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Modeling of wind turbine generators

PSS®SINCAL

At a glance

PSS®SINCAL power system analysis software can support you in conducting wind power simulation and integration studies.

The challenge

Large scale integration of wind power worldwide and particularly in Europe (with more than 300 GW planned until 2030) makes it increasingly important to evaluate the resulting effects on power systems. Influencing factors are:

- Intermittent generation characteristics
- Larger distances between generation and load
- Need for additional reserve power
- Increasing power transfer and changes in overall power flow
- Impact on power system stability
- Reduction of reactive power reserves
- Harmonic disturbances
- Influence on protection settings

Simulation software which adequately reflects the special characteristics of wind power plants can assist in evaluating these factors before connecting wind generators to existing networks.

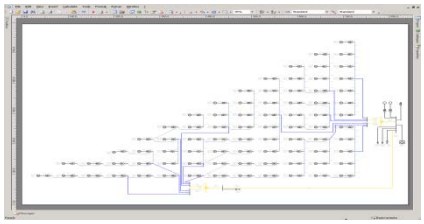

Figure 1: Wind farm model

Our solution

Siemens PTI has made its in-depth experience in wind power modeling available in PSS®SINCAL. It comprises models and analysis methods to facilitate system studies.

- For feasibility studies, where the decision for a specific generator type has not been made, generic models for squirrel-cage induction generators, doubly-fed induction generators (DFIG) and direct driven synchronous generators are provided. These consider e.g. pitch control, wind speed, crowbar, PWM controllers, etc.
- In case of detailed interconnection studies, models from specific vendors have to be used. In general, these (encrypted) models are provided by the vendors, e.g. as MATLAB® Simulink® dlls. PSS®SINCAL allows for embedding them directly into the simulation (see figure 2).

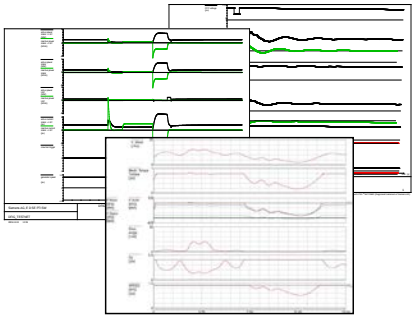

Figure 2: Simulation results using embedded, MATLAB® Simulink® vendor model

Grid Code Compliance Toolbox

PSS®SINCAL offers one overall network model provides the whole range of simulation modules necessary for the complete scope of investigations, such as load flow and short-circuit calculation, as well as harmonics, protection and dynamic simulation (RMS and EMT). Enhanced comparison capabilities across different scenarios (e.g. full power output, no wind operation, voltage drops to different levels and different times periods, harmonic distortions) are provided.

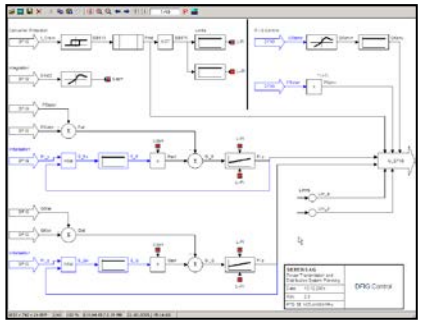

Figure 3: Example for a DFIG controller

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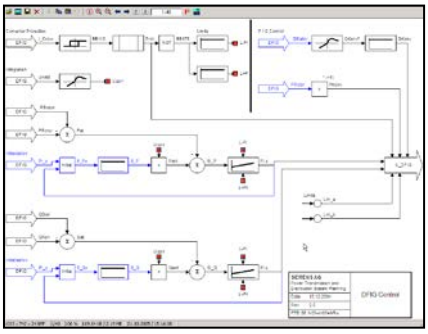

Figure 3: Example for a DFIG controller

Dynamic simulation

Dynamic simulation is a key aspect. To fulfill the grid code and / or connection agreements – besides the steady-state requirements checked in multiple operation scenarios in load flow analyses – it is also necessary to study different dynamic simulations, including unbalanced short-circuit cases (see figure 4).

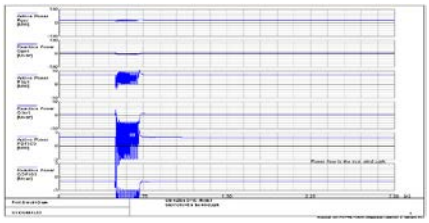

Figure 4: Simulation of unbalanced short circuits

Transient stability simulation (see figure 5) enables fault ride through (FRT) performance and voltage and / or reactive power control studies to evaluate grid code compliance. The same applies for voltage fluctuation studies for the respective transformer.

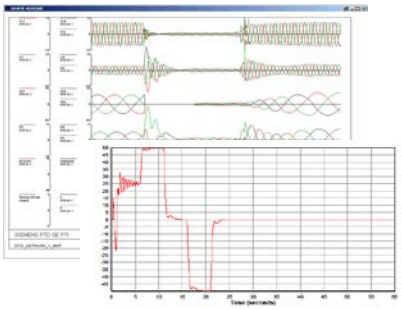

Figure 5: Electromagnetic transient simulation

Harmonic studies

In order to simulate the reactive capability of the wind power plant and to compare it to the grid requirements, or to select the correct reactive power compensation equipment (such as SVCs) in addition to the filters to limit the harmonic emission according to standards like IEC 61400-21, extended harmonic studies have to be performed in a frequency range of 100-2500 Hz. Resonance networks remarkably reduce the modeling efforts.

Grid connection models

Different connection methods, like classical HVDC, AC or VSC-HVDC, can be modeled in detail (see figure 6).

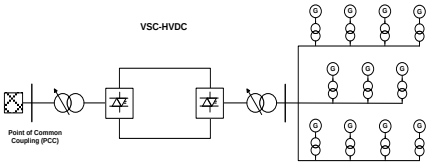

Figure 6: HVDC connection model

In addition, neutral grounding and safety earthing studies, e.g. at the transformer platforms, might be required.

Data import and export

Extensive import and export options (including data base interfaces and Microsoft® Excel® spreadsheets) allow the easy setup of a model. PSS®SINCAL especially supports the import and export of PSS®E file formats and the new XML-coded ENTSO-E CIM Profile.

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Energy Management Division
Freyeslebenstrasse 1
91058 Erlangen, Germany

For more information, please contact
power-technologies.energy@siemens.com