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Wind power

Wind power plant design and system integration

At a glance

The demand for renewable energy, especially wind, is growing faster than in previous years, not only in North America and Europe but all over the world. Developers are pushing the boundaries of technology, producing larger and more efficient wind turbines, while investors are eyeing a great deal of new wind energy projects, onshore as well as offshore.

The effect of integrating such large amounts of variable and partially predictable wind energy makes electrical power systems more vulnerable and poses challenges for developers and network operators.

While developers seek reliable wind power plant design that can guarantee their return-on-investment, network operators demand very strict technical guidelines to ensure safe operation.

Siemens Power Technologies International (Siemens PTI) combines its renowned expertise and extensive experience in network consulting to offer customers:

- complete solutions for wind power plant design and system integration
- ensured, reliable and cost efficient performance of wind power plants

Furthermore, Siemens PTI is the ideal partner during all phases of development and operation of a wind power plant.

The challenge

From the design all the way to implementation of wind power plants (WPP), several technical and economical aspects need to be taken into consideration.

In the design phase, optimal dimensioning of plant components must be performed so that performance expectations are fulfilled while investment and operation costs are minimized.

Network operators require WPPs to perform according to specific technical guidelines included in a grid code. The performance of a WPP at the point of interconnection is directly related to the technical characteristics of the WPP network components. Consequently, a suitable and validated model is required to study the performance of WPPs.

Our solution

Siemens PTI offers its consulting services for the design of WPPs as well as the integration of these plants in the power system.

Our solution bridges the gap between design requirements for the internal network of the WPP and reliable performance and control of the plant amid full compliance with the grid code.

Furthermore, our vast experience in generation interconnection studies means assuring optimal integration of WPPs into the grid.

Wind power plant design
The following studies are typically offered for the design of the internal network of WPPs and analysis of the behavior of plants as a whole:

- network design (cables, transformers, compensation)
- design of protection systems and definition of settings
- reliability focused design and availability analysis of WPP
- estimation of energy losses
- wind turbine modeling and validation
- grid code compliance investigations (reactive power capability, fault ride-through)
- power quality, including harmonics analysis (on-site measurements and design of mitigation measures) and voltage fluctuation investigation
- insulation coordination, overvoltage protection
- lightning protection system design
- neutral grounding design and dimensioning
- earthing design for personnel safety
- dimensioning of auxiliary system and equipment
- arc flash study
- plant level controller design

Moreover Siemens PTI offers its expertise to support solving technical problems during project realization or afterwards.

Integration of wind power plants in the grid

Siemens PTI also offers network studies for the integration of WPPs into the grid, such as:

- power flow study
- contingency analysis
- transfer analysis
- transient stability analysis

Application Example

Siemens PTI has performed design and integration studies for a considerable number of WPPs, especially large offshore projects, worldwide. Here are some examples:

- Bard offshore WPP, capacity 400 MW, in Germany
- Lincs offshore WPP, capacity 250 MW, in UK
- Greater Gabbard offshore WPP, capacity 500 MW, in UK

An essential requirement for any network analysis is a suitable model. For a WPP, a model represents the technical characteristics of the internal network of the plant all the way to the point of interconnection, and includes the individual wind turbine models. Siemens PTI's PSS® Product Suite offers a wide selection of standard turbine models. In addition, Siemens PTI develops customized turbine models and validates them for the most accurate and realistic performance.

Grid code demands that WPPs comply with a set of technical requirements at the point of interconnection. Specific investigations evaluate performance of the WPP from several technical perspectives and help devise optimization.

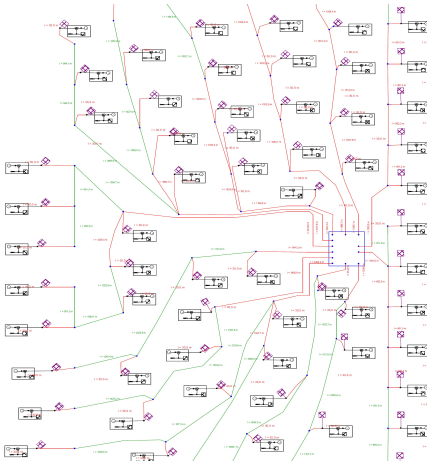

Figure 1: Network topology of an offshore WPP modeled in PSS®SINCAL

Dynamic stability studies assess the dynamic behavior of the WPP under system disturbances. Included in these analyses is the comparison of WPP performance with fault ride-through requirements of grid code.

Harmonics analysis examines harmonic voltage levels produced by the WPP combined with background harmonics at the point of interconnection against grid code requirements and other standards (e.g. IEC 61000). Mitigation measures, such as design and implementation of harmonic filters, are devised in case the requirements are not met. The overall performance of the WPP with the mitigation measures is then verified.

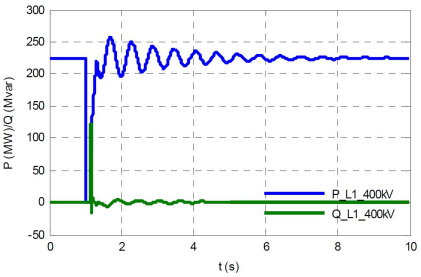

Figure 2: Real and reactive power curves during a fault-ride-through simulation

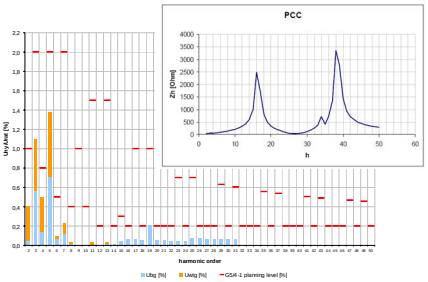

Figure 3: Harmonic spectrum at PCC

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