Energy Flow Optimization

hymate Tech Task

April 30, 2025

Design and implement an optimization model for an energy system consisting of a photovoltaic (PV) system, an electrical battery, and a connection to the external electrical grid. The objective is to meet predicted electrical energy demands while minimizing costs. The connections within the system are presented in the scheme. Each arrow represents an energy flow. All energy flow and system characteristics are in kW or kWh units.
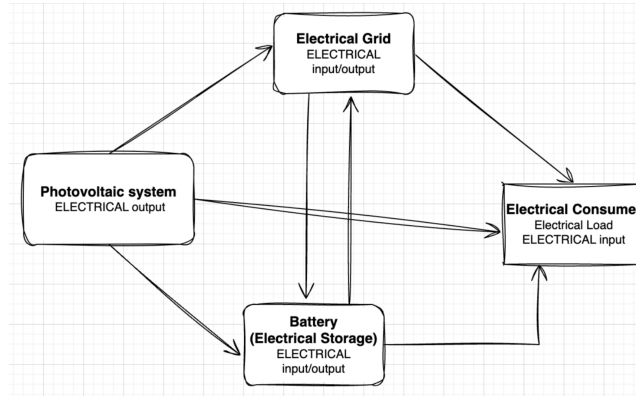

Figure 1: Graph of electricity flow between components.

1 System Description

- Photovoltaic (PV) System: Produces electricity in kWh (no losses).

- Battery:

    - Capacity: 160 kWh

    - Max charge/discharge rate: 100 kW

    - Charging efficiency: 92% (discharging is lossless)

    - Levelized cost of storage (LCOS): Consider that each kWh discharged from the battery adds a fixed cost.

- – Initial charge: 0 kWh
- Electrical Grid:
  - – Max sell power: 700 kW
  - – Max buy power: 700 kW
- Consumer: Must be supplied each hour with a specified energy demand.

You will receive the file with hourly PV production, electrical consumption, and energy prices.

Part A

Implement a linear optimization model that minimizes

$$\mathbf{Cost_{total}} = \sum_{t=1}^{n}(\mathbf{price_{buy,t}} \cdot \mathbf{energy_{bought,t}}) - \sum_{t=1}^{n}(\mathbf{price_{sell,t}} \cdot \mathbf{energy_{sold,t}})$$
$$+ \sum_{t=1}^{n}(\mathbf{lcos_t} \cdot \mathbf{energy_{discharged\_from\_battery,t}})$$

Part B (Optional)

Disallow buying and selling from the grid simultaneously.

Part C (Optional)

Only allow you to buy/sell in 100 kWh packages. Allow battery capacity to be increased (at a cost).

Deliverables

- Python Code (Pyomo suggested)
- Plots of energy flows per component per hour
- Final cost and summary table
- Description of assumptions and model
- Optional: Include answers to B/C as a markdown or PDF

Submission

Upload your solution to a public GitHub repository or share as a ZIP file. Include a README.md with:

- Setup instructions
- Model explanation
- Notes on optional parts