Distributed Generation (DG)

Pembankit Terdistribusi
Distributed Generation (DG)

• Production of electricity near the consumption place
• Resources are renewable energy and cogeneration (simultaneous production of heat and electricity)
• Renewable energy is energy from natural resources (wind, sunlight, tides, wave, geothermal heat and biomass).
DG Thecnologies

• Micro Hydro
• Wind Turbin
• Photovoltaic Panel
Micro Hydro

• use the energy in flowing water to produce electricity or mechanical energy

• The hydraulic power $P_0$ (kW) and the corresponding energy $E_0$ (kWh) over an interval time $\Delta t$ (h) will be
  
  $P_0 = \rho \cdot g \cdot Q \cdot H_0$ (kW)
  
  $E_0 = \rho \cdot g \cdot H_0 \cdot \Delta t$ (kWh)

• Where $H_0$ – net head (m); $Q$ - the discharge diverted to the power plant (m$^3$/s)
Micro Hydro

- The final power \( (P_F) \) delivered to the network is smaller than the available hydraulic power \( (P_0) \)
  \[ P_F = \eta \cdot P_0 \]
  - \( \eta = \) the global efficiency
Micro Hydro
Wind Turbine

• The wind kinetic energy is transmitted to the blades, which drives a shaft coupled to an electric generator that transforms (converts) the wind power into electric energy.

• The main parts of a wind turbine are: rotor, blades, nacelle (contains all major components such as shaft, gearbox and the electric generator) and tower.
Wind Turbine
Wind Turbine

• The power that can be generated by a wind turbine are:
  – \( P = 0.5 \cdot \rho \cdot A \cdot C_p \cdot w^3 \cdot \eta_g \cdot \eta_b \) (W)

• Where
  – \( \rho \) - air density [kg/m3];
  – \( A \) - rotor swept area, exposed to the wind (m2);
  – \( C_p \) - coefficient of performance (depending on turbine);
  – \( w \) - wind speed (m/s);
  – \( \eta_g \) - generator efficiency;
  – \( \eta_b \) - gearbox efficiency.
Photovoltaic Panel

- A photovoltaic panel transforms the light from the Sun directly into electric energy.
- The output power of photovoltaic panels can be mathematically expressed as
  \[ P = \eta \cdot I \cdot S_n \text{ (W)} \]
- Where:
  - \( \eta \) - efficiency of the panel;
  - \( I \) – insolation (the power produced per unit square meter of the panel);
  - \( S_n \) - number of panels.
Photovoltaic Panel
Optimization of DG

• The optimization aims to minimize the electricity production costs ensuring that the load is served reliably.

• Objectives
  – min \{ C(P) \}

• Restriction
  – \( P_i^{\text{min}} \leq P_i \leq P_i^{\text{max}} \)
  – \( Q_i^{\text{min}} \leq Q_i \leq Q_i^{\text{max}} \)
  – \( U_i^{\text{min}} \leq U_i \leq U_i^{\text{max}} \)

• Where :
  – \( C(P) \)- the cost of generated power ($/MWh);
  – \( P \)- active power generated (MW);
  – \( Q \)- reactive power generated (MVAr);
  – \( U \)- rated voltage (kV)
Test System

- hydroelectric (G1 having 72 MW), thermoelectric (G2 having 50 MW) and a wind turbine (G3 having 1 MW). There is also a 100 MW consumer (C1).
Typical Micro Grid Model

DS = Distributed Storage
DG = Distributed Generation
CCHP = Combined Cold Heat Power
Distributed Hybrid Energy System
Smart Micro Grid Model

- Wind Power
- Solar Power
- Micro Turbine
- Energy Storage
- Control centre
- Management (IP) Network
- Electricity Network
- SUPPLY
- DEMAND
- Sensitive
- Adjustable
- Sheddable
Daftar Pustaka
