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Analysis of Quality Performance of We3000 Power Plant of Window Power Station

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Annotation: This article provides information on models for providing quality indicators of voltage through reactive power coverage in wind power plants.

Key words: wind power plants, reactive power, active power, capacitors, wind energy, wind turbines.

Like conventional power plants, wind power plants must ensure the stability and reliability of the power supply systems connected to them and the quality of electricity needed to meet the needs of consumers connected to the network. As a result of the development of wind energy, their capacity has suddenly reached 10 MW, and the number of wind generators in each power plant is not less than 100. Therefore, the impact of wind power plants on the network was very small and any disturbances caused by such stations were considered to be commensurate with the noise level.

The number of wind turbines and wind power plants has increased significantly over the last 30 years. However, due to the lack of rules, standards and guidelines at the beginning of the development of wind energy, the stability and quality of electricity in the networks connected to the wind farm is increasing.

Today, many new wind farms are equipped with modern technology, which allows them to ensure optimal operation and supply high quality electricity. Advances in power electronics ensure the flexibility and orderly management of power supply systems. Modern wind power plants have functions such as reactive power compensation, static load switching equipment, energy storage and frequency adjustment.There are many aspects to the operation of wind farms, including the quality of electricity. When connecting wind farms to the grid, it is important to understand what the source is that affects the quality of electricity. In general, the voltage and frequency should be kept as stable as possible. In addition, we consider the possibility that the resulting voltage and current deterioration due to harmonics, as well as the loss of energy in the network due to the operation of wind generators[1,2,3].

For example, wind generators are selected based on the needs of the wind power infrastructure. If the wind speed is fast, the infrastructure will be designed to work with small and scattered wind generators. Due to the small size of wind farms, the rules governing electricity generation are not strictly followed. For example, if the number of wind generators is small, only a compensating capacitor is required to cover the reactive power in each generator. As the number of wind generators increases and the use of wind energy leads to changes in rules, standards and regulations, more attention is paid to the stability and quality of electricity in the network connected to the wind power plant.Various power supply schemes are used to analyze the interaction between wind power plants, reactive power compensation, and the power supply network, and the results of such modeling schemes may not meet current requirements. The power supply system has now been upgraded to improve compatibility with wind farms.

Since wind power plant loads fluctuate throughout the day, the best solution is to use reactive power compensation to maintain normal voltage levels. Reactive power compensation can reduce reactive power imbalances that affect

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How do wind farms affect the transmission network and what is the reactive power compensation when the wind changes? To answer these questions, let's look at modeling several wind farms[4,5,6].

Thus, during the modeling process, 24 wind farms with a capacity of 1 to 70 MW were connected to the transmission network. Each wind farm is characterized by the following features:

Wind characteristics (turbulence level, average speed, air density, etc.)

Differences in wind speed depending on the location of each wind farm in the area;

Features of wind generators (Cp-TSR) and asynchronous generator;

P-Q characteristics (active and reactive power) of each wind power plant.

Let us consider the change in wind speed and the change in voltage with a comparison between compensated and non-compensated systems. The term "compensated" refers to the use of static reactive power compensation to improve the voltage performance of wind farms[17,18].

18 MVar coverage capacitors will be installed at the HPP transmission substation. Other lines have a reactive power coverage of 77.3 MVar. The total load in the region (including the surrounding small settlements) is about 259 MW or 46.4 MW. Modeling was performed for uneven wind speeds to cover the entire region. For wind power systems, IEC 61400-21 specifies that the voltage at its oscillations within a 10-minute measurement interval should not exceed ± 5% of nominal.Normal reactive power charging can be done using static capacitors, modified capacitors, or static compensators. The simplest way to compensate for reactive power is with a static compensator (SCRM). Given the right inductive and capacitance values, SCRM can produce reactive power from Q to + Q. For example, with a 100 Mvar capacitor and a 200 Mvar inductor, smooth control can be achieved within ± 100 Mvar. If a negative reactive power is not required, a combination of a 100 Mvar capacitor and a 100 Mvar inductance will provide a range from 0 to + 100 Mvar.

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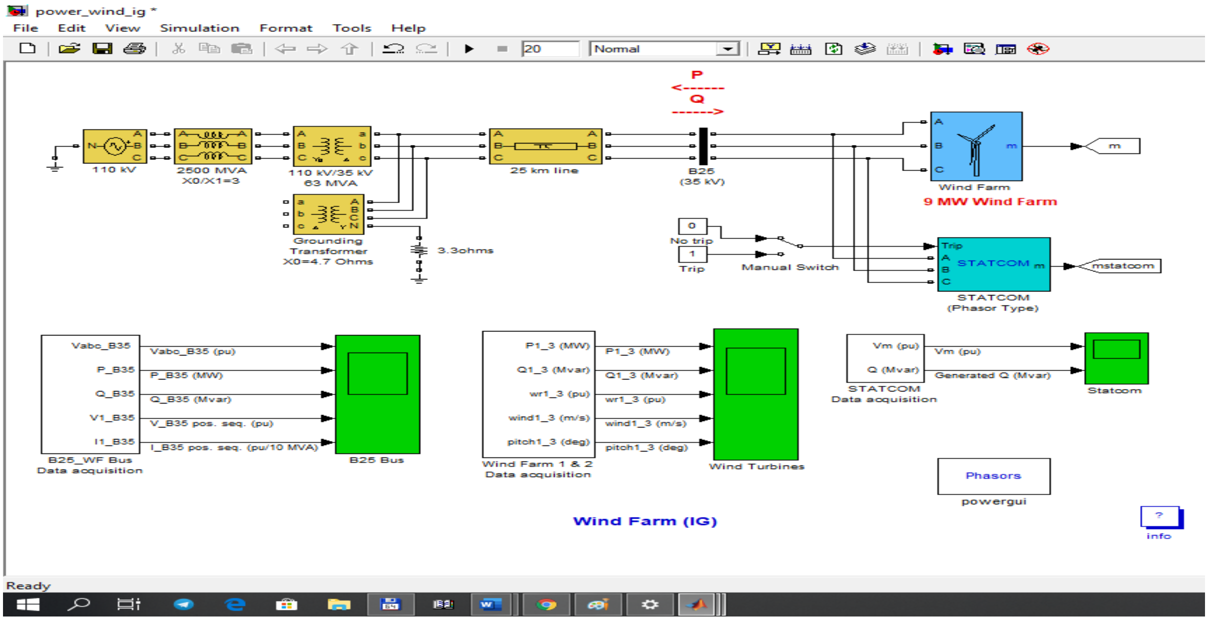
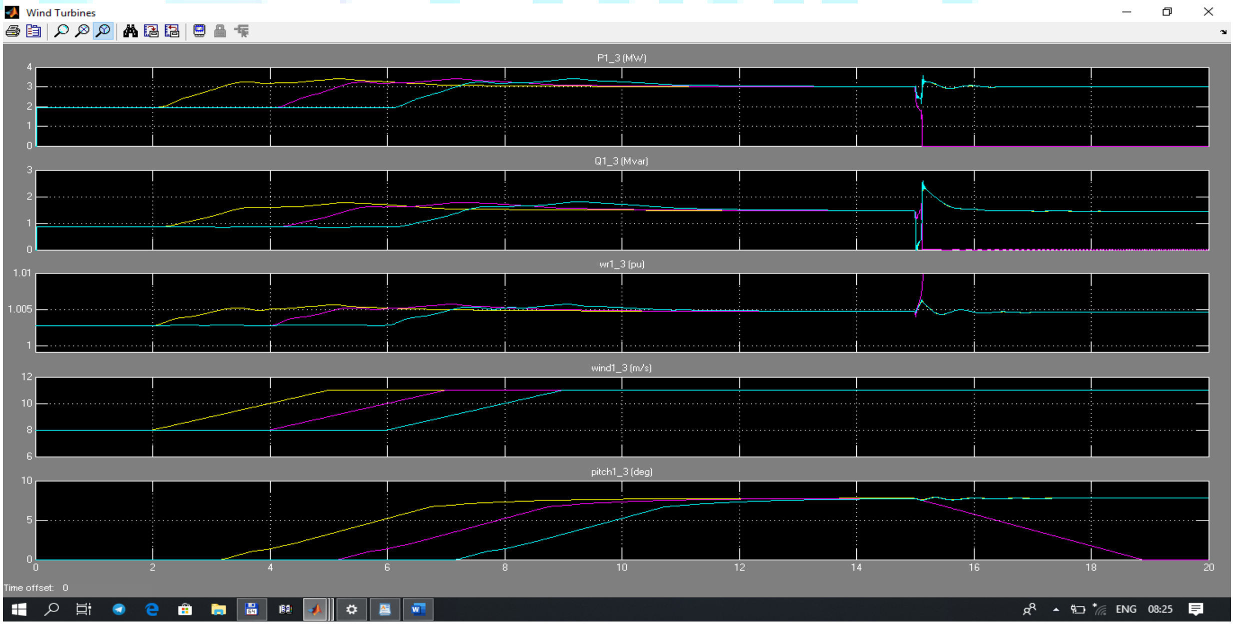


Figure 1.

The wind farm, consisting of six 1.5 MW wind turbines, will be connected to a 35 kV distribution system and transmitted to the 135 kV network via a 35 kV transmission line. A wind farm with a capacity of 9 MW is imitated by three pairs of 1.5 MW wind turbines. Wind turbines use rotor short-circuited induction generators (IG). The stator is connected directly to the 50 Gts network and the rotor is driven by an alternating wind turbine. The control angle is controlled to limit the generator output power for winds exceeding the rated speed (9 m / s). To generate power, the IG speed must be slightly higher than the synchronous speed. The speed varies between at least 1 pu and at full load of 1,005 pu. Each wind turbine has a protection system that monitors voltage, current and machine speed.



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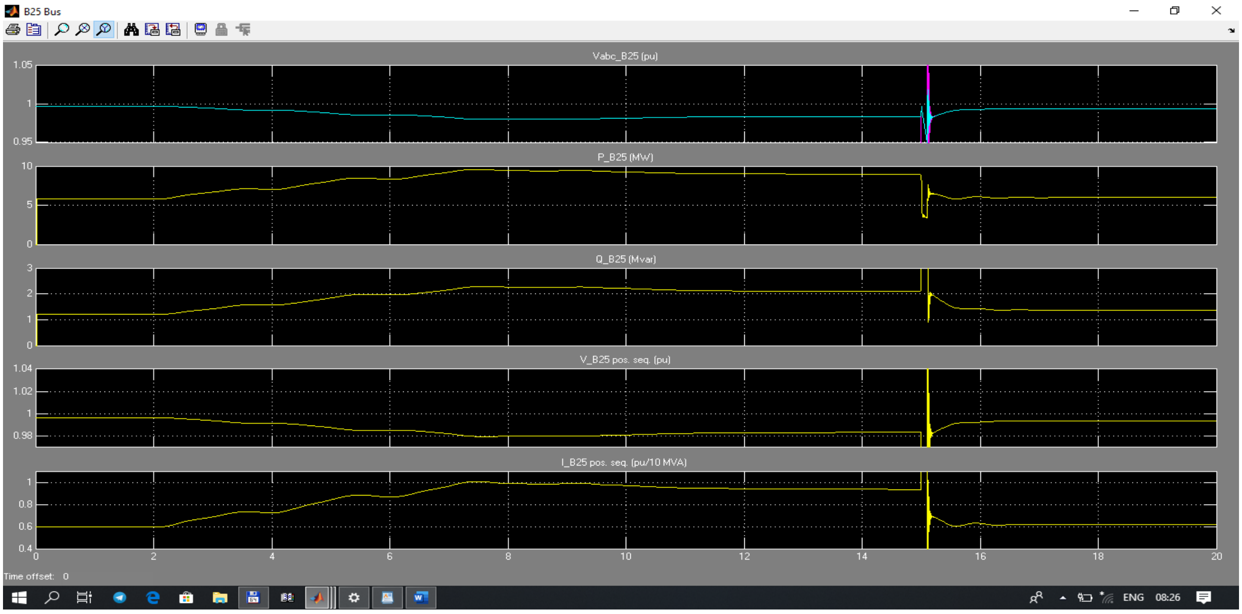

Figure 2.

The reactive power received by the IG is partially covered by capacitor banks connected to the low-voltage busbar of each wind turbine (400 kV for each pair of 1.5 MW turbines). The remaining reactive power required to maintain the 35 kV voltage close to the B35 bus1 pu is provided by the 3% Mvar STATCOM with a 3% savings.

In the following figure, we consider two parameters for a turbine and a generator. Each wind turbine block represents two 1.5 MW turbines. The mechanical power of a turbine is expressed as a function of the turbine speed from 4 m / s to 10 m / s for wind speed. The nominal wind speed (1pu = 3 MW) giving the rated mechanical power is 9 m / s. The wind turbine model and the statcom model are models that allow the study of temporary stability types with long modeling times[7,8,9,14,15,16].

The wind speed applied to each turbine is controlled from Wind 1 to Wind 3. Initially, the wind speed is set at 8 m / s, then for "Wind Turbine 1" it starts at t = 2 s, the wind speed increases to 11 m / s in 3 seconds. The same is done for wind turbine 2 and turbine 3 with a delay of 2 seconds and 4 seconds, respectively. Then, at t = 15 s, a temporary fault is applied to the low voltage terminals (575 V) of the Wind Turbine 2.

The model has the ability to monitor the signals within the "Wind Turbines", which monitors the active and reactive power of each turbine, generator speed, wind speed and angle. The active power generated by each pair of turbines gradually increases (along with the wind speed) to reach 3 MW in about 8 seconds. During this time, the speed of the turbine will increase from 1.0028 PU to 1.0047 PU. Initially, the angle of the turbine blades is zero degrees. When the output power exceeds 3 MW, the angle is raised from 0 to 8 degrees to return the output power to the nominal value. It can be observed that the accumulated reactive power increases with increasing active power. At rated power, each pair of wind turbines wins 1.47 Mvar. For a wind speed of 11 m / s, the total transmission capacity measured by the B35 bus is 9 MW, and the statcom maintains a voltage of 0.984 pu in the production of 1.62 Mvar[10,11,12,13].

Thus, in modeling, the operation of the protection system is as follows at T = 15 s, the phase phase is applied at the terminals of the wind turbine 2, which causes the turbine to move at a speed of t = 15.11 s. If you look inside the "Wind Turbine Protection" block, you can see that it started with AC protection. Once Turbine 2 is commissioned, Turbines 1 and 3 will continue to generate 3 MW each.

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