Power & Air Solutions Member of T

Battery Storage Optimization for a Microgrid

Background:

You are tasked with optimizing the operation of a battery storage system for a small microgrid that includes renewable energy sources and varying electricity demand. The goal is to minimize the total cost of energy while meeting demand and adhering to battery operational constraints.

Task:

Using Pyomo and an open-source solver (e.g., GLPK or CBC), create a linear programming model to optimize the battery storage operation over a 12-hour period.

Model Elements:

1. One battery storage system
2. Solar PV generation
3. Wind turbine generation
4. Grid connection for import/export
5. 12-hour time horizon (1-hour intervals)

Fixed Parameters:

1. Time periods: 12 hours (indexed 0 to 11)
2. Battery specifications:
   - Capacity: 1000 kWh
   - Maximum charge/discharge rate: 250 kW
   - Charge efficiency: 0.95
   - Discharge efficiency: 0.95
   - Initial state of charge: 500 kWh
   - Minimum state of charge: 100 kWh
   - Maximum state of charge: 950 kWh
3. Renewable generation forecast (kW):

Hour	0	1	2	3	4	5	6	7	8	9	10	11
Solar	0	0	0	0	0	50	150	300	400	450	480	500
Wind	100	80	50	30	20	40	50	80	120	150	180	200

4. Electricity demand forecast (kW):

Hour	0	1	2	3	4	5	6	7	8	9	10	11
Demand	300	280	260	250	240	260	300	350	400	450	500	550

5. Electricity prices (Euro/kWh):

Hour	0	1	2	3	4	5	6	7	8	9	10	11
Price	0.05	0.04	0.04	0.03	0.03	0.04	0.06	0.08	0.10	0.12	0.14	0.15

Requirements:

1. Define sets for time periods.

2. Create parameters using the fixed values provided above.

3. Define decision variables for:

   - Battery charge and discharge rates at each time period

   - Battery state of charge at each time period

   - Grid import and export at each time period

4. Implement constraints for:

   - Battery energy balance

   - Battery charge/discharge rate limits

   - Battery state of charge limits

   - Energy balance (demand satisfaction)

5. Create an objective function to minimize the total cost of energy (grid import cost minus export revenue).

6. Implement the following additional constraints:

   - The battery cannot charge and discharge simultaneously

7. Solve the model using an open-source solver and display the results, including:

   - Optimal total cost

   - Battery charge/discharge schedule

   - Battery state of charge profile

   - Grid import/export schedule

   - Renewable energy utilization

Evaluation Criteria:

- Correct implementation of the model using Pyomo

- Successful solving of the model using an open-source solver

- Code organization and readability