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Clean Energy Breakthroughs: Grid-Scale Energy Storage

Bicameral Task Force on Climate Change

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About the Series

The Bicameral Task Force on Climate Change is issuing a series of fact sheets examining emerging energy technologies that could play a significant role in the clean energy economy of the future. The transition to a clean energy economy presents technical challenges for which scientists and researchers across the country and around the world are developing solutions. Each fact sheet in the Clean Energy Breakthroughs series will examine a technical challenge, describe the opportunities it presents, and highlight new technologies that are being developed to address the challenge. Some of the profiled technologies will ultimately succeed in the commercial market while others may not.

This Clean Energy Breakthrough fact sheet is the third to examine the progress being made on grid-scale energy storage.

The Challenge

As described in the first fact sheet on grid-scale storage, today's electric grid has a limited ability to store energy. Flexible, affordable, large-scale energy storage would allow excess energy from variable resources to be stored until that energy is needed. This would further enable the widespread deployment of wind and solar generation, substantially reducing carbon emissions from the electric sector while boosting clean energy manufacturing and jobs in the United States.

The Technologies

Primus Power's Rechargeable Zinc Flow Battery

A California company called Primus Power is developing a rechargeable zinc liquid flow battery. Unlike a conventional battery, which stores energy inside the battery cell, a flow battery stores energy in chemicals that are kept outside the cell. The Primus Power battery uses zinc, which is cheap and abundant, as an electrode.

According to the company, its battery features three significant innovations. First, the metal electrode is coated with a catalyst and is porous like a sponge. As a result, it is ten times more conductive and can produce ten times more power than a standard battery with plastic or felt electrodes. Second, the zinc electrode lasts 20 years instead of three or four years like the traditional materials. Third, the Primus design eliminates the complexity of the membrane filter between the two electrodes. This also improves the lifetime and reduces the cost of the battery compared to traditional batteries with membranes, which tend to last about three years.

Starting this year, Primus will begin deploying battery modules that can store enough power to supply 250 kilowatts of electricity for four hours. Each module will consist of a shipping container holding 14 refrigerator-sized batteries.

The company has several planned demonstration projects. Primus received a contract from Raytheon to install a module at the Marine Corps Air Station in Miramar, California, as part of an effort to create a self-contained microgrid at the base. The module will be integrated with an existing 230 kilowatt solar photovoltaic system in order to reduce peak electrical demand at the facility and provide backup power when electricity from the electric grid is not available.

Primus will also deploy an array of zinc flow batteries in the Modesto Irrigation District located in California's Central Valley. The batteries will be used instead of a planned natural gas fired power plant to firm the output of intermittent wind and solar generation. The 28 megawatt battery farm will cost $56 million less than the natural gas plant over 20 years. It will store renewable energy during off-peak times and release that energy during peak load times when electricity is expensive.

Similarly, Primus is partnering with the Bonneville Power Administration and Puget Sound Energy to deliver two 250 kilowatt modules to store wind power in the Northwest. Instead of curtailing wind generation during times of high supply and low demand, the batteries will store that wind power for later use during times of high demand.

Fluidic Energy's Rechargeable Zinc-Air Battery

An Arizona company called Fluidic Energy is developing a rechargeable zinc-air battery. Zinc-air batteries have traditionally been used in small, nonrechargeable devices, such as hearing aids. Fluidic Energy's aim is to produce a high-energy, rechargeable, long-lasting zinc-air battery made of cheap, abundant materials. The battery generates energy through a chemical reaction that oxidizes zinc with oxygen from the air. The battery can operate through thousands of charge and discharge cycles and is not subject to degradation from repeatedly draining the battery all the way down. In addition, the battery is not sensitive to temperature variations.

Fluidic is deploying modules that store four kilowatt hours of electricity and can be linked together to match the scale of a project. An individual module is small enough to fit under a desk. These modules are designed to operate across a wide range of applications.

Fluidic is commercially marketing its zinc-air battery as a reliable source of backup power when electricity service is disrupted. Currently, diesel generators in combination with lead-acid batteries are typically used for this application. Fluidic is shipping its batteries to emerging markets overseas where power outages are common and backup diesel generators run routinely. According to the company, its zinc-air battery has three to six times the lifetime of a lead-acid battery and does not contain any toxic elements. By replacing diesel generators that burn fossil fuels, the batteries reduce carbon pollution while significantly decreasing operating costs.

In addition to its exports, the company also is conducting demonstration projects in the United States.

The Potential

Energy storage technologies like Primus Power's rechargeable zinc flow battery and Fluidic Energy's rechargeable zinc-air battery have multiple potential applications. Energy storage technologies can support intermittent renewable energy, assist during peak demand, provide backup power, and reduce the need for new generation.

The market potential for cost-effective energy storage technologies is huge. Sandia National Laboratories has calculated the potential U.S. market demand for energy storage for just one application – storing excess renewable energy – to be more than 36,000 megawatts over ten years.[1] The worldwide market for grid-scale energy storage is expected to exceed $30 billion per year by 2022.[2]

[1] Sandia National Laboratories, *Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide* (Feb. 2010).

[2] *Energy Storage on the Grid Will Surpass $30 Billion in Annual Market Value by 2022, Forecasts Pike Research,* Business Wire (Oct. 24, 2012).