SERVICES

PowerFactory

Training Courses

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

PowerFactory Training Course	Duration (days*)	Required Experience	Price Category
Introductory Course: Load Flow and Short Circuit Calculation	3	-	1
Scripting in *PowerFactory* with Python	2.5	Basic handling	1
Introductory Course: Time Domain Simulation	1	Basic handling	2
Power System Stability	2**	Basic and simulation handling	2
DIgSILENT Simulation Language (DSL)	2	Basic handling	2
Electromagnetic Transient Analysis (EMT)	3	Basic and simulation handling	2
Grid Connection of Renewable Generation	2	Basic handling	2
Protection	3	Basic handling	2
Harmonic Analysis	2.5	Basic handling	2
Database Management	1	Basic handling	2
Advanced Handling of *PowerFactory*	2	Basic handling	2
Contingency Analysis	1	Basic handling	2
Network Reduction	1	Basic handling	2
Quasi-Dynamic Simulation	1	Basic handling	2
QDSL Modelling	1	Basic handling	2
DIgSILENT Programming Language(DPL)	2	Basic handling	1
Power System Stabiliser (PSS) Tuning	1	Basic and simulation handling	2
Arc Flash Calculation	1	Basic handling and protection	2
Cable Analysis	1	Basic handling	2
Power Transmission with HVDC	3.5	Basic handling	2
Flexible AC Transmission Systems (FACTS)	2	Basic handling	2
Optimal Power Flow	1	Basic handling	2
Unit Commitment and Dispatch Optimisation	2	Basic handling	2
Transmission Network Tools	1	Basic handling	2
Distribution Network Tools	1**	Basic handling	2
Reliability Analysis	2	Basic handling	2
Technical Economic Calculations	1	Basic handling and reliability	2
Probabilistic Analysis	2	Basic handling	2
Motor Starting Methods	1	Basic handling	2
Grid Connection Integration Assessment for Distribution Grids (Netzanschlussgesuch-Beurteilung im Verteilnetz)	2	Basic handling	2

(*) 1 day = 4 x 90 minutes blocks
(**) For these training courses, the duration can be extended depending on the requested topics.

General Information

All courses are offered in English (EN), except the *Grid Connection Integration Assessment for Distribution Grids*, offered only in German. The courses may be provided in other languages, typically German (DE) and Spanish (ES), by arrangement based on the trainers and material availability (might include additional preparation time).

The training material is being updated on regular basis. A check of the version availability in advance of a training course is recommended. Additional preparation time might be necessary to provide the training material in a specific version.

The listed duration of the training courses is provided as a reference. It may vary depending on the area of study, the group of courses requested and the level of experience of the participants with *PowerFactory* and/or similar tools.

For online courses, the training can be split into half-day sessions (2 blocks of 90 minutes) to account for potential time zone shifts.

Introductory Course: Load Flow and Short-Circuit Calculation

Objectives: This course offers an introduction to the basic features of the *PowerFactory* software, including building a small network and carrying out load flow and short circuit calculations.

Course Content:

- Introduction to *PowerFactory*: Fundamental concepts, functionality, handling and terminology.
- Creation of a network model: The process of building a network model from scratch, including an introduction to the concept of Type objects, used for data obtained from manufacturers' datasheets.
- Load Flow calculation: Basic concepts of load flow analysis in *PowerFactory*. Execution of load flow calculations and reports.
- Voltage control in load flow calculations.
- Short Circuit calculation: Understanding the implementation of short-circuit calculations in *PowerFactory*.
- Connecting grids: Simple methods for connecting grids within a project.
- Evaluation of thermal and mechanical stresses with regard to the network components and investigation of different earthing concepts.
- Understanding basic concepts of the data structure in a *PowerFactory* project and in particular the roles of Network Variations, Study Cases and Operation Scenarios.
- Modelling network expansions using Variations and Expansion Stages.
- Analysis of different network states using Operation Scenarios and Study Cases.
- Extended network analysis using feeders. Creation of Voltage Profile Diagrams, implementation of measurements and use of the Feeder Load Scaling functionality.

Target audience: Electrical engineers new to *PowerFactory*.

Prerequisites: No previous experience with *PowerFactory* is required.

Duration: 3 days. In half-day modality 2.5 days (reduced content)

Scripting in *PowerFactory* with Python

Objectives: Python is a programming language which can be used to control *PowerFactory*. It is commonly used to automate the execution of time-consuming simulations - however, its application extends far beyond that. Python may also be used to process results, or to implement a routine that applies sequential changes to a network and calls *PowerFactory*'s analysis functions in each step.

This course provides a compact and efficient introduction to the fundamental aspects of writing scripts inside of *PowerFactory* using Python. The course includes basic concepts, syntax, accessing and modification of objects from within the code, automation of a series of calculations and presentation of the results etc.

Within the context of the training course numerous scripts will be created, which are intended to encourage new ideas or can be adapted to suit particular requirements.

Course Content:

- Introduction to Python-*PowerFactory* interface.
- Access to *PowerFactory* objects.
- Execution of *PowerFactory* commands.
- Navigation through the *PowerFactory* project.
- Reporting results, subroutines and module.
- Result files.
- Creating diagrams.
- AddOn variables.

Target audience: The course is aimed at any *PowerFactory* users interested in performing automated tasks.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Experience with *PowerFactory*'s DPL, Python itself, as well as C++, C, Java or other scripting languages is beneficial but not mandatory.

Duration: 2.5 days.

Introductory Course: Time Domain Simulation

Objectives: This course presents an introduction to the time-domain simulation for the stability (RMS) and fast transients (EMT) analyses in *PowerFactory*.

Course Content:

- Calculation of initial conditions.
- Definition of variables.
- Events definition.
- Result visualisation.
- Simulation Scan.
- Time domain simulation RMS and EMT.
- Fast Fourier Transform (FFT) analysis.
- Frames and Composite Models.
- Use of Standard Models from the *DIgSILENT* Library.

Target audience: *PowerFactory* users interested in analysing the transient behaviour of a power system.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

Power System Stability

Objectives: This course provides a comprehensive overview of power system stability and control. The dynamic modelling and simulation environment of *PowerFactory* are introduced. It includes a presentation of the built-in dynamic models of synchronous generators, induction machines and loads, as well as excitation and turbine-governor systems. Participants perform several exercises to investigate the stability of single- and multi-machine power system models using time- and frequency-domain techniques.

Course Content:

- Fundamentals of Power System Stability.
- Network models for dynamic analysis.
- Time domain analysis (RMS) using *PowerFactory*.
- Transient Stability.
- Oscillatory Stability (small signal).
- Voltage Stability.
- Frequency Stability.

Target audience: Utility engineers, power system operators, project developers, manufacturers, consultants and electrical engineers in general, interested in stability analysis of networks.

Prerequisites: Previous experience in *PowerFactory* basics and some experience in handing of *PowerFactory*'s time domain simulation functions, or attendance at the equivalent introductory courses (Load Flow and Short-Circuit Calculation and Time Domain Simulation), is essential.

Duration: 2 days. The duration can be extended depending on the requested topics.

Dynamic Simulation Language (DSL)

Objectives: The whole process of translating a control system into a set of mathematical equations and implementing it using the *DIgSILENT* Simulation Language DSL is introduced and practised. Aspects of the DSL language, such as the description of differential equations, model initialisation and issuing simulation events will be introduced systematically, with extensive practice in the implementation of various DSL models.

Course Content:

- Introduction to the dynamic modelling approach in *PowerFactory*.
- Dynamic modelling handling.
- Graphical interface and DSL syntax to develop dynamic models.
- Dynamic model initialisation.
- Practical Exercises: Complete plant control model, simple under-voltage relays, dynamic loads, switched shunts etc.

Target audience: The course is intended for utility engineers, power system operators, project developers, manufacturers, consultants and electrical engineers in general, interested in the modelling of control processes within the power systems.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the equivalent introductory courses Load Flow and Short-Circuit Calculation and Time Domain Simulation.

Duration: 2 days.

Electromagnetic Transient Analysis (EMT)

Objectives: This course focuses on the analysis of electromagnetic transients caused by switching events using time domain simulations. The course covers enhancing network models for electromagnetic transient simulations such as energising and de-energising of inductive and capacitive equipment types. It further introduces geometric modelling of overhead lines and cables for analysis of travelling wave effects for line energisation and lightning studies.

Course Content:

- Introduction of electromagnetic transients in power systems including temporary, slow front and fast front overvoltages.
- Transformer saturation models and energisation.
- Capacitor switching analysis.
- Transient recovery voltage and breaker capability analysis.
- Geometric setup of overhead lines and cables and configuration of frequency dependent models.
- Line energisation including stochastic analysis.
- Lightning transients network model enhancement and study.

Target audience: The course is aimed at power system engineers interested in the use of the electromagnetic transients (EMT) simulation function of *PowerFactory*.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the equivalent introductory courses Load Flow and Short-Circuit Calculation and Time Domain Simulation.

Duration: 3 days.

Grid Connection of Renewable Generation

Objectives: This course provides a comprehensive overview of standard wind generator models and photovoltaic models in *PowerFactory*, and their use in load flow, short-circuit, harmonic and dynamic analyses. It covers the following generation technologies: wind-turbine generators (WTG) with fully rated converter, WTG with doubly fed induction machine and photovoltaic systems.

Course Content:

- Basics of Wind and Photovoltaic Systems.
- Modelling Wind Turbine Generator Concepts in *PowerFactory*.
- Modelling Photovoltaic Systems in *PowerFactory*.
- Reactive Power Analysis (PQ and VQ curves).
- Harmonic Load Flow (IEC 61000).
- Short-Circuit Analysis (IEC 60909:2016).
- Introduction to Stability Functions.
- Using IEC 61400-27-1 and WECC WTG models.
- Practical Exercises with Wind and Photovoltaic Models.

Target audience: Power systems professionals involved in planning and operation of renewable generation.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Knowledge of DSL modelling is not needed.

Duration: 2 days.

Protection

Objectives: This courses offers an introduction of the fundamental handling of overcurrent, distance and differential protection in *PowerFactory*. The protection toolbox is applied to face issues related to directional overcurrent protection coordination, impact of intermediate infeed and parallel lines on distance protection and automatic determination of overcurrent and distance settings. Introduces the automated audit of protection settings and the modelling of relay communication schemes.

Course Content:

- Fundamentals of Ovecurrent Protection.
- Overcurrent coordination in an industrial network including fuses, LVCBs, non-directional and directional relays.
- Modelling of earth fault protection based on current summation or direct measurement at the transformer star point.
- Application of the Coordination Assistant for overcurrent and distance protection settings.
- Introduction to distance protection including setting of zone, starting and polarization blocks.
- Analysis of intermediate infeed and parallel lines using the Graphic Assistant.
- Differential protection scheme for transformers.
- Automated verification of protection settings using the Protection Audit.
- Implementation of relay communications schemes.

Target audience: Planning, operation and project engineers whose duties involve the coordination, adjustment and testing of protection devices in transmission, distribution or industrial networks.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 3 days.

Harmonic Analysis

Objectives: This course is dedicated to power quality assessment with a main focus on harmonic analysis (harmonic load flow calculation) and impedance frequency sweeps for identifying resonance conditions in power systems.

Course Content:

- Introduction to Harmonics.
- Modelling of harmonic sources and power system components including frequency dependencies in *PowerFactory*.
- Assessment of voltage distortion in the network using Harmonic Load Flow calculation.
- Determining the frequency dependency of the network impedance using the Impedance Frequency Sweep.
- Harmonic filter design.
- Power quality assessment according to IEC61000.
- Network impedance loci.
- Flicker Assessment according to IEC61400-21.
- Network impedance envelope.

Target audience: The course is aimed at power system engineers interested in power quality, especially in harmonics analysis, in the frequency domain models and the power quality simulation tools available in *PowerFactory*. The course is suitable in particular for network operators, installation planners, equipment developers and researchers.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Experience of *PowerFactory*'s frequency domain simulation functions is not required.

Duration: 2.5 days.

Advanced Handling of *PowerFactory*

Objectives: This training covers topics related to the advanced handling of *PowerFactory*, including graphical representations, the advanced use of variations, expansion stages and scenarios, load flow troubleshooting and additional tools.

Course Content:

- Creation and customisation of overview, geographical, simplified and detailed single line diagrams.
- Diagram Layout Tool.
- Load flow troubleshooting. Inner and outer loops problems.
- Handling of operation scenarios: comparing, selective updating.
- Merging and splitting expansion stages. Variation Manager.
- Compare and Merge tool.
- Project combination and connection.
- DGS Interface.
- Data Extension.
- Task Automation.

Target audience: Existing users who would like to delve into the advanced handling of *PowerFactory*.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 2 days.

Database Management

Objectives: This course focusses on the multiuser database, the creation of users accounts and associated access rights, and the use customisation of the user interface. The work-flow in a multi-user database is demonstrated and practised.

Course Content:

- The user manager tool, publishing users and user groups: the different types of user are presented, user groups are created and licences are assigned to specific users.
- Working in a multiuser database: Usage of master and derived projects. Comparing versions with the compare and merge tool.
- Customisation: Possibilities to customise the user-interface are presented.
- Database maintenance: Usage of housekeeping command, external archives and database migration.

Target audience: Multiuser database administrators and key users.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation, and should understand the *PowerFactory* database structure.

Duration: 1 day.

Contingency Analysis

Objectives: This course covers the concepts and application of Contingency Analysis in *PowerFactory*, including results reporting and some of the extended functions such as Time Sweep and Remedial Action Schemes.

Course Content:

- Overview of the basic concepts and use of Contingency Analysis.
- Single time phase contingency analysis.
- Multiple time phase contingency analysis, effectiveness and post-fault actions.
- Contingency sweep calculation.
- Application of short-term thermal ratings.
- Remedial action schemes.

Target audience: The course is intended for any power system engineers interested in the use of the contingency analysis (n-1 calculations) in *PowerFactory*.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

Network Reduction

Objectives: To learn how to use Boundaries and the Network Reduction in *PowerFactory*. Understand the use cases of the different reduction methods.

Course Content:

- Working with Boundaries. Boundary definition tool.
- Static Network Reduction options (Ward and REI reduction) for Load Flow and Short Circuit.
- Evaluation of results and troubleshooting a Network Reduction.
- Dynamic Network Reduction based on coherent generator groups (RMS Simulation).
- Applying the Parameter Identification to tune controller parameters.
- Introduction of the Regional Network Reduction for Load Flow applications.
- Using the Network Reduction in a Quasi-Dynamic Simulation.

Target audience: Users interested in using the Network Reduction tool to simplify networks or remove confidential data.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

Quasi-Dynamic Simulation (QDS)

Objectives: In this training the participants will learn the principles and the handling of the Quasi-Dynamic Simulation tool in *PowerFactory*; working with time-series characteristics. The training covers also the visualisation and different options to analyse the results.

Course Content:

- Introduction into the Quasi-Dynamic Simulation in *PowerFactory*
- Different modelling aspects to implement time-series characteristics
- Time Sweep Analysis

Target audience: Power system engineers dealing with time-series-based load flow calculations and analysis.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

QDSL Modelling

Objectives: QDSL is a powerful modelling capability to develop user-defined Quasi-Dynamic Simulation models (QDSL models), where users are given access to the model calculation algorithm through the application of user-defined equations during Load Flow and Quasi Dynamic simulation. Within this training, different representative examples will be explained and developed, with which the user will be able to derive user-defined control strategies such as electric vehicle charging procedures.

Course Content:

- Handling of user-defined models for Quasi-Dynamic simulation.
- Modelling an active power P(U) controller.
- Modelling a user defined transformer tap changer controller.
- Using a state variable to model electric vehicle charging.

Target audience: Power system engineers dealing with controller modelling for static simulation.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation, and *DIgSILENT* Programming Language (DPL). Knowledge of Quasi-Dynamic Simulations will be useful.

Duration: 1 day.

DIgSILENT Programming Language (DPL)

Objectives: This course includes the concepts and syntax of the *DIgSILENT* Programming Language (DPL), which is integrated into *PowerFactory* and is commonly used to automate the execution of time-consuming simulations.

Course Content:

- Introduction to DPL and basic syntax.
- How to handle objects, sets and DPL Selection.
- Automated command execution.
- Reporting Results in the output window.
- Write, read and export with result objects.
- Create and modify Table Reports.
- Read and write External Data Files.

Target audience: The course is aimed at *PowerFactory* users interested in performing automated tasks.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Programming experience is not a prerequisite, but would be beneficial.

Duration: 2 days.

Power System Stabiliser (PSS) Tuning

Objectives: This course covers the theory of small-disturbance rotor angle stability, and its enhancement using power system stabilisers. *PowerFactory* is used to tune a single-input as well as a dual-input power system stabiliser. A significant part of the course is devoted to exercises. Participants investigate the stability of single-machine and multi-machine power systems, using time-domain and frequency-domain techniques. They tune power system stabilisers with the aid of Bode Plots and Root-Locus Diagrams.

Course Content:

- PSS Basics.
- PSS Phase and Gain Adjustment.
- Dual-input PSS.
- Multi-machine Power Systems.

Target audience: Power system engineers working on power systems' analysis and control for operation and planning studies.

Prerequisites: Participants should be proficient in the use of stability functions of the *PowerFactory* software, acquired through experience or our Power System Stability training.

Duration: 1 day.

Arc Flash Calculation

Objectives: This training covers tools available in *PowerFactory* to perform arc-flash hazard analysis, including their technical background, descriptions of the Arc-Flash Hazard Analysis command and Arc-Flash Reports dialogs. By the end of the training participants should be able to determine employee Personal Protective Equipment (PPE) requirements using *PowerFactory*.

Course Content:

- Introduction to Arc Flash Calculation.
- Estimating Incident Energy and PPE.

Target audience: The course is intended for planning and project engineers interested in personal protection and safety in medium voltage systems.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Knowledge of overcurrent protection fundamentals and their application in *PowerFactory* is also necessary; therefore the Protection course is recommended.

Duration: 1 day.

Cable Analysis

Objectives: This course covers the Cable Ampacity and Sizing calculation. The course will investigate the current-carrying capacity for cable systems based on the physical laying arrangements and environmental conditions at the specific site. The training also covers the automatic determination and verification of cable types against typical constraints.

Course Content:

- Cable modelling based on geometric data.
- Laying arrangements and environmental conditions at the specific site
- Introduction to the basic concepts of Cable Ampacity calculations.
- Cable Ampacity Calculation of single circuit and multiple circuit cable trenches.
- Practical exercise for the calculation of ampacity for the cables of a large wind farm, taking into account environmental conditions and laying arrangements.
- Advanced analysis for multi-cable systems.
- Determination of new cable types for a planned construction area.
- Verification and Reinforcement of cables.

Target audience: The course is aimed at power system engineers interested in Cable Ampacity and Sizing Calculation.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

Power Transmission with HVDC

Objectives: This course gives an overview of High-Voltage Direct Current (HVDC) transmission. Line-commutated converters (LCCs) and modular multi-level converters (MMCs) are addressed. Topologies and controls, steady-state, harmonic as well as dynamic behaviour are explained. The participants will learn how to model these systems in *PowerFactory*. Practical use case scenarios are investigated.

Course Content:

- Introduction to HVDC Systems.
- Steady state and dynamic analysis of LCC-HVDC.
- Steady state and dynamic analysis of VSC-HVDC systems (with focus on MMC-HVDC).
- Applications: 50 Hz/60 Hz link, embedded link in 50 Hz grid, offshore wind farm link.

Target audience: This course is intended for any utility engineers, power system operators, project developers, manufacturers, consultants and electrical engineers in general, interested in HVDC and their application in power systems.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Experience with *PowerFactory*'s time domain and frequency domain simulation functions is recommended but not mandatory.

Duration: 3.5 days.

Flexible AC Transmission Systems (FACTS)

Objectives: This course provides an introduction to Flexible AC Transmission Systems (FACTS) and its applications. Static VAR compensators (SVCs), STATCOMs and thyristor-controlled series capacitors (TCSCs) are addressed. Topologies and controls, steady-state as well as dynamic behaviour are explained. At the end of the course, the participants will be able to deploy, configure and analyse simulation models of FACTS equipment using *PowerFactory*. Practical use case scenarios are investigated.

Course Content:

- Parallel Compensation with FACTS: SVC/SVS and STATCOM.
- Series Compensation: TCSC.
- Practical applications and analysis using *PowerFactory*.

Target audience: The course is intended for any utility engineers, power system operators, project developers, manufacturers, consultants and electrical engineers in general, interested in FACTS and their application in power systems.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Experience with *PowerFactory*'s time domain and frequency domain simulation functions is recommended but not mandatory.

Duration: 2 days.

Optimal Power Flow (OPF)

Objectives: In this course the participants are introduced to calculating Optimal Power Flow (OPF) using *PowerFactory*. Objective functions, system constraints and control variables are presented for each optimisation method. The concepts of marginal price and shadow price are also discussed.

Course Content:

- Introduction into Optimal Power Flow
- AC Optimisation Method (Interior Point Method)
- DC Optimisation Method (Linear Programming)
- Contingency Constrained DC Optimisation (LP Method)
- Practical Exercises

Target audience: Power systems professionals involved in network planning and operation.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

Unit Commitment and Dispatch Optimisation

Objectives: This training offers an introduction to the Unit Commitment and Dispatch Optimisation tool in *PowerFactory* considering market data, as well as network constraints and system contingencies.

Course Content:

- DC and AC Unit Commitment.
- Market simulation.
- Redispatch calculation.
- Consideration of storage and virtual power plants.

Target audience: *PowerFactory* users interested in using the Unit Commitment and Dispatch Optimisation tool.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 2 days.

Transmission Network Tools

Objectives: This *PowerFactory* training introduces the Transmission Network Tools, a suite of dedicated calculation functions specially tailored for the analysis of transmission networks.

Course Content:

- Application of PV and QV curves in steady-state voltage stability analysis.
  - Use of PV curves to calculate the maximum active power transfer while considering different scenarios.
  - Use of QV curves to evaluate the sensitivity of bus voltages with respect to reactive power injections.
- Using Transfer Capability Analysis to assess the maximum feasible power exchange between two subsystems.
- Using power transfer distribution factors (PTDF) to assess physical flow changes and estimate generation redispatch to alleviate transmission congestion.

Target audience: Power systems professionals involved in planning and operation of transmission networks.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

Distribution Network Tools

Objectives: This training is designed for users in the distribution sector who wish to streamline their daily processes using the tools available within *PowerFactory*. The course starts with an overview of the distribution network tools, including a description of the relevant models, then continues with sections dedicated to each of the available distribution functions.

Course Content:

- Introduction into the Medium-Voltage Load and Low-Voltage Load model as well as Feeders and their applications.
- Tie Open Point Optimisation.
- Voltage profile Optimisation.
- Optimal Capacitor Placement.
- Phase Balance Optimisation.
- Hosting Capacity Analysis.
- Optimal Equipment Placement (batteries, voltage regulators).

Target audience: Power systems professionals from the distribution sector.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day. The duration can be extended depending on the requested topics.

Reliability Analysis

Objectives: This course offers a practical introduction to the basics and the application of the reliability calculation to network planning with DIgSILENT *PowerFactory*. In the first part of the training, the fundamentals of the probabilistic reliability analysis are treated. After the introduction to relevant data and reliability models of the equipment, approaches for assessing the reliability of power supply, such as comparisons of network variation, vulnerability analysis and cost assessment are considered. Techniques to improve power system reliability, such as tie open optimisation and classical grid expansion are also treated.

Course Content:

- Fundamentals of the probabilistic reliability analysis. Introduction to reliability analysis as a network planning tool. A comparison of probabilistic and deterministic planning criteria are provided.
- Basic stochastic failure models and components are introduced. Common reliability indices, their calculations and application in network planning.
- Vulnerability Analysis: Identifying components having the highest impact the reliability of a customer, identify weak areas (feeders) of the network
- Reliability cost assessment, reliability enhancement based on optimisations tools and network expansion.
- Reliability indices based Variation comparison.

Target audience: Utility engineers, power system operators, project developers, manufacturers, consultants and electrical engineers in general, interested in *PowerFactory*.

Prerequisites: Participants should be familiar with the handling of *PowerFactory*, based on completion of the Introductory Course: Load Flow and Short-Circuit Calculation course, together with practical experience with the software. A knowledge of scripting is advantageous.

Duration: 2 days.

Technical Economic Calculation

Objectives: This course provides a foundation for the application of the Technical Economic Calculation (TEC) Tool in *PowerFactory* and to enable power system engineers to employ techno-economic assessments in a consistent and transparent way. The course covers multiple analyses involved with TEC like Load Flow, Reliability, Tie Open Point Optimisation and planning management techniques.

Course Content:

- Fundamentals of Reliability Analysis and Basic Distribution Functions.
- Introduction to Technical Economic Analysis: Cost factors and costs analysis based on NPV, internal rate of return, estimated payback period and discounted estimated payback period.
- Technical Economic Calculations in *PowerFactory*, interruption costs, cost of losses, investment, additional and user defined costs.
- Cost Benefit Analysis using Efficiency Ratio Calculation.
- Cost Based Comparative Analysis of network expansion strategies.

Target audience: The course is intended for utility engineers, power system operators, project developers, manufacturers, consultants and electrical engineers in general, interested in *PowerFactory*.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation. Some basic knowledge of reliability assessment and power system planing tools like variations and system stages is assumed. A knowledge of distribution system tools will be useful.

Duration: 1 day.

Probabilistic Analysis

Objectives: This training introduces the principles and the handling of the Probabilistic Analysis tools in *PowerFactory*. The participants will learn how to create and assign distributions and correlations, define result variables, execute the analysis and use the various options to analyse the results.

Course Content:

- Introduction into Probabilistic Analysis of the Load Flow (PLA) and the Optimal Power Flow in *PowerFactory*
- Probabilistic Load Flow Analysis in a Wind Park
- Probabilistic Network Planning in a Medium-Voltage Network
- Probabilistic Spare Load and Hosting Capacity

Target audience: This advanced training course is intended for people who want to learn how to perform probabilistic network planning studies in *PowerFactory*.

Prerequisites: Previous experience in *PowerFactory* basics and handing, or attendance at the equivalent introductory course: Introductory Course: Load Flow and Short-Circuit Calculation, is essential.

Duration: 2 days.

Motor Starting Methods

Objectives: This course provides an overview of the most common starting methods for induction motors through an initial theoretical background and then practical exercises in *PowerFactory*. Depending on the complexity of the study, the participant will be able to handle both the static and dynamic analysis tools thus giving the possibility of obtaining either fast and accurate enough results or more time consuming but in-depth and precise calculations.

Course Content:

- Basics of Motor Starting Methods.
- Direct and star-delta starting.
- Other methods: Variable rotor resistance; Auto-transformer, series reactor starting.
- Introduction to Variable-Speed Drive driven motors: starting using dynamic simulation.

Target audience: The course is aimed at any power system engineers interested in the subject of AC motor starting techniques and their analysis using *PowerFactory*.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 1 day.

Grid Connection Integration Assessment for Distribution Grids (Netzanschlussgesuch-Beurteilung im Verteilnetz)

Objectives: This training introduces common and new tools for assessing grid connections of new generating units and new loads at the distribution grid level. It includes a systematic approach for a grid connection integration assessment taking into account approved standards and techniques.

Course Content:

- General hosting capacity analysis.
- Grid connection integration assessment of generating units, heat pumps and electric charging stations.
- Quasi-dynamic simulation for grid connection integration assessment purposes.
- Stress test analysis with the low-voltage load flow analysis.

Target audience: The course is aimed at any power system engineers interested in the subject of a grid connection integration assessment at distribution level using *PowerFactory*.

Prerequisites: Participants should be familiar with the basic handling of *PowerFactory*, either from experience or by completing the Introductory Course: Load Flow and Short-Circuit Calculation.

Duration: 2 days.

Language: This training is offered only in German.

ABOUT DIGSILENT

DIgSILENT was founded in 1985 and is a fully independent and privately owned company located in Gomaringen close to Stuttgart, Germany. DIgSILENT continued expansion by establishing offices in Australia, South Africa, Italy, Chile, Spain, France, the USA and Oman, thereby facilitating improved service following the world-wide increase in usage of its software products and services. DIgSILENT has established a strong partner network in many countries such as Mexico, Malaysia, UK, Colombia, Brazil, Peru, China and India. DIgSILENT services and software installations are used in more than 170 countries.

POWERFACTORY

DIgSILENT produces the leading integrated power system analysis software PowerFactory, which covers the full range of functionality from standard features to highly sophisticated and advanced applications including wind power, distributed generation, real-time simulation and performance monitoring for system testing and supervision. For various applications, PowerFactory has become the power industry's de-facto standard tool, due to PowerFactory models and algorithms providing unrivalled accuracy and performance.

STATIONWARE

StationWare is a central asset management system for primary and secondary equipment. In addition to handling locations and devices in a user-definable hierarchy, the system allows manufacturer-independent protection settings to be stored and managed in line with customer-specific workflows. It facilitates the management of a wide variety of business processes within a company and centralises the storage of documents. StationWare can be integrated seamlessly into an existing IT environment and the interface with PowerFactory enables the transfer of calculation-relevant data for protection studies.

MONITORING SYSTEMS

Our Power System Monitoring PFM300 product line features grid and plant supervision, fault recording, and power quality and grid characteristics analysis. The Grid Code Compliance Monitoring PFM300-GCC system also offers compliance auditing of power plants with respect to grid code requirements. This monitoring and non-compliance detection provides the complete transparency and assurance required by both plant operators and utilities.

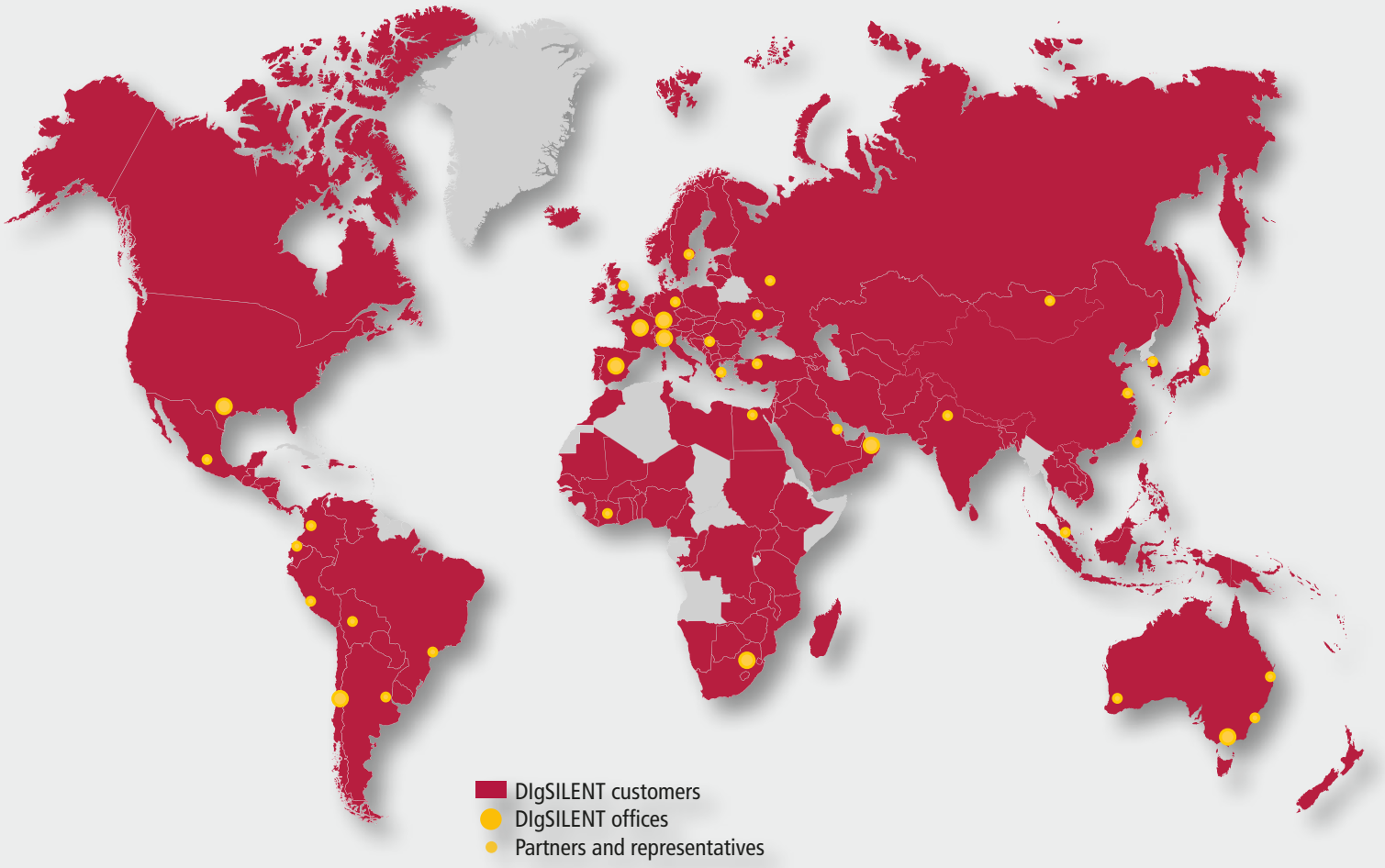
TESTING AND CERTIFICATION

The DIN EN ISO/IEC 17025 accredited DIgSILENT Test Laboratory for NAR Conformity carries out measurements in accordance with FGW TR3 on the operational type 1 generation plant (directly coupled synchronous machines). These measurements are carried out in accordance with the "individual verification procedure" as required by the German grid connection guidelines VDE-AR-N 4110/20/30. DIgSILENT has many years of international expertise in the field of generation and consumption/load systems testing. The in-house developed and produced measuring systems enable the testing laboratory to offer customised measuring solutions for a wide range of power plants and applications.

SERVICES

DIgSILENT GmbH is staffed with experts of various disciplines relevant for performing consulting services, research activities, user training, educational programs and software development. Highly specialised expertise is available in many fields of electrical engineering applicable to liberalised power markets and to the latest developments in power generation technologies such as wind power and distributed generation. DIgSILENT has provided expert consulting services to several prominent PV and wind grid integration studies.

SERVING MORE THAN 170 COUNTRIES



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