

# Rye Simulator

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## 1 Nomenclature

Decision variables have non capital letters Parameters have capital letters

### Parameters

- $P_t$  - spot market price at hour t - NOK/kWh
- $G^{energy}$  - per unit energy grid tariff - NOK/kWh
- $G^{peak}$  - peak grid tariff - NOK/kW/month
- $C_t$  - consumption per hour - kWh/h

### Decision variables

- $s_t^{battery}$  - charge level in battery - kWh
- $s_t^{hydrogen}$  - charge level in hydrogen - kWh

## 2 Assumptions

- Indefinite power can be drawn from grid
- No battery wear and tear costs
- No hydrogen wear and tear costs, no minimum charge or discharge level
- Grid tariff consists of one per unit energy cost, and a peak tariff that must be paid for the maximum peak that month
- Power can be drawn from the grid, but not injected into the grid, as the microgrid has no production license

### 2.1 Objective:

The objective is to minimize the cost of energy for the microgrid

$$\min TotalCost = \sum_t (P_t + G^{energy}) gridimport_t + G^{peak} * \max_t (gridimport_t) \quad (1)$$

## 2.2 Constraints:

There must be instant balance between consumption and access to power:

$$Wind_t + PV_t + discharge_t^{battery} + discharge_t^{hydrogen} + gridimport_t = C_t + charge_t^{battery} + charge_t^{hydrogen} + curtailment_t \quad (2)$$

There is loss in the energy conversion from electricity form electrical energy to chemical and back. The loss is 15 percent.

$$s_{t+1}^{battery} = 0.85 * charge_t^{battery} - discharge_t^{battery} \quad (3)$$

There is loss due to electrolysis and fuel cell processes in the hydrogen system. Losses are 32.5 percent.

$$s_{t+1}^{hydrogen} = 0.325 * charge_t^{hydrogen} - discharge_t^{hydrogen} \quad (4)$$

The charge/discharge and state must be within battery limits

$$0 \leq s_t^{battery} \leq s^{battery,MAX} \quad (5)$$

$$0 \leq discharge_t^{battery} \leq discharge^{battery,MAX} \quad (6)$$

$$0 \leq charge_t^{battery} \leq charge^{battery,MAX} \quad (7)$$

Same type of restrictions apply to the hydrogen system:

$$0 \leq s_t^{hydrogen} \leq s^{hydrogen,MAX} \quad (8)$$

$$0 \leq discharge_t^{hydrogen} \leq discharge^{hydrogen,MAX} \quad (9)$$

$$0 \leq charge_t^{hydrogen} \leq charge^{hydrogen,MAX} \quad (10)$$