

# GRIDED

The Center for Grid Engineering Education

## **Introduction to Energy Storage Short Course Series**

### **Course Description**

This course was developed and offered by GridEd to address several evolving forces that will alter the fundamental operating characteristics of the electric grid, transforming it from a one-way central supply structure to one that has bidirectional, flexible power flows resulting from the integration of energy storage systems. The focus is on energy storage technologies and applications. Students will learn about the technical challenges facing the wider use of energy storage and what can be done to address those challenges. Additionally, considerations for energy storage project development and deployment will be discussed. This course is provided in a live-online environment and includes a 6-hour introduction to energy storage followed by three optional 2-hour deep dives on energy storage valuation, battery technology and performance, and safety.

### **Who Should Attend**

The course is intended for anyone interested in the energy storage technology landscape and understanding how energy storage can be used as an asset to maintain or improve grid reliability and operations. Students will include utility engineers and technicians, procurement officers, regulatory compliance staff, legal staff, and possibly regulators. Previous technical training is helpful but not necessary.

### **Short Course Information**

- **Introduction to Energy Storage (6 hours)**
  - **Deep Dive 1: Valuation Training (Optional 2-hours)**
  - **Deep Dive 2: Safety (Optional 2 hours)**
  - **Deep Dive 3: Battery Technology and Performance (Optional 2- hours)**
- PDH Available: \*12 Hours**
- \*Deep Dive PDHs only available if Introduction course is completed.**
- \*All PDHs require live attendance.**

### **Registration Fee: \$100/hr/person**

- 20% discount for organizations sending three or more staff
  - 25% discount for government workers (non-utility)
  - 25% discount for college professors\*
  - 75% discount for graduate students\*
- \*University ID required

### **EPRI Contacts:**

**EPRI Subject Matter Experts:** Ben Kaun, Erin Minear, Mike Simpson, Miles Evans, Dirk Long and Brittany Westlake.

**Coordinator:** Amy Feser, [afeser@epri.com](mailto:afeser@epri.com)

Participants will need access to an Ethernet broadband internet connection (wireless not recommended) from a standard desktop/laptop computer equipped with speakers, microphone and common web browser, i.e. Internet Explorer, FireFox, Google Chrome, etc. Students will join live, synchronous web conference sessions via WebEx, with two-way voice capability through a telephone bridge. Sessions will be recorded and posted for later viewing.

## Meet the Instructors



**Ben Kaun** currently manages the Energy Storage and Distributed Generation program at EPRI. He has 15 years of experience in the field of energy storage, power system modeling, and advanced battery development. His responsibilities cover the evaluation of new technology, techno-economic modeling, and the integration of energy storage projects into planning and operations. In prior roles at EPRI, Ben led the Energy Storage Integration Council (ESIC), which works collaboratively with industry participants to publish tools and guidelines to support energy storage deployments. Ben also spearheaded development of the publicly-available Storage Value Estimation Tool (StorageVET). Prior to EPRI, Ben worked with multiple companies to engineer and commercialize Li-ion battery technology. Ben earned a BS in Industrial & Enterprise Systems Engineering from the University of Illinois and an MS in Management Science & Engineering from Stanford.



**Erin Minear** is a Sr. Project Manager for the Energy Storage and Distributed Generation Program at the Electric Power Research Institute (EPRI). She manages projects related to the implementation of energy storage assets into the utility grid, including managing the Energy Storage Integration Council (ESIC). Erin has previous experience developing commercial and utility energy storage projects for an engineering, procurement, construction (EPC) firm and implementing microgrids and renewable energy projects. Erin is a registered Professional Engineer in the state of California and has a BS and MS in Electrical Engineering from California Polytechnic State University, San Luis Obispo.



**Mike Simpson**, Sr. Technical Leader at EPRI, leads projects in the Energy Storage and Distributed Generation program. Mike applies a multi-disciplinary background in energy R&D to produce studies that bolster the feasibility of energy storage integration for a more sustainable, more robust, and cost-effective utility grid. Prior to EPRI, he worked in renewable energy and energy efficiency with AES Distributed Energy, NREL, and Rocky Mountain Institute. He has a B.S. in Aerospace Engineering from the University of Colorado and an M.S. in System Design and Optimization from the Georgia Institute of Technology.



**Dr. Brittany Westlake** is a Technical Leader at EPRI. She leads projects related to understanding existing and emerging storage technologies and how they meet grid application needs across multiple grid sectors. Brittany also works on understanding end-of-life and recycling implications of batteries and energy storage systems to enable utility planning as they deploy these grid systems. Prior to joining EPRI, Dr. Westlake worked as a Science and Technology Policy Fellow at both the U.S. Department of Energy's Office of Electricity and the American Chemical Society. She holds a B.S. in Chemistry from the University of Georgia, and a M.S. and Ph.D. in Physical Chemistry from the University of North Carolina at Chapel Hill.



**Miles Evans** is an Engineer Scientist at the Electric Power Research Institute (EPRI). Miles received his MS in Civil and Environmental Engineering from Stanford in 2017 and a BS in Environmental and Ecological Engineering from Purdue University in 2015. At EPRI, Miles is involved in valuation, data analysis, and modeling efforts in the energy storage and distributed generation program. He works on simulating the operation of, valuing the effects of, and characterizing the real-world performance and reliability of energy storage systems. In addition to research in these areas, Miles is leading new energy storage modeling and valuation tool development, hoping to make state of the art analysis techniques accessible to a broader audience.

## Course Outline

### Introduction to Energy Storage (6 hours)

- I. Drivers and Big Picture
- II. Economics
  - Cost components and trends
  - Introduction to values and services
  - Bulk storage applications
  - Utility distribution applications
  - Customer-sited applications
  - Hybrid applications
- III. Technologies
  - Characteristics of energy storage
  - Overview of technologies
  - Technology readiness and validation
- IV. Implementation
  - Project lifecycle (planning, procurement, deployment, operations and maintenance, decommissioning)
  - Remaining challenges and research agenda

### Energy Storage Deep Dives (2 hours each)

- I. Deep Dive 1: Valuation Training
  - Modeling approaches
  - Overview of EPRI's Storage Value Estimation Tool (StorageVET)
  - Example case studies
  - Valuation sensitivity analysis
- II. Deep Dive 2: Safety
  - Hazards
  - Codes, standards, and regulations (CSR)
  - Risk analysis and mitigation
- III. Deep Dive 3: Battery Technology and Performance
  - Comparison of lithium ion chemistries
  - Emerging battery technologies
  - Integrated battery energy storage systems
  - Testing and evaluation
  - Performance guarantees