CHANGING THE GAME:

UTILITY-SCALE ENERGY STORAGE

Montana boasts the nation's second-highest wind energy potential and fourth-highest solar energy potential. Developing these resources will be essential to decarbonizing our energy system. These energy sources are variable by nature: abundantly available when the wind blows and the sun shines, and less available in low-wind periods or when the sun isn't out. This doesn't mean these resources can't support a reliable electric grid, but instead means we need to change how we manage the grid and approach reliability.

Along with regional power sharing to take advantage of complimentary weather patterns across the West, energy storage systems are essential to capture renewable energy when it is available in abundance so it can later be discharged when it is most needed. While utilities in other states rush to bolster reliability through investments into increasingly affordable energy storage technology, NorthWestern Energy has been caught flat-footed with no energy storage system currently operating, in development, or planned. (Meanwhile, Texas leads the country in new battery storage deployment in 2024 at 6.4 gigawatts (GW) of planned new power capacity development.)

ENERGY STORAGE SYSTEMS

Energy storage systems are secondary generation sources, meaning they must be charged by a primary electricity-generating source, such as solar or wind, before they can discharge energy themselves. Energy storage systems do not produce their own energy.

Two metrics are important for understanding how a given electricity storage project can contribute to the electric grid:

- Power Capacity is the maximum instantaneous electricity discharge rate that can be achieved from an energy storage system. This is measured in kilowatts (kW), megawatts (MW), or gigawatts (GW). 1 GW = 1,000 MW = 1,000,000 KW.
- Energy Capacity is the maximum total amount of energy that can be stored in an energy storage system, to be discharged over time. Energy capacity can be calculated by multiplying power capacity by the number of hours the storage system is designed to discharge before fully depleting its charge. This is measured in kilowatt-hours (kWh), megawatt-hours (MWh), or gigawatt-hours (GWh).

The difference between power capacity and energy capacity for an energy storage system can be analogized to a tank storing water (see graphic below). The total volume of water stored in the tank is analogous to the energy capacity of an energy storage system when fully charged. The flow rate per second of water out of the tank is analogous to power capacity – the flow rate of energy per second out of the battery.

System	**Storage Volume *(Units)***	**Maximum Flow Rate (*Units*)**
Water Tank Storage	Water Tank Volume (Gallons)	Water Volume per Second (Gallons per Second)
Energy Storage	Energy Capacity Gigawatt-hours (GWh)	Power Capacity – Energy per Second Gigawatts (GW)

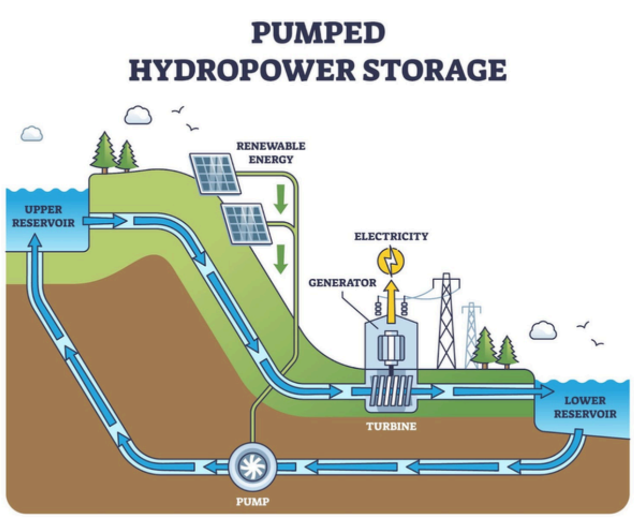
TYPES OF ENERGY STORAGE

The primary types of energy storage systems in use on the electric grid today are batteries and pumped storage hydropower.

Pumped Storage Hydropower

Pumped storage hydropower uses electricity to power a pump that moves water uphill to a storage reservoir, using the potential energy of gravity to store energy. To discharge, this water is allowed to flow downhill through a turbine that drives an electric generator, much the same as traditional hydroelectric power is generated.

The U.S. electric grid includes over 22 GW of pumped storage hydropower, at 550 GWh of energy capacity. Pumped storage hydropower technology has existed for over 100 years, long dominating the energy storage capacity on the US grid. However, battery storage has rapidly caught up in recent years.



Batteries

Battery storage technologies convert and store electricity as chemical potential energy, with lithium-ion technology the most common. As of July 2024, there were nearly 21 GW of utility-scale battery storage on the U.S. grid, with nearly 3 GW (nearly 10 GWh) of additional utility-scale storage installed between July and September 2024 alone.

Projections show that as much as 75 GW (250 GWh) of energy storage will be installed between 2024 and 2028. As recently as 2019, total battery storage on the US grid was no more than 1 GW. Falling costs and increased demand for this technology to balance growing renewable energy generation on the grid are driving this growth in grid battery storage.

JUSTICE CONSIDERATIONS WITH LITHIUM & OTHER BATTERY MATERIALS

While the need for electrification is an urgent piece of the decarbonization puzzle and hinges on the availability of energy storage technologies, we must fully consider and do our best to mitigate the harms that can come from such a push, particularly in the race to mine enough minerals to create these technologies.

Multiple reports cite that more than 50% of the minerals needed for electrification are on or adjacent to Indigenous lands, including more than 80% of lithium reserves. No mining should occur on these lands without free, prior, and informed consent of these nations.

We should consider alternative solutions to reduce the need for mining. Earthworks has reported that mineral recycling can reduce the need for new mining for materials in batteries by 25%-55%, depending on the mineral.

In addition, EV batteries and grid energy storage batteries can and are beginning to be made with more readily-available materials that don't need to be mined: batteries made from hemp, iron, or even salt are proving to be as effective as lithium batteries. It's inevitable that mining companies may try to stall or even prevent these projects, so it's imperative that supporters demand these products in the pursuit of more just climate solutions.

How long does storage last?

Battery technology is changing quickly. While most storage technologies have traditionally been considered "short-term," longer duration technologies are emerging rapidly. "Short-term" storage generally provides four to eight hours of energy storage discharge. This is great for shifting mid-day solar generation peaks to supply energy for evening demand peaks, or other same-day generation shifting to match energy supply with energy demand.

However, long-term storage solutions are necessary to capture and shift larger weather variations, storing energy longer than eight hours and up to several days. This technology is beginning to emerge. Form Energy, for example, has raised over $1.2 billion for its 100-hour iron-air battery technology, breaking ground for a first-of-its-kind pilot project in 2024 with several other projects in development. Numerous others are also working to develop long-duration storage solutions.

Energy losses

Energy storage is not 100% efficient, and anytime energy changes form, there will be some losses. For example, coal combustion for electricity generation is generally about 33% efficient, meaning that only 33% of the chemical potential energy stored within coal is captured as electricity when that fuel is burned in a coal plant.

Pumped storage hydropower technology generally operates at around 80% efficiency, meaning if 1 MWh of electricity is stored, 0.8 MWh will later be discharged for utilization. Lithium-ion batteries range from 85% to 95% efficient. Hydrogen can also technically be used as an energy storage solution, but converting electricity into hydrogen for storage and then converting that hydrogen back into electricity is expensive, often polluting, and only 25% to 45% efficient.

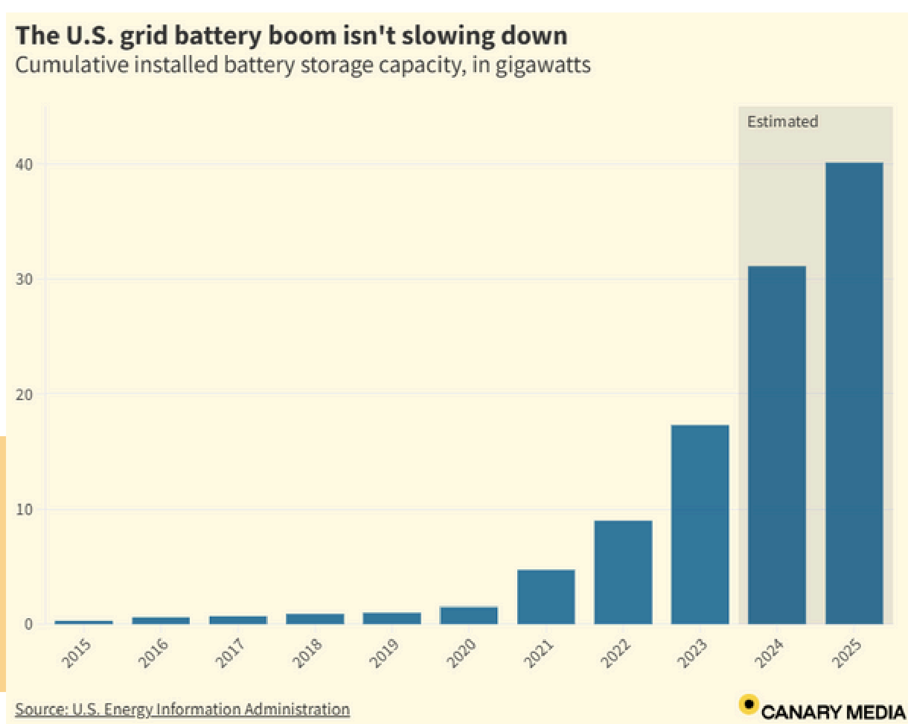
Salt batteries have a high level of efficiency at around 90%, while iron batteries come in at less than 50% efficiency. Lower-efficiency battery materials may still have a place in the clean energy future, as batteries made from more common materials can be produced in larger quantities to fulfill our needs, while avoiding the damages (and energy demands) of critical mineral mining.

SO WHAT IS NORTHWESTERN ENERGY, MONTANA'S LARGEST MONOPOLY UTILITY, DOING ABOUT IT?

The short answer is: nothing. For years, developers have tried to secure funding for the Gordon Butte pumped storage hydroelectric project in Montana. Unfortunately, NorthWestern Energy has expressed no interest in the project.

A few years ago NorthWestern Energy requested permission to charge customers for the proposed Beartooth Energy Storage battery system but abandoned the project when it withdrew its original request for preapproval of the Yellowstone County Generating Station methane gas plant.

When NorthWestern returned to seek permission to charge customers for the methane plant, it did not revisit its request for the storage project.



While other utilities rush to add energy storage technology, NorthWestern Energy has no energy storage system operating, in development, or planned.

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