Pumped Hydro Storage

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PUMPED HYDRO

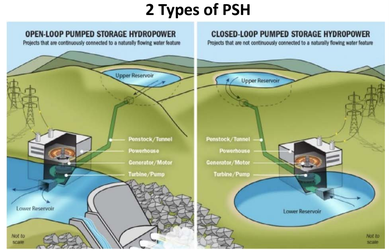
What is it and how does it work?

Pumped storage hydropower (PSH) is a type of hydroelectric energy storage. It is a configuration of two water reservoirs at different elevations that can generate power as water moves down from one to the other (discharge), passing through a turbine.

Advantages

- Renewable and Sustainable
- Large-scale
- Cost-effectiveness
- Reactivity
- Mature technology
- Multi-functional

2 Types of PSH



BATTERY STORAGE

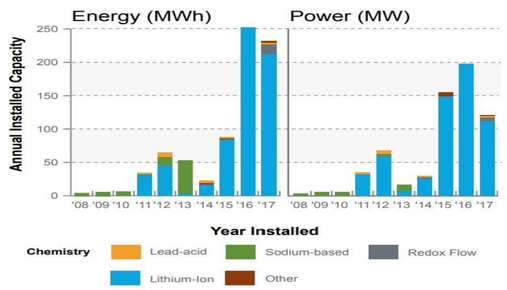
What is battery storage?

- Battery storage or Battery energy storage system (BESS) is a technology that enables utilities and power system operators to store energy that can later be released when it is needed.

Advantages of battery Storage:

- BESS can compensate for the energy needed.
- Prevent "Black Start".
- BESS can replace the amount of energy renewable energy plants cannot produce at different times of the day.

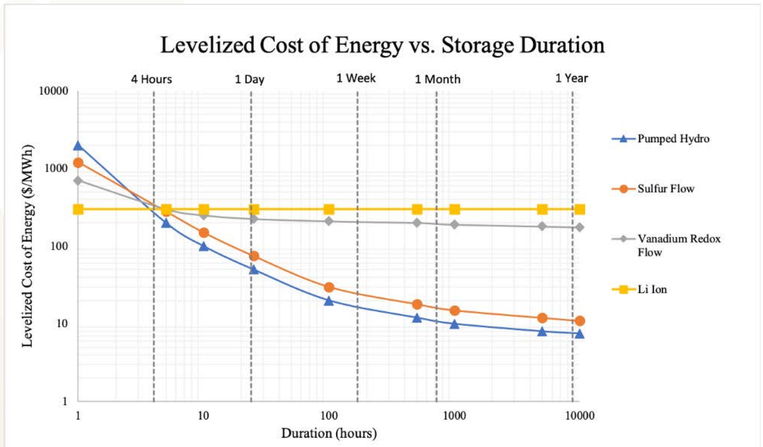
Source: Leisch, Jennifer E, and Ilya Chernyakhovskiy . "Grid-Scale Battery Storage - NREL." *Greening the Grid* , USAID, Sept. 2019, https://www.nrel.gov/docs/fy19osti/74426.pdf.



PUMPED HYDRO VS BATTERY STORAGE

LCOE of Pumped Hydro v.s. Lithium-ion Batteries

- LCOE - net present value of all future costs divided by the net present value of electricity generated over its lifetime ($/MWh).
- Figure details the LCOEs of lithium-ion batteries compared to flow batteries and pumped hydro from 2017 data.



- *Source: "Lithium-Ion Energy Storage Cost Vs. Pumped Hydro Or Flow Battery Cost Are Dependent On Time" Published by CleanTechnica., 2020.*

	Max Power Rating (MW)	Discharge time	*Max cycles* or lifetime	Energy density (watt-hour per liter)	Efficiency
Pumped hydro	3,000	4h – 16h	30 – 60 years	0.2 – 2	70 – 85%
Li-ion battery	100	1 min – 8h	*1,000 – 10,000*	200 – 400	85 – 95%

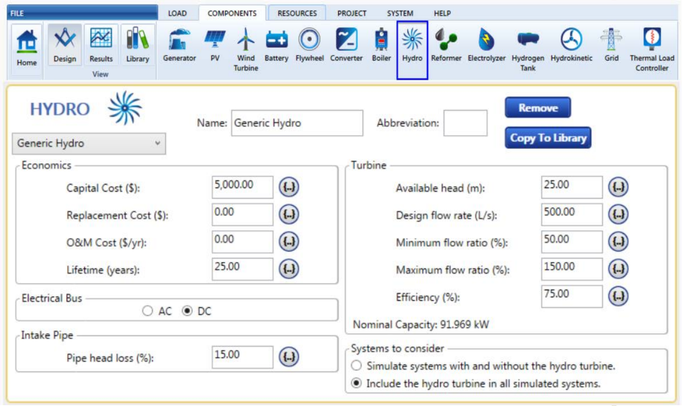
- *Source: "Fact Sheet: Energy Storage (2019)" Published by Environmental and Energy Institute, 2019.*

- *Right:* San Diego Gas & Electric's 30-MW, 120-MWh battery storage system in Escondido, California.

- *Left:* Geesthacht pumped storage plant, by Hamburg, Germany.. Has an installed capacity of 120-MW.

HOMER/RETScreen & SAM

- Homer and RETScreen are two similar softwares that can be used to design and analyze Pumped Hydro Storage systems. Great for comparing projects side by side.



Source: "Hydro Module" homer energy. 2022

- SAM (System Advisor Model) is an economic software model for the renewable energy industry. Does not work for PHS, but it could be used for battery storage to compare with a pumped hydro storage system