Practical Seminar

Integration of Renewable Energy Resources using DIgSILENT PowerFactory (Basic V15): Generic Model

Santiago de Chile-Chile

19th - 20th August 2015

1. Introduction

The planning, design, and operation of power systems require properly-conceived and adequately-conducted studies in order to evaluate existing and proposed system performance, reliability, safety, and economics. These studies are a powerful cost-effective way to prevent surprises and to optimize equipment selection. System's studies at design stage allow identifying and avoiding potential deficiencies in the system before it goes into operation. Studies help locate the cause of equipment failure and disoperation, and determine corrective measures for improving system performance in existing systems. Renewable energy resources (RES) have behaviour considerably different to the classical electro-mechanical generators, as consequence, the integration of RES impacts every single aspect on the planning, design, and operation of power systems. Carefully designed models must be used for simulations of RES and very different approached must be to establish the actual impact on the power system behaviour and to define required improvement to match system operation requirements.

DIgSILENT PowerFactory is widely used power system simulation software. It is capable of simulating from short term transient stability to long term control design situations and it is used in transmission and distribution networks, industry, wind farms, PV systems and smart grids. There are several new features on the most recent version of PowerFactory. Version 14.1 made available a new global "Templates" library (\Library\Templates\) that contains "ready for use" models. This global templates library contains the following "ready for use" models: Double Fed Induction Wind Turbine Generator, Fully Rated Converter Wind Turbine Generator, Photovoltaic Systems and Battery Energy Storing System.

Brilliant power engineers working on operation, planning and control of power system including RES must take advantages of the new features of template library in PowerFactory 14.1 and maximize its use in integration studies. This seminar is designed to provide a comprehensive overview about the generic models included into the Templates Library in DIgSILENT PowerFactory 15.0 and their use in the main power system integration studies.

2. Objective:

This seminar is designed for two general objectives:

1. To provide a thorough and comprehensive overview of the most important aspects for modelling and simulation of RES for the generic models included in the Templates Library of PowerFactory 15.0.
2. To use the generic models included in the Templates Library of PowerFactory 15.0 for the main power system integration studies using DIgSILENT.

3. Indicative Content:

The topics to be covered during the seminar include:

- Introduction to modelling and simulation of RES
- Introduction to integration studies, grid code requirements
- General overview of Wind Energy and Photovoltaic
- Generator concepts in PowerFactory
- Short circuit analysis considering RES
- Introduction to time-domain simulations in power system –Stability function, RMS simulations-
- Overview of the generic models, model description, Template library description, Template structure, model's parameters, customization of the model, running simulations: Load flow, Short circuit and Dynamic simulation (RMS):
  - Wind turbine generator (WTG) with fully rated converter
  - Doubly Feed Induction Generator (DFIG)-WTG
  - Generic Photovoltaic (PV) model.
  - Battery Energy Storage System

4. Detailed Schedule:

First Day

9:00 Introduction

Welcome and presentation of workshop topics

9:30 Basic of Wind Energy and Photovoltaic

Producing Electricity using Prime-mover
Energy conversion systems: Main Characteristics and types
Wind Energy Conversion Systems (WECS).

10:00 Generator concepts used inside DIgSILENT PowerFactory

Synchronous Generator (ElmSym)
Asynchronous Generator (ElmAsm)
Fixed speed induction machine –Single Cage Rotor
Induction generator with variable rotor resistance -Wound Rotor
Doubly-fed induction generator (DFIG) –Wound Rotor
Wind Turbine using generator with fully rated converter

10:30 Overview of the generic models: Using Templates

Model description
Template library description
Template structure
Model's parameters
Customization of the model
Running simulations
Templates:
Wind turbine generator (WTG) with fully rated converter
Doubly Feed Induction Generator (DFIG)-WTG
Generic Photovoltaic (PV) model.
Battery Energy Storage System

11:00 Exercise 1: Setting up a Wind Park Model (Steady-State Simulations)

Assembling the wind farm model (study case)
Running a load flow analysis
Introduction to grid code compliance analysis wind park with regard to:
- Reactive power management
- Compensation
- Voltage limits

Reactive power limits in generators
Reactive power Capacity Curve

12:30 Lunch Break

13:30 Exercise 2: Reactive Power Compensation

Requirements at point of common coupling (PCC)
Reactive Power Capability/Compensation Design: An introduction
PQ Capacities of a Wind Farm
Setting of Wind Farm PQ-curve in DIgSILENT

15:00 Short-Circuit Analysis

Introduction to Short-Circuit Analysis
Short-circuit analysis: Methods.
Short-circuit contribution from wind generators
How to model fault contributions
Current iteration method

15:00 Exercise 4: Short-Circuit Analysis

Data requirements, usage of the static generator for fault analysis.

17:00 End of first day

Second Day

9:00 Recapitulation of first Day

9:15 Introduction of Stability Function (RMS Simulation)

Defining Simulation Events
Defining Result Variables
Presenting Results

11:00 Introduction of the Model for a WTG with fully rated Converter

Model with fully rated converter
Description of the dynamic model

12:30 Lunch Break

13:30 Exercise 5: Wind Turbine Generator: Fully rated Converter

FRT-studies of a single wind generator with fully rated converter

Scaling the model for representing a wind farm
Steady state and dynamic studies of the equivalent wind farm model

14:30 Introduction of the DFIG-WTG

Model of a doubly fed induction generator
Description of the dynamic model
Use of the built-in protection mechanism

15:30 Exercise 6: DFIG

Change the number of parallel machines
Change the rated power of the WTG
Try different controller settings
Run different simulations

15:30 Exercise 7: Generic Photovoltaic Model

Usage and configuration of the PV Model

16:45 Discussion

Questions and answers
Seminar evaluation

3. Pre-requisites:

- A basic mathematical understanding of load-flow studies and fault calculations and very good mathematical knowledge of the basic techniques used on control system design.
- Good understanding of dynamic processes in power systems, previous experiences in time-domain simulations is desired.
- Participants should be familiar with the general handling of the PowerFactory software: Load flow and Short-circuit calculation with PowerFactory.
- Background experience through the use of DIgSILENT PowerFactory - this will greatly enhance the participants; the handling of the RMS-simulations is highly desired.
- Knowledge of DSL modelling is not required but it can be helpful.

4. Duration:

This seminar is designed for duration of 2 days, considering 8 hours per day.

5. Location:

Universidad de Santiago de Chile, DIE-Usach, Av. Ecuador 3519, Estación Central, Santiago de Chile, Chile.

6. Audience:

- Postgraduate students
- Utility engineers
- System operators
- Maintenance staff
- RES producers
- Consultants and researchers on RES.

7. Instructor Affiliation

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8. Instructor Biography

Francisco M. Gonzalez-Longatt is currently a Lecturer in Electrical Engineering in the Faculty of Engineering and Computing, University of Coventry and he is Vice-President of Venezuelan Wind Energy Association. His academic qualifications include first Class Electrical Engineering of Instituto Universitario Politécnico de la Fuerza Armada Nacional, Venezuela (1994), Master of Business Administration (Honors) of Universidad Bicentenaria de Aragua, Venezuela (1999) and PhD in Electrical Power Engineering from the Universidad Central de Venezuela (2008). He is former associate professor on Electrical engineering Department of Universidad Nacional Politécnico de la Fuerza Armada Nacional, Venezuela (1995-2009). He was formerly with the School of Electrical and Electronic Engineering, The University of Manchester as Postdoctoral Research Associate (2009-2011). His main area of interest is integration of intermittent renewable energy resources into future power system and smart grids. More details: www.fglongatt.org.

9. Costo, contacto e inscripciones

El valor del curso es de 30 UF (treinta unidades de fomento) por persona y se dictará siempre y cuando se inscriban 15 asistentes. Teniendo en cuenta que el Departamento de Ingeniería Eléctrica dispondrá equipos con licencias individuales para ejecutar el curso de manera práctica y expositiva.

Para egresados del DIE-UdeSantiago se aplicará un 10% de descuento.

Se incluye el almuerzo para no demorar el curso con el horario de colación.

Personal de contacto en Santiago de Chile, Chile:

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