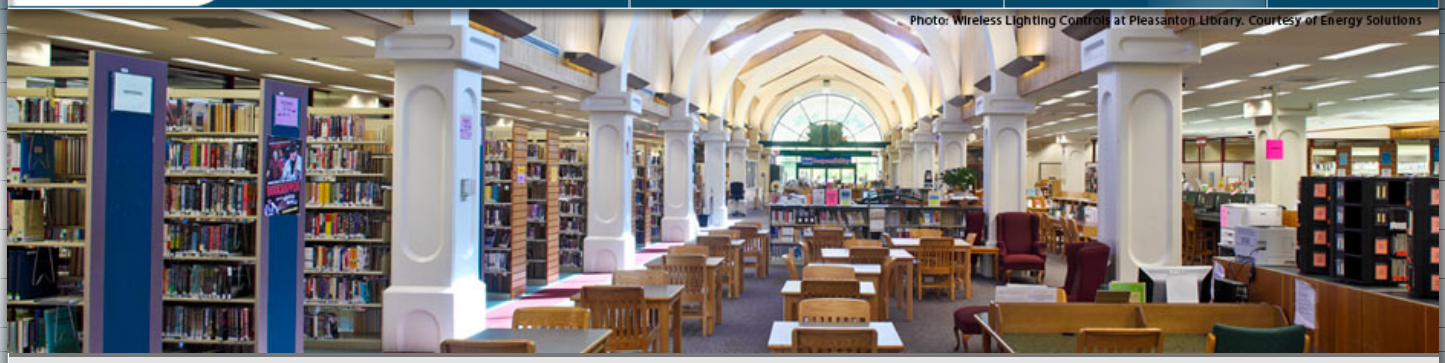
Photo: Wireless Lighting Controls at Pleasanton Library. Courtesy of Energy Solutions

Energy Storage Research

What is Energy Storage?

Energy Storage technologies do not generate electricity but can deliver stored electricity to the electric grid or an end-user. They are used to support the integration of renewable generation and to improve power quality by correcting voltage sags, flickers, and surges, or to correct for frequency imbalances. Storage devices are also used as uninterruptible power supplies (UPS) by supplying electricity during short utility outages. These energy devices can be located at or near the point of use, so they are included in the distributed energy resources category. When coupled with Demand Response technologies, Energy Storage can achieve peak load reductions at the same performance with enhanced system response at lower system cost. Energy Storage and Demand Response are two aspects of the Smart Grid research within PIER's Energy Technology Systems Integration Research Area.

What are the different kinds of Energy Storage technologies?	
Battery	Utilities typically use batteries to provide an uninterruptible supply of electricity to power substation switchgear and to start backup power systems. Batteries also increase power quality and reliability for residential, commercial, and industrial customers by providing backup during power outages. However, there is an interest to go beyond these applications by performing load leveling and peak shaving with new battery systems. Although lead-acid is currently the standard battery type used in energy storage applications, sodium-sulfur and lithium-ion batteries are nearing commercial readiness for future utility applications.
Flow Batteries	Flow batteries differ from conventional rechargeable batteries in one significant way: the power and energy ratings of a flow battery are independent of each other. This is made possible by the separation of the electrolyte and the battery stack. A flow battery, on the other hand, stores and releases energy by means of a reversible electrochemical reaction between two electrolyte solutions. There are four leading flow battery technologies: Polysulfide Bromide (PSB), Vanadium Redox (VRB), Zinc Bromine (ZnBr), and Hydrogen Bromine (H-Br) batteries.
Flywheel	A flywheel is an electromechanical device that couples a motor generator with a rotating mass to store energy for short durations. During a power outage, voltage sag, or other disturbance the motor/generator provides power.
Superconducting	Superconducting magnetic energy storage systems store energy in the field

Energy Technology Systems Integration Research

- Planning
- Policy
- Projects
- Publications
- Funding Opportunities

Research Focus Areas

- Smart Grid
  - Demand Response
  - Energy Storage
  - Transmission and Distribution
  - Security
- WESTCARB
- Energy Innovations Small Grants

Resources

- Research Home
- Meetings and Workshops
- Program Support Unit
- Contractor Information

Magnetic Energy Storage (SMES)	of a large magnetic coil with direct current flowing. It can be converted back to AC electric current as needed. Low temperature SMES cooled by liquid helium is commercially available. High temperature SMES cooled by liquid nitrogen is still in the development stage and may become a viable commercial energy storage source in the future. SMES systems are large and generally used for short durations, such as utility switching events.
Supercapacitor	Supercapacitors (also known as ultracapacitors) are DC energy sources and must be interfaced to the electric grid with a static power conditioner. A supercapacitor provides power during short duration interruptions and voltage sags. Also, by combining a supercapacitor with a battery-based uninterruptible power supply system, the life of the batteries can be extended. Small supercapacitors are commercially available to extend battery life in electronic equipment, but large supercapacitors are still in development and may soon become a viable component of the energy storage field.
Compressed Air Energy Storage (CAES)	Compressed air energy storage uses pressurized air as an energy storage medium. An electric motor-driven compressor is used to pressurize the storage reservoir using off-peak energy and air is released from the reservoir through a turbine during on-peak hours to produce energy. The turbine can also be fired with natural gas or distillate fuel. Ideal locations for large compressed air energy storage reservoirs are empty aquifers, abandoned conventional hard rock mines, and abandoned hydraulically mined salt caverns.
Pumped Hydro Energy Storage (PHES)	Pumped Hydro Energy Storage (PHES) is the largest-capacity form of grid energy storage. PHES involves storing energy in the form of water pumped from a lower elevation reservoir to a higher elevation reservoir by using pumps running on abundant low-cost, off-peak electric power. During periods of high electrical demand or less available power, the stored water is released through turbines to produce electric power to meet demand. Despite some energy losses during this process, the overall system increases available power and revenue by selling more electricity during periods of peak demand, when electricity prices are highest.

Energy Storage Benefits

- Help integrate higher levels of renewable generation on the grid.
- Improves power quality and reliability.
- Provides energy/demand cost savings from load leveling.
- Decreases and/or defers transmission and distribution infrastructure investment.
- If applicable, reduces sizing of distributed generation systems.
- Promotes job creation in related technological and service industries.

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