Term Project

Phase 1

The intended project is a modeling and simulation for hybrid Photovoltaic (PV) and Wind Turbine (WT) grid connected power generation system.

As a student, you will receive requirements on phases. This document is to describe the first phase you should work at.

Simply, your system can be described as Fig. 1 below.

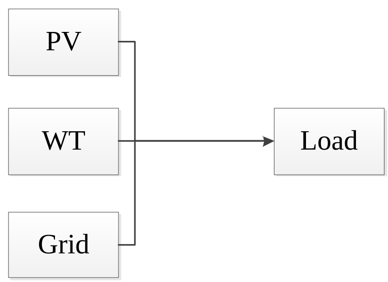

Fig. 1: Hybrid system configuration

Provided Data:

You will be provided with data vectors for solar radiation in W/m2, wind speed in m/s, and load profile in kWh/hour (you can assume it as power). All data vectors will represent one year simulation (8760 hour). Moreover, you will be provided with technical data specifications for PV and WT, and all related costs.

PV system model

Power produced from the PV plant P_{PV} can be calculated through equation (1), where V_{OC} is the open-circuit voltage and I_{SC} is short-circuit current I_{SC}. Both can be calculated using equations (2) and (3).

$$P_{PV}(t) = N_{PV} V_{OC}(t) I_{SC}(t) \eta_{PVInv.} FF(t) \quad (1)$$

$$V_{OC}(t) = V_{OC.STC} - K_V (T_C(t) - T_{ref}(t)) \quad (2)$$

$$I_{SC}(t) = \left[I_{SC.STC} + K_I \left(T_C(t) - T_{ref}(t) \right) \right] \frac{G(t)}{1000} \quad (3)$$

$$T_C(t) = T_A(t) + \left[\frac{(NCOT - 20)}{800}\right] G\ (t) \quad (4)$$

WT modelling

Power produced from WT is strictly related to the wind speed distribution v at the tower height H_{WT}; in particular, v is given by equation (5), H_r is the reference height wind speed measurement, where you can assume it 13m, and ζ equals to 0.8.

$$v = v_r.(H_{WT}/H_r)^{\xi} \quad (5)$$

While, the output power from WT, indicated in the following as P_{WTout}, is calculated by exploiting (6) and (7):

$$P_{WT}(t) = \frac{1}{2}\rho A\, v(t)^3 C_P(t)\eta_{WT\,Inv}.\eta_{Mech}. \quad (6)$$

$$P_{WTout} = \begin{cases} 0 & v(t) < v_{ci} \\ P_{WT} & v_{ci} \le v(t) < v_{ra} \\ P_r & v_{ra} \le v(t) \le v_{co} \\ 0 & v_{co} < v(t) \end{cases} \quad (7)$$

For both WT and PV models, use the data provided in Table 1.

Table 1: PV and WT specifications and simulation parameters

Wind Turbines			
P_{rated} [kW]	10	30	50
$P_{maximum}$ [kW]	15	45	75
Rotor diameter [m]	8	10	12
C_p	0.42	0.42	0.42
Tower height [m]	12	18	18
η_{WTInv}, η_{Mech}	0.98, 0.94		
PV modules			
P_{max} [W]	250		
V_{oc} [V], V_{pm} [V]	37.6, 30.3		
I_{sc} [A], I_{pm} [A]	8.9, 8.26		
NOCT [^{o}C]	47.5		
K_V [1/^{o}C], K_I [1/^{o}C]	-0.00351, 0.0053		
η_{PVInv}	0.98		

Phase 1 output requirements:

1. Develop a function to simulate PV module (one module $250W_p$)
2. Develop three functions to simulate the three WTs (10, 30, and 50kW)

Hint: be smart and well organized in your functions since you will use it later in the coming phases.