

Exploring Energy Storage Opportunities on the Grid

BY KRISTEN RUSSELL

Utility companies across the nation have always pondered the idea of energy storage. With today’s technology, research, and legislation, these companies are quickly exploring the possibilities and opportunities that energy storage has to offer.

THE RECENT GROWTH OF ENERGY STORAGE

The need for energy storage has been recognized for decades. However, the problem has only gained popularity in the last few years due to the increase in projected profitability. Initial project costs have dramatically decreased on account of technological advancements and investment tax credits (ITCs) introduced in the August 2022 Inflation Reduction Act. Previously, the government only awarded ITCs for solar-paired projects, but now for the first-time, standalone energy storage is eligible for an ITC [2]. The US\$45/kWh credit on U.S.-manufactured battery cell plus modules motivated 14 new battery manufacturing facilities to announce operation this year. Figure 1 illustrates the leap large-scale battery storage capacity is making in the United States.

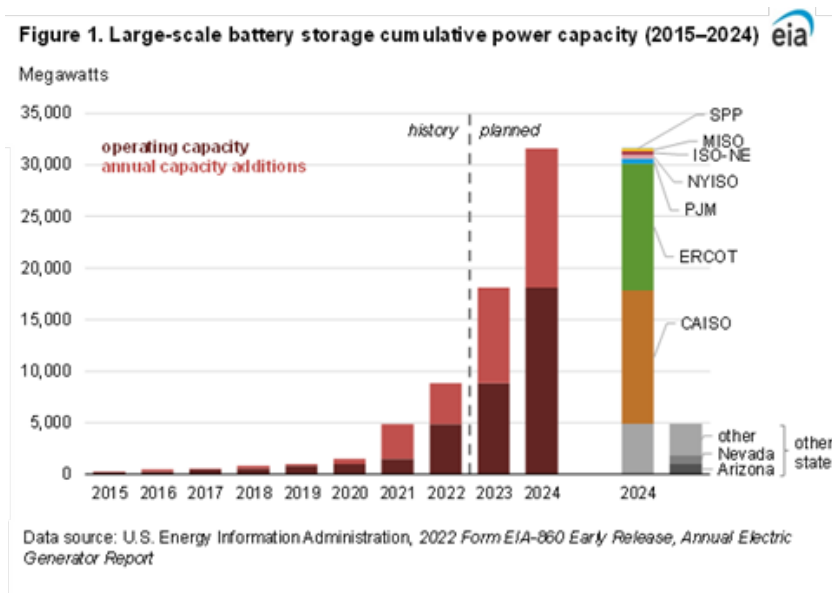
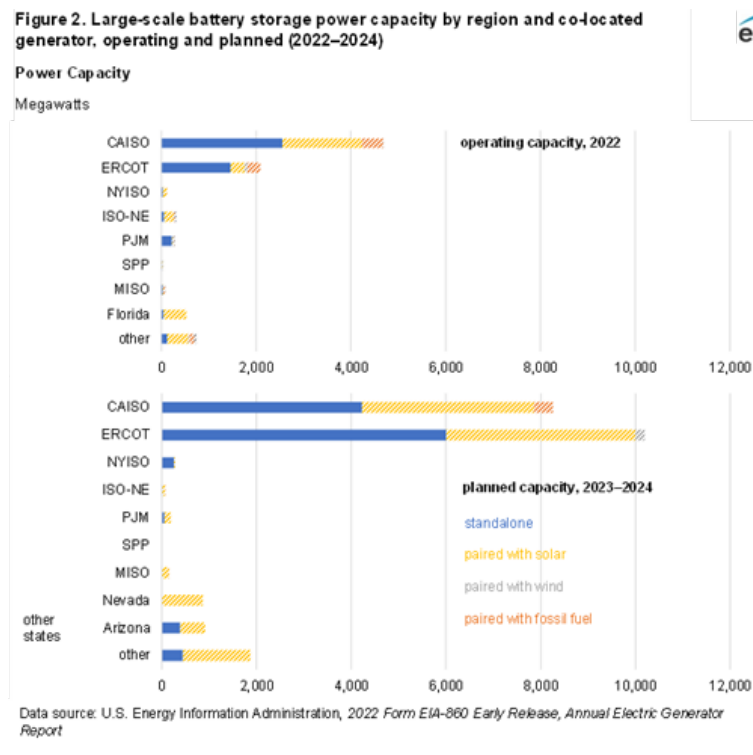


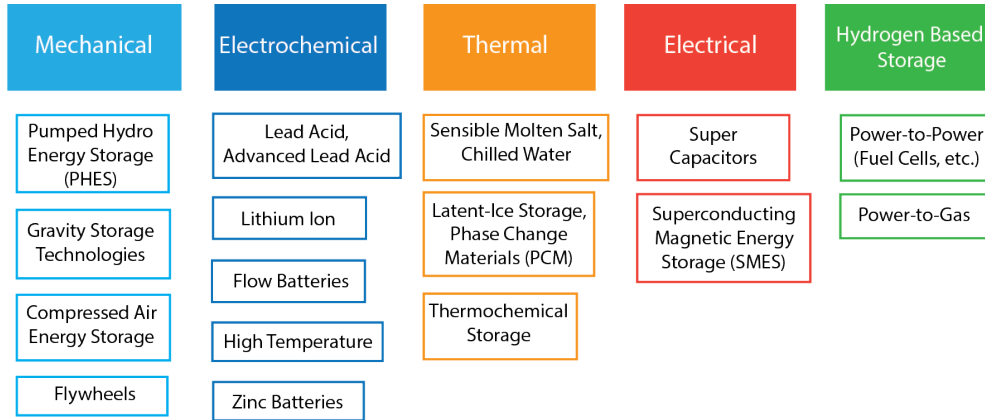
Figure 2 below illustrates the type of project, most commonly standalone or paired with a solar generation facility.



WHY THE ELECTRIC GRID NEEDS ENERGY STORAGE TO MEET DECARBONIZATION GOALS

Utility companies have begun strategizing about how they will reduce their greenhouse gas emissions to comply with clean energy legislation. Cutting carbon emissions is not a quick and easy task. Historically, America’s main source of reliable power has been coal and natural gas plants, which produce carbon dioxide (CO₂). Switching to different renewable sources, such as solar and wind power, only provides part of the solution. Solar panels and wind turbines do not create greenhouse gas emissions when generating electricity and can be forecasted well, based on weather predictions. However, their available electrical production is not constant and cannot be turned on and off on demand, making these methods less user-friendly. At times, solar and wind power generation sources produce more electricity than needed by the local grid. When this occurs, the excess energy is wasted. This production of waste is referred to as ‘curtailment.’ According to the California Independent System Operator (CAISO), in 2021, 1,500GWh of their solar and wind energy was curtailed. This is enough energy to power nearly 220,000 homes for a year. If all 1,500 GWh of curtailed solar and wind power was stored for later use, it could have avoided 350,000 metric tons of CO₂ emissions, which is the equivalent to the yearly CO₂ emissions of over 76,000 passenger vehicles [1].

FIGURE 3. CATEGORIES OF ENERGY STORAGE



Renewable energy sources must be incorporated into the grid with a form of energy storage to capture all available renewable generation. Storing excess power produced by solar panels or wind turbines will increase the viability of renewable projects and increase reliability of the grid.

THE DIFFERENT TYPES OF ENERGY STORAGE BATTERIES

The terms ‘Energy Storage’ and ‘Battery’ are very broad. Upon hearing these words, people tend to think of lead acid (the typical AA or car battery) or more modern lithium-ion (rechargeable) batteries. These are only two cathode/anode combinations on a long list of electrochemical batteries. There are many factors to weigh when designing a battery system for the grid. The types of materials used in batteries, their energy densities, and their round-trip efficiencies all contribute to the total cost and capacity of a battery system. Electrical energy can also be stored through various mechanical, thermal, electrical, and hydrogen-based methods as shown below in Figure 3.

STRATEGIC LOCATIONS FOR ENERGY STORAGE INSTALLATION

The best place to put an energy storage system depends on the services it is going to provide. Utility scale batteries are not only useful for storing surplus renewable energy, but they can also help regulate the quality of electricity on the grid and provide a backup energy source.

Co-locating storage with solar or wind installations is excellent for many reasons. First, renewable energy produces direct current (DC) energy which is stored in batteries. Having both in the same spot enables them to become ‘DC-coupled’ or directly connected. The main electric grid uses alternating current (AC) electricity so having renewables and storage at different locations requires the use of inverters. This changes the produced electricity from DC to AC to travel across the grid, and back from AC to DC to store in batteries. Every time the current is changed in an inverter, some efficiency is lost. Therefore, DC-coupled systems are more productive and economical. In addition, batteries directly connected to renewable energy sources help control their varying frequency and send higher quality electricity to the grid. The Gemini Solar + Storage project in Clark County, Nevada is planned to

go online by the end of this year with 690MW solar + 380MW/1.4GWh battery energy storage [10]. It is one of the largest dc-coupled projects in the world.

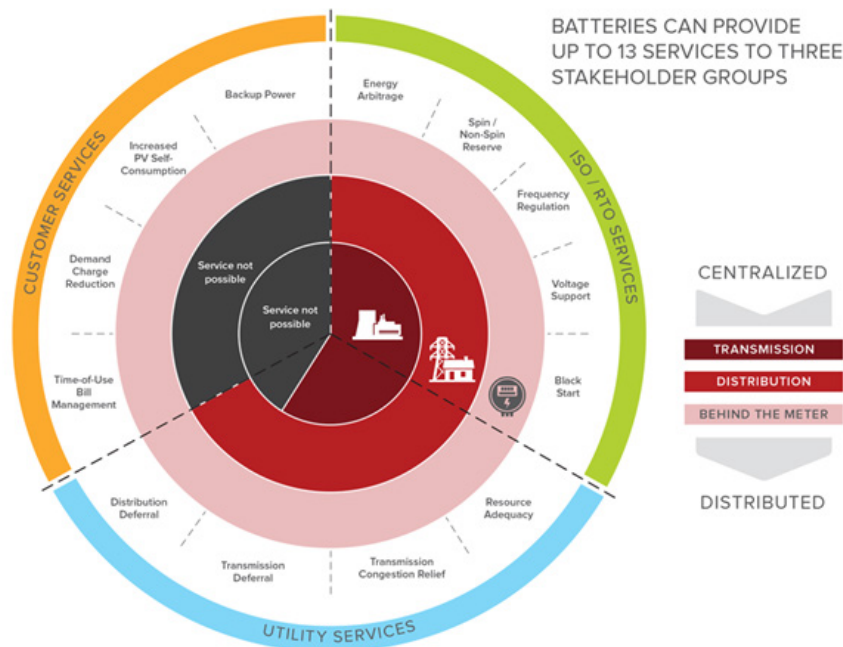


FIGURE 4. ENERGY STORAGE SERVICES

There are also worthy possibilities for standalone storage connections. For instance, incorporating energy storage near substations has potential for which utilities are just beginning to recognize. New York’s first state-owned utility-scale battery in Franklin County is connected to the nearby Willis substation [11]. The Byrd Ranch Storage project in Sweeny, Texas as well as the Clairemont Microgrid in San Diego, also have their facilities strategically connected to substations [12][13]. These systems can be easily integrated as a backup energy source for communities since substations have existing equipment to isolate and switch feeders and serve as the main hub for distributing electricity. These systems already have protection, controls, and security in place that new battery projects can take advantage of. New pilot projects for home batteries are in the works in states like Texas, Vermont, and California [14]. With smart grid technology, they are testing different ways the utility companies can monitor home batteries to create a Virtual Power Plant (VPP). This would be a direct path to improving grid resiliency. Having energy storage attached to homes and businesses could mitigate blackouts from extreme weather events. The VPP projects also offer to pay consumers for programming their devices to discharge electricity to the grid during times of high demand [15].

In conclusion, installed battery energy storage has the potential to increase profitability of renewable projects across the country. Whether behind the meter in a residential home, or in a utility scale facility, additional energy storage. is required to meet the United States’ grid reliability and decreased emissions goals.

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