a time-of-use retail rate. May provide option of providing grid services to utility or wholesale market.
Commercial appliance	System that contains limited energy and power	Provides behind the meter demand reduction.

https://www.lazard.com/media/438042/lazard-levelized-cost-of-storage-v20.pdf

Positioning of Storage Technologies

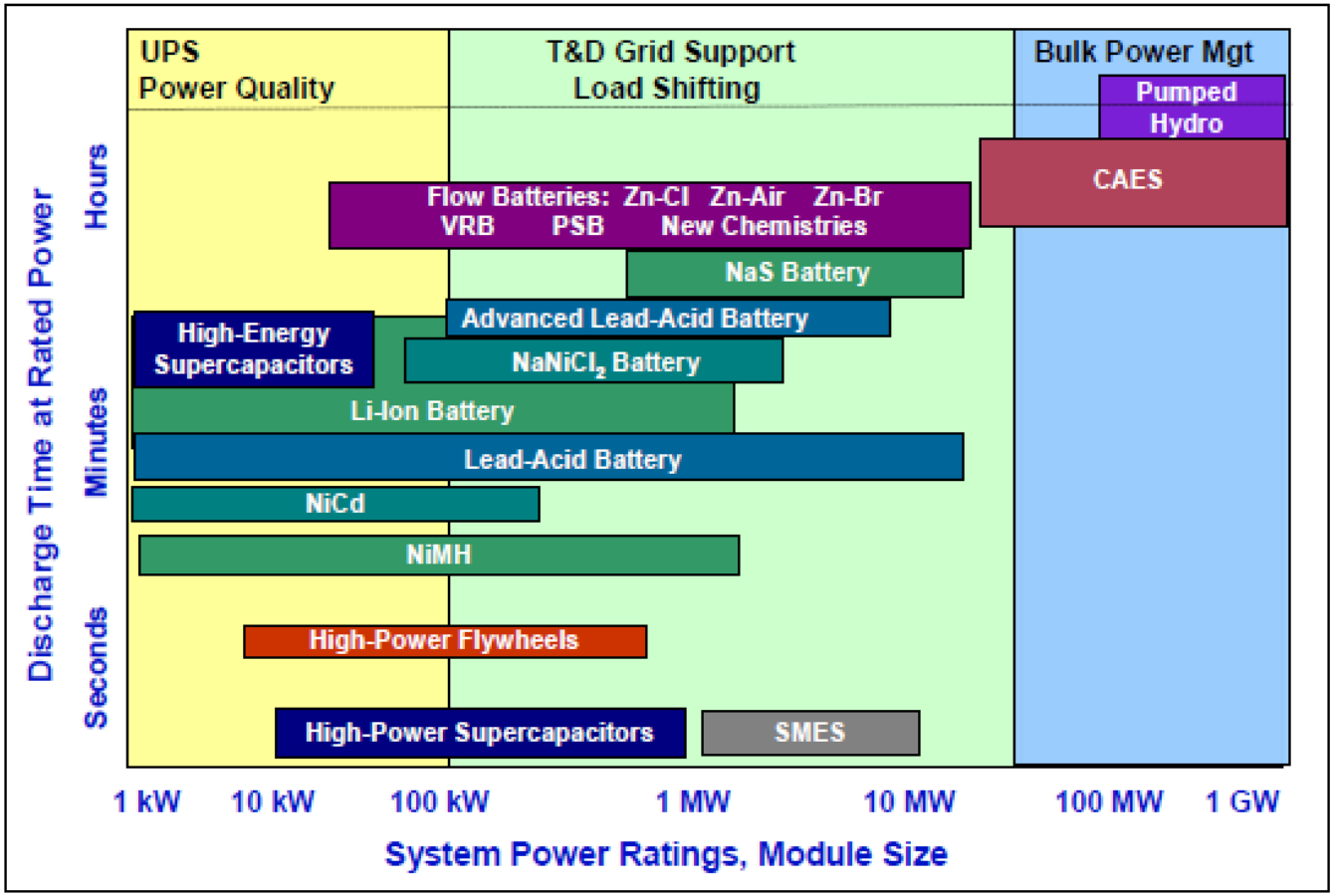

Figure 19. Positioning of Energy Storage Technologies

https://www.sandia.gov/ess-ssl/publications/SAND2015-1002.pdf

Storage in Great Britain

- GB market - balancing, short term energy exchanges (APX Group and Nordpool), capacity mechanism

- Storage definition:
  - a form of *generation* whereby the electricity is converted into a form of energy that can be stored, that energy is stored and subsequently reconverted back into electricity.

- Participation:
  - Enhanced Frequency Response (load following)
  - Firm Frequency Response (more defined events)
  - CM contracts for 2018/19, 2020/21 and 2021/22 auctions.

Storage in Great Britain

- Context
  - 13GW of solar capacity by spring 2018.
  - 160,000 electric vehicles on British roads and growing.
  - Heat pumps and other storage developing.

- National Grid approved ‘Social Energy’s’ domestic battery offering to provide demand side response and grid-balancing services such as frequency response.

- OFGEM approved derogations allowing Limejump to enter balancing mechanism with a VPP comprising technologies such as batteries and renewables (wind and solar).

Storage in Great Britain

- Current market design rules - many applications for 30 minute duration batteries (frequency response).
  - Traditionally pumped hydro, 96.11% de-rating factor.
    - Investment contributed to low clearing prices, below NetCONE.
    - ‘Stress events’ for UK energy networks typically => 2-hours.
- Now, de-rating factors reflect Equivalent Firm Capacity that could be replaced during periods of system stress.
  - Technology duration of >4 hours (flow batteries) continue with 96.11% de-rating factor.
  - 30 minute duration de-rated to 17.89%.
  - Contracts awarded in 2016 grandfathered to remain in place.
  - May push sector towards longer-duration batteries (?).

Storage in Great Britain

- EFC particular to specific set of conditions - should not be used as substitute for capacity outside of this very limited context. Caution use of EFC as capacity rating in auctions.

- Participation in multiple markets (eg. frequency response and balancing) overlapping in time (‘either/or’ trade-off options) may require exhaustion (or filling to capacity) of a storage unit shortly before requirement to respond to capacity stress event.

- Storage is self-dispatched and cost of failure to deliver is never more than capacity payment - more immediate and potentially higher revenues from other markets may reduce availability of limited duration storage.

Storage in North America - FERC order 841

- Markets - generally energy, ancillary services and capacity.
- Federal Energy Regulatory Commission (FERC) amending regulations to remove barriers to participation of electric storage resources *in capacity, energy, and ancillary services markets*.
  - 28 February 2018 FERC order 841 - Electric Storage Participation in Markets Operated by RTO and ISO's

  https://www.ferc.gov/media/news-releases/2018/2018-1/02-15-18-E-1.asp#.WtIfi8EUlfx .
- Each RTO and ISO required to revise tariffs – establish participation model recognising physical and operational characteristics of storage resources and facilitate participation.
- Market design - technology neutral to provide equal access and reduce long term investment risk associated with development of new electric storage resources.

Storage in North America - FERC order 841

- Storage definition:
  - FERC Order No. 841: a resource that is capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid.
- Narrow definition that limits or does not enable full technological capability of batteries may create barriers to entry, reducing competition and efficiency by inhibiting developers incentives to design storage resources to provide all capacity, energy and ancillary services that they can provide.
- Broader definition will ensure market rules not designed for any particular electric storage technology (batteries, flywheels, compressed air and pumped hydro).
- Will account for many different locations of batteries, whether situated on transmission or distribution system or behind the meter.

Storage in North America - FERC order 841

- Participation model must:
  - ensure resource using the model:
    - is eligible to provide all capacity, energy, and ancillary services that technically capable of providing in the markets;
    - can be dispatched and set wholesale market clearing price as both a wholesale seller and buyer, consistent with existing market rules governing when resource can set wholesale price.
  - account for physical and operational characteristics of resources through bidding parameters or other means; and
  - establish minimum size requirement for participation in RTO/ISO markets that does not exceed 100 kW.
- Each RTO/ISO must specify that sale of electric energy from markets to an electric storage resource that resource resells back to those markets must be at wholesale locational marginal price.

Storage in North America - New England

- Since 1970s, nearly 2,000 MWs of pumped-storage hydroelectric units, with total storage capability of nearly 12,000 MWhs.

- Participated in wholesale electricity markets since inception and can participate in energy, reserves, regulation, and capacity.

- Pumped-storage units are modeled in ISO's software, and participate in New England markets as two distinct asset types:
  - a dispatchable Generator Asset - submits offers to supply energy and offers to provide regulation; and
  - a Dispatchable Asset Related Demand (DARD) – submitting bids to consume energy to pump, typically when prices are low.

- Dispatch of either is sequential

Storage in North America – New England

- New storage technologies, with different characteristics not accounted for.

- ISO set out to build onto Generator Asset/DARD pumped-storage approach to provide means for storage technologies capable of continuously and rapidly transitioning between charging and discharging to participate simultaneously in energy, reserves, and regulation markets.
  - "rapid" means ability to transition between a facility's maximum consumption capability and its maximum generation capability in 10 minutes or less,
  - "continuous" means ability to be dispatched to any MW level between facility's maximum consumption capability and its maximum generation capability.

Storage in North America – New England

- The Proposal:
  1. the commitment process,
  2. energy market offers and energy market clearing,
  3. the regulation market,
  4. real-time telemetry,
  5. reserves, sustainability, and operating limit adjustments,
  6. self-dispatch, and
  7. settlement.

Other North American Markets

- PJM (Straw man proposal)
  - https://www.pjm.com/-/media/committees-groups/committees/pc/20181011/20181011-item-09-electric-storage-participation-order-841.ashx
  - https://www.pjm.com/committees-and-groups/issue-tracking/issue-tracking-details.aspx?Issue=%7b736CAC88-9404-4421-B178-BD392366098F%7d
- California
  - http://www.caiso.com/participate/Pages/Storage/Default.aspx
  - http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx
- NYISO
  - http://www.nyiso.com/public/markets_operations/key_topics/topic/index.jsp?meta=Energy Storage Int and Opt
- MISO Energy Storage Task Force
  - https://www.misoenergy.org/stakeholder-engagement/stakeholder-feedback/order-841-compliance-proposals/

Closer to home – the NEM

- Work is progressing through AEMO
  - potential strategic improvement - rules, procedures, systems
  - how to better integrate grid-scale ESS NEM, enabling the NEM framework to incorporate new business models.

❖ Stream 1 - define ESS and create new category for bi-directional technologies to facilitate participation, including integrating into dispatch with single offer, where required. Initially cover stand-alone. AEMO to submit rule change to AEMC by March 2019.

❖ Stream 2 - consult stakeholders and analyse appropriate participation model and requirements to facilitate aggregation of 'hybrid systems' (on-site generation or load offering to market as aggregate resource).

https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Initiatives/Emerging-Generation-and-Energy-Storage-in-the-NEM---Grid-Scale

Thank you

Ask any questions

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