Day Ahead Dispatch For The Micro-grid Using MATLAB

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BASIC CONCEPTS

- **Power system:** a network which consists of generation, transmission, and distribution systems
- **Micro-grid:** a localized group of electricity sources and loads which can be connected to the main grid but can also operate autonomously
- **MATLAB:** a program, also known as Matrix Laboratory, employed to solve the optimized model

INTRODUCTION

The objective of day-ahead dispatch is to plan the usage of distributed generators and batteries in the micro-grid in order to minimize the total electricity cost in a day using the program MATLAB. The optimal model employed to do this is composed of a series of mathematical equations and inequalities that are then converted into matrix form. This model is solved by the linear programming function *linprog* of MATLAB, and the solutions are analyzed in order to reach a more realistic conclusion.

METHODS

Variable Inputs

- Power of PV (solar), WT (wind turbine) and load (users), electricity price – *non-controllable* – given parameters
- Charging or discharging power of battery, exchanged power with the main grid – *controllable* – control variables

Optimization Model

- $P_{\mathrm{WT}}(t)+P_{\mathrm{PV}}(t)+P_{\mathrm{bs}}(t)+P_{\mathrm{G}}(t)=P_{\mathrm{L}}(t)$
- $S(t)=S_0-\dfrac{\sum_{h=1}^{t}P_{\mathrm{bs}}(h)\Delta h}{E_{\mathrm{b}}}$
- $\sum_{t=1}^{T}(P_{\mathrm{bs}}(t)\Delta t)=0$
- $-0.2E_{\mathrm{b}}\le P_{\mathrm{bs}}(t)\le 0.2E_{\mathrm{b}}$
- $0.25\le S_t\le 0.9$
- $-150\le P_{\mathrm{G}}(t)\le 150$

Objective Function

$$Min\ F=\sum_{t=1}^{24}f_{\mathrm{G}}(t)=\sum_{t=1}^{24}c_{\mathrm{G}}(t)P_{\mathrm{G}}(t)$$

Variable *(t)* stands for the 24 hours in a day, *C_G* stands for the electricity price from the main grid, *P_G* stands for the exchanged power with the main grid, and *F* stands for the total electricity fee paid to the main grid in a day.

Linear Optimal Model

$$\min\ \boldsymbol{f}^{\mathrm{T}}\boldsymbol{x}$$
$$\boldsymbol{A}\cdot\boldsymbol{x}\le\boldsymbol{b}$$
$$\boldsymbol{A}_{\mathrm{eq}}\cdot\boldsymbol{x}=\boldsymbol{b}_{\mathrm{eq}}$$
$$\boldsymbol{lb}\le\boldsymbol{x}\le\boldsymbol{ub}$$

The established optimal model is converted into the same form as the left.

SOLUTION ANALYSIS

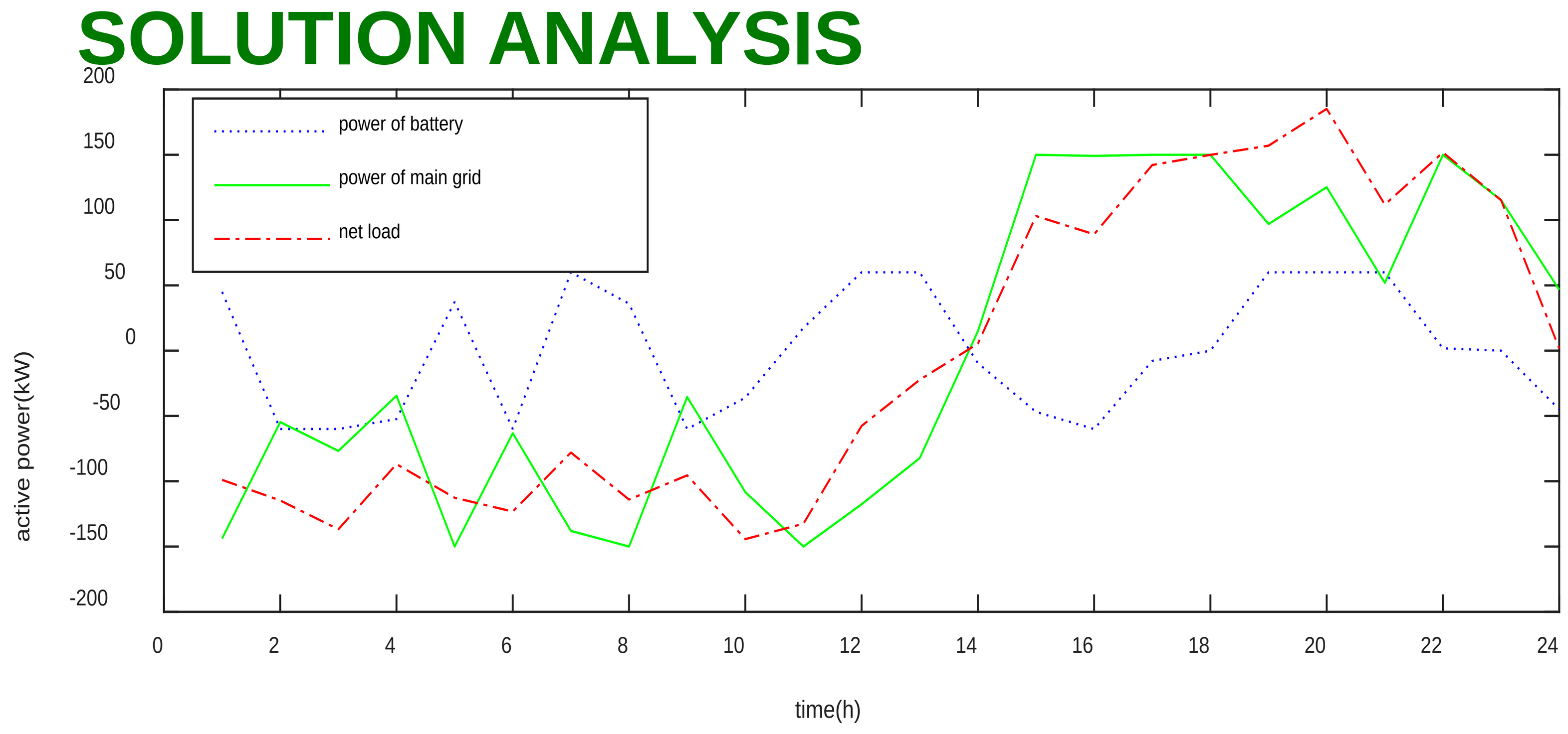

Figure 1 – Optimal Output and Net Load

- Net load represents the power of load minus the output power of PV and WT.
- Usually, the battery power's peaks and valleys correspond to the inverse of the main power grid until around 2:00 PM when the net load peaks to the point where the battery can no longer keep up, and electricity must be bought from main grid.
- The battery keeps charge in most cases from 1:00 AM to 1:00 PM when net load is negative, otherwise it keeps discharge.

Figure 2 – State of Charge of Battery and Electric Price Rate

- SoC denotes the state of charge of battery while price rate is the ratio of electric price to maximum in a day.
- When the price rate is low and the wind and solar are higher than the load, the battery charges.
- The battery discharges when the electricity cost is highest.
- Battery plays an important role in minimizing costs.