



## Impact of Renewable Energy Sources



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## Introduction:

The increased penetration of renewable energy sources constitutes one of the most important aspects of power generation systems due to the respective economic benefits that may occur and the appropriate environmental constraints. This fact results in a continuously increased rate of investments concerning appropriate generation facilities in many power generation facilities worldwide. An increased penetration level of renewable energy sources is expected to be achieved. However, it may affect the secure operation of the entire power system and the reliable supply of electric energy to the customers due to the uncertainty of weather conditions that constitute the main operational features of the respective generating plants. The objective of the training course is to describe the concepts and features of computational methodologies that can be used for assessing the reliability and operational performance of power generation systems with an increased penetration level of renewable energy installations

## Targeted Groups:

- Professionals of electric power utilities, system operators Independent System Operators - ISOs, Regional Transmission Operators - RTOs, Transmission System Operators - TSOs
- Professionals of regulation authorities
- Professionals of companies involved in projects concerning renewable energy installations
- Power system consultants

## Course Objectives:

At the end of this course the participants will be able to:

- Determine the most important aspects of renewable energy plants that need probabilistic modeling and evaluation assessment
- Understand the main features of the computational methods that are available for the reliability and operational performance modeling of the relevant systems
- Understand the main indices that need be calculated for the quantification of power system operational performance
- Carry out practical assessment studies
- Compare and justify alternative schemes for the reinforcement of power generation systems

## Targeted Competencies:

- State of the art knowledge of the available computational methods
- Efficient computational methods that can be applied for the analysis of the respective reliability problems
- Description of the appropriate sets of reliability and operational indices that need to be calculated
- Presentation of application examples by using practical power systems and case studies
- Important conclusions concerning the necessary procedures and practices for the planning and operation of power generation systems with an increased penetration level of renewable energy installations

## **Course Content:**

### **Unit 1: General Aspects:**

- Basic principles of probabilistic modeling and reliability evaluation methods
- Generation challenges and main issues for planning purposes of low emission power systems
- Main characteristics of conventional power plants
- Main features of renewable energy installations
- Ancillary services and impact of storage installations
- Simulation computational approaches for modeling power system operational performance

### **Unit 2: Conventional Power Plants:**

- Modeling the generation characteristics of thermal power plants
- Modeling the generation characteristics of cogeneration plants large, small
- Modeling the generation characteristics of hydroelectric power plants large, small with and without pumping facilities
- Spinning reserve requirements
- Demand response programs
- Reliability criteria for the operation of power generation systems

### **Unit 3: Integration of Wind Generation Installations:**

- Main modeling aspects concerning the stochastic generation variability
- Equivalent daily curves predicting wind generation
- Correlation of wind generation with system load demand requirements
- Reduction events of wind generation
- Indices for wind capacity credit
- Operational integration costs for wind generation
- High penetration levels and wind parks in future power systems

### **Unit 4: Integration of Other Renewable Energy Installations:**

- Main modeling aspects concerning the stochastic generation variability
- Equivalent daily curves predicting the solar generation
- Correlation of generation with system load demand requirements
- Operational integration costs for solar generation
- Reliability assessment of photovoltaic plants and their interconnection links
- Biomass installations
- Battery storage facilities

### **Unit 5: Operational Assessment of Power Generation Systems:**

- Simulation of power system operation
- Reliability criteria and characteristics of system generation
- Calculation of performance indices
- Spinning reserve criteria and demand response programs
- Interconnected power systems
- Isolated power systems