Introduction to Grid Storage

Grid-scale storage can help integrate electricity generation from intermittent renewable energy technologies, particularly solar and wind, to help meet the increasing global electricity demand while simultaneously reducing CO_2 emissions. A scenario where renewable resources comprise 50% of energy generation is likely to require the integration of large-scale energy storage to support, balance, and stabilize the power system.

Energy storage options apply to different niches in the power system and are often categorized by their power ratings (kW to GW) and discharge rates (seconds to hours). They can be based in different fundamental processes including mechanical, electrical and electromagnetic, and electrochemical. Existing technologies, however, suffer from a number of drawbacks that inhibit widespread adoption and deployment such as cost, performance, durability, and scalability.

GCEP currently funds four programs to address grid-scale storage all of which have been underway for approximately six months. Professor Scott Barnett at Northwestern University is collaborating with Professor Robert Kee at the Colorado School of Mines to develop a novel solid oxide flow battery using H-C-O chemistry. The program performs fundamental studies of the materials, cells, stacks, and system designs to validate and improve upon the device. They have made progress in materials development, electrochemical cell fabrication, to the construction of the pressure-testing vessel. Additionally system design and models have been informing the experimental work for operating parameters and set-up design.

A team at the University of Texas, Austin lead by Professor Jeremy Meyers and Allan Bard has been researching electrolytes for flow batteries. This program is rooted firmly in re-examining the fundamentals of flow battery technology and engaging in an effort in which the active redox couples, the materials that separate the couples, and the flow characteristics that dictate the rate of delivery are optimized, thereby allowing system-level solutions with high efficiency and with capital costs that are much lower than if each aspect of the system were optimized with the other aspects left unchanged. Tin bromide has emerged as a promising material candidate because both redox couples are dissolved in the same solution, which eliminates concerns of cross contamination.

Professor Robert Hebner at the University of Texas, Austin and Professor Ray Baughman at the University of Texas, Dallas, are researching a low-cost flywheel design and flywheel materials. Their investigation of flywheel designs attempts first to understand the level of energy storage needed at the distributed and transmission levels, and then to reduce mass and use ultra-low loss bearings and motor-generators made from superconducting materials. An enabling technology may be the development of multifunctional carbon nanotube yarns that combine high strength with the magnetic and superconducting properties needed to levitate rotors for flywheel batteries.

Professors Yi Cui and Robert Huggins from the Department of Materials Science and Engineering at Stanford University are leading a program to develop inexpensive, safe, high power lithium batteries using aqueous electrolytes. The team is exploring aqueous electrolytes to extend voltage ranges and new group of electrode materials based on common, earth-abundant materials that has a zeolitic open framework type of crystal structure.