Northwest **Power** and **Conservation** Council

July 5, 2023

MEMORANDUM

TO: **Power Committee Members**

FROM: **Annika Roberts, Dylan DSouza**

SUBJECT: **Emerging Trends in Battery Storage**

BACKGROUND:

Presenter: Dylan DSouza, Annika Roberts

Summary: The new energy landscape we find ourselves in, defined by clean policies, heavy renewable builds, and electrification, necessitates a system that can be flexible, works with intermittent resources to ensure reliability, and doesn't overload transmission. Storage resources fulfill many of those needs. Both regional utility IRPs and state/national energy policy have acknowledged the important role storage will need to play in the country's energy transition, devoting considerable resources into their further development. This presentation will focus on utility scale battery storage, as it is a rapidly developing technology presently garnering a lot of interest and attention, though there are other forms of storage that can provide similar benefits. Staff will describe the policies shaping storage adoption, outline the existing and planned storage resources in the region and nationally, and will then summarize the technologies available now and emergent technologies to watch for the future.

Relevance: In the 2021 Power Plan there were a number of recommendations in the research and development section to look more closely at battery storage. Both as an emerging technology with potential in the region, as well as a non-wires alternative to help address existing transmission capacity

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Bill Edmonds
Executive Director

503-222-5161
800-452-5161

challenges. Battery storage is showing up in most regional utilities integrated resource plans in some capacity and is poised to play a greater role in the regions electric mix than it has historically.

Workplan: Track emerging technologies, both supply and demand side, providing periodic updates to the Council.

Background: In the 2021 Power Plan the Council developed generating resource reference plants for utility-scale battery storage, pumped storage, and utility-scale solar PV + battery storage which may provide useful context for how the Council has considered storage in the past and the assumptions surrounding storage that went in to the most recent power plan.

Emerging Trends in Battery Storage

July Power Committee

Annika Roberts, Dylan DSouza

Agenda

- Overview of energy storage in the 2021 Plan
- Policy Drivers for Battery Storage
- Existing & Planned Energy Storage (Nationally/Regionally)
- Storage Technology Overview
- Short Duration Storage
- Emerging Technologies

Battery Storage in the 2021 Plan

Storage *was* selected in the Plan’s broader WECC analysis:
Depending on the scenario, anywhere from 6,000-190,000 MW of additional storage resource development was seen in the Plan’s WECC-wide build out assessment by 2030

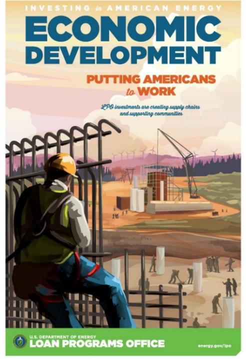
- Resource Strategy
  - Lots of new renewables necessitate resources that provide flexibility and reliability, & transmission
- Battery storage selected in decarbonization scenario in 2021 PP
  - Stand alone (800 MW) and co-located with solar (2,100 MW)
- Recommendations for R&D:
  - In a directive to explore alternative approaches to power system operation, transmission, and non-wires alternatives the Council recommended the region consider the role of battery storage, targeted demand response, and other demand-side resources to address existing transmission capacity challenges
  - Research and explore the regional resource potential of supply side emerging technologies including energy storage

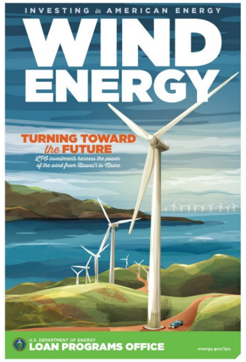
THE 2021 NORTHWEST POWER PLAN

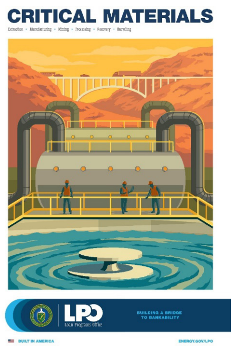
Northwest Power and Conservation Council

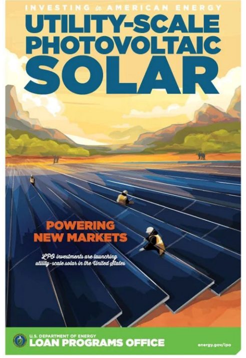
Storage Policy Drivers

Federal Policy









IRA

Expanded the ITC for renewable energy projects to standalone and co-located storage systems

- Applies to battery, thermal or hydrogen energy storage projects with a nameplate capacity of at least 5 kWh
- Tax credit starts at 6% of project development cost, can increase to 30% if certain labor practices are used. Additional 10% available if project meets domestic content requirements
  - Also allows for cash payments in lieu of tax credits available to tax-exempt organizations including state/local governments and tribes

Supply of critical minerals

- Advanced Manufacturing Production Tax Credit directs nearly $30 billion to the domestic production of critical components—including rare earth minerals and their substitutes
- Portion of the $500 million reserved for the DOD is intended to support domestic mining of critical minerals and to explore potential alternative minerals that would reduce demand on the few existing sources of rare earth minerals

IIJA

PNW Pumped Storage Hydropower Development Act

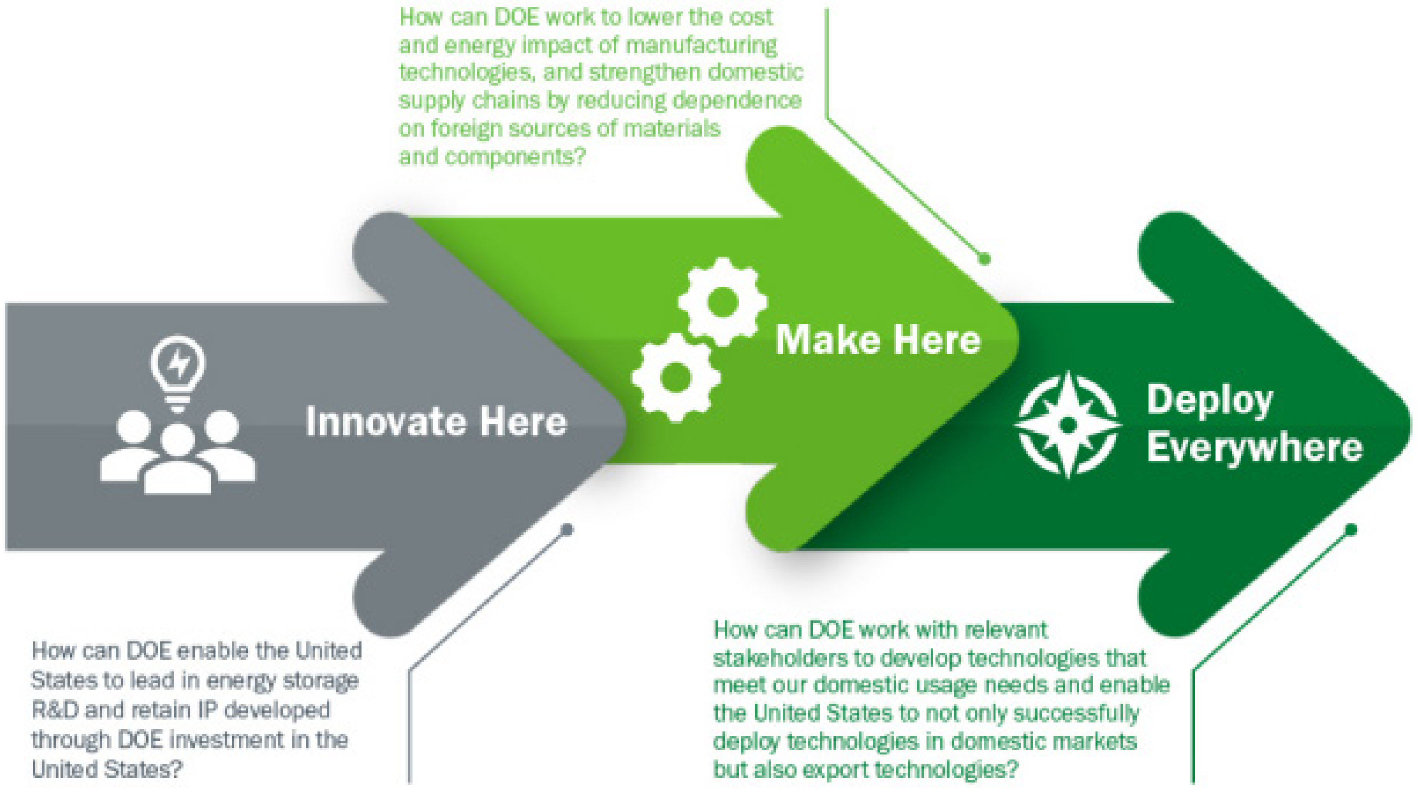
- Streamlines permitting processes for pumped storage for non-federal pumped storage development at federally owned reserves
- Introduced by WA congressmember intended to encourage pumped storage development at some of the Federal Columbia River Power System dams in the region

Appropriated $505 million for the development of grid-scale, long-duration energy storage demonstrations

National focus

Department of Energy’s Energy Storage Grand Challenge:

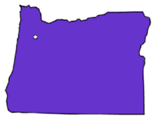
- Develop and domestically manufacture energy storage technologies that can meet all US market demands by 2030
- 3 strategic goals (innovate here, make here, deploy everywhere) and supported by quantitative targets
- Designed to ‘create and sustain American leadership in energy storage’



Policy

Oregon

- HB2193: Storage mandate for the two largest IOUs of 5 MWh each by 2022 at a minimum, and up to 1% of 2014 peak load
- Directs OR PUC to develop analytical guidelines for evaluating energy storage.



Washington

- UTC released policy statement directing the study of energy storage as a candidate non-wires alternative for T&D upgrades,
- WA Clean Energy Fund has provided $14.3 million in matching funds for development of 4 utility-scale storage projects.

Montana

- MT PSC issued Order 7621b allowing distributed storage to be used in net metering & directed its IOUs to investigate pumped storage in its next IRP

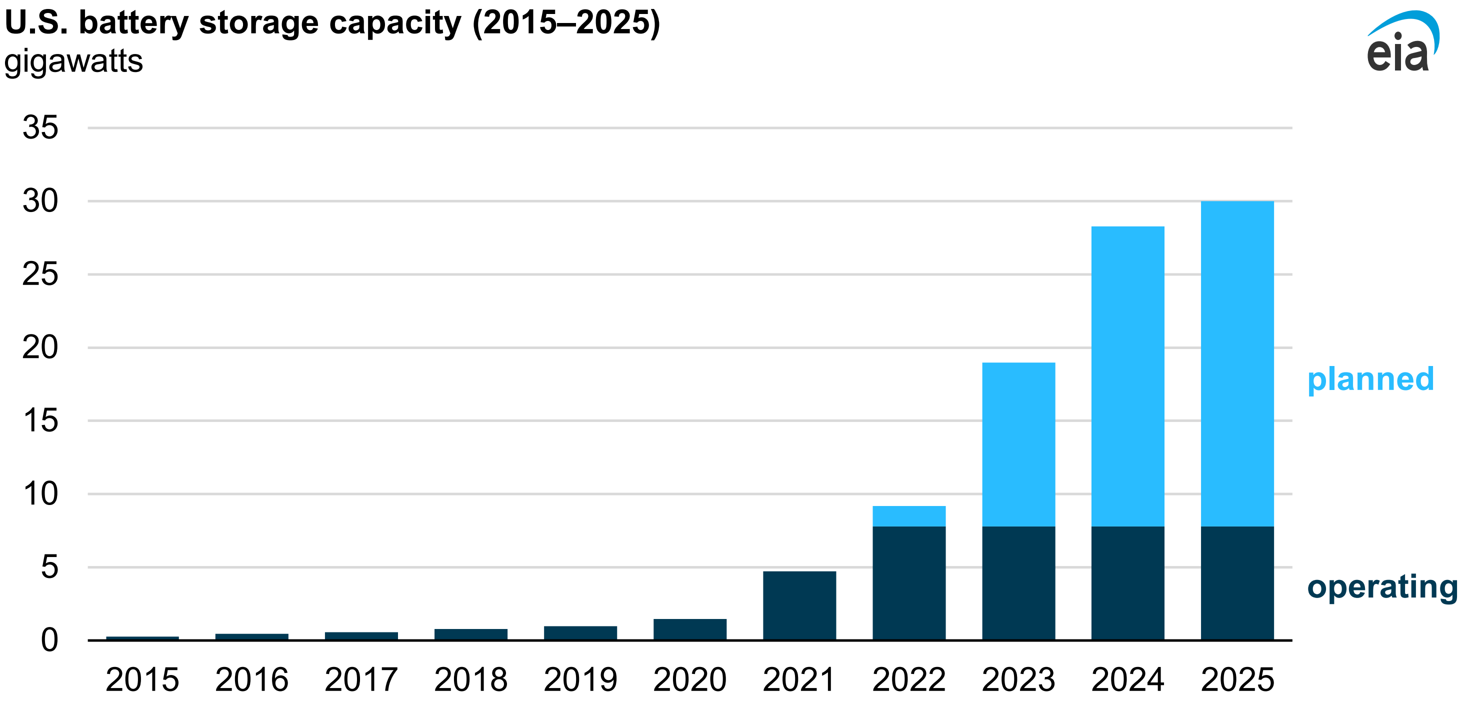
Idaho

- No storage specific directives at this time. Idaho Power announced plans for the state’s largest utility scale Battery storage project at 120 MW of storage to be online by June 2023.

Storage Buildout: *Existing & Planned*

National Battery Storage Capacity

- Utility-scale battery storage capacity is likely to reach 30.0 GW by the end of 2025
- US battery storage capacity is outpacing even the early growth of the country's utility-scale renewable capacity
- Battery storage projects are becoming increasingly larger in capacity:
  - Pre to 2020: 40 MW
  - Currently: 409 MW (FL's Manatee Energy Storage)
- Developers have scheduled more than 23 large-scale battery projects, ranging from 250 MW to 650 MW, to be deployed by 2025.



U.S. utility-scale battery storage and co-located generator power capacity

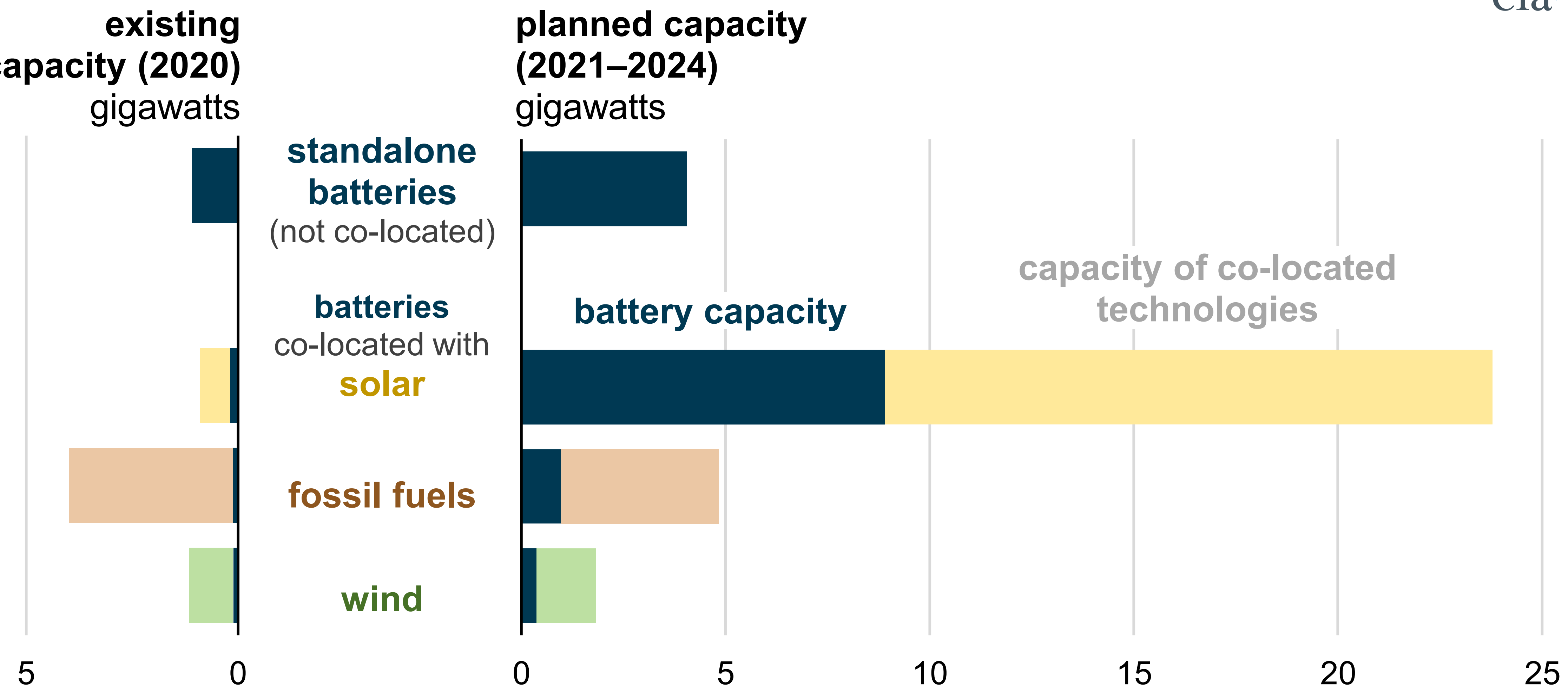
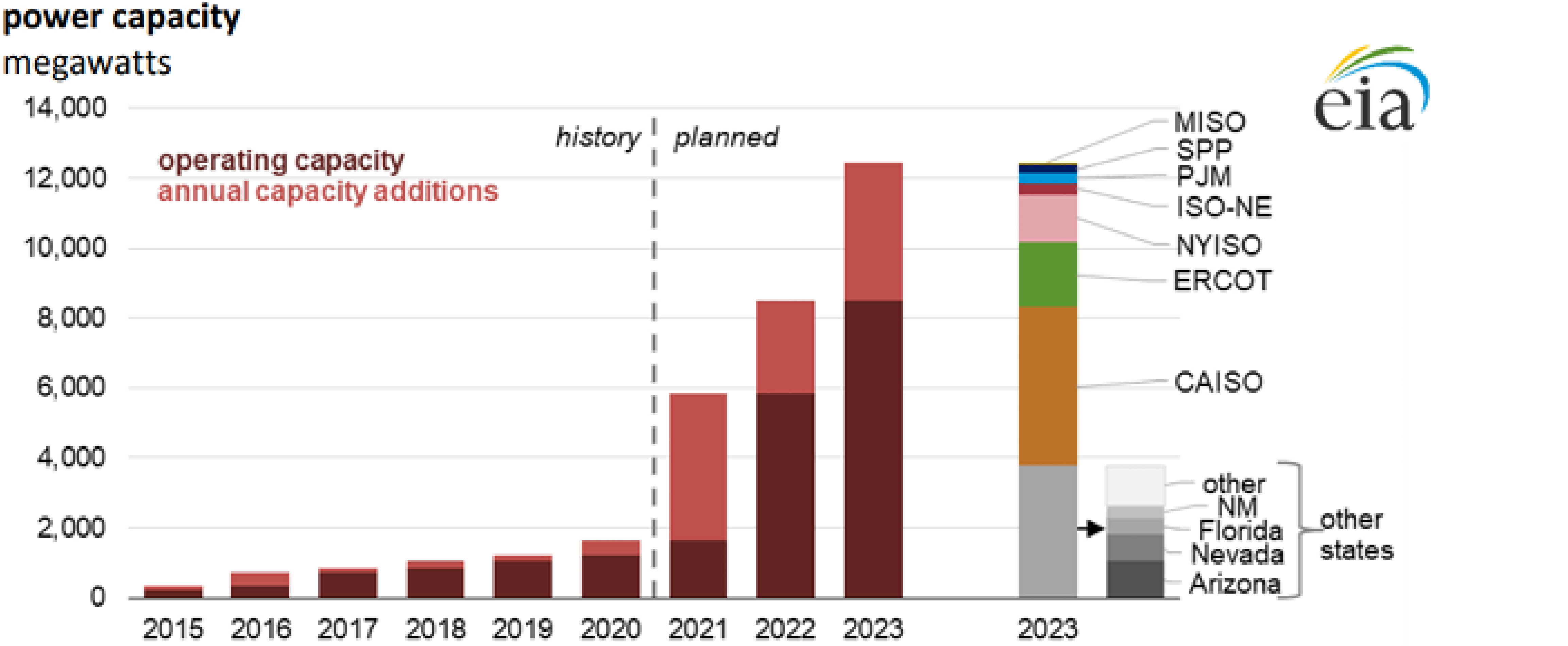
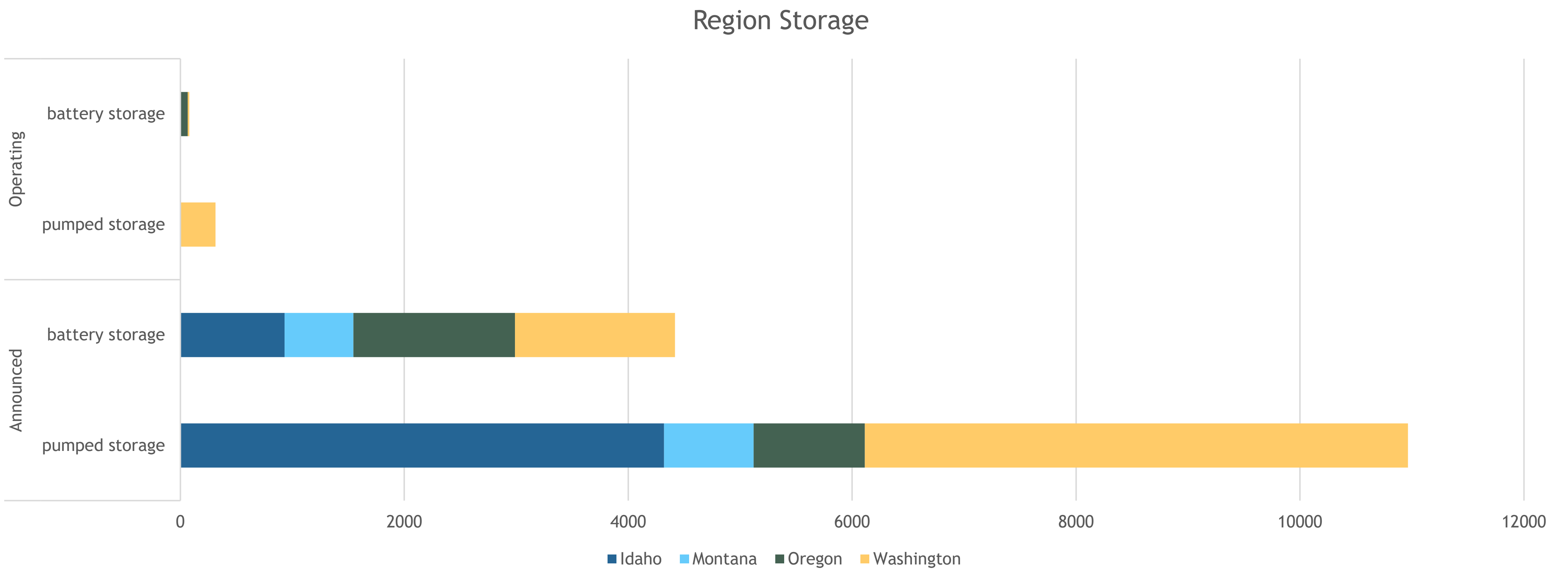


Figure 3: U.S. Large-Scale Battery Storage Cumulative Power Capacity, 2015-2023[37]



Source: U.S. Energy Information Administration, Dec 2020 Form EIA-860M, *Preliminary Monthly Electric Generator Inventory*

In Region Storage: *Announced and Operating*



In Region Storage: *Operating*

	Power Plant	Nameplate Capacity (MW)
Oregon	Salem Smart Power Center Battery Storage (Battelle Memorial Institute)	5
	Wheatridge Battery Storage Project	30
	Wheatridge II Battery Storage Project	30
Washington	Arlington Microgrid Solar & BESS Battery Storage	1
	Horn Rapids Battery Storage and Training Project	1
	Innovation 2 Battery Storage Project	4
	PSE 2 MW Glacier Battery Storage	4
	Snohomish PUD - MESA 2 Battery Storage	2.4
	SNOPUD MESA 1 (Battery Storage) Project	2

In Region Storage: *Announced*

930 MW

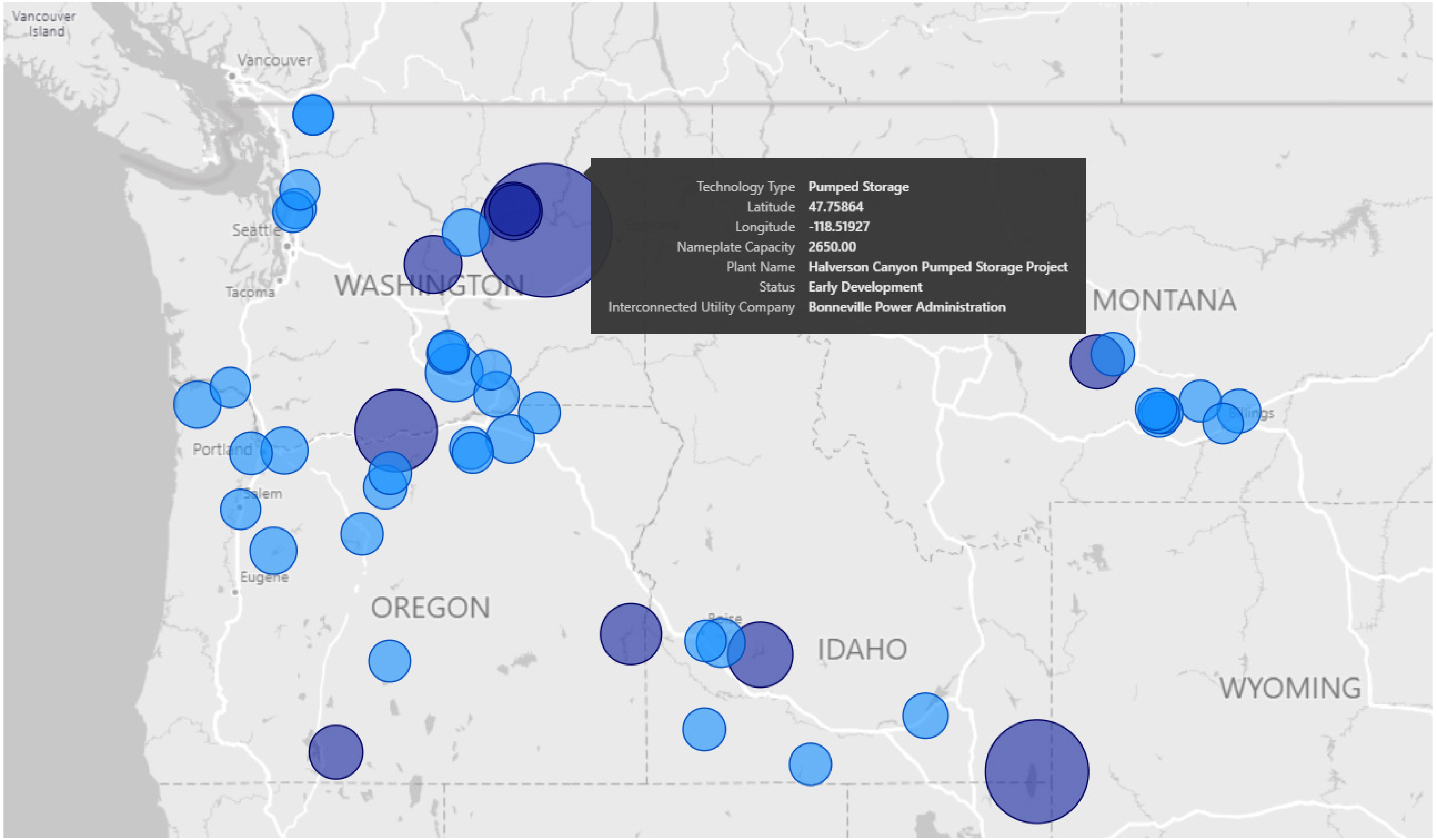
615 MW

1443 MW

1430 MW

State	Power Plant	Year in Service	Nameplate Capacity (MW)
IDAHO	Bluebunch Battery Storage Project		150
	Desert Ridge Battery Energy Storage System	2024	250
	Downey Populus Battery Storage Project		350
	Franklin BESS (Twin Falls)	2024	60
	Black Mesa BESS	2023	40
	Hemingway BESS	2023	80
MONTANA	Beaver Creek I Battery Storage Project (I-IV)	2025	240
	Broadview I & III Battery Storage Project	2024	200
	Haymaker Ranch Battery Storage	2027	100
	Meadowlark Solar Battery Storage	2024	25
	Beartooth Battery Storage Project (EsVolta)	2024	50
OREGON	Cedar Island Battery Storage Project	2025	80
	Madras Solar Energy Facility Battery Storage		63
	Muddy Creek Battery Storage Plant	2025	199
	Nolin Hills Solar Battery Storage Project	2026	240
	Port Westward Generating Battery Storage Project		6
	Stateline (OR) Battery Storage Project		100
	Evergreen Battery Storage Project	2024	75
	Obsidian Battery Storage Project	2026	50
	Seaside Battery Storage Project	2025	200
	Troutdale Battery Storage Project	2024	200
	Wheatridge East Battery Storage Project	2026	30
	Bakeoven Battery Storage Project	2026	200
WASHINGTON	Badger Mountain Energy Battery Storage	2024	200
	Hop Hill Battery Storage Project	2025	1000
	Horse Heaven Hybrid Battery Storage Project	2023	150
	Ostrea Battery Storage	2025	40
	High Top Battery Storage	2025	40

Technology Type Battery Pumped Storage



Storage in Regional IRPs

This list is not comprehensive but an illustration of how much of the region is considering storage in their planning

Utility	Utility Scale Storage
PacifiCorp (2023 IRP)	7,560 MW Li-Ion battery by 2028 35 MW pumped storage by 2028 (+350 MW by 2036)
Avista (2023 IRP)	52 MW by 2039 195 MW by 2045 (primarily long duration iron oxide batteries)
Portland General Electric (2023 IRP)	176-503 MW by 2030 (4-hour Li-Ion batteries)
Idaho Power (2021 IRP)	1685 MW by 2040 (large storage projects + 17 selections of 5 MW grid-located storage projects for T&D deferral)
NorthWestern Energy (2023 IRP)	25-700MW battery(4-hour) 200-400MW pumped storage (through 2042)*
Puget Sound Energy (2023 IRP)	1,000 MW by 2030 1,800 MW by 2045 (4-6 hour Li-Ion batteries and 8 hour pumped hydro)
Tacoma Power (2022 IRP)	10 MW Demand Response in preferred portfolio though identified utility-scale battery storage as supply-side alternative
Snohomish (2021 IRP)	35-70 MW 8-Hour Storage by 2031**

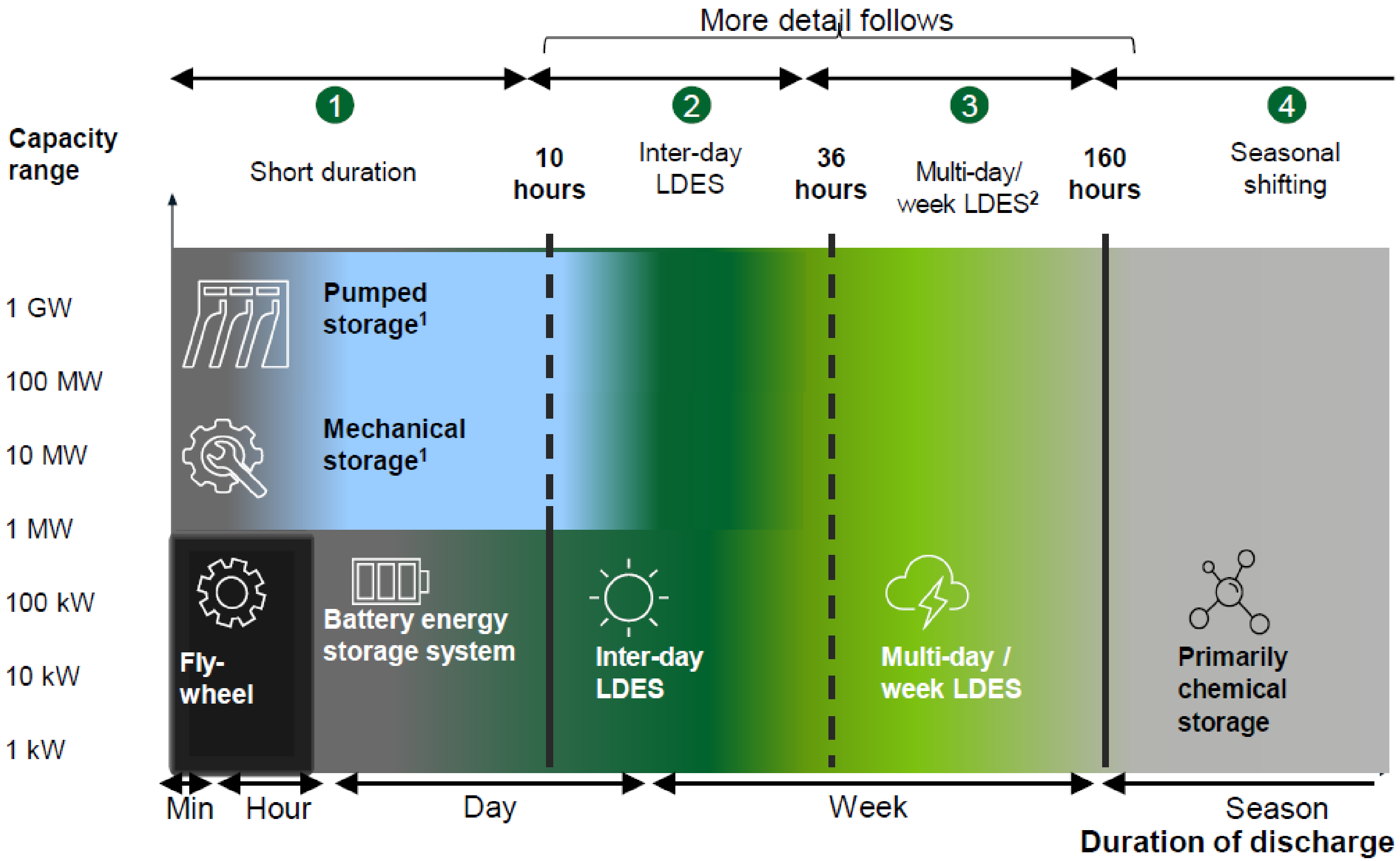
*NorthWestern's IRP does not identify a preferred portfolio among the 20 scenarios

**Snohomish's IRP does not specify an underlying technology of the storage resource, the study focuses on specific characteristics to meet the PUD's needs

Storage Technology Overview

Utility-Scale Energy Storage

LDES technologies can be used for inter-day and multi-day use cases at a variety of scales



Codifying the technology

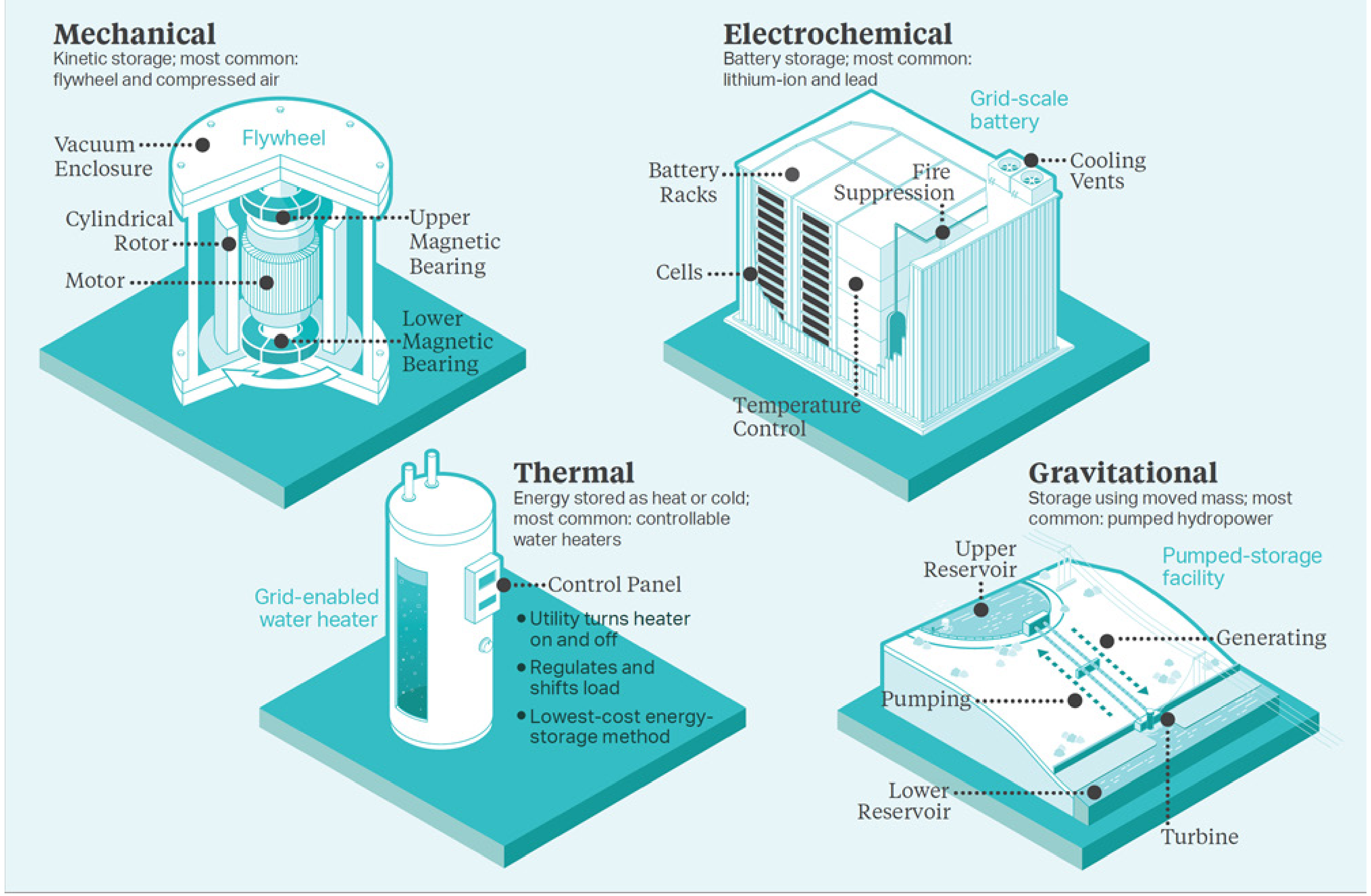
0-10 hours — 1 — **Short duration:** Durations up to 10 hours

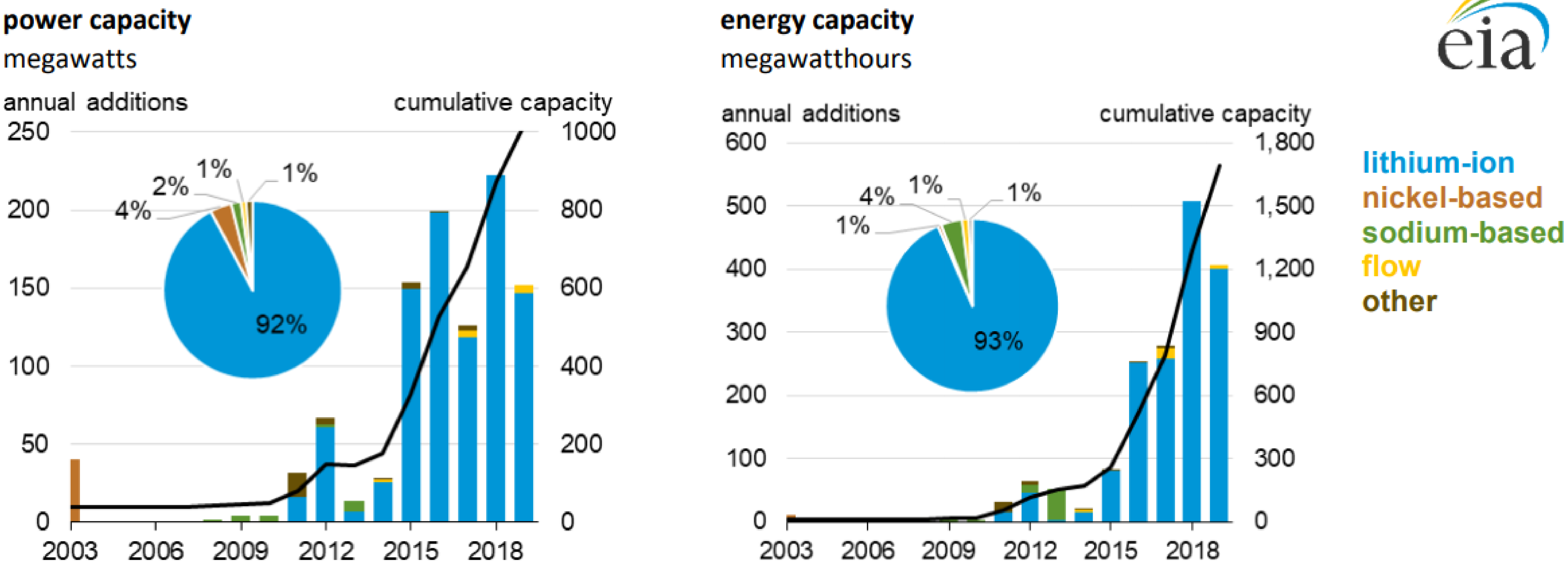
10-36 hours — 2 — **Inter-day LDES:** Sometimes called “diurnal”

36-160 hours[2] — 3 — **Multi-day / week LDES:** Commonly called “seasonal”

160+ hours — 4 — **Seasonal shifting:** Generally included in “seasonal”, but distinct in that this does function as a conventional, storable fuel

Energy Storage Technologies





Source: U.S. Energy Information Administration, 2019 Form EIA-860, *Annual Electric Generator Report*

Short Duration Battery Storage

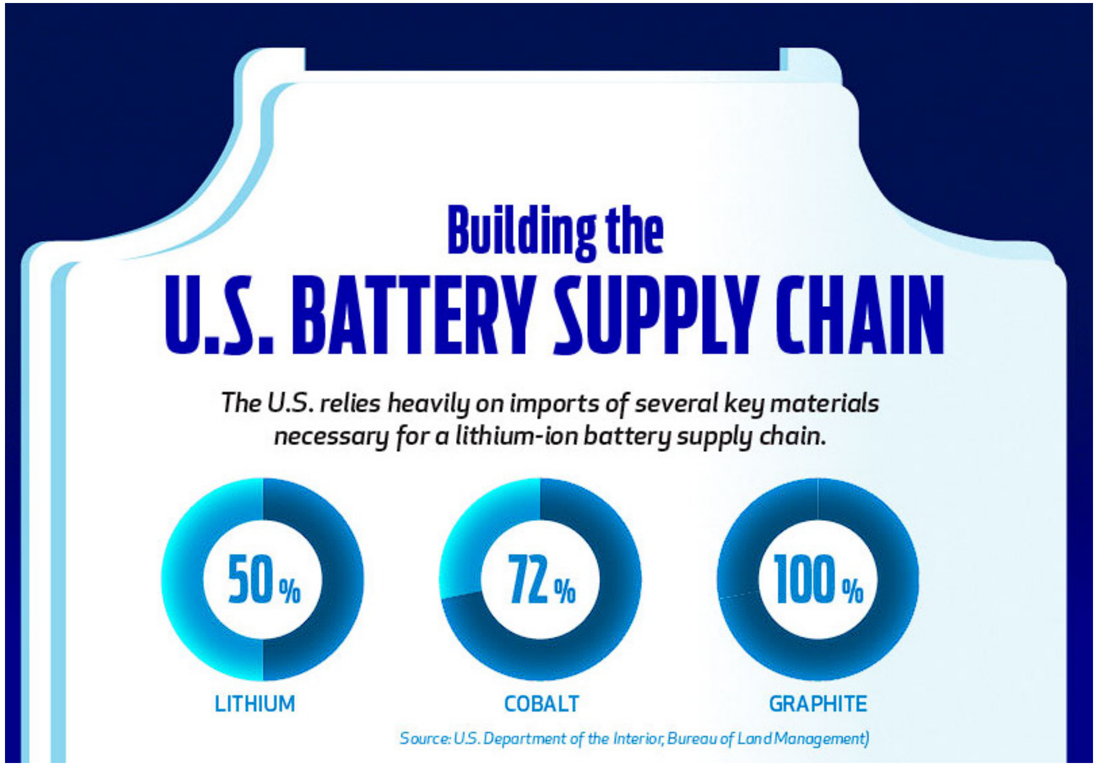
Lithium-ion (Li-ion) Battery Technology

- Dominant option for short duration storage
- Efforts are continuing to expand duration of Li-ion
- Fit for flattening the curve
- Discharge rate and frequency
- Supply chain concerns and constraints
- Common uses: cell phones, electric vehicles, **utility-scale storage**

Capacity Factor, Round Trip Efficiency and LCOS

- Capacity Factor
  - A 4-hour device has an expected capacity factor of 16.7% (4/24 = 0.167), and a 2-hour device has an expected capacity factor of 8.3% (2/24 = 0.083)
- Round-Trip Efficiency
  - Round-trip efficiency is the ratio of useful energy output to useful energy input. For 2022 NREL adopted 86% as a representative round-trip efficiency for these battery systems
- Levelized Cost of Storage
  - According to the same 2022 NREL study, ranging from $428/kWh down to $333/kWh cost decreases with size and duration changes

Supply Chain and Other Hurdles

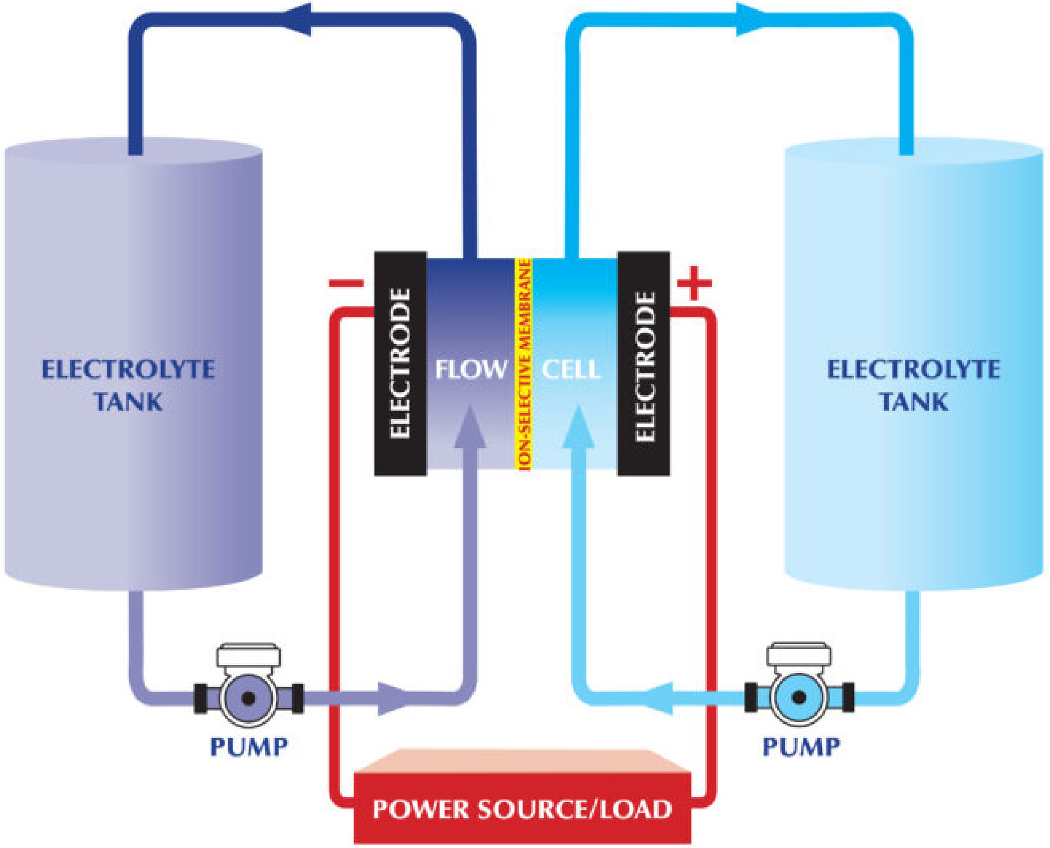


- Supply Chain constraints
- Interconnection
- Policy
- Regulation

Emerging Technologies

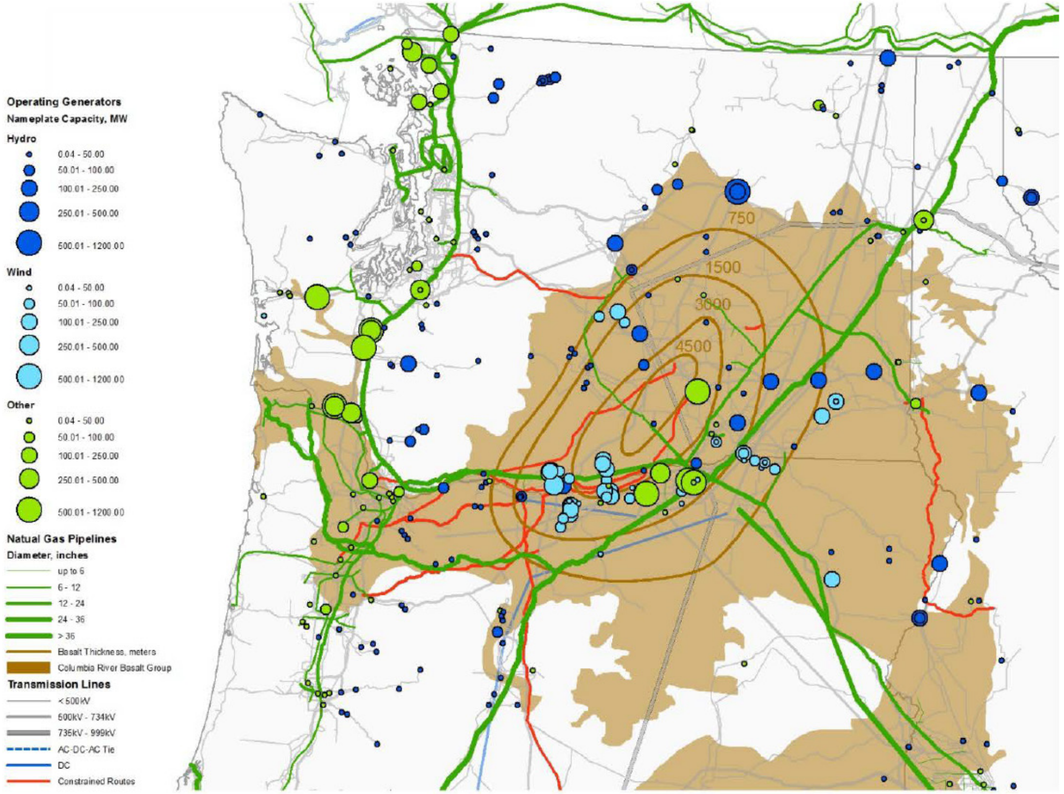
Flow Batteries

- A flow battery is a rechargeable battery in which electrolyte flows through one or more electrochemical cells from one or more tanks
- With a simple flow battery, it is straightforward to increase the energy storage capacity by increasing the quantity of electrolyte stored in the tanks
- The electrochemical cells can be electrically connected in series or parallel, so determining the power of the flow battery system
- This decoupling of energy rating and power rating is an important feature of flow battery systems
- ESS Eastern Oregon factory and Iron-Air Batteries by Form Energy



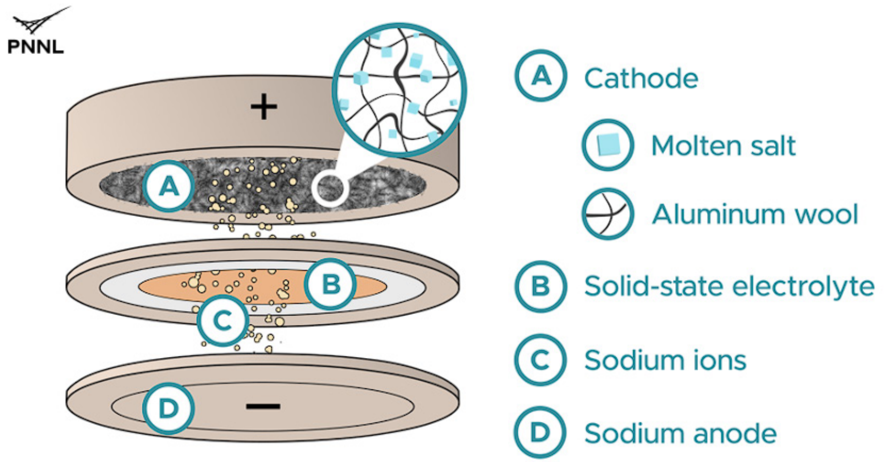
Emerging Utility-Scale Storage Technologies

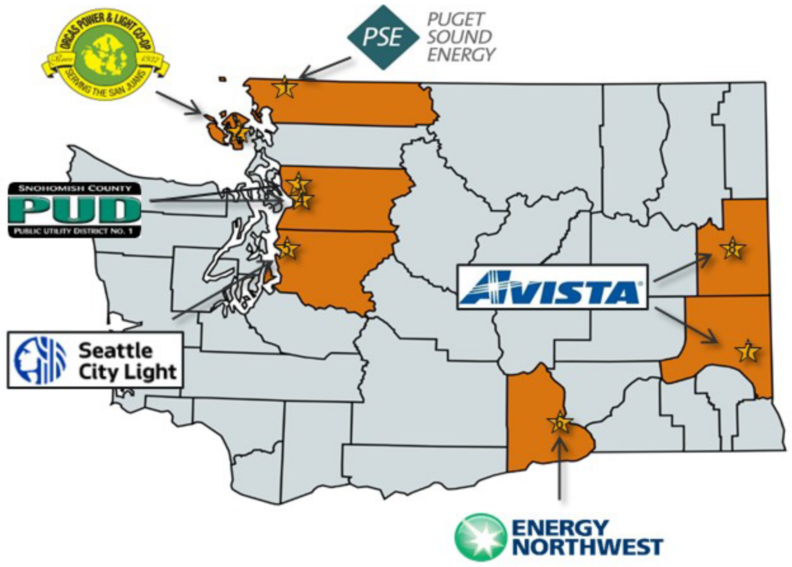
- Flow Batteries
  - Iron-Air Batteries
- Hydrogen Storage
  - Ammonia
- Compressed Air Energy Storage (CAES)
  - Study done in 2013 by PNNL in conjunction with BPA



Pilots and Research In-Region

- Washington Clean Energy Fund Grid Modernization Projects
- PNNL and Washington Clean Energy Testbeds





1. Puget Sound Energy Glacier Energy Storage Project
2. Orcas Power & Light Co-Op Community Solar and Energy Storage Project
3. Snohomish Public Utility District MESA 1 & MESA 2 Energy Storage Project
4. Snohomish Public Utility District MESA 3 Energy Storage Project
5. Seattle City Light Microgrid
6. Energy Northwest Battery and Solar Training Facility
7. Avista Turner Energy Storage Project
8. Avista Shared Energy Economy Model Project

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