Tutorial 5 Solution

1) Why induction generator need to absorb significant amount of reactive power?

Answer:

To supply the magnetizing current to create a magnetic field.

To supply the reactive current consumed by leakage inductance.

2) When connecting a small-scale DG to a distribution network, why the issue of voltage rise is less severe for induction generator (without PE converter)?

Answer:

To generate power, induction generator needs to absorb significant amount of reactive power, which tends to cause a voltage drop.

3) How can reactive power affect the voltage variation with a more inductive power line?

Answer:

With inductive power lines, the generation of reactive power will increase the voltage; while the consumption of reactive power will decrease the voltage.

4) Why the voltage regulation by reactive power is less effective in LV system than MV system?

Answer:

Since the X/R ratio is lower, the voltage drop of LV system is mainly determined by active power.

5) An induction generator is connected to an infinitive distribution bus bar with a cable inductance of 1 mH and a resistance of 0.31 Ω.

Assume the reactive power consumed by magnetizing current has been fully compensated by a shunt capacitor. Defining the maximum output power of the DG is P_{max}, and the corresponding reactive power consumption after the capacitor compensation is Q_{max}. What is the ideal ratio of Q_{max}/P_{max} to make the output voltage rise 0.

Answer:

$$X = 2\pi f L = 2\pi \times 50 \times 1\text{mH} = 0.314$$

$$\frac{X}{R} = \frac{0.31}{0.31} = 1$$

Considering the voltage rise is

$$\Delta U_{gen,max} = R \times \left(1 - \alpha \frac{X}{R}\right) P_{max}$$

To make the voltage rise 0, the idea ratio of

$$\alpha = \frac{Q_{max}}{P_{max}} = \frac{R}{X} = 1$$

6) Briefly explain the motivation of Virtual Power Plant.

Answer:

Aggregate the small-scale distributed generation so they can be more visible to the operator and power market.

7) Briefly describe the objectives of microgrid

Answer:

- To be a good "citizen" to the external utility grid
  - Provide controllable/scheduled power flow
  - Provide auxiliary support to utilities:
  - frequency support, reactive power support

      – Comply with grid requirement: fault-ride-through, etc.
- To be perfect power supplier to the internal end-user
    - Provide uninterrupted power supply even during a utility fault
    - Able to sustain a prolonged islanding operation automatically at any time

8) State the main economical constraint for the implementation of microgrid

Answer:

   The cost of energy storage system.

9) Briefly explain why DC microgrid control strategy is easier than AC?

Answer:

   There is no concern on frequency and reactive power.