Training Content

Grid Connection of Renewable Generation

MODULE 1: Introduction to Grid Connection of Renewable Generation (Estimated Time: 1.5 h)

Grid Connection of Renewable Generation

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

Exercise: Building a power park model

Setting up a 50 MW power park with inverter based resources (IBR). Definition of the PQ capability of a single generation unit.

MODULE 2: Grid code compliance in steady-state study (Estimated Time: 2.5 h)

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).

Exercise: Reactive Power Capability

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.

MODULE 3: Short-Circuit Analysis (Estimated Time: 1.5 h)

Short-Circuit Analysis

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

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

MODULE 4: Power Quality Assessment (Estimated Time: 2.5 h)

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*. *PowerFactory*: Harmonic Load Flow handling.

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

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.

MODULE 5: Dynamic Simulation of Wind Generators (Estimated Time: 5.5 h)

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.

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.

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

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.

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.

MODULE 6: Photovoltaic (PV) Systems (Estimated Time: 2.5 h)

Photovoltaic (PV) Systems

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

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 data and apply various operational settings.

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