Xtreme Power storage system with wind turbines. The company, headquartered south of Austin, Texas, manufactures systems ranging from 500 kW to 100 MW.

Photo: Xtreme Power

„The market will evolve“

In California and elsewhere in the USA, renewable energy developers have been struggling for years to increase the reliability of renewable energy sources. Storage is still expensive. But the costs are expected to drop as new technologies develop.

Developers and utilities are looking into energy storage because it would help provide reliable, base-load power instead of variable, intermittent energy. Renewable energy producers who provide energy during off-peak hours could store it and sell it during peak hours at higher prices.

A new California bill would likely help move the industry along by requiring utilities to add energy storage equal to 2.25 % of daytime peak power by 2014 and 5 % of daytime peak power by 2020 in order to help meet peak demand. “The goal is to stabilize the load so there aren’t peaks and valleys and brownouts,” says Patrick Perry, a partner with the California law firm Allen Matkins’ Energy Group. “Right now, if utilities don’t have storage during peak demand and they are relying on renewable energy, they will have to use fossil fuels to meet demand.”

With enough storage on the system, utilities wouldn’t need to build expensive peaking plants adds William Holmes, Chair of Stoel Rives LLP’s renewable energy initiative. The energy storage unit wouldn’t produce air pollution or emit greenhouse gases, he says.

In spite of these advantages – in California and elsewhere in the US – adding new storage poses a number of challenges. “Over the last ten years, the 50 US states combined have only installed 12 MW of new storage capacity,” explains Bill Gray, CEO of Velkess Inc. in California. Based on power predictions from the California Independent System Operator (ISO), a 2.25 % storage penetration would require 135 MW of additional storage per year for the next five years.

The US has seen little energy storage installed because it’s expensive. According to a report by the California ISO, it typically costs developers $ 1 million to $ 1.5 million per MW of capacity. „The market for large-scale energy storage is incredibly massive but it hasn‘t been bitten off because there are no technologies in the market today that are economical,“ says Gray. “Storage is the holy grail for many renewable energy technologies,” adds Jeff Atkin, a partner with Foley & Lardner LLP in California.

Because storage technology is expensive today, venture capital investors often ignore it. “The key to attracting investments and making storage more economically viable is for developers to find ways for

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storage to play multiple roles in value streams", says Carlos Coe, founder and CEO of Xtreme Power, Texas. Storage devices can play a wide range of roles simultaneously. They can regulate frequency, support the stabilization of distributed generation systems, and provide backup during blackouts or power interruptions.

Variety of technologies

In the US, the various technologies are either too expensive or impossible to manage in today's existing energy network. "Storage technologies need to be fast, efficient, capable of storing a large amount of power and cost-effective. Most technologies satisfy only one of four criteria for entering the marketplace," Coe sums up. But: "Businesses and governments alike are beginning to invest more money into energy storage research and development in order to better meet these criteria and capitalize on the potential market," he says. In 2009, venture capital investment for energy storage companies more than doubled 2008 funding.

In the past, once a storage technology became cost-effective, developers exploited it. For example, pumped hydroelectric storage has been in use since the early twentieth century. However, it requires a very specific geology – lakes close to steep mountains – and therefore most of its storage capacity is already being used.

Compressed air energy storage

Another existing storage technology – Compressed Air Energy Storage (CAES) – is getting renewed attention from the Electric Power Research Institute. In this process, a pump compresses air into a chamber or an underground cave. When electricity is needed, the air is heated and expands, which turns a generator. „One advantage of the system is that it can store large amounts of energy," says Daniel Abraham, engineer at the chemical sciences and engineering division of Argonne National Laboratory, Illinois. For example, the Mcintosh Salt Dome in Alabama has a 110-MW storage capacity. CAES technology is also well understood and has been tested for over 30 years. Despite being fairly simple, CAES is expensive and inefficient. „When air is compressed and then gets hot, thermal energy is lost," Gray explains. "The system is only 45 % efficient." In spite of the cost, Sandia National Laboratories, a Department of Energy laboratory (DOE), is exploring a 2,200-foot-deep inactive limestone mine in northeastern Ohio as the storage vessel for a CAES power plant.

Flywheels

Another technology gaining government attention is flywheel energy storage. Here, spinning wheels store energy in its rotational momentum. "Flywheels perform well, with high efficiency, long life, and quick response time," says Abraham. Beacon Power, a leading flywheel developer, has developed a fourth generation flywheel composed of a heavy carbon-fiber composite rim, supported by a metal hub and shaft. Beacon Power's heavyweight material increases the amount of energy the system can hold. Its new flywheel can absorb and inject up to 25 kWh into the grid in response to power grid requirements. Beacon Power is now constructing its first full-scale 20-MW plant in New York. In addition, the company has received a $ 24 million DOE "smart grid" stimulus grant.

Gray's company, Velkess Inc., a start-up located in California, takes a different approach to flywheel storage. Velkess uses very lightweight materials and increases the velocity of rotation, which increases storage capacity. „Our flywheel, instead of being super rigid and strong, is entirely flexible, like a cowboy's lasso," Gray explains. "Most of the cost of rigid and heavy flywheels goes into costly materials and strong frames to keep them in place. Our design also allows us to use stretchy materials in the motor, which are much less expensive." Velkess is now working to expand its test facilities into fully operational commercial technologies capable of producing 100 MW per month in the next few years.

Different types of batteries

Another type of energy storage technology – batteries – could potentially store large amounts of energy. For example, lithium ion batteries – common in electronic devices like cell phones and computers – are efficient ways of storing small amounts of energy. The problem is that they become too expensive at larger scales. „It's technically viable, but impossible to do cheaply," says Gray.

Another type of battery, a flow battery, is an emerging type of storage technology that pumps electrolytes through anelectrochemical cells. This results in an oxidation and reduction reaction and the release of energy. „Flow batteries are scalable to large applications, have high energy and power density capacity, and can recharge rapidly," says Abraham. "On the down side, the tanks are cumbersome to manage because they are sized in the hundreds of gallons." In spite of these challenges, flow batteries are gaining attention from US investors. The startup EnerVault, California, raised $ 3.5 million in venture funding to build a prototype that can demonstrate that its flow battery technology can scale up to support enough power to be useful to renewable energy plants.

Batteries, flywheels, CAES and other energy storage technologies will play an integral role in the growth of renewable energy. „The market will evolve and grow such that each storage technology will fill a different niche market that caters to site-specific demands, from grid regulation to renewable energy storage," says Coe. Jeff Atkin adds: "The price/technology gap is closing quickly, and we will likely see cost competitive energy storage solutions soon as the potential market and opportunities are great."

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