EXERCISE N° 3

DISTRIBUTED STORAGE MANAGEMENT

Objective:

Developing a simple control strategy for charge/discharge of battery storage connected to a prosumer with PV generation.

Problem Description:

Assume an aggregated prosumer whose consumption and generation profiles are provided (in an Excel file attached to this exercise test). The generation resource is PV and the consumption is more residential. Consider a battery storage with 1 kW nominal power (P_n) and 1 kWh nominal capacity (E_n). Designing a simple controller for charge and discharge of battery is requested considering the following parameters for the battery:

- Maximum State-Of-Charge: SOC_{max} = 90%
- Minimum State-Of-Charge: SOC_{min} = 10%
- Battery constant efficiency: η=0.9
- Initial State-Of-Charge at time 00:00 SOC_0 = 50%

The local controller reads the total amount of active power exchange and calculates the required amount of active power to be injected or absorbed by the battery, as the amount of discharge or charge respectively.

The power measurement is periodically (every 15 minutes) sent to the battery controller.

Implement the basic algorithm described hereinafter to obtain the daily profiles of:

- battery charge or discharge power,
- battery State-Of-Charge,
- and the total net absorption power of the prosumer considering this storage integration.

Hints for the algorithm implementation:

In each iteration corresponding to each 15-minute time interval:

Step 1) Compare the net consumption of the prosumer with the battery nominal power; initially battery charge/discharge power can be considered equal to the amount of net consumption, BUT it cannot exceed the battery nominal power (let's call it P_b).

Step 2) If charging is needed, but SOC is already over its maximum limit, P_b (battery power output) would be zero in this time interval, and of course the new SOC corresponding to this interval remains equal to the SOC of the previous interval.

In the contrary, if discharging is requested, but SOC is already less than its minimum limit, P_b (battery power output) would be a again zero in this time interval, and of course the new SOC corresponding to this interval remains equal to the SOC of the previous interval.

Step 3) A new SOC should be calculated using the SOC of the previous interval:

$SOC_{new} = SOC_{old} + (P_b * \eta * \Delta T)/E_n$ in case of charging needed;

$SOC_{new} = SOC_{old} + (P_b * \Delta T)/ (\eta * E_n)$ in case of discharging needed;

Step 4) The new calculated SOC should be compared with the SOC limit. If the limits are violated, the new SOC should be fixed equal to the limit amount for this interval. In this case, from the equations in step 3, new P_b should be computed.

* Note that when net consumption is positive, the prosumer is in load mode and discharging of the battery is needed (if possible), and in the contrary, if the net consumption of the prosumer is negative, it is purely in generation mode, therefore the surplus energy can be charged in the battery (of course if it is possible).