Breakthroughs elusive to the 'challenging problem' of storage

Christa Marshall, Environment & Energy Publishing, 6-16-16

At one point during a congressional hearing yesterday on potential breakthrough energy technologies like bionic leaves, Rep. Steve Knight (R-Calif.) asked how his state will meet aggressive renewable deployment.

Last year, California mandated that it obtain half of its electricity from renewable power by 2030. Citing the 50 percent figure and the possibility of the mandate going higher, Knight said that "we might get to that line" where we can't go any higher because of the intermittency challenges of renewables. So, instead, "we'll have to burn something" to keep the lights on.

He asked a panel of scientists which storage technologies hold the most potential to back up the grid when the sun isn't providing energy and the wind isn't blowing.

Referring to massive solar projects like the Ivanpah Solar Electric Generating System in California's Mojave Desert that take up a lot of space, Knight said it "will become a problem" to use so much land over time. "If we cannot use this energy at a later time, then we might be on the wrong technology. We might want to look at something else," he said during a hearing of the House Science, Space and Technology Subcommittee on Energy.

Texas A&M University engineering professor Daniel Hallinan responded that storage from massive renewable projects is a "challenging problem" because of the current cost and performance constraints of batteries but also because of the need to "charge and discharge at a rate commensurate with either the production or consumption" of electricity.

Flow batteries, which are recharged by chemical components dissolved in liquids, are currently the best option for stationary storage because scaling up mainly involves adding a "bigger tank of liquid," Hallinan said. But the technology is not fully ready, he explained.

Hallinan and three other scientists told lawmakers about various aspects of research on materials, solar fuels and energy storage that, if successful, could address Knight's dilemma and transform the way energy is produced and sold. Much existing research on the technologies is supported by the Department of Energy, which funded $1.85 billion in basic energy research in fiscal 2016.

Several witnesses called for more money to upgrade equipment and broaden programs to find breakthrough technologies.

Hallinan outlined how large-scale "synchrotron light sources" operated by the national labs are critical to advancing energy research. For example, X-rays generated by light sources allow scientists to create 3-D maps of the composition of materials. The technology can be used for things such as perfecting batteries and building better membranes for water purification. But existing equipment at the national labs is in need of upgrades, Hallinan said.

"With upgrades to these facilities, other barriers will come down, making it possible to see structural changes at the atomic level that happen before a steel girder starts to crack ... and before an electric car's battery begins to fail," he said.

Similarly, Case Western Reserve University chemistry professor Daniel Scherson said that "increased research support from the government" is needed to train the next generation of scientists working on energy storage. Scherson told lawmakers that the lithium-ion batteries common in electric cars may reach a limit to how much power they can produce per given unit of space. To get around that, there needs to be more testing of things such

as new salts and solvents that work with magnesium batteries -- which may be able to store more energy than existing technology.

Then there is solar fuels or artificial photosynthesis, which holds the potential of creating a range of fuels in a lab just by combining sunlight, water, air and materials. The "bionic leaf" idea, for example, recently was explained in *Science* magazine and in theory holds the potential to make vast amounts of liquid fuels in a lab (*Greenwire*, June 3).

Nathan Lewis, a scientist at California Institute of Technology, told lawmakers about his research on solar fuels and finding new materials that can create a range of fuels through artificial photosynthesis at low cost.

"Imagine a high performance fabric that can be rolled out like artificial turf, supplied with sunlight, water and perhaps other feedstocks in the air such as nitrogen and/or carbon dioxide, and produces a fuel that is wicked out into drainage pipes and collected for use," Lewis testified.

Other countries like China and Sweden have launched research programs in solar fuels. "We can beneficially leverage these international efforts but need to stay in the lead domestically on the research front," Lewis said. In response to Knight, he also called for a "broad program" examining all technology options on how utilities can meet greater and greater loads of renewables.

Several Republican lawmakers called on DOE to prioritize basic research over grants for technology that is ready for commercial deployment. "When the government steps in to push today's technology in the energy market, it competes against private investors," said subcommittee Chairman Randy Weber (R-Texas).

Yet Rep. Mark Takano (D-Calif.) asked scientists to address what he said is a "false boundary" between basic and applied science. It's not "realistic" to divide government-backed basic research and applied research funded by the private sector, he said.

Lewis responded that "we don't want to be wasting our time making discoveries of materials ... that end up when combined into a battery are explosive and unsafe."

Yet Hallinan noted that MRI machines resulted from basic research that originally was not thought to have a practical application. "While taking things to market is extremely important ... it shouldn't be at the expense of basic science," he said.