Interconnection of Distributed Generation & Storage to Power Systems Training Course (2019 & 2020)

DESCRIPTION

Distributed generation (DG) and distributed energy storage are playing an increasing role on the power system. This trend is accelerating as photovoltaic (PV) sources emerge as a leading option for DG. The number of PV interconnections has become so significant that changes in utility operating practices and approaches are needed. Other forms of distributed generation such as advanced internal combustion engines, combustion turbines, microturbines, and fuel cells are also seeing expanded markets as a result of lower natural gas prices and technological advances of these devices. Distributed energy storage technologies such as lithium ion batteries, while roughly 10 years behind PV on the market development curve, have recently reached a critical cost/performance threshold where they too are now strongly growing for energy management and grid support applications.

The interconnection of DG or energy storage devices of any type in sufficient quantity can bring complications since the power system was not originally designed for generation resources to be located at the power distribution level. While DG can offer potential system benefits, there can be problems that might impact safety, reliability and power quality. Issues related to voltage regulation, voltage flicker, over-current protection, unintentional islanding, temporary/transient overvoltage, stability, harmonics, and other factors can occur. Utility engineers, planners, regulators and DG developers must understand the matrix of issues and risks associated with DG interconnection and utilize interconnection strategies that will maintain safety, reliability and power quality.

This course provides the background to understand the issues that are faced when interconnecting DG to the power system. The course discusses the analytical methods for screening and assessing problems, the technical standards which apply to interconnection and it gives practical examples of interconnection approaches and field proven solutions to various problems. It covers the key types of DG now being deployed as well as applications of the new emerging distributed energy storage devices. Engineers, planners, regulators and developers involved in power system DG integration decisions can benefit strongly from this course. They will gain an understanding of the strategies/methods to deal with DG interconnection projects.

COURSE OUTLINE

The course is available as a **standard two-day format** presented at the client site. In addition, customized courses of longer or shorter duration and/or with tailored topics can also be arranged based on client needs. For the standard course, each day of instruction typically starts at 8:00 AM and finishes at about 4:30 PM with a one hour break for lunch and short 10 minute break in the middle of the morning and afternoon session. Start and stop times can also be customized upon client request. The general content of a standard two-day course with approximate time devoted to each topic is as follows:

- **Course Introduction and Overview** (1/2 hour on first day)

- **DG and Distributed Storage Technology Review** (2.5 hours on first day)
  (This section is a review of the theory, technical status & characteristics of DG devices. Includes ICE Engines, combustion turbines, small steam turbines, fuel cells, photovoltaic sources, wind turbines, thermal-electric generators, micro hydro electric power, energy storage devices)

- **Power converters** (1 hour on first day)
  (Power converters play a large role in defining the behavior DG connected to the power system. This

section explains the different types of converters used and the key characteristics that define their behavior. Inverters, induction machines, and synchronous machines are covered.

- **Power Grid Impacts, Screening and Analysis of DG** (3 hours day 1 and 4 hours day 2)
  (Topics include voltage regulation interactions, voltage flicker issues, fault levels & interactions with feeder over-current devices, neutral grounding design [effective grounding] and transformer configuration selection, temporary overvoltage during ground faults, generator load rejection overvoltage, unintentional islanding impacts, harmonics, ferroresonance, and stability. These concepts are discussed as they apply to DG connected on radial, looped and network distribution systems. Subtransmission level impacts are also discussed. Screening methods for indentifying troublesome system impacts are also discussed as well as successful methods for mitigating problems.

- **DG Interconnection Standards, Practices and Solutions** (2 hours on second day)
  Areas discussed include:
  - *Typical interconnection design layouts for DG systems (sample diagrams)*
  - *IEEE 1547, UL1741 and other standards*
  - *Review of state level interconnection requirements*
  - *Review of federal level requirements*
  - *Discussions of relay functions and settings suitable for overcurrent protection, abnormal voltage range settings, frequency limits, unbalance protection, reverse power, motoring protection, etc.*
  - *Discussion of anti-islanding protection relays, settings and methods including the various passive and active methods as well as DTT and other forms.*

- **DG Future Integration Issues and Technology Concepts** (1 hour on second day)
  This section reviews concepts and technology trends and that can be useful in helping the system deal with higher penetrations of DG on the system. Topics discussed include:
  - *Evolution of the grid design and future grid compatibility with DG*
  - *Smart grid role in the future of DG*
  - *Distributed energy storage role in high penetration DG applications*
  - *Emerging DG control and power conditioning technology trends that will impact integration*
  - *T&D support concepts with DG*
  - *Microgrids, DC grids, emerging off-grid applications*

- **Summary and Wrap-up Session** (15 minutes on second day)

To encourage student interaction, in-class problem solving sessions, and interactive question/answer exchanges are utilized to enhance the instructional experience.

TARGET AUDIENCE AND PREREQUISITES

This course is directed at electric power engineers, system planners, utility regulators, and DG developers which wish to learn about or enhance their background knowledge in the area of distributed generation interconnection. An electrical engineering background and knowledge in three-phase power and power distributions systems is recommended but not required.

PRICING

Courses are presented at client sites typically to class sizes between 5 and 50 persons, although larger classes are occasionally requested. Prices in 2019 and 2020 are as follows:

Standard 2-day DG Course: Pricing for a 2-day Standard DG Course at Client Office Locations within the U.S for class sizes up to 10 students is generally $14,800. An additional fee of $400 is included for *each* student beyond 10. Prices shown here assume that the client provides a suitable classroom with projector at client expense. Prices include instructor T&L cost and one copy of the course handouts for each student participant. The PowerPoint notes for this class will come in a *three ring binder*. The notes are printed in black & white format with tabs for each section and an

appendix of papers, etc. The notes are also provided in PDF file format on a CD for each student. Please contact Nova Energy Specialists for a specific price quotation.

Customized DG Courses: For customized courses with content significantly different than the standard course or with longer or shorter duration (such as 1 day or 3 day formats), please contact Nova Energy Specialists for specific price quotations for those options.

INSTRUCTOR

The course instructor is Phil Barker. Mr. Barker has worked in the electric power industry for over asteroid--Psyche 130 years. He has developed and taught extensive training courses at numerous utilities and has trained over 1500 utility professionals in topics related to power distribution, lightning protection, power quality, and distributed generation. Over his career he has performed some of the industry's leading analytical and field studies related to power quality, lightning protection and distributed generation (see a detailed biography at www.novaenergyspecialists.com for more information). He worked as a consulting engineer at *Power Technologies, Incorporated (PTI)* for 14 years, developed and led a branch engineering office for *EPRI PEAC Corporation* in Schenectady, NY from 2000 to 2003, and in 2003 he founded *Nova Energy Specialists, LLC* a firm involved heavily in DG integration and interconnection studies for utilities. He has contributed to several IEEE working groups and standards related to DG, lightning, power quality and power systems (e.g. IEEE 1547, IEEE C62.22, IEEE 1410, etc.) In 2010, he received the IEEE Award for Excellence in Power Distribution Engineering. Mr. Barker has published 30 papers. He received his Bachelors and Masters Degree in Electrical Engineering from Clarkson University in 1985 and 86 respectively.

SOME OF NOVA'S OTHER COURSES

Nova also offers several other courses. Please contact us for more information on the following:

- Electric Power Distribution Systems (4 or 5 day courses available)
- Lightning Protection of Power Systems (1 and 2 day courses available)
- Power Quality and Reliability (1 day)
- Application of Emerging Energy Technologies to Power Systems (1 and 2 day courses available)

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