Training Content

Grid Connection of Renewable Generation

DAY 1

MODULE 1: Introduction to Grid Connection of Renewable Generation

Grid Connection of Renewable Generation — ½ h

General introduction into the field of grid connection studies for power parks.

Exercise: Configuring a power park model — 1 h

Configuring a 50 MW power park with inverter based resources (IBR). Getting acquainted with the existing power park network. Definition of the PQ capability of a single generation unit.

Coffee break

MODULE 2: Grid code compliance in steady-state study

Grid code compliance in steady-state study — ½ h

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).

Exercise: Reactive Power Capability — 1 h

Grid code compliance in terms of reactive power provision at the PoC. Identification of the V-Q and P-Q power park capability and comparison with given grid code requirements. Design the reactive power compensation unit so that regulatory compliance is achieved.

Q&A session

DAY 2

MODULE 3: Short-Circuit Analysis

Short-Circuit Analysis — ½ h

Learn about the options *PowerFactory* offers to consider short-circuit contribution from IBR according to different standards and with focus on IEC 60909 and the proprietary *Complete Method*.

Exercise: Short-Circuit in a Power Park — 1 h

Verification of equipment ratings using the IEC 60909 method (worst case/planning stage behaviour). Verification of thermal ratings of a MV cable.

Coffee break

MODULE 4: Power Quality Assessment

Power Quality Assessment — 1 h

Fundamentals. Harmonic Load Flow according to IEC 61000-3-6. Overview of the calculation procedure. Definition of IEC harmonic sources in *PowerFactory*. *PowerFactory*: Harmonic Load Flow handling.

Exercise: Power Quality Assessment acc. to IEC 61400-21 — ½ h

Evaluate the power quality of a power park according to IEC 61400-21, including calculation of voltage distortion due to harmonics injections and relative change in voltage due to switching operations in the power park.

Q&A session

DAY 3

MODULE 5: Dynamic FRT Simulation of Wind Generators

Wind Energy Basics and Turbine Generator Concepts — ½ h

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.

Dynamic FRT Simulation of Wind Turbines and Introduction of the Dynamic Model of a WT with fully rated converter — 1 h

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.

Coffee break

Exercise: WT with fully rated Converter — 1 ½ h

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 settings (e.g. K factor for LVRT).

Q&A session

DAY 4

MODULE 6: Dynamic LFSM Simulation of Wind Generators

Introduction of the Dynamic IEC DFIG Model — ½ h

Become familiar with the *PowerFactory* dynamic models for doubly fed induction generator (DFIG) wind turbines, focusing on IEC models, their structure, control block diagrams, and supported functionality. Set up an aggregated wind farm with plant level control. Simulate overfrequency and underfrequency events, evaluate the response of the power park.

Exercise: LFSM Simulation with IEC Type 3 WTG — 1 h

In this exercise, you will analyze the LFSM behavior of an aggregated wind farm model using a preconfigured *PowerFactory*project. Voltage and frequency profiles are provided via a measurement file, enabling simulation of specific grid events. The goal is to evaluate the system's response during under- and over-frequency scenarios.

Coffee break

MODULE 7: Photovoltaic (PV) Systems

Presentation: Photovoltaic systems — ½ h

Fundamental introduction to photovoltaic systems. Load Flow models for PV systems. The "Photovoltaic System" built-in model for steady-state analysis. Introduction into the tool "Park Energy Analysis" and into the "Quasi-Dynamic Simulation".

Exercise: Calculation of the energy yield of a large PV park — 1 h

Learn how to use the Power Park Energy Analysis tool using time series data. Study the steady-state voltage profile of the feeder. Adapt PV system ratings and apply various operational settings.

Q&A session

Time Schedule (Central European Time)

	Time
First 90 minutes block	9:00
Coffee break	10:30
Second 90 minutes block	10:45
Q&A session	12:15
End of the training day	12:30

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