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 low cycle life, cost, performance, durability, and scalability.

In 2012, GCEP issued a targeted solicitation on grid-scale storage. Of those programs funded, one program was completed over the past year, and two are ongoing but nearing completion. The most recent program with Professor Honjie Dai started in the last quarter of 2013. It is titled "Photoelectrochemically Rechareable Zn-Air Batteries" and attempts to develop novel nanocarbon-inorganic hybrid materials for the oxygen reduction reaction and oxygen evolution reaction. The objective is to create electrocatalysts and photoanodes for photoelectrochemical recharging of Zn-Air batteries. Their work has resulted in six publications including several high impact journals such as Science, Nature and Nature Communications**.**

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 (SOFB) 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. The results obtained in the past year have filled in many important details regarding materials, SOFB device characteristics, and system design. Particularly important are the observations that practical reduced temperature SOCs are available and appear to be robust, reversing cell operation does not cause degradation, and that degradation is eliminated for the moderate current densities that are consistent with high efficiency.

A team at the University of Texas, Austin is now lead by the Professor Allan Bard, to research "Novel Electrolyte Energy Storage Systems". 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. This work allows system-level solutions with high efficiency and capital costs that are much lower than if each aspect of the system were optimized individually. To date, the group completed fundamental material and mechanistic studies and reported the development of the first alkaline redox flow battery (a-RFB), a novel Fe/Co alkaline system, which has negligible crossover and capacity fade. They also explored multi-electron couples, focused on tin-based systems, with the aim of multiplying the possible energy density. I