COMMITTEE ON SCIENCE AND TECHNOLOGY
Subcommittee on Energy and Environment
U.S. House of Representatives

Energy Storage Technologies: State of Development for Stationary and Vehicular Applications

Wednesday, October 3, 2007
10:00 a.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, October 3, 2007 the Subcommittee on Energy and Environment of the Committee on Science and Technology will hold a hearing to receive testimony on the state of developing competitive energy storage systems for both stationary and vehicular applications and the role for the Department of Energy's (DOE) research and development programs in supporting the development of these systems.

There are significant economic and environmental benefits for improving the nation's energy storage capability. Broad deployment of energy storage technologies can help to improve the operational efficiency and reliability of our electricity delivery system, and allow for more diversified electricity sources and vehicle models that utilize less conventional liquid fuel, have lower emissions, and address concerns about global climate change. However, there is concern that the U.S. is falling behind in the race to develop and manufacture a wide range of energy storage technologies, and a significant effort is underway to build up a domestic energy storage industry for both stationary and vehicular applications.

The Subcommittee will hear testimony from two panels of witnesses. The first panel will focus primarily on stationary energy storage technologies, and the second panel will emphasize the state of storage technologies for applications in vehicles. The first panel will be comprised of representatives from the Department of Energy, the Electricity Storage Association, an electric utility, and the Electric Power Research Institute. The second panel will consist of representatives from the automobile and battery manufacturing industries, as well as a second electric utility witness who can speak to the potential for integrating the electricity and vehicles sectors.

WITNESSES

Panel One:

Ms. Patricia Hoffman, Deputy Director Research and Development, U.S. Department of Energy Office of Electricity Delivery and Energy Reliability. She will discuss the Department's programs to advance stationary electricity storage and how it relates to the electric grid. She will also provide information regarding the Department's activities on storage technologies for automobiles.

Mr. Brad Roberts, Chairman, Electricity Storage Association. He will discuss the state of stationary storage technologies and the various benefits of developing and commercializing storage technologies on a wider scale.

Mr. Larry Dickerman, Director Distribution Engineering Services for American Electric Power. He will speak to AEP's announcement to expand use of stationary electricity storage and the main benefits realized by storage investment.

Mr. Tom Key, Technical Leader, Renewable and Distributed Generations, Electric Power Research Institute. He will discuss the role that electric energy storage plays in the power delivery system today and in the future.

Panel Two:

Ms. Lynda Ziegler, Sr. Vice President for Customer Services, Southern California Edison. She will discuss the company's initiatives to advance electric vehicles in the marketplace.

Ms. Denise Gray, Director Hybrid Energy Storage Systems, General Motors. She will speak to the state of battery technology development for vehicles, as well as General Motors views as to how vehicle electrification fits into a portfolio of advanced vehicle technologies

Ms. Mary Ann Wright, Vice President and General Manager Hybrid Systems for Johnson Controls, Director of Advanced Power Solutions, a Johnson Controls and Saft joint venture. She will discuss the electrification of vehicles through advanced battery systems, and reducing their costs through advances in manufacturing technology, enhancing our domestic supply base, and establishing demonstration fleets.

BACKGROUND

Stationary Storage Technologies

Today, electricity is generated as it is used, with very little electricity being stored for later use. While this system has worked for decades, it is not very efficient. Demand for power varies greatly throughout the day and throughout the year as demands for lighting, heating and cooling fluctuate through the seasons. Because the capacity for generation of power matches the consumption of power, the electricity supply system must be sized to generate enough electricity to meet the maximum anticipated demand, or peak demand. This inefficiency becomes more evident when considering that it is possible that the peak electricity demand for any given year could be for a very short period – a few days or even hours. Rather than maintain massive generation systems that are designed around a short-lived peak demand, energy storage technologies would provide a means to stockpile energy for later use and essentially reduce the need to generate more power during times of peak electricity demand. Generally, energy storage systems could be charged at night during off-peak consumption hours and then discharge the energy during peak demand. Using our generation capacity at night time to store energy for use during the day is more efficient, cheaper, and helps to equalize the demand load.

The expanded use of energy storage would also help to avoid the need to upgrade transmission and distribution facilities as well as reduce the need to run certain generation plants that may have higher operating costs and/or have a poor emissions profile. Energy storage also can improve reliability by providing an alternate source of power during an outage of the primary power source.

Advances in energy storage technologies are often regarded as key to increasing the reliability and widespread use of many renewable energy technologies. Renewables such as wind and solar produce electricity only when wind speeds are high enough and sunlight is bright enough to generate power. Strategically distributed storage would permit electricity from these renewable sources to be stored and used during times of high demand or low resource availability.

Together, all of these potential benefits from broad deployment of energy storage technologies would help to improve our energy security. Because our economy relies heavily on an affordable and reliable electricity delivery system, the energy security benefits achieved from greater use of energy storage systems could be significant.

There are a number of promising energy storage technologies being developed, but they are not all at the same stage of development and certain storage systems are better suited for specific purposes. Described below are some of the more promising technologies:

Pumped Hydropower – water is pumped into a storage reservoir at high elevation during times when electricity is in low demand and relatively inexpensive. When demand is high, the water is released and used to power hydroelectric turbines. It is well-suited for applications requiring large power levels and long discharge times.

Compressed Air Energy Storage – this technology uses high efficiency compressors to force air into underground reservoirs, such as mined caverns. When demand for energy is high, the stored air is allowed to expand to atmospheric pressure through turbines connected to electric generators that provide power to the grid. In Alabama and Germany, compressed air energy storage has dispatched power to meet load demands and keep frequency and voltage stable.

Batteries – there are different types of battery systems for energy storage. With conventional batteries, chemical reactions within the battery generate electrons that travel from the negative terminal through a wire to an application, thus providing electric power, and then return to its positive terminal. A different battery system such as flow batteries store electrolytes outside the battery and circulate them through the battery cells as needed. Batteries have great potential for use in a range of energy storage applications.

Flywheels – these energy storage systems consist of a rotating cylinder on a metal shaft which stores rotational kinetic energy. Flywheels are suitable for stabilizing voltage and frequency.

Electrochemical Capacitors – electrochemical capacitors store energy in the form of two oppositely charged electrodes separated by an ionic solution. They are suitable for fast-response, short-duration applications such as backup power during brief outages.

Power Electronics – power conversion systems are not explicitly a storage device, but are a critical component of any electricity storage system as they serve as the communication device between the storage system and the electric grid.

Smaller energy storage systems may also be deployed in stationary applications, such as a residence or in a neighborhood, in order to supply back-up energy and level the load on the electric grid. Advances in smaller energy storage systems, specifically batteries, may also allow for entirely new vehicles such as plug-in hybrid vehicle technologies to enter the mass market.

Energy Storage Technologies for Vehicles

Concerns about energy independence and climate change have caused a renewed interest in enhancing the role of electricity in the transportation sector. The benefits of this have been seen to some degree in the rise in popularity of Hybrid Electric Vehicles (HEV) because of their high fuel efficiency and lower emissions. Switching vehicles' primary energy source from petroleum-based fuels to electric batteries reduces overall consumption of conventional liquid fuels. Additionally, several recent studies have shown that, regardless of its source, electricity used as a vehicle fuel reduces greenhouse gas emissions. However, greater electrification of the vehicles sector is constrained by the technological limits of energy storage technologies used in conventional hybrids, specifically the Nickel Metal Hydride (NiMH) batteries.

Plug-In Hybrid Electric Vehicles (PHEV's) are seen by some as the next logical step towards greater electrification of the transportation sector, and the eventual move towards market acceptance of all-electric drive vehicles. PHEV's allow for electricity to be used as an additional or even primary source of power for a vehicle, with a secondary role for the gasoline engine as a back-up power system. Advocates claim that 100 miles per gallon would be reasonable for PHEV's, approximately twice the gasoline mileage of today's hybrids. However, current NiMH batteries for conventional hybrids are not optimal for this application.

While significant technological advances are still likely in NiMH, and even the ubiquitous Lead Acid batteries, many in the industry believe the future of PHEV's depends on breakthroughs in new battery technologies, such as the lithium ion (Li-Ion) batteries. To expand the use of electricity in the vehicles sector batteries must be smaller, lighter, more powerful, higher energy and cheaper - all of which require considerable research and development. Achieving these needed breakthroughs will require meaningful federal support and public-private partnerships with a range of stakeholders.