EPRI | ELECTRIC POWER RESEARCH INSTITUTE

GridEd

The Center for Grid Engineering Education

Distributed Energy Resource (DER) Interconnection on Radial Distribution Systems

Course Description

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). 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. Key topics include:

- Typical radial distribution design
- Voltage rise/drop due to DER
- Primary and secondary voltage regulation
- Smart Inverter functions and settings modeling for voltage regulation
- Fundamentals of hosting capacity
- Grounding and fundamental frequency temporary overvoltage (TOV)
- Fault performance and protection
- Emerging DER management schemes
- Key integration considerations

This course includes three design case studies based on the open source software OpenDSS. An OpenDSS tutorial will be provided as part of this course and no previous experience with this software is needed. The case studies include material on Smart Inverter capability and the traditional methods for identifying DG penetration level limitations. This course is being offered in a web-based format with 8 sessions (90-minutes each) scheduled over a 4-week period.

Who Should Attend

This course is intended for distribution engineers and DER design engineers with a background in electrical engineering.

Students should have some familiarity with distribution systems and equipment.

PDH Available: 12 Hours

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

To inquire further on course discounts, please reach out to Amy Feser, afeser@epri.com.

Location: Online - Live sessions will be recorded and available following the live web conference.

EPRI Contacts:

Devin Van Zandt, dvanzandt@epri.com, 518-281-4341

Amy Feser, afeser@epri.com, 865-218-5909

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

Devin Van Zandt is a Senior Technical Executive currently leading EPRI's efforts related to assessing the grid impacts of Distribution Energy Resources (DER). His primary research involves developing modeling methods and guidelines for evaluating distribution system connected resources. Prior to joining EPRI in June 2018, Mr. Van Zandt spent 28 years in a variety of roles and, most recently, leading a team of power systems and software engineers developing commercial planning software tools – GE PSLF, GE MAPS, and GE MARS. Mr. Van Zandt holds a BS in Electrical Engineering from Cornell University, and an MS in Electric Power Engineering from RPI

Tom Ortmeyer is Professor of Electrical and Computer Engineering at Clarkson University. At Clarkson, he teaches courses in the areas of electric machinery, power systems, protection, and power quality. Ortmeyer began his career at Commonwealth Edison Company, where he was a member of the Operations Analysis Department. While on the Clarkson faculty, he has held short term appointments or fellowships at NASA, US Air Force, Kumamoto University, University of Canterbury, and EPRI. At Clarkson, he was the founding director of the Alcoa Experiential Learning Program and is currently involved in collaborative research projects with New York State Energy Research and Development Authority, Department of Energy, National Grid and others. Ortmeyer is a fellow of IEEE based on his work on the modeling and analysis of power system harmonics. He received his Bachelor's, Master's and Ph.D. degrees in electrical engineering from Iowa State University.

Tom Key is a Senior Technical Executive at EPRI. He has over 30 years' experience in technical direction, planning and management of energy related R&D in the US Navy, at Sandia National Laboratory in Albuquerque, and at EPRI. He has specific expertise in electric power systems, energy storage, renewable technologies, power quality, and related power electronics and system integration. He is a Fellow of the IEEE and a nationally recognized leader in power system compatibility research, integration of distributed and renewable energy resources, application energy storage and power electronic technologies. He is currently leading EPRI activities in the area of integration of renewable energy into the electric grid.

Brian Deaver is a Senior Technical Executive at EPRI. He has worked in the electric distribution industry for over 30 years and is a Senior Member of IEEE. Brian leads EPRI's research portfolio regarding Distribution Operations. This research covers a wide range of applications including Distribution Automation, Automated Service Restoration, Volt/VAR Control, Distribution Management Systems, Fault Location and Switching. Additionally, Brian is moderator of EPRI's

Distribution Operations Interest Group which provides control center managers and staff the opportunity to discuss and share experiences related to the critical issues surrounding deployment, operation, maintenance and training on key control center technologies and processes.

Course Outline

Session 1 – Radial Distribution System Basics

- Typical medium and low voltage system designs
- Voltage regulation with capacitors, voltage regulators, and load tap changers (LTC)
- Introduction to voltage regulation analysis using OpenDSS

Session 2 – PV and Inverter Basics

- PV Array and output variation
- Maximum Power Point Tracking
- Modern inverter characteristics and capability
- Case Study 1: (assigned in Session 2, due in Session 3)

Session 3 – Smart Inverter functions and settings modeling for voltage regulation

- Discussion of Case Study 1
- IEEE 1547-2018 overview
- Advanced DER functions and settings
- DER reactive power control and system voltage regulation

Session 4 – Introduction of Hosting Capacity

- Common approaches to calculating Hosting Capacity
- Demonstration of the EPRI Distribution Resource Integrated Value and Estimation (DRIVETM) tool
- Case Study 2: (assigned in Session 4 and due in Session 5)

Session 5 – Emerging DER Management

- Discussion of Case Study 2
- Distributed Energy Resource Management Systems (DERMS)
- Flexible Interconnection Solutions (FICS)
- Voltage and thermal constraint management
- Example modeling case studies

Session 6 – Effective grounding and Temporary Overvoltage (TOV)

- Overview of DER behavior during abnormal system conditions
- Need for effective grounding
- Interconnection transformer connections, neutral-grid reactance
- OpenDSS fault Studies
- Case Study 3: (assigned in session 6, due in session 7)

Session 7 – Distribution Automation

- Discussion of Case Study 3
- Basics of Distribution Automation / Automated Restoration
- Impacts of DER on Distribution Automation
- Mitigations for DER Impacts

Session 8 – DER Application Special Topics

- Unintentional Islanding, Direct Transfer Trip, Protection Coordination, Battery Energy Storage Ride-through, Long Term Planning, Etc.

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