GRIDED
The Center for Grid Engineering Education

# 2022 GridEd Short Course Summary

GridEd's short course program seeks to train professional engineering staff on topics to prepare them to design and operate the grid of the future. Regular and sustained course offerings are derived from surveys and regular feedback from GridEd utility industry advisors. Courses are taught by EPRI experts, GridEd Partner university professors, and/or other university professors and industry experts with specialized knowledge in power systems engineering, distributed energy resources (DER), distributed generation (DG), and other related topics. To learn more about this project visit GridEd's website. To be added to the GridEd email distribution list email: GridEd@epri.com.

**Self-paced Courses:** GridEd's self-paced courses are available at no fee to tier II members of the supplemental project. Non-members can purchase courses. Courses are priced at $100/hour.

| Self-Paced Courses | | |
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| **Course Title** | **Description** | **Course Fee** |
| Strategic Planning with Business Capabilities<br><br>.50 Hours | This course for business capability modeling is a part of GREAT with Data. This course introduces Strategic Planning with Business Capabilities. Within this course you will be able to Strategic Planning with Business Capabilities by identifying the motivation for using Business Capabilities for Strategic Planning. An introduction to the strategy development process which will cover the following: determine scope, determine drivers, develop objectives, develop course of action, identify capabilities, and develop roadmaps. The roadmap development is the bulk of this training. | $50 |
| Business Capability Models and How to Create Them<br><br>1 Hour | This course will cover what is a Business Capability, what is a Business Capability Model (BCM), things to keep in mind before starting to create a BCM, how to develop and create a BCM, and options for creating a BCM. | $100 |

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| Introduction to Enterprise Architecture<br><br>.25 Hours | This course provides a brief overview of an introduction to Enterprise Architecture. If there were numbers or an order, then this would be the first training to take. Some of the topics that will be covered in this module are as follows: What is Enterprise Architecture (EA) in nontechnical terms, Enterprise Architecture Frameworks, and modeling languages, what is business architecture, what are Application and Technology Architectures and the connection to capabilities from Business, Application and Technology Layers. After this training you will have the introduction information that will enable you to consume and learn the other capability modeling training modules. If you are already familiar with Enterprise Architecture, this can be skipped. | $25 |
| Labeling Images for Machine Vision Applications<br><br>.50 Hours | This course is designed to provide fundamentals of how Image Labeling is performed. It includes topics on how images are collected and prepared for labeling and contains utility related examples that make use of various Image labeling techniques. It also covers various do's and don'ts of Image labeling along with some advanced topics that can help with accelerating the Image Labeling projects. This course is intended for professionals who wish to apply Image labeling knowledge at their own utility. | $50 |
| AI in the Electric Industry: An Introduction for Managers<br><br>4 hours | This course covers introduces artificial intelligence (AI) that aims to provide managers of AI projects with the basic core concepts in the area, enabling them to scope a project, identify suitable approaches and available resources, and understand how to assess results. Project management considerations that are specific to these types of projects are also discussed. | $400 |
| Basic Power Systems I & II<br><br>30 hours | This course is provided as an introductory course in electric power systems via The Center for Grid Engineering Education (GridEd) as a part of curriculum development under its U.S. DOE award from the Solar Energy Technology Office known as Grid Engineering for Accelerated Renewable Energy Deployment (GEARED) as well as conceptualized and funded in part by Electric Utilities comprising participants in an EPRI supplemental project "Educating Power Engineers for a Future Distribution Grid." | $0 |
| Cloud Security for Utilities<br><br>.75 hours | This training module provides an overview of cloud computing and an understanding of cloud service models and associated security challenges and recommendations. The aspects of cloud governance and responsibility for ensuring security in cloud environments have also been discussed. To better understand the security challenges associated with cloud computing, the discussion has been categorized based on the different cloud service models such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). The level of control varies as per the cloud service model. Utilities may leverage the information gained from this training module while making decisions regarding hosting services in the cloud. The security and information technology teams may benefit from this material while managing cloud-based utility services. This computer-based training module expects the audience to have prior knowledge of cybersecurity, software, and networking fundamentals. | $75 |

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| DER Cyber Security - Energy Storage Systems and EV Charging Infrastructure<br><br>1 hour | This course provides an overview of DER cybersecurity and in-depth understanding of DER architectures, risks, vulnerabilities, and security recommendations associated with them. Energy storage systems and electric vehicle charging infrastructure have been discussed in detail as use-cases for DER.<br>Hardware security aspects are discussed, providing a brief overview of challenges and hardware design recommendations. Lastly, Trusted Platform Modules (TPMs) are discussed at a high-level providing an understanding of TPM fundamentals, functions, and implementation. This CBT course expects the viewer to have some familiarity with cybersecurity and hardware security fundamentals but does not require any extensive prior knowledge on DERs. | $100 |
| Distributed Generation Technologies & Applications<br><br>11 hours | This course addresses the 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 power flows resulting from distributed energy resources (DER). Self-generating consumers will alter the design requirements for the electric distribution system. | $1,100 |
| Embedded System Penetration Testing<br><br>.75 hours | This course provides an overview of penetration testing with an emphasis on embedded systems. It is a high-level examination of penetration testing fundamentals, standards, methodologies, and tools and their applicability to systems in an OT environment. Only a basic understanding of cyber security is required. | $75 |
| Information and Communication Technologies for Distributed Energy Resources and Systems<br><br>7 hours | This course trains participants in understanding the fundamentals and applying the information and communication technologies (ICT) for distributed energy resources (DER) and systems such as demand response (DR), solar, energy storage, and electric vehicles. Electric utilities and grid operators across the world are looking at solutions for effective use and operation of the smart grid in the era of increasing deployments of DER technologies such as solar, energy storage, and flexible loads for demand response (DR). A vital element of the solution is to enable interoperable and cost-effective monitoring and control of these resources. | $700 |
| Insider Threat<br><br>1 hour | This hour-long course introduces insider threat and the associated technologies and data sources needed to build an insider threat program. The course also relates these concepts to an Integrated Security Operations Center (ISOC) and includes example use cases performed in the EPRI Cyber Security Research Lab.<br><br>Areas covered: Insiders and Insider Threats; How Insider Threat is different; Tools and technologies for an Insider Threat program; Data sources for Insider Threat program; Insider Threat detection examples; Objective Review. | $100 |

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| Introduction to Data Analytics<br><br>3 hours | This course is intended to provide foundational information and practical steps to increase someone's knowledge of data analytics. The course will provide sample data analytics use cases in the electric power industry, introduce data science techniques, and provide information on available resources for deeper learning. This course is intended to assist people with diverse backgrounds, interests and skills, from analysts to engineers to data scientists. | $0 |
| Introduction to Energy Storage Technologies<br><br>1 hour | This course was developed and offered by GridEd to provide an overview of energy storage technologies for electric power applications. Students will learn about the categories of energy storage and key technical characteristics that differentiate them. The course will walk through several commercially available energy storage technologies, describing how each technology works, its advantages and challenges, and other notable attributes. | $100 |
| Introduction to Energy Storage Use Cases and Economics<br><br>2 hours | This course was developed and offered by EPRI's GridEd project to provide an overview of energy storage use cases and economics. Students will learn about energy storage applications to support transmission, distribution, and customer needs. The course will also discuss value streams, cost, business models, and challenges and approaches for modeling and evaluating energy storage. | $100 |
| Introduction to Intrusion Detection Systems (IDS)<br><br>2 hours | This course provides utility cyber security personnel with an introduction to intrusion detection systems (IDS), including use cases for threat management planning, tips for installation and configuration, and the direction of IDS development. The course includes live examples of IDS in action from EPRI's Cyber Security Lab. | $200 |
| Introduction to Security Automation<br><br>1 hour | This hour-long course introduces security automation and the associated technologies, such as SOAR platforms. The course also relates these concepts to an Integrated Security Operations Center (ISOC) and includes example use cases performed in the EPRI Cyber Security Research Lab. Areas covered: What is security automation; IACD introduction and reference; ISOC and data sources; SOAR automation use cases. | $100 |
| Load Forecasting<br><br>3 hours | This course starts with a basic introduction to electric load forecasting covering its basic statistical properties and then builds up from traditional modeling techniques such as linear regression and autoregressive integrate moving average (ARIMA) models, to more modern approaches such as neural network models including recurrent neural networks and long short-term memory (LSTM) models. | $300 |
| OpenDSS Training<br><br>7 hours | OpenDSS is an electric power distribution system simulator (DSS) designed to support distributed energy resource (DER) grid integration and grid modernization. It enables engineers to perform complex analyses using a flexible, customizable, and easy to use platform intended specifically to meet current and future distribution system challenges and provides a foundation for understanding and integrating new technologies and resources. | $0 |

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| Position, Navigation, and Timing (PNT) Vulnerabilities and Mitigations<br><br>0.75 hours | This hour-long course provides an overview of the use of Position, Navigation, and Timing (PNT), the vulnerabilities that exist and potential impacts caused by exploitation, and mitigation technologies, methodologies, and frameworks for building system resiliency. This will include hypothetical and real-world examples and use cases. Some of the impacts have been tested and reproduced in both EPRI and member utility laboratory environments. There is no prerequisite knowledge expectation. | $75 |
| Utility Applications of Power Electronics<br><br>11.5 hours | This course addresses the 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 power flows resulting from distributed energy resources (DER). This course addresses aspects of interfacing various generation technologies with the utility grid through power electronics. This class identifies and serves to fill the gaps between common course offerings such as Power Electronics and Power Systems. The class covers steady state and dynamic aspects of grid interface, along with teaching about various industry standards that require compliance prior to interconnection with the power grid. Students will also learn about modeling grid tied inverters, which is a common building block to interface modern generation technologies with the utility grid. | $1,150 |
| Zero Trust Architectures for Utilities<br><br>1 hour | This provides an overview of Zero Trust (ZT) as a concept and as a network security architecture. This high-level look at Zero Trust Architecture (ZTA) explores the publicly available information Zero Trust and how it could be applicable to the operational technology environment. This will include some historical information about Zero Trust Architectures and hypothetical examples. There is no prerequisite knowledge expectation, though familiarity with networking may be beneficial. | $100 |

**Live-online & In-person Short Courses:** Tier I GridEd members receive 36 hours of course seats per year. Tier II members receive 180 seat hours. Non-members can also bulk purchase courses. View our Training and Activities supplemental for course discounts. Email Amy Feser, afeser@epril.com to inquire further.

| Live-online and In-person Short Courses | | |
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| **Course Title** | **Description** | **Course Fee** |
| Business Case Analysis in the Electric Utility Industry<br><br>12 hours | This course introduces participants to financial and economic principles and practices electric utilities employ to plan and operate power systems. Utilities are a business, but they operate under financial, commercial, and regulatory conditions that in many respects differ from those of competitive firms. Principal among them is their charter to provide universally least cost, reliable service, and operating under a regulated rate of return. Moreover, those circumstances differ among utilities depending on the market structure they operate in. | $1,200 |
| Cyber Security 101 – Practical Survival Tips for Navigating the Cyber Threat Landscape<br><br>12 hours | Critical infrastructure, governments, public institutions, and utility providers are under constant attack. New and emerging cyber threats have increased exponentially during the last decade and exploded during the COVID-19 pandemic as more industries became reliant on internet-based applications and remote workers. Currently, anyone who uses technology is at risk due to online fraudsters and hackers, targeting them at work, home, and on the road. Employees who understand cyber threats and can help safeguard their organizations from these risks, making themselves more valuable and in great demand.<br><br>This course is designed to introduce anyone who uses technology to the basic concepts of Cybersecurity. The goals of the course are to:<br><br>1. Increase participants' overall security awareness and ability to identify cyber-threats.<br>2. Provide practical tips and tricks to reduce cyber-threat exposure and to reduce the risk of attacks both in the workplace and at home.<br>3. Encourage participants to step into the role of a cyber-champion to promote cybersecurity best practices to others. | $1,200 |
| Cyber Security Operational Technology Equipment Familiarization Course<br><br>30 hours | Utility OT cyber security analysts must be familiar with the systems they are tasked to protect, which can be quite different than enterprise IT environments. This training course provides utility cyber security engineers, analysts, and managers with hands-on exercises and discussions for a variety of components commonly used to monitor and protect both power delivery systems and the networks that support grid operations. GridEd Utility Members receive a 50% course discount. | $30,000 |

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| Distributed Energy Resource (DER) Interconnection on Radial Distributions Systems<br><br>16 hours | This course addresses 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 power flows resulting from distributed energy resources (DER). This course includes discussion of key issues that arise when exporting inverter-interfaced DER are added to radial distribution systems and followed by exercises on specific issues. | $1,600 |
| Electric Power Distribution Systems<br><br>16 hours | This course is part of an educational library of short courses 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 power flows resulting from distributed energy resources (DER). Self-generating consumers or those with electric storage devices will alter the design requirements for the electric distribution system. This course focuses on electric power distribution systems and covers background and analysis of many modern distribution problems. | $1,600 |
| Electric Power Quality<br><br>12 hours | This short course relates to electric power quality, the characteristics of maintaining rated electrical parameters in a power system. The topics discussed are the main points that encompass this field in the world today including voltage sags, harmonics, momentary events, interference, and waveform distortion. These topics are studied in terms of definitions and theoretical bases; measurement and instrumentation; circuit analysis methods; standards; sources of problems; and alternative solutions. A special focus on power quality issues related to solar photovoltaic and wind energy resources is included. The impact of solid state switched loads is also described. An important objective of the short course is to acquaint the attendee with the most recent developments, issues and solutions in electric power quality engineering | $1,200 |
| Electric Transportation Fundamentals<br><br>10.5 hours | Beginning with an overview of the electric transportation space, this course will cover the basics of transportation electrification opportunities, vehicle technologies, charging technologies, and the benefits of electrified transportation technologies. Students will learn about integration of goods movement technologies and electric vehicles with the grid, reverse energy flow from electric vehicles and pertinent standards relative to the electric vehicle space. The course will introduce participants to methods being used to manage electric vehicle charging and to mitigate high power loads that have very low duty factors. | $1,200 |
| Energy Storage Deep Dive: Battery Technology and Performance<br><br>2 hours | This module will expand on the technology module, focusing on battery energy storage technology. It will examine the differences between lithium-ion chemistries, emerging battery technologies and their strengths and weaknesses, and what makes up an integrated battery energy storage system. This module will also provide an overview of EPRI's performance and reliability research on batteries.<br>Students will have a better understanding of battery technologies, specifically lithium ion. This information can feed in valuation modeling, specification, safety, and operations of lithium-ion systems. | $200 |

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| Energy Storage Deep Dive: Safety<br><br>2 hours | Safety is priority for all utility operations and energy storage technologies can present some unique hazard conditions. Battery energy storage systems have a risk of fire, thermal runaway, and explosion if not properly designed and operated. There are new and emerging codes and standards being developed to help ensure safety installation and operation. This module will present safety risks and mitigation strategies for energy storage systems. Students will learn about applicable codes and standards. It will also inform on aspects of safety that should be considered in specification, design, installation, and operation. | $200 |
| Energy Storage Deep Dive: Valuation Training<br><br>2 hours | This module provides training on energy storage valuation. It will review modeling approaches and demonstrate EPRI's Storage Valuation Estimation Tool (StorageVET®). The training will walk through example case studies and show how sensitivities can impact valuation results.<br>Students will learn how to use StorageVET to perform cost-benefit analysis and how to interpret analysis results. | $200 |
| Integrated Energy Regulation and Sustainability<br><br>12 Hours | This course integrates business neutral, regulation agnostic and technically integrated knowledge in three domains for common understanding by the non-lawyer, non-regulator, nonvendor, non-engineer, non-businessperson to gain full appreciation of diversities and synergies overlapping our shared electric energy enterprise: (1) energy regulation and sustainability, (2) grid-resilient technology inclusive of physical and digital coupled with services, and (3) traditional and reformed business structures. | $1200 |
| Introduction to Energy Storage<br><br>6 hours | 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. | $600 |
| Machine Learning and Big Data Analytics in Smart Grid<br><br>12 hours | The course focuses on big data analytics and machine learning in smart grid. The value, velocity, volume, and variety of big data in smart grid will be discussed. The course will also review the basics of unsupervised learning, supervised learning, reinforcement learning algorithms, and generative models. Important applications of big data analytics and machine learning in electric power distribution systems, transmission networks, and electricity markets will be presented with real-world data set. The applications covered in the short course includes:<br><br>Distribution Systems: 1) Topology identification, 2) Electricity theft detection, 3) Predictive maintenance of distribution equipment, 4) Estimation of behind-the-meter solar generation, 5) Reinforcement learning based control. Transmission System: 1) Anomaly detection with PMU data, 2) Motifs and signatures discovery with PMU data, 3) Event classification with PMU data. Electricity Market: 1) Algorithmic trading with virtual bids in electricity market. | $1,200 |
| Machine Vision in the Electric Industry – A | This course is one in a series of several courses developed and offered through GridEd to help workforce readiness through training and education of personnel with needed skill sets to design and develop Machine learning and Deep learning | $2,000 |

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| Hands-On Training for Practitioners<br><br>20 hours | systems for the power utility industry. This 20 Hour course focuses on some key aspects of Machine Vision development that utility Computer Vision engineers deal with in their everyday jobs. This includes remedying various data related issues and model development challenges. Further, assessment of Computer Vision models using relevant metrics will be discussed. The applications discussed in the course relate to Visual Inspection of Assets in the Transmission sector, concepts of which can be easily extended to various sectors. Some key problem statements covered in the course are as follows: 1. Insulator make will be classified using Image Classification (Model development and assessment) 2. Insulator defect detection will be conducted using Object Detection (Model development and assessment). | |
| Operations Simulator Training<br><br>16 hours | This course will introduce students to many of the foundational concepts associated with operating the distribution system. This course is designed for individuals considering a career in distribution operations. For this instance of the course, new hires in a distribution control center are encouraged to attend and to provide feedback on the course content. Topics included in this course are basic electricity, distribution equipment, distributed energy resources, outage management systems, advanced metering infrastructures, basic protection, fault isolation and service restoration, reliability indices, outage cause codes, basic distribution SCADA and operation of a SCADA simulation. | $1,600 |
| Training on PV and Energy Storage Technology Testing Evaluation<br><br>24 Hours | This 3-day course focuses on Photovoltaic (PV), Energy Storage (ES) and hybrid inverter system technology performance evaluation testing. Hands-on training will be given on configuration, operation, commissioning, and performance evaluation testing of smart inverters. Participants will also be exposed to installation practices, DER plant design with inverter choices, National Electric Code (NEC) code requirements, interconnection standards, and safety.<br><br>The topics covered in the short course includes:<br>Inverter Technologies •Circuit Topologies •Maximum Power Point Tracking •Islanding Detection •Real and Reactive Power Control •Grid Support Functions •Voltage and frequency ride through •Harmonics<br><br>Laboratory Systems •Grid, PV, and ES Simulators •Active and Passive Load Banks • Data Recording •Power Quality Meters •Current Transformers and Shunts •Test Setup Design •Laboratory Safety •National Electric Code Application<br><br>Steady State and Dynamic Performance Evaluations •Abnormal Voltage and Frequency •Fault Ride-Through •Dynamic Voltage Support •Smart Inverter Function Testing •Energy Storage Inverter Testing •Inverter Commissioning •Post-processing and Data Analysis | $2400 |

## Courses in Development

| Course Title | Description | Expected |
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| Machine Learning Applications for | This course is one in a series of several courses developed and offered through GridEd to help workforce readiness through training and education of personnel with needed skill sets to design and develop Machine learning and Deep learning | Q4 2023 |

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| PMU Data- a Hands-on Training for Practitioners<br><br>22 hours | systems for the power utility industry. This 22-hour course focuses on machine learning applications using phasor measurement unit (PMU) data in power transmission systems. This course mainly covers the applications of power system event detection and classification using PMU data. The attendees will learn how to detect power system events without a large amount of labels and how to classify power system events with supervised machine learning algorithms. | |
| Machine Learning Applications for Smart Meter Data – a Hands-On Training for Practitioners<br><br>22 hours | This course is one in a series of several courses developed and offered through GridEd to help workforce readiness through training and education of personnel with needed skill sets to design and develop Machine learning and Deep learning systems for the power utility industry. This 22-hour course focuses on machine learning applications using smart meter data in power distribution systems. This course mainly covers the applications of phase connectivity identification and state estimation in power distribution systems. The applications of both unsupervised and supervised machine learning algorithms will be covered via hands-on training and homework questions. | Q2 2023 |
| Machine Learning Applications for Time Series Data in Power Systems – a Hands-on Training for Practitioners<br><br>22 hours | This course is one in a series of several courses developed and offered through GridEd to help workforce readiness through training and education of personnel with needed skill sets to design and develop Machine learning and Deep learning systems for the power utility industry. This 22 Hour course focuses on machine learning applications for time series data in power systems. The attendees will be taught how to preprocess time series data and train machine learning models using time series data in power systems. This course mainly covers the applications of deep neural networks to model time series data. The application discussed in the course include electric load forecasting using deep neural network. The training, tuning, and forecasting using the deep neural network model will be covered. The students will learn how to program in Python and leverage state-of-the-art machine learning packages. | Q4 2023 |