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Grid code compliance

System interconnection studies for large generators or loads

At a glance

As electric power system loads continue to increase and older power plants are retired, a significant number of new power generation units, including conventional fossil-fired and renewable energy units, will be connecting to the transmission network.

Siemens Power Technologies International (Siemens PTI) can help customers gain a better understanding of the ability of their transmission network to accommodate new generator interconnections.

The challenge

New power plants may be located far away from load centers. This may create a technical challenge for the existing transmission network, which may not have been designed to handle large amounts of power transfer from remote locations. Furthermore, the variable nature of renewable generator output may introduce frequency and voltage control issues that are not often encountered with conventional thermal or hydro power plants.

Many transmission system operators have developed interconnection criteria or grid codes to ensure that the interconnection of a proposed generation project will not negatively impact the reliability performance of the power system.

Our solution

Siemens PTI has extensive experience in performing generation interconnection studies for clients in many countries. We have conducted studies involving power flow, short circuit, transfer limit, transient, and dynamic stability analyses - associated with the interconnections of conventional steam/gas turbine plants, hydro plants, nuclear plants and wind farms.

Besides providing consulting services, Siemens PTI is also the developer of advanced software tools in the PSS® Product Suite that are used by system operators and electric utilities around the globe for power systems analyses. Our powerful and comprehensive software contains a vast library of simulation models for power system equipment and their controls, including conventional generators, wind generators, photovoltaic units and FACTS devices.

We can start with a high level review of the transmission capacity in the immediate neighborhood of one or more proposed plant sites to determine if the plant's output can be exported to the network with no or limited restrictions.

The second type of analysis is a feasibility study, which may include steady-state power flow and short-circuit analyses of the transmission network with the proposed plant interconnected. This will provide the power plant developer or owner with preliminary information on whether major investments will be required to reinforce the transmission network for interconnecting the project.

A more detailed analysis is the system impact study. This study consists of more thorough steady-state analyses that consider a range of system operating scenarios, as well as dynamic simulations that evaluate the transient and dynamic performance of the network to ensure compliance with the transmission network criteria or grid code.

Before a power plant can be interconnected, a facility study may have to be performed, during which the equipment requirements for interconnecting the project and, if necessary, for upgrading the network to maintain reliability, are better defined. This step typically involves the interconnecting transmission network owner who will provide input on their equipment preferences and practices.

Technical issues

An interconnection study looks at the potential impact of a proposed generation project on the performance of the network.

Steady-state performance

Transmission facilities are expected to be within their respective thermal-normal and emergency ratings, and system voltages should be maintained within normal and emergency ranges.

The analysis typically requires hundreds or even thousands of power flows that look at a variety of conditions, including the outages of major components in the network. Our power system analysis tools are designed for such type of contingency analyses and produce graphs and reports that can be reviewed by our experienced consultants. Very often, tests are performed with and without the proposed power plant, so that the relative impact of the project can be easily identified. Situations that do not meet the criteria will require corrective action, which may involve the addition of new transmission equipment or replacement of old ones.

Transient and dynamic stability

The introduction of a power plant to the network may cause dynamic stability problems after network disturbances. This requires dynamic simulations. Stability problems may require changing power plant equipment parameters or protection settings. Dynamic stability problems may require the application of power system stabilizers. Our consultants are experienced in calculating critical fault clearing times and tuning power system stabilizers to address such concerns.

Short-circuit level

The addition of generating equipment may increase the short circuit currents in the network and, as a result, may cause the duties of existing power system protection equipment to be exceeded. Short circuit calculations are performed to determine if circuit breakers in the existing system need to be replaced as a result of new power plant interconnections.

Voltage support

Conventional synchronous generators are typically able to provide adequate voltage support to the transmission network. Hence, their interconnections are generally not of concern, in terms of system voltage performance, unless the power transferred from the power plant to the load centers creates significant voltage drop in the network. On the other hand, some renewable generating units have limited voltage control capabilities. Power flow and dynamic simulation studies are performed to identify such voltage problems so appropriate voltage support equipment can be selected. Our power system analysis software tools include models for many types of wind turbines and solar voltaic units, as well as static var compensators (SVCs) and static synchronous compensators (STATCOMs).

An example of a reactive power capability study for a wind farm is shown in Figure 1. The green curves show the maximum reactive power capability in the inductive and capacitive regions. The brown curve indicates the grid code requirements. In this case, appropriate measures must be taken to reach grid code compliance.

Voltage ride-through

Many transmission owners and operators are now requiring renewable energy units to continue operating during severe voltage dips in the network.

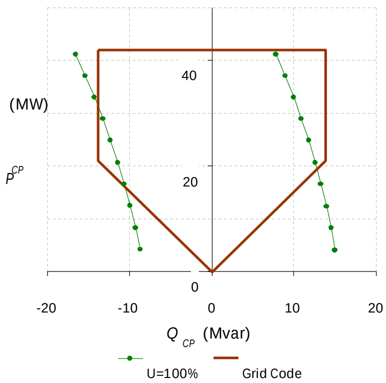

Figure 1: Example of reactive power capability curves

Often, the interconnection study of a wind farm will include a voltage ride-through test to ensure it can perform within the criteria of the transmission entity. An example of such criteria is shown in Figure 2.

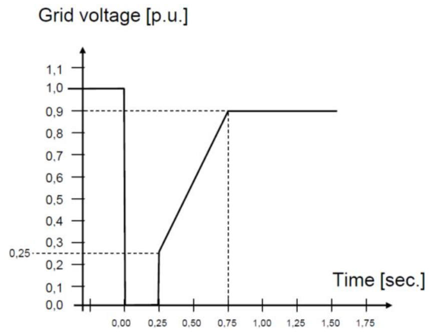

Figure 2: Example of a fault ride-through requirement curve

Frequency response

While most conventional generators can respond rapidly to system frequency changes, wind- and solar-powered generators have limited ability to vary their output. Some grid codes are now requiring renewable generators to ramp their outputs up or down in response to system disturbances.

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