DOCKETED	
Docket Number:	19-ERDD-01
Project Title:	Research Idea Exchange
TN #:	236432
Document Title:	Long Duration Energy Storage Overview Comments - Long Duration Energy Storage Overview
Description:	N/A
Filer:	Cody Goldthrite
Organization:	Long Duration Energy Storage Association of California
Submitter Role:	Public
Submission Date:	1/25/2021 8:09:36 AM
Docketed Date:	1/25/2021

LONG DURATION ENERGY STORAGE

ASSOCIATION OF CALIFORNIA

Long Duration Energy Storage Overview

About Us

The Long Duration Energy Storage Association of California (LDESAC) is a 501(c)4 organization that serves to promote the development of long duration energy storage to complement short duration storage technologies and enhance California's ability to achieve its climate goals, while operating a safe and reliable energy grid.

LDESAC is fully focused on promoting long duration energy storage technologies that are needed to meet CA's climate and clean energy goals. The organization works closely with other renewable, clean energy, storage and allied organizations to advance our shared priorities.

Executive Director

Julia Prochnik is executive director of the Long Duration Energy Storage Association of California. Previously, Prochnik was a director at the Natural Resources Defense Council where she oversaw energy policy creation and implementation with a focus on grid operations and transmission planning. She has also worked in multiple roles at the U.S. Department of Energy and served as director of intergovernmental relations for the North American Electric Reliability Corporation and as a project developer for Clean Line Energy Partners.

Our Supporter Companies

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The Need for Long Duration Energy Storage

- Recent modeling from the CPUC Integrated Resource Planning (IRP) process identified the need for **2,200+ megawatts (MW) of long duration energy storage** to meet the state's GHG reduction targets.

- Governor Newsom has issued a call for the state to fast track efforts to meet our low carbon goals, and **long duration energy storage is a core part of the solution.**

- Los Angeles was able to **avoid the recent blackouts** by relying on the Castaic Pumped Storage Project in Southern California. We **need grid-scale storage** to protect the rest of California.

About Long Duration Energy Storage

- **Long duration storage complements shorter duration storage technologies**, by providing large amounts of renewable energy back to the grid for eight hours or more.
- Examples of long duration energy storage include **flow-batteries, pumped hydro, liquid air, zinc-air batteries and hydrogen.**
- These technologies can work together to ensure the **flexible and efficient use of least-cost energy resources** like wind and solar power while also providing important ancillary services to the grid.

Flow Batteries

Liquid Air Storage

Long Duration Energy Storage Technologies

Company	Technology or Service Description
7Skyline, LLC	Select, initiate, execute and manage long duration energy projects throughout the development lifecycle
Blattner Energy	Over 400 energy projects across North America, including solar, wind and energy storage
Cat Creek Energy, LLC	Pumped hydro – Cat Creek Energy Project in the Boise River Basin, Idaho
Cupertino Electric, Inc.	One of the largest solar, storage and clean energy engineering, procurement and construction (EPC) firms in the United States
GE Renewables North America, LLC	Flywheel, hybrid and other storage technologies
GreenGen Storage	Pumped hydro – Mokelumne Water Battery Project outside of Jackson, California (400-1200MW)
Highview Power	Liquid air energy storage with capacity ranging from 50 to 150 MW and duration from 8+ hours (supporting days and weeks of storage)
H2B2 USA, LLC	Centralized and distributed hydrogen production and manufacturing facilities with 10 hours to indefinite duration with solar, wind and biogas sources; also developing salt cavern & well-bore sub-surface storage
McMillen Jacobs Associates	Infrastructure and pumped hydro

Long Duration Energy Storage Technologies

Company	Technology or Service Description
Morse Associates, Inc.	Concentrating solar power with long duration (e.g. 15-18 hours) thermal energy storage
NantEnergy	Zinc-air battery combines fuel cell technology with traditional solid-state electrode design
NextEra Energy Resources	Long duration storage, including proposed 1300MW Eagle Mountain pumped storage facility in Riverside County, California
NEXTracker	Solar and long duration storage hybrid tracker technology and advanced software and data analytics and control systems
Renewell Energy	Re-purposing oil & gas infrastructure as storage for local needs
Stantec	A variety of types of energy storage technologies including pumped hydro, compressed air energy storage, flywheel energy storage, flow batteries, thermal storage, and many lithium ion chemistries
Zinc8 Energy Solutions	Zinc-air regenerative fuel cell system with up to 100 hours of storage duration

Which energy storage technology can meet my needs?

Electrical energy storage is key to balancing the supply and demand of energy, optimising our use of intermittent energy sources such as wind or solar, and also enabling the electrification of transport.* Here's our guide to energy storage technologies.

Where is the storage technology needed?

Grid
What will the technology be used for?

Stationary electric vehicles may provide storage for the grid

Transport
What form of transport?

Seasonal storage
Requirement: Large storage capacity, slow discharge
1 5

Daily peak shifting
Requirement: Hours of available supply
1 2 3 5 6 7 8

Grid support / balancing intermittency
Requirement: Fast response, seconds to hours of available supply
1 3 4 6 7 8

Road
Requirement: High power and small unit size
5 6

Shipping / Aviation
Requirement: High power and energy per volume
5

Domestic off-grid / microgrid
(e.g. balancing renewables)
Requirement: Small scale, long lifetime
5 6 7 8

	1 Pumped hydropower	2 Compressed air energy storage	3 Thermal cycle	4 Flywheels / supercapacitors / SMES†	5 Hydrogen electrolyser / fuel cell	6 Lithium-ion batteries	7 Lead-acid batteries	8 Redox flow batteries
Capital cost	$ – $$	$ – $$	$ – $$	$$ – $$$	$$$	$$	$ – $$	$$
Cost per cycle	–	–	–	–	–	–	–	
Response time	Seconds – Minutes	Minutes	Seconds	Milliseconds – Minutes	Minutes	Milliseconds	Milliseconds	Milliseconds
Total deployment	3	2	1	1 / 2 / 1	3	2	3	1
Efficiency (%)	70 – 85	50 – 75	55 – 80	85 – 98	<40 (mature) Up to 66 (developing)	80 – 90	65 – 85	65 – 85
Daily self-discharge	>0.5%	>10%	0.5 – 1%	(100% / 5 – 20% / 10 – 15%)	~0%	~0%	~0.2%	~0%
In a nutshell	Affordable, but large and site-specific	Affordable, but large and site-specific	Potentially affordable, non site-specific	Fast response, but rapid discharge	Potential for long-term storage, currently expensive	High energy density, rapidly developing	Mature, but bulky and toxic materials	High number of cycles in lifetime, but bulky

Capital cost: ($/kWh for 1 – 8hr energy system): $ = 10 – 100, $$ = 100 – 1000, $$$ = 1000 – 10,000)

Cost per cycle: (including capital/cycle life, and operation, and maintenance. units $/kWh/cycle):
= < 0.01, = 0.01 – 0.10, = 0.10 – 1, = 1 – 10

Response time: Time a storage system requires to ramp up supply

Total deployment:
1 = less than 100 MW / 100MWh deployed
2 = 100 MW / 100 MWh to 10 GW / 10 GWh deployed
3 = more than 10 GW / 10 GWh deployed

Efficiency: Energy out divided by energy in

Daily self-discharge: Percentage of charge lost in device each day

* Other measures, such as increased interconnectivity, demand side management, thermal storage and dispatchable generation, also play a part in regulating the supply of electricity

† Superconducting Magnetic Energy Storage

Grantham Institute
Climate Change and the Environment
An Institute of Imperial College London

Find out more at **www.imperial.ac.uk/grantham/energy-storage**

Value of Long Duration Energy Storage to the Grid

Long duration energy storage provides a variety of **critical ancillary services to the grid**:

- Improving power quality/reliability and alleviating the intermittence of renewable source power generation
- Managing distributed/standby power and meeting remote and vehicle load needs
- Supporting the realization of smart grids
- Meeting peak electrical load demands and providing time varying energy management
- Providing flexibility to electric energy import during peak demand periods

Value of Long Duration Energy Storage to the Grid

Storage is essential to grid reliability and resiliency

Removing barriers is essential to meeting decarbonization goals

- Fix Model **inaccuracies** and policy restrictions (e.g. timing & externalities)
- Improve coordination to process interconnect energy storage and solar-plus-storage systems safely to the grid
- Increase awareness of diverse reliability, **economic** and public policy benefits
- **Improve awareness** of diverse technologies and existing short and long duration energy storage technologies and grid services
- Need for **stronger procurement** mechanisms to purchase storage both local and system wide benefits

Education

Data Access

Market Signal

Action Needed

<u>Trends:</u> decreasing costs, diverse technologies and projects, wide range of benefits

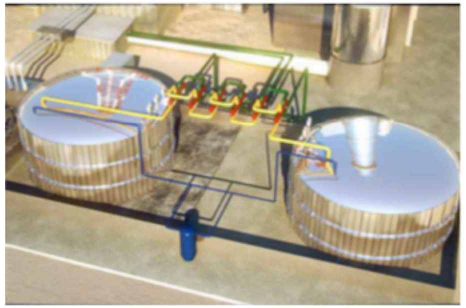
- The CPUC, CEC and CAISO should operate with a **renewed prioritization** of long duration energy storage technologies.

- The CPUC should **fast track procurement of shovel-ready** long duration storage projects to ensure we meet our climate goals on time and in a reliable way.

- State energy agencies should **continue to support emerging storage technologies** through R&D, pilot programs and other initiatives that encourage innovation and support a robust and competitive market for storage.








CEC/ UC Merced Project

Study Value of Long-Duration Storage

What role(s) will long-duration storage play?

What cost target must a technology reach to be helpful?

TAC
Erin Childs (CESA)
Paul Denholm (NREL)
Jennifer Dowdell (TURN)
Shucheng Liu (CAISO)
Keith Parks (Xcel Energy)
Julia Prochnik (LDES Association of California)
Ron Sinton (Sinton Instruments)
Priya Sreedharan (GridLab)
David Williams

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Questions?

www.storeenergyca.org
Email: julia@storeenergyca.org
Facebook: @StoreEnergyCA
Twitter: @StoreEnergyCA