Energy-storage options: abundant alternatives and tricky tradeoffs

Bill Schwebert - August 17, 2017

Engineers know that getting energy from various sources is important, but determining how to store it for later use is an equally critical factor in many system designs. Even when the source is perceived to be “free” (of course, there is no such thing) due to use of energy harvesting, solar power, or wind generation, there are almost always two associated issues: storing unused excess energy, and transmission of that energy. While the generation gets much of the public’s attention, the other two factors in the triad are equally important. The technical realities and economics of renewable “green” sources change dramatically when you can’t store any unused energy for use during slack periods.

Energy storage turns out to be an especially difficult problem as you scale up to larger and larger numbers, and is generally much more difficult than the transmission problem. A recent trio of nearly concurrent articles in The Wall Street Journal looked at some of the issues, along with some associated costs (we can’t ignore those!). The articles, “Beyond Batteries: Other Ways to Capture and Store Energy,” “Home Batteries Aren’t Economical—Yet,” and “The Race to Build a Better Battery for Storing Power,” offered a variety of perspectives and insight, and also looked at the present and near-term commercial realities.

The leading options for storage are batteries (usually lithium based), pumped hydropower, flywheels, and compressed air. Batteries have received a lot of attention, especially due offerings such as Tesla’s Powerwall system for residential backup. As in most things “engineering,” and even putting cost aside for now (which you can’t do in the real world), each option has some subtle tradeoffs in up-front effort, capacity, maintenance issues, and long-term attractiveness. For example, batteries may have a life of only five or 10 years, and that number is likely dependent on the usage cycling.

A small note: As we often see, the writers occasionally confuse energy (kWhr) with power (kW). Part of this is simple terminology sloppiness – and engineers who know better are guilty of this, as well –but some of it is technical misunderstanding. Energy and power are intimately related, of course: energy is time integral of power, and power is the rate at which energy is used. In practical terms, you generally collect energy whenever and however you can, and you use it as power to support your loads. Still, when the subject is energy and power, it’s best to use the right words at each point so the analysis stays crisp and doesn’t get blurred.

Reading through these articles and others on these topics, you’ll get a strong sense that while storage is certainly not an intractable problem, it’s difficult to solve while satisfying conflicting
goals. Every aspect of the design (siting, installation, and long-term support) gets much more difficult as you scale up into the tens, hundreds, and perhaps even thousands of kWhr range. Any problems or mistakes tend to be large-scale, with no easy fixes; this is generally not a situation where some fine-tuning of the software algorithms or finding and fixing some software bugs will take care of the problems, since “big stuff” is inherent in the project.

If your project has any larger-scale energy-generation and -storage aspects, you’ll likely spend as much time and effort on the latter as the former, even if the glamour and hype is with the generation aspects (which these days seem to get most of the attention). The fundamental laws of physics, which are the basis for generation and storage, say that both aspects are important, and how you decide to implement both as a pair has to be both good for each individually and a good match together. Often, though, what’s best for optimizing sourcing is in some conflict with what’s best for the paired combination, which makes for some difficult decisions on both technical and economic aspects. Perhaps that’s why many well-intentioned and well-designed projects have struggled or even failed.

Have you had any project-level experience with larger-scale energy storage, either for commercial or personal use? What did you learn? What were some unexpected issues?

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