Developing a Flexible Platform to Improve the DOE Global Energy Storage Database

SAND2016-2115C

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***Abstract*—The U.S. Department of Energy (U.S. DOE) Global Energy Storage Database is a publicly accessible archive of electrical energy storage projects and policies. The information presented in the database is research-grade -- vetted by a third party. The GESDB represents a dynamic catalogue whose users provide up-to-date information. This tool presents an opportunity for a variety of stakeholders to become more engaged and to use data to help shape the next generation of electricity storage systems (ESS) researchers, investors, policy makers, and end-users. To make the leap requires a more flexible platform and better presentation of the technical content provided.**

***Index Terms*—Database, Energy Storage Database, ESS, Platform.**

I. Introduction

THE U.S. Department of Energy (DOE) Global Energy Storage Database began as an online service that provided free, up-to-date information about grid-connected energy storage projects and relevant state and federal energy storage policies. The information posted on the website is vetted through a third-party verification process. The chief objective of the site is to encourage greater research and development and deployment (RD&D) of energy storage technologies. All data on the GESDB can be exported to either Excel or PDF.

In March 2016, there were 49 energy storage technologies divided in five categories: electro-chemical, electro-mechanical, hydrogen storage, pumped hydro storage, and thermal storage. The resource lists operational projects in 57 countries for a total 145.9 GW of energy storage capacity.

The database employs P. Weill and S. Woerner's three components for optimizing a digital business model: relevant content, customer experience, and platform[1]. The GESDB offers a unique service to its users; however, the tool can become more useful by improving the data content and use of a more flexible platform. This paper will use the three elements of a digital business model to propose needed changes to create greater value and to better engage the technical user of the DOE GESDB.

II. CURRENT STATUS

Upon accessing the DOE GESDB site at http://www.energystorageexchange.org/, one finds the following: (a) the image of a global map with balloons pinned to specific locales, (b) two major options for searchable records – either storage projects or policies, (c) the menu: contact information, partners, glossary of terms, Digital Millennial Copyright Act, download disclosure, (d) newsletter sign-up option, and (e) social media options.

A. Navigating Current GESDB Content: Projects & Policies

Clicking on the global map balloons does not engage the site. One must choose from either "Projects" or "Policies" to advance into the site. Should the selection be for "Projects" option, then the next page is populated with a more detailed map that serves as a summary of projects around the globe, against the backdrop of a map. Filters are offered according to the table below.

Technology Type	Rated Power	Ownership Model
Country	Duration	Status
State/Province	Service/Use Case	Grid Integration

Table 1. Filters to Search Projects on the GESDB site

Selection of balloons after the opening page does render data about the name and size of the project, the country, the technology type, and operational status. Options exist to export data, perform an advanced search, to further filter the data, or add new projects.

When the selection is "Policies", then a 2011 map of North America and its Regional Transmission Organizations (RTOs) is the page default. There are two Canadian (Alberta Electric System Operator and Ontario Independent Electricity System Operator) and seven U.S. RTOs represented on the map: California ISO, ERCOT, SPP RTO, MISO, PJM Interconnection, NY ISO, and New England ISO. Currently only Texas' ERCOT has a list of state policies listed. If one selects a state or region where there is no RTO, then the search returns empty.

B. GESDB and its Unique Partnerships

The current list of partners are global in scope: (1) The California Energy Storage Alliance, a membership-based advocacy group made up of technology manufacturers, project developers, systems integrators, consulting firms, and others in the clean energy industry; (2) The China Energy Storage Alliance (CNESA), a not-for-profit member-based energy storage association in China, composed of ES technology developers, renewable energy manufacturers, venture

capitalists, and ES research institutions; (3) The India Energy Storage Alliance (IESA), whose stakeholders promote ES and micro grid technologies; (4) New York Battery and Energy Storage Technology (NY-BEST) Consortium, motivated by ES applications for transportation, grid storage, and power electronics; and (5) Strategen, a clean energy markets consulting firm.

The unique partnerships contribute to the more exclusive content for the database. Energy storage systems owners, developers are key players, providing dynamic data that is not available in this manner, at one website, in this easy to assess platform. The website developers track use of the services and users of the site, inclusive of pages viewed and length of time of views to gauge current data needs.

C. Technical and Legal Considerations

The GESDB offers a comprehensive glossary of the technical nomenclatures used for each of the filters and associated terminology. Where possible, an example of the term is also shared. As an example, for the ancillary service "black start", the broad description of a technical term like "performance" or legal references like "policy number", the website shares the following:

Term	Definition	Example
Black Start	A black start is the process of restoring a power station to operation without relying on the external electric power transmission network.	An energy storage system is used to re-start turbines of a generation facility after a large blackout causes generators to go offline.
Performance	Any performance statistics or results available on the project.	The system performed at a capacity factor of 90% during the year of 2010. Other examples of performance statistics include: - Round Trip Efficiency (RTE) - Ramping Rate - Greenhouse Gas Emissions - Noise (decibels) - Availability - Number of maintenance visits
Policy Number	The assigned tracking number for a given policy.	R. 11-09-011

Table 2. Example of GESDB Glossary of Terms

The database shares with users the legal terms of data use and reproduction along with its Digital Millennial Copyright Act (DMCA) and the applicable Download Disclosure Terms of Use Agreement.

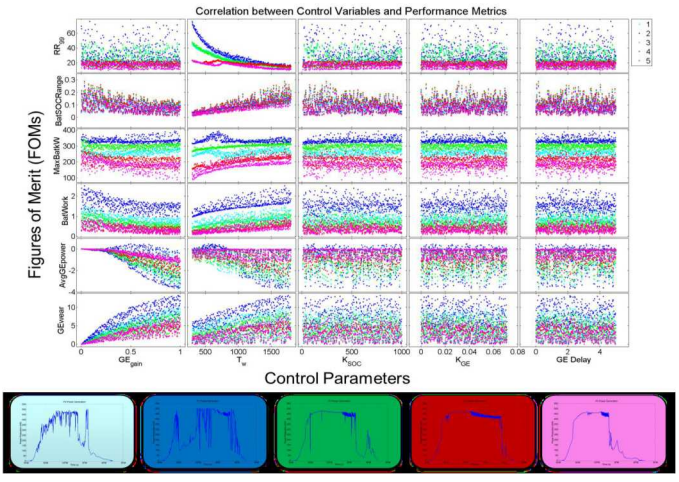
D. Project Data Type, Use, and Format

In 2009 the U.S. Department of Energy provided $185M in federal matching funds from the American Recovery and Reinvestment Act (ARRA) to support energy storage research and development projects in five categories: battery storage for utility load shifting, ancillary services, distributed storage for grid support, compressed air energy storage and promising storage technologies. The Public Service Company of New Mexico (PNM) won one of those grants for its Prosperity Project.

PNM completed research that used a 500kW (2.5MW) advanced lead-acid battery and a small gas engine-generator to develop a controller that mitigated power fluctuations for a photovoltaic (PV) system. In order to optimize control parameters, the experimenters used figures of merit (FOMs) to represent different design performance metrics and costs. For this simulation, the FOMs[2] were:

- AvgGEPower – The average gas engine-generator production on kW
- BatSOC Range – The range of battery capacity expressed as the difference between max and min SOC during simulation
- BatWork – Total work done by the battery during the simulation in GJ.
- GE_{Wear} – The amount GE adjustment during the simulation
- RR_{99} – The 99th percentile of the 1-minute ramp rate in kW/min for a given test period

The Latin Hypercube Sampling (LHS) process was used to develop an understanding of the control parameters on different FOMS. The PNM Prosperity Project results are depicted in Figure 1.



Fgure 1. LHS Results and FOMs for five days[3].

Other variables on the graphic include

GE – Gas Engine
T_W – Window of time for the controller moving average
K_{SOC} – Battery proportional control to return the batter to the reference SOC
K_{GE} – Gas engine-generator proportional control to return the GE to nominal power
GE_{Delay} – Gas engine-generator control signal delay
SOC – State of Charge

MaxBatkW – The maximum output power

The figure displays that some of the FOMs are profoundly influenced by the PV power output profile. Analysis of the simulations led the experimenter to observe and record specific benefits of using the coordinated control: less required battery capacity, smaller inverter size, less State of Charge (SOC) range utilization and reduced amp-hour throughput.[4]

The GESDB has access to the publicly available information from this and similar projects. In the next phase of data-sharing, the database project manager will need to make decisions about the type and format to present for the end user.

III. PLANNED IMPROVEMENT

The five immediate areas to improve the existing body of work provided by the GESDB are as follows:

1. Build out the policy section,
2. Work with an agency to expand the scope of the data,
3. Develop the platform to share applicable codes and standards for energy storage systems,
4. Improve data visualization and social media tools, and
5. Establish an advisory board.

The policy section will retain landmark decisions like FERC Orders and post up-to-date DOE policy mandates that affect energy storage. However, there is also the opportunity to include current docket information for state and regional jurisdictions in the United States. If there is something similar with other countries that implicate major changes in energy storage, then that data will also be posted.

A primary goal of the GESDB is that it provides accurate data for comparison and analysis by many different users. Strategen is teaming with Sandia National Laboratories to develop the inquiry construct with respect to energy storage projects at 1MW or greater to become part of the data collected by the U.S. Energy Information Agency (EIA). The EIA serves as the U.S. authority on energy statistics based on its comprehensive data collection program.

The science of energy storage is proven. However, the applications and technological advances are still emerging. The narrative about safety, industry codes and standards relate directly to the many varied applications of energy storage. The Sandia Labs and Strategen team members are working toward creating a tool within the database that can be a useful reference of codes, standards, and regulations for energy storage systems.

An advisory board of approximately 10-15 people is planned. The board would include partners from around the world, with Dr. Imre Gyuk of the U.S. DOE-OE taking the lead role. An agency, however, would be the U.S. representative on the panel. Lastly, a newsletter is planned to highlight new projects and new policy developments and to engage the broader community of GESDB users.

IV. CONCLUSION

The DOE GESDB is a unique tool that provides data for energy storage systems (ESS) users, researchers, and other stakeholders based on exclusive input from global partners. It can provide better value by improving its information about relevant energy policies, expanding the scope of its technical data, developing a platform to share ESS codes and standards, improving data visualization and establishing an advisory board.

ACKNOWLEDGEMENT

The authors thank Dr. Imre Gyuk and his colleagues at the United States Department of Energy, Office of Electricity Reliability and Delivery for funding the Global Energy Storage Database and making available data from ARRA-funded projects.

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administrator under contract DE-AC04-94-AL8500.

Strategen provides strategy consulting to global leaders creating profitable ventures in clean energy markets.

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