Experiment No. 9

Objective: To analyze the effect of distributed generations in microgrids.

Software: MATLAB Simulink

Theory: A Wind Turbine Asynchronous Generator (Induction Generator) in an isolated network is a type of system used in small-scale wind power applications where the generator operates independently from a grid. This setup commonly uses a squirrel-cage induction generator, which converts mechanical energy from wind turbines into electrical energy. The key advantage of this system is its ability to self-excite, enabling it to generate power even without external electrical supply, making it suitable for remote locations.

In an isolated network, the generator operates at variable speed depending on wind conditions. As the wind turbine drives the induction generator, reactive power compensation (usually with capacitors) is required for the system to maintain voltage levels, as induction generators do not inherently regulate their voltage.

System Description: The isolated microgrid system consists of wind turbine asynchronous generator, synchronous condenser, primary load, and variable secondary load, as given in Table I.

Table I System parameters

Component	**Rating**
induction generator	480 V, 275 kVA
synchronous condenser	480 V, 300 kVA
primary load	50 kW
variable secondary load	0 to 446.25 kW

Analysis: In a wind-turbine asynchronous generator in an isolated network, variations in load and wind speed can significantly affect both voltage and frequency, as the system lacks direct grid support to stabilize these parameters.

1. Effects of Load Variations:

Voltage: As the load increases, the reactive power demand increases. Since asynchronous generators don't inherently supply reactive power, the voltage tends to drop. Inversely, a decrease in load can lead to an over-voltage condition as the system's reactive power demand drops.

Frequency: A rise in load demands more mechanical power from the turbine. If the available wind energy is insufficient, the generator slows down, causing the system frequency to drop. Conversely, if the load decreases, the turbine may speed up, raising the frequency above nominal levels.

2. Effects of Wind Speed Variations:

Voltage: At higher wind speeds, more mechanical power is available, increasing the electrical output of the generator. However, voltage may fluctuate if wind speeds are erratic, as the generator's reactive power generation isn't directly controlled.

Frequency: Wind speed variations directly affect the rotor speed of the asynchronous generator. Higher wind speeds cause the rotor to accelerate, leading to a frequency increase, while lower wind speeds reduce rotor speed, causing the frequency to drop.

Problem Statement:

(i) Using MATLAB Simulink, model an isolated network with a wind turbine asynchronous generator, synchronous condenser, primary load, and variable secondary load.

(ii) Simulate the variations in load and wind speed, and observe its effect on voltage and frequency at point of common coupling.

(iii) Interpret the voltage and frequency data under each scenario.

Simulation:

1. Run “power_windgen” in the command window.
2. Change the Stop Time to 10 s.
3. Change the switching time of the primary load circuit breaker to 5 s.
4. Add a step block for the wind speed, keeping step time at 2 s changing from 10 m/s to 11 m/s.

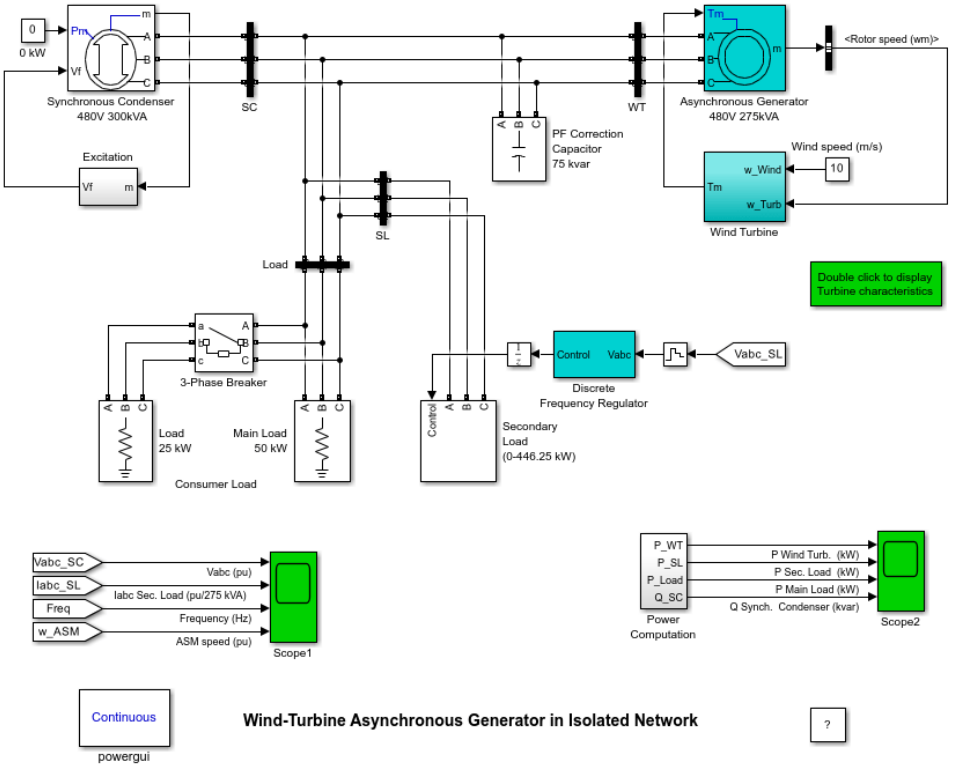

Fig. 1. Wind-Turbine Asynchronous Generator in Isolated Network