BOOST
THE LEADING TRAINING PROVIDER

Electrical Engineering

Integration of Solar and Wind into a Smart Grid

Course Introduction

This course introduces the building blocks for the modern power system with increased penetration of renewable resources. The electric power system is undergoing changes due to short-, mid-, and long term business objectives. In the same time, it has become increasingly necessary to leverage the changes brought by the new technologies in renewable resources and power electronics and balance these with the ever changing consumer expectations.

The operating flexibility

The course presents the integration of solar power in light of regulatory changes and the penetration of large solar energy resources facilitated by the operating flexibility brought by power electronics. The unique characteristics of solar projects are discussed from a local, consumer centric and also from a system perspective bringing to life the ever changing paradigm for delivery energy to customers. Interoperability aspects and standards are discussed, as well as the consumer centric paradigm of Transactive Energy.

The course presents the technical challenges associated with interconnecting and integrating hundreds of gigawatts of solar power onto the electricity grid, safely and reliably. It introduces state of the art methodologies in forecasting solar power along with case studies from the international community.

The flexibility of the invertor-based resources facilitates higher penetrations of PVs, storage, and demand response and co-optimizes customer resources. The course describes how the microgrids' controllers allow fully automated energy management.

The course gives a broad overview of the power systems fundamentals, new grid requirements, and the increased impact of renewable resources on the operation and planning of the power system. It provides the necessary tools to understand the short and long term reliability assessments and the processes undertaken to evaluate long term adequacy requirements. The system automation is increasingly sophisticated with advanced information technology and digital controls leading to a

network that not only benefits from with self-healing elements but then again it facilitate new business models for all classes of customers.

Target Audience

- Power system protection engineers
- System planners
- Technical staff responsible for Smart Grid integration into power system monitoring and control

Learning Objectives

- Solar energy and the integration into the modern power grid, discussed from the perspective of power system operation and financial cost structures
- Types of Solar Systems from Grid connected to Off Grid
- The power system stability in the context of solar projects
- Smart Grids and Interoperability
- Power system operation, operating requirements imbedded in a deregulated energy market

Course Outline

- **DAY 01**

  The Historical Evolution of the Electrical Power Systems

  - Structure of Power Systems
  - Evolution from Economy of scale to Energy Markets

TRANSMISSION OF ELECTRICAL POWER

- Concepts of Active Power
- Concepts of Reactive Power
- Power Capacitors
- FACTS and power electronic applications to AC transmission Harmonics and power quality

POWER SYSTEM Stability

- Control of Active Power and Frequency
- Control of Reactive Power and Voltage
- Power System Stability
- Basic Concepts, Definitions and Classification of Power System Stability
- A Stable and Secure Operation of Power Systems in the context of a Market
- Examples of major Disturbances

SOLAR POWER & TYPES OF SYSTEMS

- Grid connected Solar Resources
- Microgrid Solar Resources
- Off the grid Solar Resources
- Commercial/ Residential and Utility scale

• **Day 02**

SOLAR POWER TECHNOLOGIES: Concentrated Solar Power and Photovoltaic Projects

- Concentrated Solar Power Technologies
- Parabolic trough, power tower, and dish Sterling engine systems
- Photovoltaic Solar Power

STORAGE PLANT COMBINATION with SOLAR

- Residential Solar-Storage
- Smart Home Energy Management
- Utility scale: Storage Plant combinations
- Industrial energy storage devices with inherent power storage and solar conversion capacity

VARIABILITY IN ENERGY OUTPUT

- Short Term variability of a Photovoltaic Resource
- Solar Energy Forecast
- Impacts on Load Forecasting
- Maximum Power Output (MPPT)
- Case Study #1: THE ORANGE BUTTON

• **Day 03**

The Performance of Inverter based Resources and the Power System Controls

- DISTRIBUTED ENERGY RESOURCES
- Voltage and Frequency Control
- Synthetic Inertia
- Inverter capabilities
- Control Algorithms
- Regulatory Agreements NERC, EU ENTSO
- Control Operator-ISO, Dispatcher
- Power System Control Actions
- Reliability Role, Adequacy, Security limits, Operating States
- Voltage Reduction, Load Shedding
- Abnormal frequency, restoration plan

SYSTEM OPERATION with INCREASED INVERTER BASED RESOURCES

- Flexibility in Operation from Inverter Based Resources
- Types of Reserves: Contingency Reserves, Regulating Reserves, Following Reserves
- Ancillary products: AGC, Voltage and Var Regulation
- Frequency and Voltage Ride Through

- Case Study #2: NREL IEEE 1547 and 2030 Standards for Distributed Energy Resources Interconnection and Interoperability with the Electricity Grid Dec 2014
- Case Study #3: NREL Demonstration of Essential Reliability Services by a 300-MW Solar Photovoltaic Power Plant in California, 2017

HIGH PENETRATION OF RENEWABLE RESOURCES

- Study Case: Achieving a 100% Renewable Grid
- Inverter Dominated Grid
- Power System Stability in an Inverter dominated Grid
- Frequency and Voltage Regulation

LOAD MANAGEMENT in a SYSTEM with DISTRIBUTED RESOURCES

- Demand Response
- Demand Side Management
- Weather Normal Forecast

• **Day 04**

FINANCIAL MODELS of SOLAR and WIND PROJECTS

- Avoided capacity cost
- Cost recovery mechanisms
- Financial planning and budgeting
- Cost and Life Cycle
- Adjustment Energy Cost: Global Energy Charges
- Feed in Tariffs
- Case Study #4: NREL U.S. Solar Photovoltaic System Cost Benchmark 2017

COST ANALYSIS OF

- Renewable Generation
- Wind Power
- Solar Power
- Levelized Cost of Electricity-LCOE

POWER SYSTEM OPERATION with RENEWABLE RESOURCES

- Power System Operations
- Power system dynamic modeling: components and systems
- Power system stability: phenomena, analysis, and techniques
- Energy control centers
- Distribution operation
- System control
- Operating economics and pricing

The DISTRIBUTION COMPANY of THE FUTURE

- Communication Requirements
- Optimal Configuration
- Electrical Substations/ Digital Substations
- Relief to Distribution Utilities
- Systems Interface Architecture
- Plug-In Electric Vehicle Charging Infrastructure
- SMART METER INFRASTRUCTURE: Roadmap and Architecture
- Controllers for Local Energy Networks
- Residential Energy Management Systems
- Big Data

Confirmed Sessions

FROM	TO	DURATION	FEES	LOCATION
Dec. 14, 2025	Dec. 18, 2025	5 days	4250.00 $	Qatar - El Doha
May 11, 2025	May 15, 2025	5 days	4250.00 $	KSA - Riyadh
July 14, 2025	July 18, 2025	5 days	4250.00 $	UAE - Dubai
Nov. 23, 2025	Nov. 27, 2025	5 days	4250.00 $	Oman - Muscat