EPRI

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 a discussion of key issues that arise when DER are added to radial distribution systems and includes 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)
- DER and distribution automation
- Emerging DER management schemes
- Key integration considerations

This course includes several case studies based on the open source software OpenDSS. Access to an OpenDSS tutorial will be provided as part of this course and no previous experience with this software is needed. This course is being offered in a web-based format with 8 sessions (120-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.

Schedule: Eight sessions from 2:30- 4:30 p.m. ET for four weeks

PDH Available: 16 Hours

Registration Fee: $1600/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

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

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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. Sessions will be recorded and posted for later viewing. Recordings will be available for 30 days after the course ends.

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 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.

Stephen Kerr is a Technical Leader at EPRI on the DER Grid Impacts Analysis team. In this role, he performs and guides distribution feeder analysis to understand the technical implications of autonomous and managed DER. This includes grid impacts from the perspective of hourly load shape changes, advanced inverter capabilities, and potential behaviors from specialized operating schemes like DERMS and voltage optimization. Previous to joining EPRI, Stephen worked for ten years at Arizona Public Service, where he supported distribution operations and planning efforts to maintain, forecast, and upgrade the feeder distribution system. Stephen has a BS in Electrical Engineering from Arizona State University, and is a licensed Professional Engineer.

Dr. Aminul Huque is a Principal Project Manager at EPRI. His research focus includes smart-inverters, interconnection standards, PV, energy storage (ES), and load integration. He leads multiple DER research, development, and demonstration projects to investigate benefits and challenges of smart inverters and integration DER. Aminul received a PHD from the University of Tennessee at Knoxville, an MSc from the Imperial College London, and a BSc from the Bangladesh University of Engineering Technology in 2010, 2003, and 2001, respectively.

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
- Case Study 1: (assigned in Session 1, due in Session 3)

Session 2 – DER Basics

- PV Array and output variation
- Maximum Point Point Tracking
- Modern inverter characteristics and capabilities

Session 3 – Application of Active and Reactive Power Functions

- Discussion of Case Study 1
- IEEE 1547-2018 overview
- Advanced DER functions and settings
- DER reactive power control and system voltage regulation
- Case Study 2: (assigned in Session 3, due in Session 5)

Session 4 – DER Interconnection Considerations

- Need for effective grounding
- DER behavior during abnormal system conditions (islanding, protection)
- Interconnection transformer connections, neutral-grid reactance

Session 5 – Introduction of Hosting Capacity

- Discussion of Case Study 2
- Common approaches to calculating hosting capacity
- Demonstration of the EPRI Distribution Resource Integrated Value and Estimation (DRIVETM) Tool
- Case Study 3: (assigned in Session 5, due in Session 7)

Session 6 – Emerging DER Management

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

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
- Case Study 4: (assigned in Session 7, due in Session 8)

Session 8 – DER Application Special Topics

- Discussion of Case Study 4
- Unintentional Islanding, Direct Transfer Trip, Protection Coordination, Battery Energy Storage Ride-through, Long Term Planning, etc.

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