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 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 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

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DAY 4

Introduction of the Dynamic IEC DFIG Model **1 h**

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.

Exercise: IEC DFIG type 3 model **½ h**

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.

Coffee break

MODULE 6: 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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