Solution - Tutorial 2

1) List the variables that can be used to model a renewable power plant in “power flow” (or load flow) analysis.

Answer:

Voltage magnitude (voltage);
Voltage angle (angle);
Active power;
Reactive power.

2) List the key assumptions in power flow analysis:

Answer:

The power system is operating at steady state with linear impedance and fixed frequency.

3) Why iterative numerical methods are being used in power flow program?

Answer:

The solution of power flow analysis involves solving non-linear equations. It is difficult to find an analytical solution to such equations whereas iterative methods can provide numerical solutions.

4) What are the general steps to carry out power flow analysis with the aid of a power flow software.

Answer:

Gathering data : (generators , transformers, lines, cables and loads) in per unit
Creating a systematic model
Setting up cases: (load and generation conditions, position of transformers taps and setting of other control devices, etc.)
Running the program
Analyzing the results

5) How can DG affect distribution losses when the capacity is still limited.

Answer:

Small-scale DG can reduce the losses.
The generation is closer to the load so the power losses to supply local loads from DG are much less than from remote centralized generator through transmission line.
The current/power carried by local distribution lines are likely to be reduced, resulting in lower I^2t losses.

6) Which one is more of a concern in a distribution network with significant DGs, overvoltage or undervoltage?

Answer:

Overvoltage. Low-voltage distribution lines in distribution network tend to be more resistive and the voltage across the distribution line is more determined by the active power (current) carried by the power lines. Active power injection from the end user will contribute to a voltage rise; when the local load is light, overvoltage may occur.

7) Use an example to explain why the biggest reduction in losses is obtained when the DG is located at the same premises as the consumption?

Answer:

EG is connected closer to the consumption than conventional large-scale generation

The power is delivered via a shorter distance with smaller impedance hence a reduction in losses.

Examples can be: Domestic CHP, rooftop solar panels, household micro-wind turbine, etc.

8) A radial distribution feeder is shown in Figure 1. Assume the impact of reactive power is negligible. The consumption data for the loads is provided in Table 1.

(a) Determine the "first hosting capacity" of all the feeders.

(b) Using the data provided in Table 2 to determine the "second hosting capacity" (when the actual overload starts to occur) for all feeder sections.

(c) Based on the results obtained in part (b), determine the threshold at which circuit breaker at location A will trip.

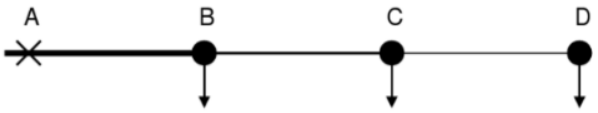

Fig. 1

Table 1- Consumption data

	B	C	D
Maximum Active Power	2.5 MW	3 MW	2MW
Minimum Active Power	600 kW	800 kW	500 kW

Table 2- Conductor data

Feeder Section	**AB**	**BC**	**CD**
Maximum permissible Power	10 MVA	6MVA	4 MVA

Answer:

(a) for feeder section CD the first hosting capacity is:

$P_{gen.max} = P_{cons,max} + P_{cons,min}$= 2MW+500 kW=2.5 MW

For feeder section BC, the whole downstream load should be considered, that is, load D plus load C:

$P_{gen,max}$= (3+2 MW)+ (500+800kW) = 6.3 MW

For feeder section AB:

$P_{gen,max}$= (3+2 +2.5MW)+ (500+800+600kW) = 9.4 MW

(b)

The second hosting capacity for feeder section CD is :

$P_{gen,max} = P_{max,limit} + P_{cons,min}$ = 4 MW+500kW= 4.5 MW

The second hosting capacity for feeder section BC is :

$P_{gen,max}$= 6 MW+(800+500 kW)= 7.3 MW

The second hosting capacity for feeder section AB is :

$P_{gen,max}$= 10 MW+(800+500+600 kW)= 11.9 MW

(c)

When the second hosting capacity for the first feeder section is exceeded (above 11.9 MW), the circuit

breaker at location A will trip. This is when the maximum generation coincides with minimum consumption.

9) In determining the hosting capacity of Distribution network (the maximum amount of DG that can be connected), why losses are less of a concern than overloading?

Answer:

An increase in losses is not really a concern, neither from a cost viewpoint (because losses are a minor part of the total cost of electricity supply) nor from an environmental viewpoint (because the gain by using renewable energy or energy-efficient sources is much higher than the increase in losses).

A minor increase in losses is not a serious concern compared to a minor overload of a line (in which the line will trip, often resulting in an interruption for one or more customers)

10) List different techniques to improve the hosting capacity when overloading is the main concern by introducing DG

Answer:

- Increasing the loadability (costly)
  – Using wires with a larger cross section to increase the thermal rating of a line
  – Adding a new line in parallel
- Building new connections (costly)
- Intertrip schemes (complex) (The DG connection status will be switched on/off according to the change of the network configuration)
- Energy Management System (EMS)
- The use of power electronic technology: MVDC for instance
- Dynamic loadability according to ambient temperature/weather conditions