POWERFACTORY

Grid Connection of Renewable Generation

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June 22nd - June 23rd 2021

Online training course

This training introduces the participant to the tools and techniques commonly used in practice for the analysis of grid integration of renewables in the power system with focus on wind power and photovoltaics (PV). This two-day course provides a systematic approach for performing a grid compliance study, by covering the following topics:

- Steady-state behaviour with consideration of grid code requirements
- Short-circuit calculation
- Harmonic analysis according to IEC 61000
- Dynamic simulation for fault behaviour

Each topic above includes theoretical background and a practical exercise in which participants acquire hands-on experience in the use of *PowerFactory*.

The course introduces the different renewable generation technologies, starting from the most common wind turbine (WT) types
and up to the various photovoltaic (PV) inverter systems. Throughout the proceedings, the participant learns how to take advantage of the task automation capabilities of PowerFactory by executing DPL scripts which greatly simplify particular tasks such as generating a PQ diagram of a Wind/PV park at the grid connection point or the analysis of generation and losses of a wind park. Although most of the exercises are based on WT systems, due to the similarities between wind power and photovoltaics in terms of grid connection studies, the same exercises can be tailored for solar power as well.

WHO SHOULD ATTEND:

The course is intended for

- Consultants
- Engineers working for manufacturers
- Project Developers in the field wind/solar power
- Utility engineers
- Power system operators
- Electrical engineers in general

Participants should be familiar with the basic handling of *PowerFactory* or have attended the equivalent introductory course: “Load Flow and Short Circuit Calculation”.

PRICE PER PARTICIPANT:

- 1,116.00€* (with valid maintenance contract)
- 1,270.00€* (without valid maintenance contract)
- 380.00€* (with valid student identification)

*Prices are exclusive of VAT

Training schedule

Central European Time (UTC +01:00)

DAY 1

9:00 Wind Energy Basics and Turbine Generator Concepts
The various types of wind generators (Type 1 to 4) are introduced. The advantages and disadvantages of each type are explained, with focus on the active/reactive power regulation capabilities of the unit and the behaviour during network disturbances (e.g. threephase short-circuits).

10:30 Coffee break

11:00 Exercise: Building a Wind Farm Model
Setting up a 50MW wind farm based on fully rated wind turbine (WT) models. Getting acquainted with the WT templates existing in the global library. Definition of the PQ capability of a single WT.

11:30 Exercise: Grid Code Compliance in Steady-state Study
Overview of typical grid code requirements specified for renewable generation. Steady-state requirements: voltage control, P-Q and V-Q capability at Point of Connection (PoC).

12:00 Exercise: Reactive Power Capability
Grid code compliance in terms of reactive power provision at the PoC. Identification of the V-Q and PQ wind farm capability and comparison with given grid code requirements. Design the reactive power compensation unit so that regulatory compliance is achieved.

12:30 Lunch break

13:30 Power Quality Assessment
Fundamentals. Harmonic Load Flow according to IEC 61000-3-6. Overview of the calculation procedure. Definition of IEC harmonic sources in PowerFactory. Voltage flicker assessment according to IEC 61400-21. PowerFactory: Harmonic Load Flow handling.

14:30 Exercise: Power Quality Assessment acc. to IEC 61400-21
Evaluate the power quality of a wind farm according to IEC 61400-21, including calculation of voltage distortion due to harmonics injections, relative change in voltage due to switching operations in the wind farm and the flicker severity during continuous and switching operations.

15:00 Coffee break

15:30 Short-Circuit Analysis
Learn about the options PowerFactory offers to consider short-circuit contribution from wind turbines according to different standards and with focus on IEC 60909 and the proprietary Complete Method. Learn how to consider dynamic voltage support (reactive power injection during faults) of converter based renewables using the Complete Method of the shortcircuit calculation.

16:00 Exercise: Short-Circuit in a Wind Farm
Verification of equipment ratings using the IEC 60909 method (worst case/planning stage behaviour). Verification of thermal ratings of a MV cable. Verification of the dynamic voltage support function of the individual wind turbine using the Complete Method (operational behaviour).

17:00 End of the first day

DAY 2

9:00 Dynamic Simulation of Wind Turbines and Introduction of the Dynamic Model of a WT with Fully Rated Converter
Dynamic Simulation Fundamentals. Handling in PowerFactory. Get familiar with the PowerFactory dynamic models designed for fully rated converter WTs, with focus on IEC models, their structure, control block diagrams and supported functionality.

10:30 Coffee break

11:00 Exercise: WT with Fully Rated Converter
Use a WECC type 4 model (fully rated converter based) to perform a dynamic short-circuit study according to the German VDE-AR-N 41xx or the ENTSO-E regulations. Learn how to test dynamic controllers and apply different controller settin (e.g. K factor for LVRT).

12:30 Lunch break

13:30 Introduction of the Dynamic IEC DFIG Model
Get familiar with the PowerFactory dynamic models for doubly-fed induction generator (DFIG) wind turbine, with focus on IEC models, their structure, control block diagrams and supported functionality.

14:30 Exercise: IEC DFIG Type 3 Model
Develop an aggregated DFIG WT model based on IEC 61400-27-1 for dynamic analysis, connect it to a transmission network and adjust ratings. Use it to perform a dynamic short-circuit study according to the German VDE-AR-N 41xx grid code requirements and technical guidelines. Learn how a DFIG WT reacts during a fault and adjust settings.

15:00 Coffee break

15:30 Photovoltaic (PV) Systems
Fundamentals: Solar cell technologies; P-V/I-V curves; DC system layouts; PV inverter types; PV power plant layouts. Load Flow models for PV systems. The “Photovoltaic System” built-in model for steady-state analysis. Dynamic Models for PV systems. Other solar energy sources.

16:00 Fault Analysis on a LV Feeder with Photovoltaics
Learn how to use the generic PV template, add it to an LV network. Study the steady-state voltage profile of the feeder. Perform a dynamic simulation and monitor the PV inverter behaviour during faults. Adapt PV system ratings and apply various operational settings.

17:00 End of the training course

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