Harvard Kennedy School Energy Policy Seminar Series, Fall 2014
An organic mega flow battery for utility-scale energy storage

Monday, November 10, 2014

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Taking up the thread of two previous seminars on the potential role of large-scale electrical energy storage in a future energy mix, Michael Aziz, Gene and Tracy Sykes Professor of Materials and Energy Technologies, explained how his ongoing work on the development of an organic mega flow battery could change the current energy storage landscape.

Currently, the cheapest energy storage is not battery storage, but large-scale mechanical storage, such as pumped hydro or underground compressed air energy storage—technologies that are just not available unless the surrounding geography is right, Aziz explained. Battery storage can theoretically be located anywhere, but technologies available in the market each have their own limitations. Conventional batteries are impractical for large-scale energy storage because they come with the expensive but unnecessary (for utility storage purposes) capability of rapidly discharging their entire energy store. Flow batteries can be adjusted to provide an optimal balance of storage and rate capabilities, but the flow batteries that are currently available rely on rare and expensive elements, such as Vanadium. In many cases, toxicity or flammability are potential safety issues.

Referring back to the previous week's energy policy seminar presentation from David Keith, Aziz noted that Keith's research, though suggesting that the amount of storage needed for a low-carbon grid is less than often supposed, still suggests a market for significantly more bulk energy battery storage than is currently available—a growth from almost nothing (0.1%) up to a potential 4% of total generation capacity, assuming the cost could be lowered significantly. California has adopted a storage procurement mandate for its major utilities, attempting to prepare for projected rapid load fluctuations as a greater share of the grid comes to depend on solar energy.

In this context, Aziz detailed the promising results of his lab's work on a new kind of flow battery which uses an organic compound called a quinone (one of the key elements of the photosynthesis process), research which is funded through ARPA-E. The materials necessary for this battery are readily available, Aziz said, at one-third or less of the cost of the elements used in the currently most successful flow batteries, are non-toxic (closely related to a compound found in rhubarb), and use a water solution (and are therefore non-flammable). The prototype battery is still being fine-tuned, but Aziz sees a "fighting chance" to bring capital costs into the target range of between $100 and $150 per kilowatt hour of storage capacity, both through technical fine-tuning and through measures like identifying cheaper sources of raw materials and potentially retrofitting other types of flow batteries to use the new quinone solution.

Aziz's talk was part of the Kennedy School's Energy Policy Seminar Series, which is jointly sponsored by the Energy Technology Innovation Policy research group of the Belfer Center for Science and International Affairs and by the Consortium for Energy Policy Research of the Mossavar-Rahmani Center on Business and Government.