2018 Biennial Energy Storage Review

Recommendations for the
U.S. Department of Energy

June 2019

EAC
ELECTRICITY ADVISORY COMMITTEE

2018 Biennial Energy Storage Review

Introduction

This report fulfills the requirements imposed on the Energy Storage (Technologies) Subcommittee (the Subcommittee) of the Electricity Advisory Committee (EAC) by the Energy Independence and Security Act (EISA) of 2007 that are related to assessing the Department of Energy's (DOE) activities in energy storage technologies. Title VI, Section 641(e) requires the formation of a Council to serve in an advisory role to DOE. Specifically, EISA Section 641(e)(4) states that every five years "the Council, in conjunction with the Secretary [of Energy], shall develop a five-year plan for integrating basic and applied research so that the United States retains a globally competitive domestic energy storage industry for electric drive vehicles, stationary applications, and electricity transmission and distribution." EISA Section 641(e)(5) further states that "the Council shall (A) assess, every two years, the performance of the Department in meeting the goals of the plans developed under paragraph (4); and (B) make specific recommendations to the Secretary on programs or activities that should be established or terminated to meet those goals." The Subcommittee was formed in March 2008 to serve as the Council identified in EISA.

The 2018 Biennial Energy Storage Review presents the Subcommittee's and EAC's findings and recommendations for DOE. DOE has the following three high-level goals for its energy storage-related research, development, and deployment (RD&D) activities.

- Energy storage should be a broadly deployable asset for enhancing renewable penetration—specifically to enable storage deployment at high levels of new renewable generation.
- Energy storage should be available to industry and regulators as an effective option to resolve issues of grid resiliency and reliability.
- Energy storage should be a well-accepted contributor to realization of smart-grid benefits—specifically enabling confident deployment of electric transportation and optimal utilization of demand-side assets.

We find that DOE's energy storage-related RD&D activities are meeting DOE's goals. However, we provide recommendations for ways to improve these activities for better meeting the needs of third-party users of the RD&D outcomes.

Approach

The Subcommittee advised DOE in the EAC's June 2018 "A Review of Emerging Energy Storage Technologies" that the EAC is adopting a broad definition of energy storage (Electricity Advisory Committee 2018). Specifically, energy storage should be defined in an all-encompassing manner that focuses more on capabilities than physical attributes. Thus, energy storage should be viewed as any process (e.g., mechanical, chemical, or thermal) that is capable of absorbing energy, storing it for a period of time, and then releasing the stored energy. The EAC recommended that DOE consider doing the same. Consistent with this definition, the EAC and Subcommittee set about preparing the 2018 Biennial Energy Storage Review by reviewing the full scope of DOE energy storage-related RD&D

activities and a broad range of stakeholder views. Information for this assessment was gathered in the following three-step process.

1. Representatives from DOE offices that are engaged in substantive energy storage-related RD&D activities provided a webinar-based briefing to the EAC on August 6, 2018. This briefing provided the EAC and Subcommittee with an overview of DOE's activities, which are pertinent to this current assessment. A list of the offices that participated in this webinar is provided in Appendix A.
2. Three EAC members, who are listed in Appendix B, attended the DOE Office of Electricity (OE) Energy Storage Peer Review 2018, which took place in Santa Fe, New Mexico, in September 2018. This peer review provided an opportunity for the members to see the totality of OE's RD&D portfolio. The members also conducted a series of in-person interviews with third-party stakeholders of DOE's RD&D products. The interviewees consisted of energy storage developers, researchers, and deployers. The interviewees' names and affiliations are provided in Appendix C. The members advised the interviewees that their names and affiliations would be included in this assessment document, but that individual comments would not be attributed to any individuals or organizations.
3. To supplement the interviews that were conducted at the DOE OE Energy Storage Peer Review 2018, telephone interviews were held with additional third-party stakeholders. The interviewees consisted of additional deployers, state regulators and policymakers, renewable-energy developers, environmental interest groups, reliability interest groups, and independent system operators. The EAC and Subcommittee strived to capture a diversity of perspectives from states and regions with different levels of energy storage adoption and experience.
   A full list of telephone interviewees and their affiliations is in Appendix D. As with the in-person interviews, all telephone interviewees were advised that their names and affiliations would be included in this assessment document but that individual comments would not be attributed to any individuals or organizations.

Findings

Based on the information gathered from the DOE webinar, DOE OE Energy Storage Peer Review 2018, and in-person and telephone interviews, the EAC identified the following key findings, which are categorized as follows.

Resources, Dissemination, and Coordination

- Many interviewees were not familiar with DOE's energy storage-related RD&D activities. Those who were aware of the activities tended to have greater familiarity with those activities that are undertaken by the Office of Energy Efficiency and Renewable Energy (EERE) than activities of other DOE offices. However, interviewees were largely supportive of the energy storage-related RD&D activities of which they were aware.
- DOE and its energy storage activities achieved transformational advances in energy storage RD&D through the work that was carried out with funding from the American Recovery and Reinvestment Act of 2009 (ARRA). The energy storage activities could use more resources, especially to disseminate the lessons learned from pilot, demonstration, and research projects to relevant stakeholders.

- Offices within DOE could have a more holistic view of their different program goals and coordinate their activities better, especially with respect to determining those goals and focusing specific RD&D activities toward solving issues that meet program goals in different offices.

Technology Research

- DOE's energy storage-related RD&D activities have had great success in advancing electro-chemical energy storage. However, many interviewees identified long-duration (e.g., weekly, monthly, or seasonal) energy storage as the next grand challenge. Some questioned whether DOE should focus on a broader range of energy storage technologies to address this challenge. They suggested that a focus on long-duration energy storage technologies is a major gap in DOE's energy storage-related activities.
- A number of interviewees expressed a need for improved understanding of the design and integration of hybrid energy storage systems (e.g., energy storage that is hybridized or combined with another generation or load technology).
- A number of interviewees expressed a need to have greater understanding of manufacturing and supply-chain issues and how these may affect the cost competitiveness of energy storage technologies.
- Third parties may have limited visibility into whether energy storage technologies can meet technical capabilities that are claimed by vendors. This perceived information asymmetry may hinder energy storage-technology adoption.

Valuation, Integration, and Education

- There are mixed locational and stakeholder opinions on the value of providing common methodologies for energy storage-valuation assessment and related modeling tools. Some regions of the country have relatively well-developed energy storage industries and are focused on conducting case-specific valuation and modeling exercises, for which common or generic valuation and modeling tools are less useful. Interested stakeholders in other regions of the country still benefit from having generic or common valuation studies and models available.
- Many state-level regulators and policymakers want more educational materials and help with understanding energy storage. Industry participants are mixed in their views of the value of general modeling tools and valuation studies for educational purposes.
- Overall, continuing to develop and provide common methodologies, studies, and tools for modeling and valuation of energy storage can be valuable if DOE wants to pursue an "all-state" strategy in its energy storage-related RD&D activities that would accommodate different regions of the country and different stakeholders having different levels of energy storage-related savviness.

Recommendations

Based on its findings, the EAC and Subcommittee provide the following recommendations (which use the same categorization) for DOE's energy storage-related RD&D activities.

Resources, Dissemination, and Coordination:

- DOE should develop a concerted strategy and greater resources to deliver its RD&D outcomes to potential users and to ensure that lessons learned from pilot, demonstration, and research projects are broadly disseminated to relevant stakeholders. While DOE does maintain a comprehensive repository of its RD&D outcomes (https://www.sandia.gov/ess-ssl/), a number of interviewees are unaware of this. Additional resources can help DOE disseminate its RD&D products further and to a broader audience, including to industry and through national industry, policy, and regulatory associations such as the Electric Power Research Institute (EPRI), National Association of State Energy Officials (NASEO), National Association of Regulatory Utility Commissioners (NARUC), the National Governors Association (NGA), and other energy-focused organizations. Such dissemination may require allocation of increased travel and dissemination-related funding. DOE also may want to consider hosting its repository of RD&D outcomes using a DOE url, as opposed to a url that is associated with Sandia National Laboratories, so that third parties more easily can identify the repository as being associated with DOE.
- DOE's energy storage-related activities should have the level of funding and available resources that allow its successes in achieving groundbreaking energy storage-related RD&D with ARRA funding to continue. Funding and resources will allow DOE to continue its transformational work and meet future grand challenges (e.g., developing economically viable long-duration energy storage technologies).
- DOE leadership should ensure better coordination between offices and better integration of different goals in the design of programs and activities. The offices should develop a common set of high-level goals and priorities for the program. The offices should also ensure that individual RD&D activities are solving issues that help meet program goals. In doing so, the offices should work to minimize overlap while exploiting strengths within each individual office. These planning and coordination activities should also include external stakeholders and users of the program's ultimate RD&D outputs to ensure that their needs are being accounted for.

Technology Research:

- DOE's energy storage-related RD&D activities should have a forward-looking focus on developing economically viable long-duration energy storage technologies. This is in light of a future grand challenge for energy storage: the development of economically viable long-duration technologies. Having a concerted focus on development of economically viable long-duration energy storage technologies would fill a major gap in DOE's activities.
- DOE should focus on examining the unique deployment, integration, and validation issues of hybrid energy storage systems. DOE does have some projects within its energy storage-related RD&D activities that examine these issues. These should be expanded on to achieve

a fuller understanding of the capabilities and challenges of integrating and operating such hybrid deployments within power systems.

- DOE should examine manufacturing and supply-chain issues that pertain to energy storage and how these may affect the cost competitiveness of energy storage technologies. DOE does have some efforts (e.g., in concert with NAATBatt International) that examine these issues for next-generation battery technologies that are based on Earth-abundant materials. These efforts should be expanded to other energy storage technologies.
- DOE and the National Laboratories should determine what role they may have, perhaps along with other representatives from the public or private sector, in providing an unbiased third-party platform to test and validate the technical capabilities of energy storage systems against vendor claims. Such third-party validation of vendor claims may help address technology-adoption challenges that are related to information asymmetries and concerns that are related to technical risk. In its fiscal year 2020 budget, DOE has proposed the development of a Grid Scale Launchpad to undertake some of these activities. DOE has also established the Energy Storage Test Pad at Sandia National Laboratories, Energy Storage Reliability at Pacific Northwest National Laboratory, and a test facility at Southern Research. The EAC is highly supportive of these programs because they could help address major potential barriers to the adoption of energy storage.

Valuation, Integration, and Education:

- DOE should continue its valuation and modeling work to ensure that the work remains useful across various market, operational, and planning regions. These valuation studies and modeling tools continue to be valuable to stakeholders in many parts of the country because energy storage deployment is at different levels in each of the 50 states. Some interviewees noted the benefits to understanding how to model better energy storage in market, operational, and planning settings.
- DOE should consider very forward-looking integration and valuation studies and how energy storage can support low-cost, reliable, and resilient electricity service. An illustrative example is examining the role of energy storage and the integration and control challenges of using energy storage for synthetic inertia in a future power system with very little or zero synchronous generation.
- DOE should consult with states and other stakeholders to gain a better understanding of their educational, data, and modeling needs and work toward tailoring energy storage-related RD&D activities accordingly.

Conclusion

The EAC, Subcommittee, and overwhelming majority of the interviewees find the DOE's goals for its energy storage activities to be appropriate. Moreover, DOE is making excellent progress toward meeting its goals. The recommendations that are provided here are intended to build further on these successes and achieve better alignment between energy storage-related RD&D and the needs of third-party users.

Appendix A: Representatives and Offices Involved in August 2018 EAC Webinar of Storage RD&D Activities

Name	Office
Imre Gyuk	Office of Electricity, Advanced Grid Research and Development
Ian Hamos	Office of Energy Efficiency and Renewable Energy
John S. Vetrano	Office of Science, Basic Energy Sciences
Paul Albertus	Advanced Research Projects Agency—Energy

Appendix B: EAC Members at DOE OE Energy Storage Peer Review 2018

Name	Affiliation
Flora Flygt	American Transmission Company (Ret.)
Lola Infante	Edison Electric Institute
Ramteen Sioshansi	The Ohio State University

Appendix C: In-Person Interviewees at DOE OE Energy Storage Peer Review 2018

Name	Affiliation	Stakeholder Type	Date
Curtis Ashton	CenturyLink, Inc.	End User	September 26, 2018
Brian Berland	ITN Energy Systems, Inc.	Energy Storage Developer	September 26, 2018
James Greenberger	NAATBatt International	Energy Storage Developer	September 26, 2018
Matthew Lazarewicz	Helix Power Corporation	Researcher	September 26, 2018
Haixiong Tang	Powdermet Inc.	Researcher	September 26, 2018

Appendix D: Telephone Interviewees

Name	Affiliation	Stakeholder Type	Date
Kristin Abbott	Public Utility Commission of Texas	State Regulator	March 29, 2019
Jan Ahlen	National Rural Electric Cooperative Association	Energy Storage Deployer	February 7, 2019
Mark Ahlstrom	NextEra Energy	Renewable Developer	February 26, 2019
Mark Brownstein	Environmental Defense Fund	Energy and Environment Think Tank or NGO	February 21, 2019
Jason Burwen	Energy Storage Association	Energy Storage Deployer	March 29, 2019
Danielle Byrnett, Tom Stanton, & Kiera Zitelman	National Association of Regulatory Utility Commissioners	State Regulator	February 25, 2019
Keith Casey, John Goodin, & Peter Klauer	California Independent System Operator Corporation	Independent System Operator	March 21, 2019
Howard Gugel & Brad Gordon	North American Electric Reliability Corporation	Energy and Environment Think Tanks or NGO	February 22, 2019
Udi Helman	Helman Analytics	Renewable Developer	February 27, 2019
Chuck Hookham	CMS Energy	Energy Storage Deployer	February 8, 2019
Mark Irwin	Southern California Edison	Energy Storage Deployer	February 1, 2019
Amanda Levin	Natural Resources Defense Council	Energy and Environment Think Tanks or NGO	February 20, 2019
Greg Rowland & Matthew Schultz	Duke Energy	Energy Storage Deployer	February 7, 2019
Kevin Vannoy	MISO	Independent System Operator	March 21, 2019

References

Electricity Advisory Committee. 2018. "A Review of Emerging Energy Storage Technologies." Approved June 25, 2018. https://www.energy.gov/oe/services/electricity-advisory-committee-eac/electricity-advisory-committee-reports-and-memos.