

# 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.

### Registration Information

#### Dates and Times:

- [Introduction to Energy Storage \(6 hours\)](#)  
August 23-24, 9:00 AM-12:30 PM PT
- [Deep Dive 1: Valuation Training \(2 hours\)](#)  
August 29, 9:30 AM - 11:45 AM PT
- [Deep Dive 2: Safety \(2 hours\)](#)  
August 30, 9:30 AM - 11:45 AM PT
- [Deep Dive 3: Battery Technology and Performance \(2 hours\)](#)  
August 31, 9:30 AM - 11:45 AM PT

**Course Length:** 12 Hours for all four courses

**\*Courses in this series can be taken combined or separately.**

Participants who attend the full course will receive a Certificate of Attendance with the appropriate number of Professional Development Hours for this course. Participants who attend the full course and pass an optional exam will be provided a Certificate of Completion.

**Registration Fee:** Introduction course is \$600 and deep dives are \$200 each

- 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  
\*Email Amy Feser to inquire on discounts: [afeser@epri.com](mailto:afeser@epri.com)

**Location:** Live on-line lecture

**EPRI Subject Matter Experts:** Erin Minear, Miles Evans, Ram Ravikumar, Lakshmi Srinivasan

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

Participants will need access to an internet connection 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.

## Meet the Instructors



**Erin Minear** is the Program Manager for the Energy Storage and Distributed Generation Program at the Electric Power Research Institute (EPRI). The research program focuses on the evaluation and demonstration of emerging technology, techno-economic analysis, and integration of storage into utility planning and operations. In previous roles at EPRI, Erin managed EPRI's Energy Storage Integration Council (ESIC) and led collaborative research projects focused on utility implementation of storage. Prior to joining EPRI, Erin developed commercial and utility storage projects for an engineering, procurement, construction (EPC) firm. She also has experience as a power systems engineer implementing reliability, renewable energy, and microgrid 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.



**Miles Evans** is an Senior Project Manager 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.



**Ram Ravikumar** is currently serving as a Technical Leader in the Energy Storage and Distributed Energy Resources Program at the Electric Power Research Institute (EPRI). Ram responsible for energy storage and distributed generation deployment, implementation, and valuation analysis and leads several government-funded energy storage projects. He is also involved in microgrid feasibility analysis and is one of the technical leads of DER-VET® (<https://www.der-vet.com/>). Ram graduated with a master's degree in Power Engineering from the University of Southern California and a bachelor's degree in Electrical Engineering from Anna University, India.



**Lakshmi Srinivasan** is a Sr. Technical Leader within the Energy Storage program at EPRI. She leads the battery safety research program developing new learnings and guidance for the industry. Lakshmi also does research in emerging storage and controls technologies, evaluating the performance and viability of new products. She aims to incorporate social equity and environmental justice into EPRI's storage research. She serves on technical panels for standards making bodies, such as IEEE and CSA. Prior to EPRI, Lakshmi spent ten years commercializing various storage technologies, including Compressed-Air Energy Storage, Lithium-ion batteries and flow batteries. Lakshmi earned a B.E. in Mechanical Engineering from Dartmouth College and a M.Sc in Energy Science and Technology from ETH Zurich.

## 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. **Project life-cycle** (planning, procurement, deployment, operations, and maintenance, decommissioning)
- V. **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