



Integration of Fuel Cells and Electrolysers in Powergrid Applications

Stefan Bohatsch

GT-Suite Technical Conference, Frankfurt, Oct2022

true zero emissions

Marine



Passenger Vessels



Fast Ferries



Cargo Vessels



Large Yachts

Stationary



Prime Power



Back-up Power



Peak Shaving



Shore Power

Off-Road



Material Handling



Mining Equipment



Agricultural Machinery



Construction Equipment

Aviation



Passenger planes



Drones



eVTOL

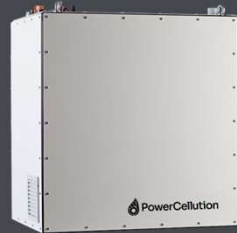


true zero emissions

POWERCELLUTION PRODUCTS | SCALABLE PRODUCT PORTFOLIO



VS-5



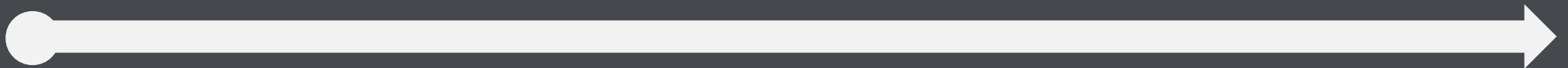
VS-30



PS-100

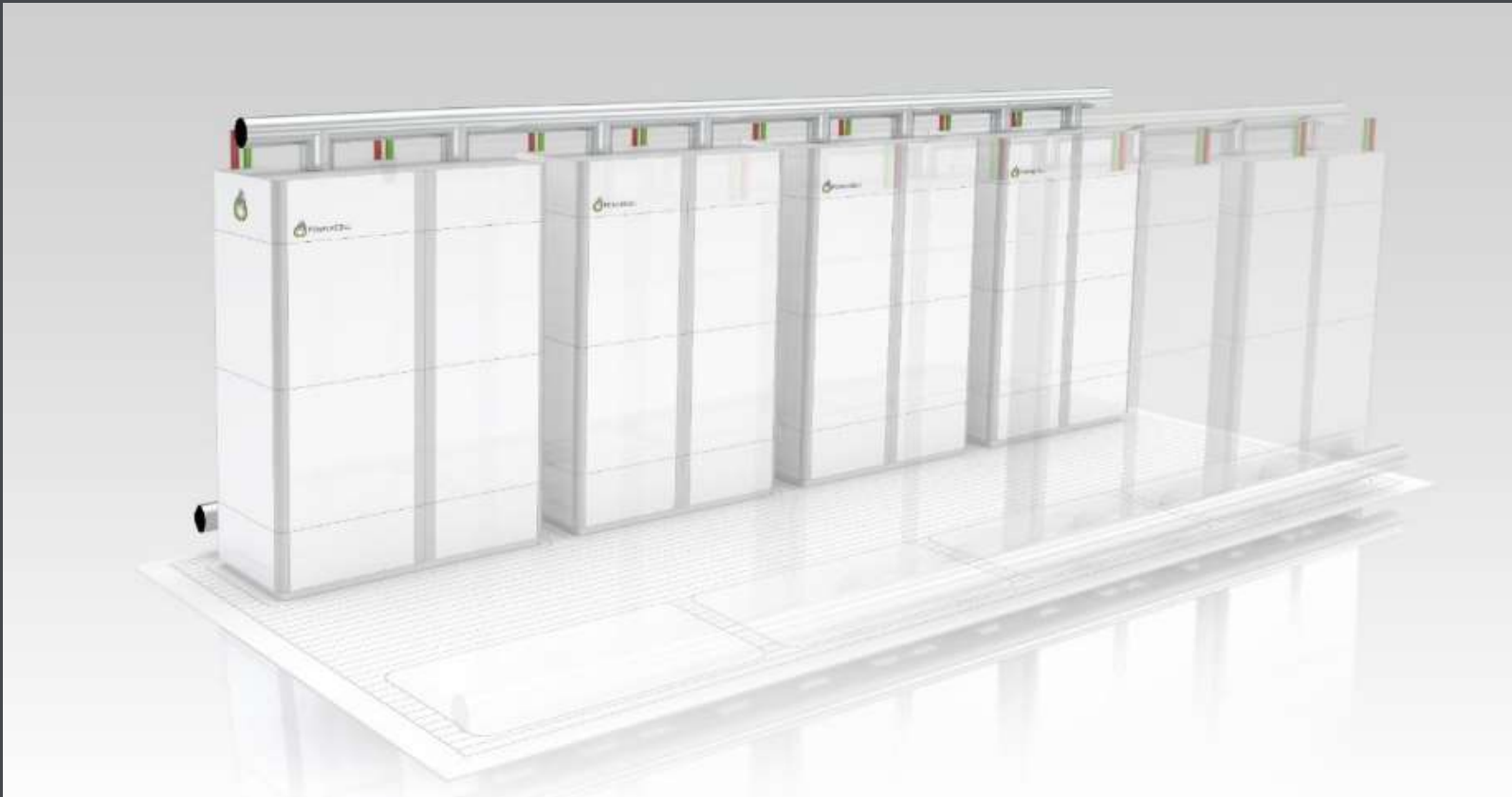


PS-200



true zero emissions

POWERCELLUTION PRODUCTS | SCALABLE ARCHITECTURE



true zero emissions

POWERCELLUTION PRODUCTS | CONTAINERIZED SOLUTIONS



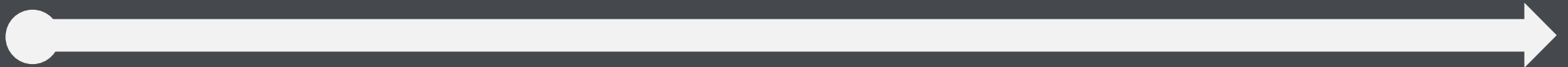
5 – 15 kW



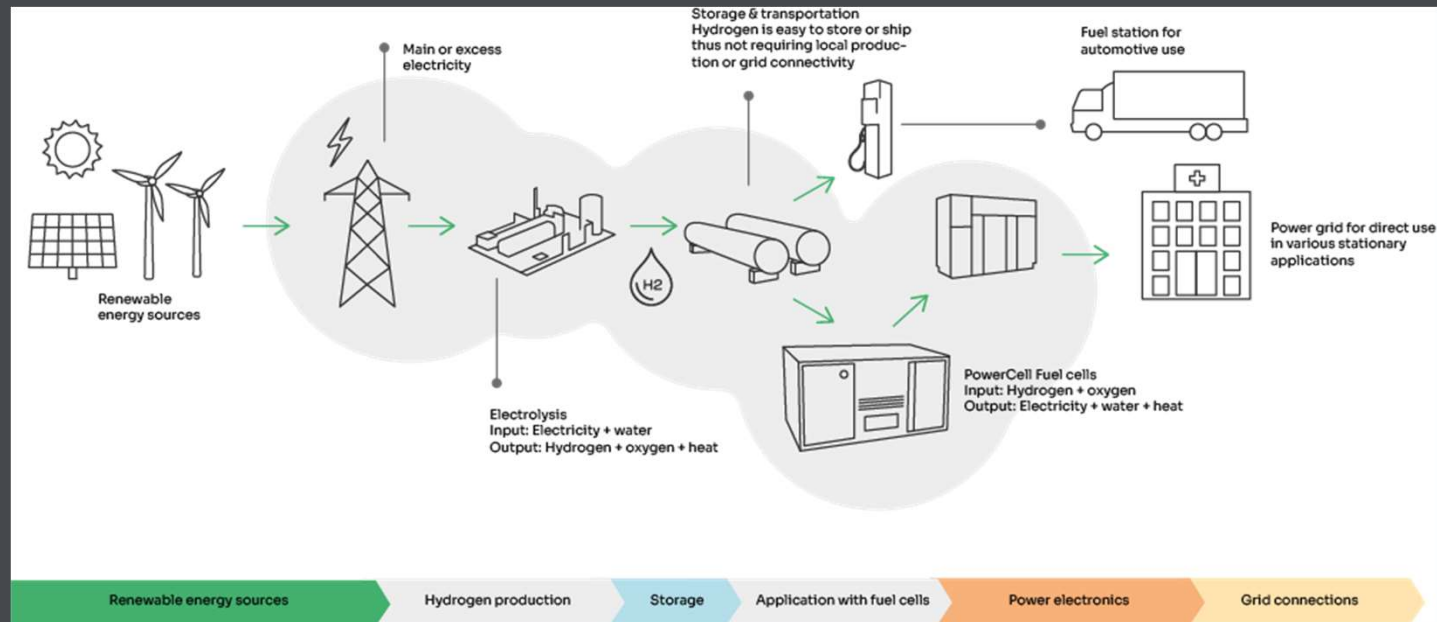
100 / 200 kW



Megawatt solutions



Powergrid Integration



Use Cases:

- Power Supply Regulation (up & down)
- Grid Stabilization
- Peak Shaving
- Off-Grid Applications (stationary & mobile)
- Backup Power



Customer Case:

2.5 GWp Solar plant in southeast Europe; calculated total energy output: 1500 hours, 2.5 MW = 3.75 GWh / year

- Total electricity upload:
2 MW @1500 hrs / year → ~4 hrs/day
- Max. continuous Power Supply:
2 MW for max. 8 hrs / day

→ Fuel Cell Capacity?

→ Electrolyser Capacity?

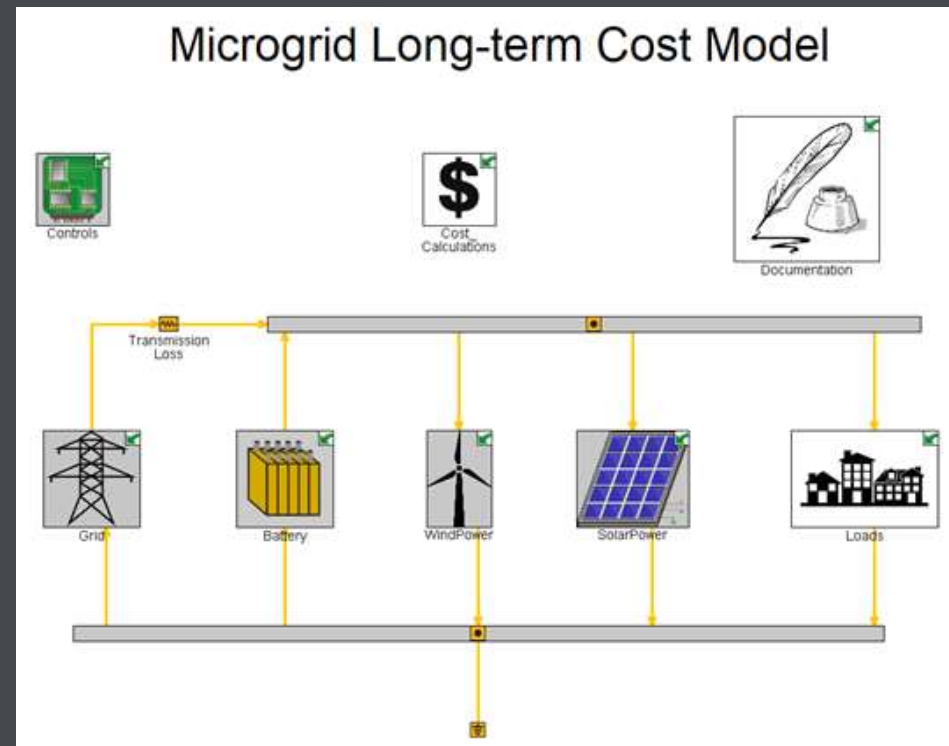
→ Storage Capacity?

→ Feasibility?



Powergrid Model

Starting Point: Micro-Grid Model
from GT-Blog by Holden
Symonds and Joe Wimmer
([LINK](#))

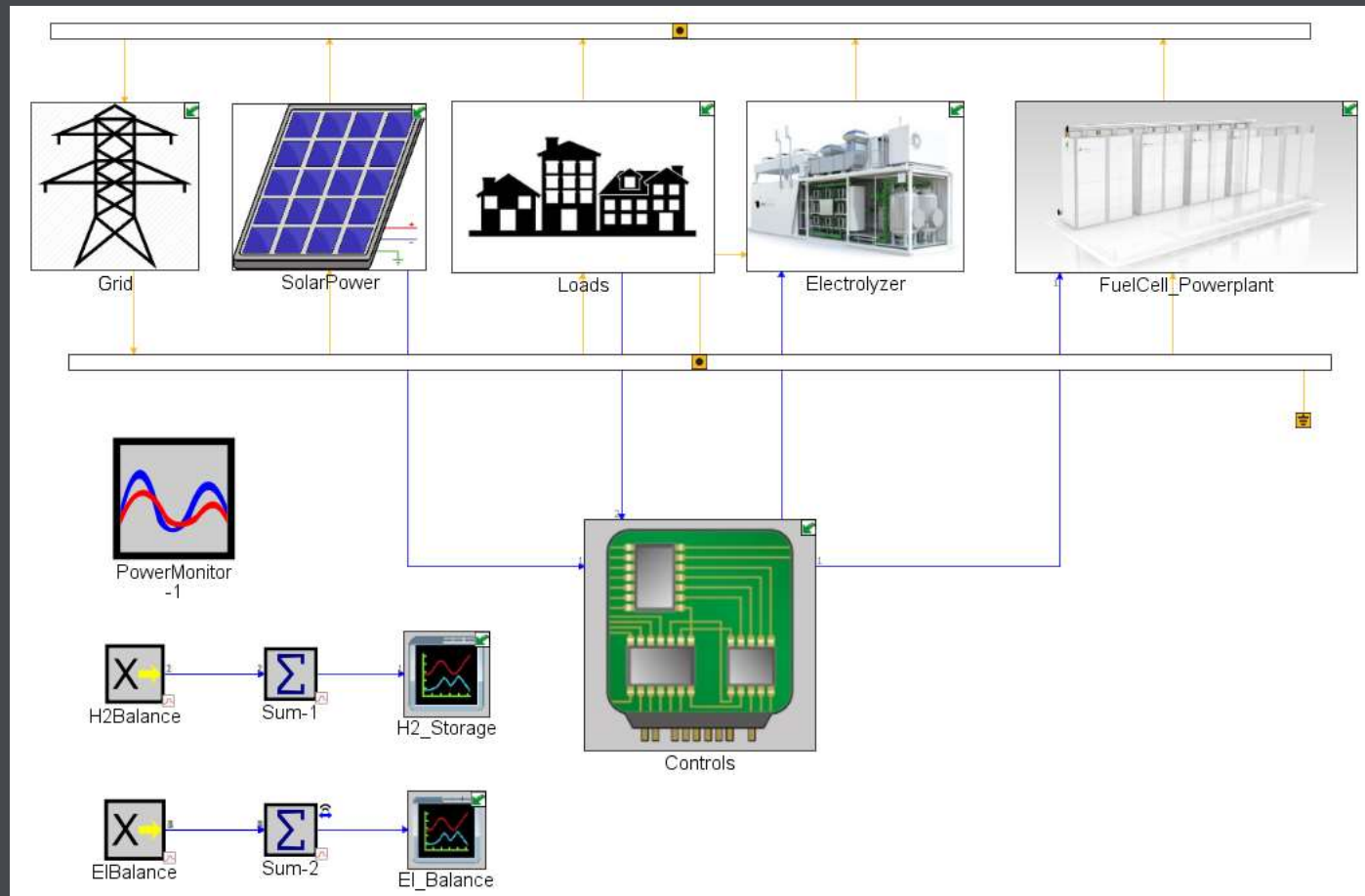


Powergrid Model

Starting Point: Micro-Grid Model
from GT-Blog by Holden
Symonds and Joe Wimmer
([LINK](#))

Modifications:

- Delete Wind Power
- Delete Battery
- Add Electrolyser
- Add Fuel Cell
- New Control Strategy



Solar Data:

Data Source: PV-GIS

Required input:

- Location
- Installed peak power
- System losses
- Type of installation

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PHOTOVOLTAIC GEOGRAPHICAL INFORMATION SYSTEM

European Commission

European Commission > EU Science Hub > PVGIS > Interactive tools

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Cursor: **Selected:** Select location!
Elevation (m):
PVGIS ver. 5.2

Use terrain shadows:
☒ Calculated horizon
☐ Upload horizon file
Switch to version 5.1

Download CSV: [Download CSV](#)
Download JSON: [Download JSON](#)
Choose File: No file chosen

GRID CONNECTED

TRACKING PV
OFF-GRID
MONTHLY DATA
DAILY DATA
HOURLY DATA
TMY

PERFORMANCE OF GRID-CONNECTED PV

Solar radiation database*
PV technology*
Installed peak PV power [kWp]*
System loss [%]*
Fixed mounting options
Mounting position *
Slope [°]
Azimuth [°]
PV electricity price
PV system cost (your currency)
Interest [%/year]
Lifetime [years]

Crystalline silicon
1
14
Free-standing
☐ Optimize slope
☐ Optimize slope and azimuth

Visualize results

Download CSV: [Download CSV](#)
Download JSON: [Download JSON](#)

Last update: 01/03/2022 Top



Solar Data:

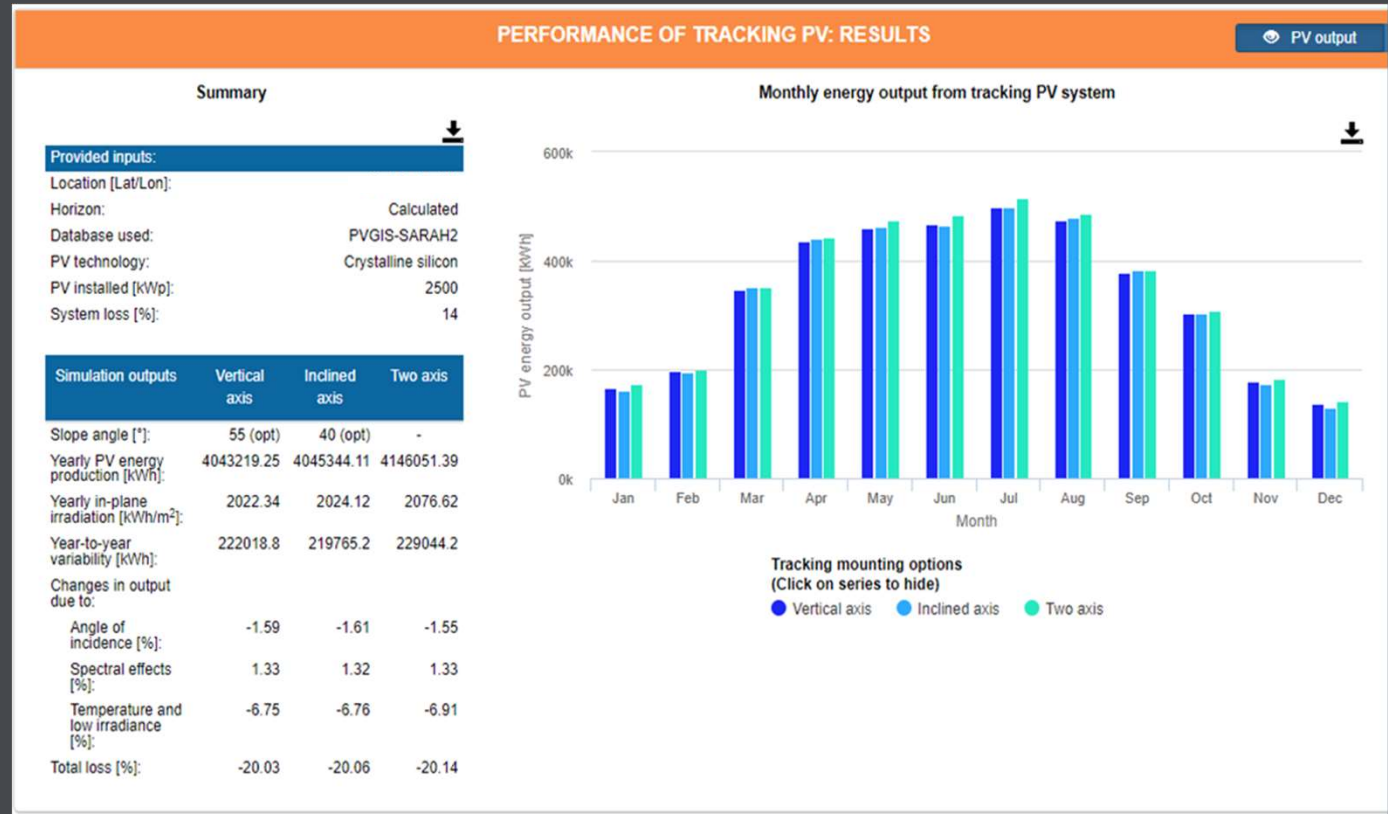
Data Source: PV-GIS

Required input:

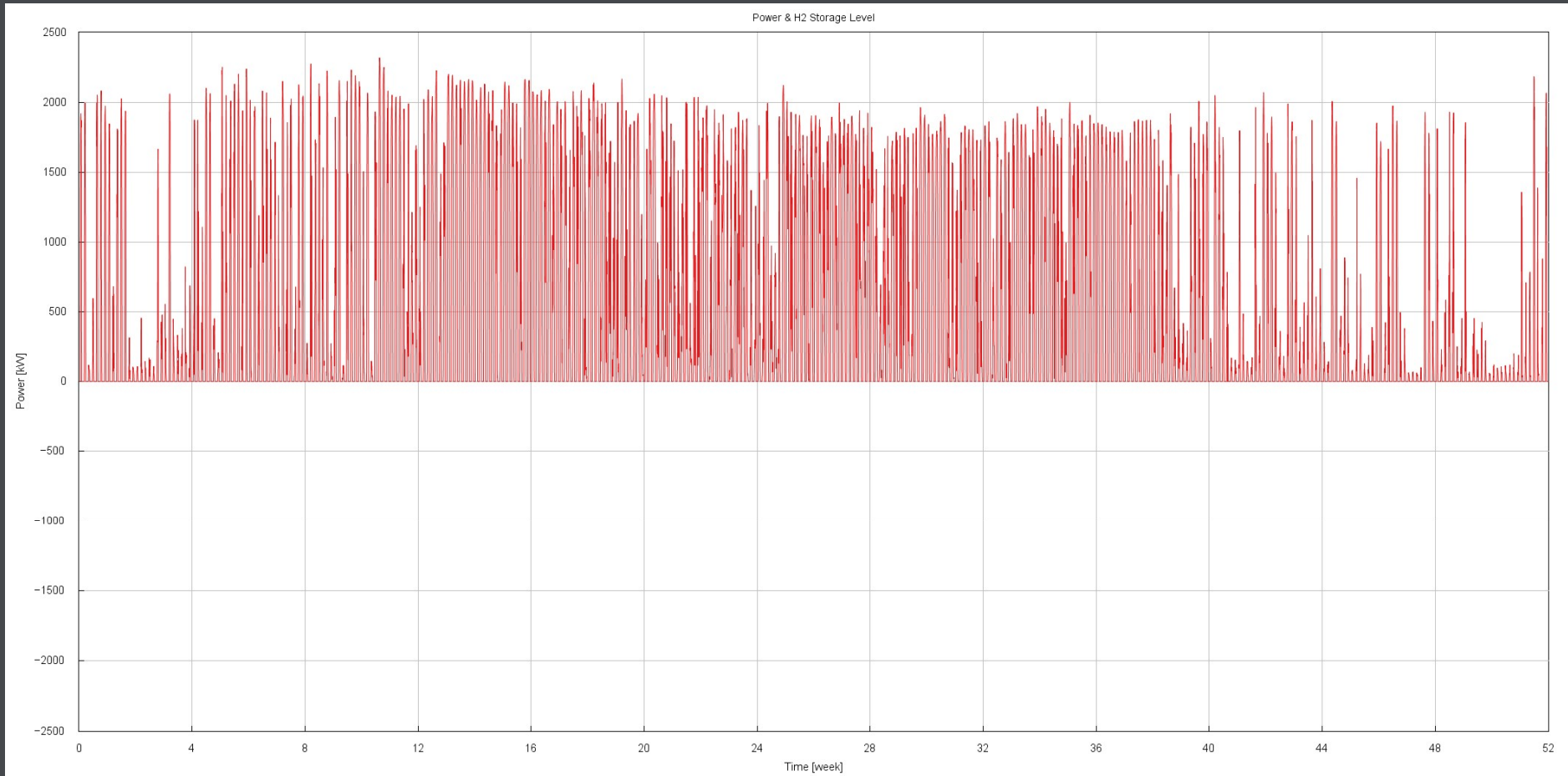
- Location
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- Type of installation

Output:

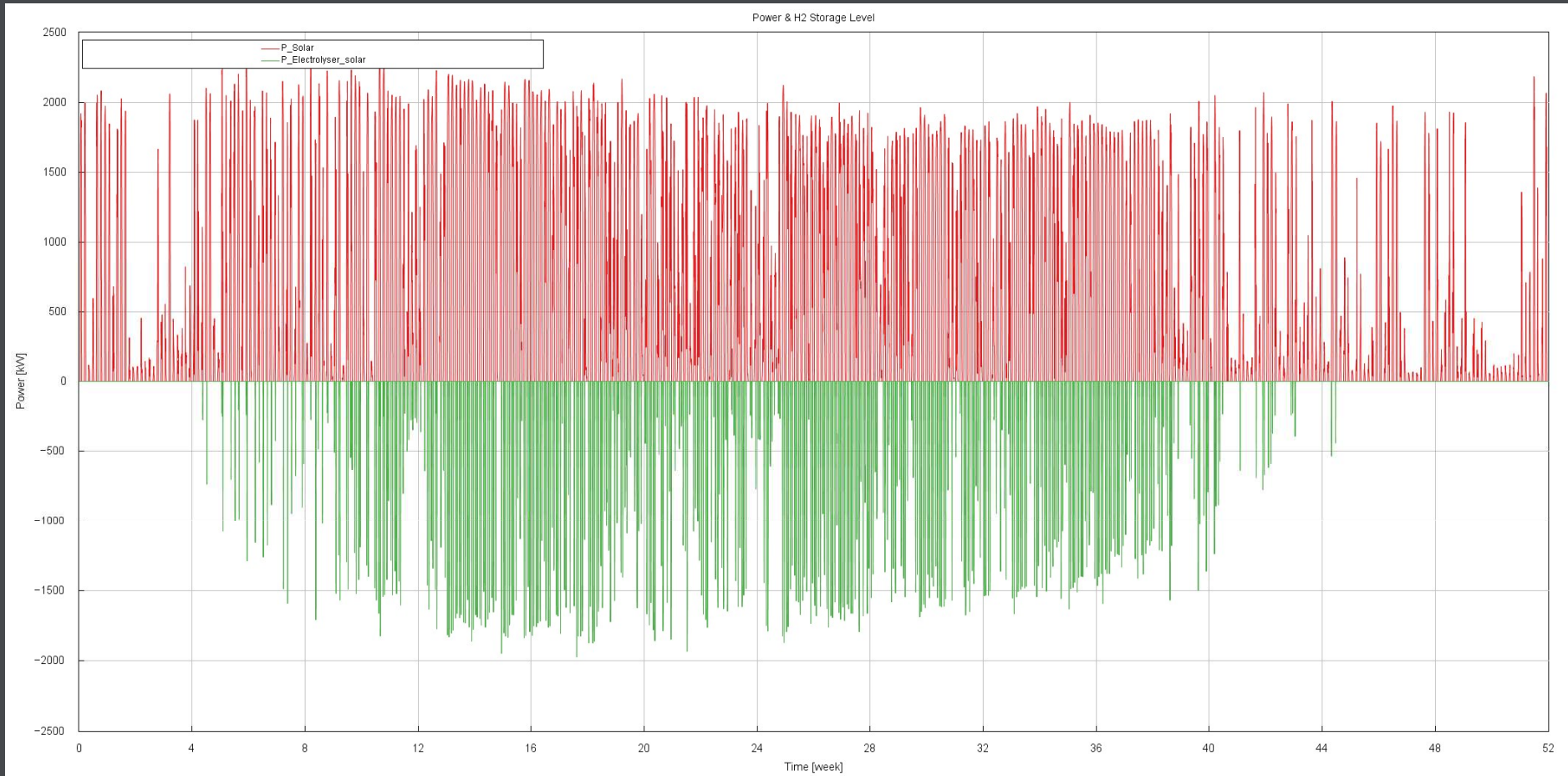
Hourly profile of available solar power based on past years (2005 – 2020)



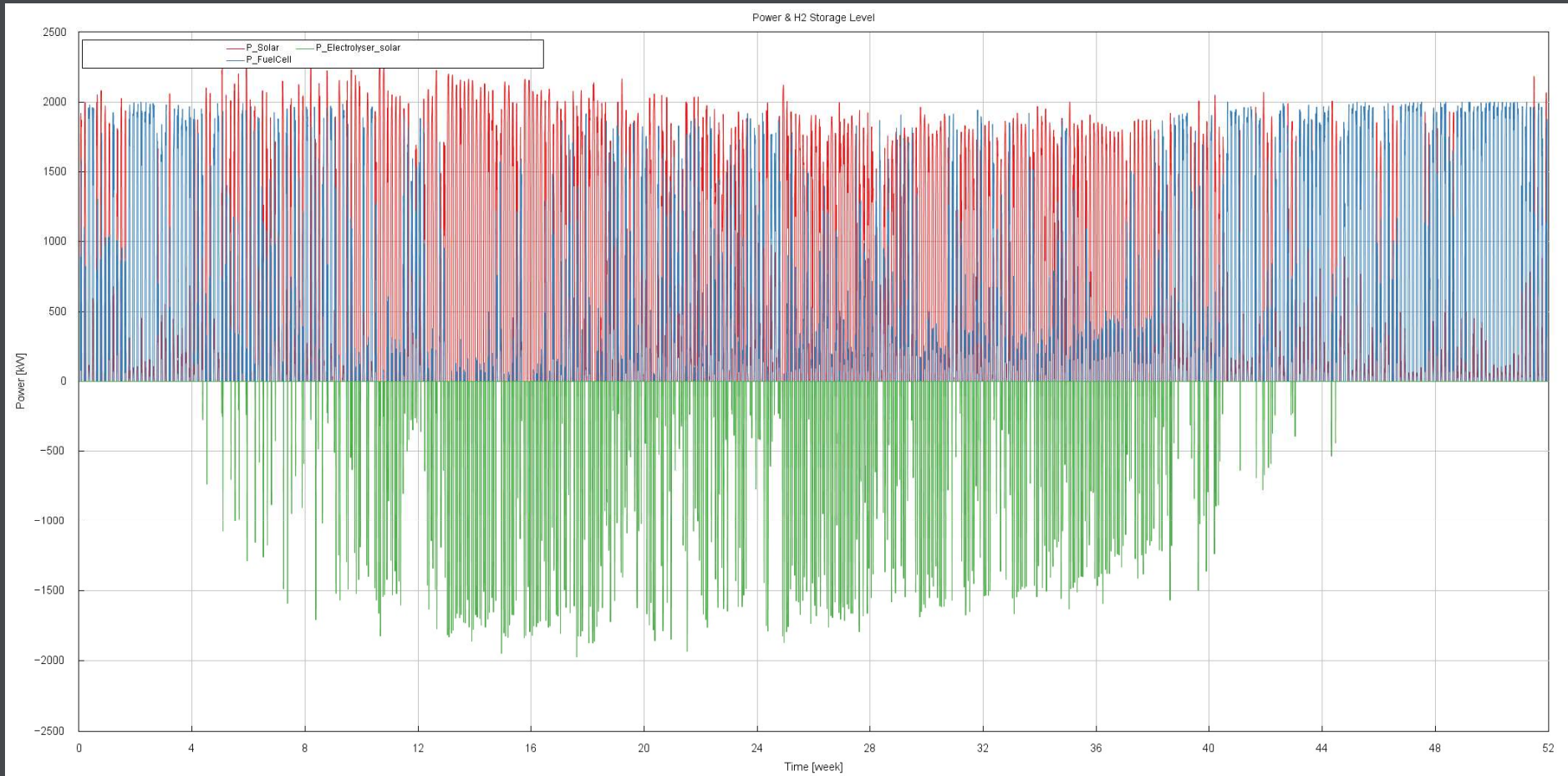
Worst Case: 2MW @ 8 hrs / day (7:00 – 15.00):



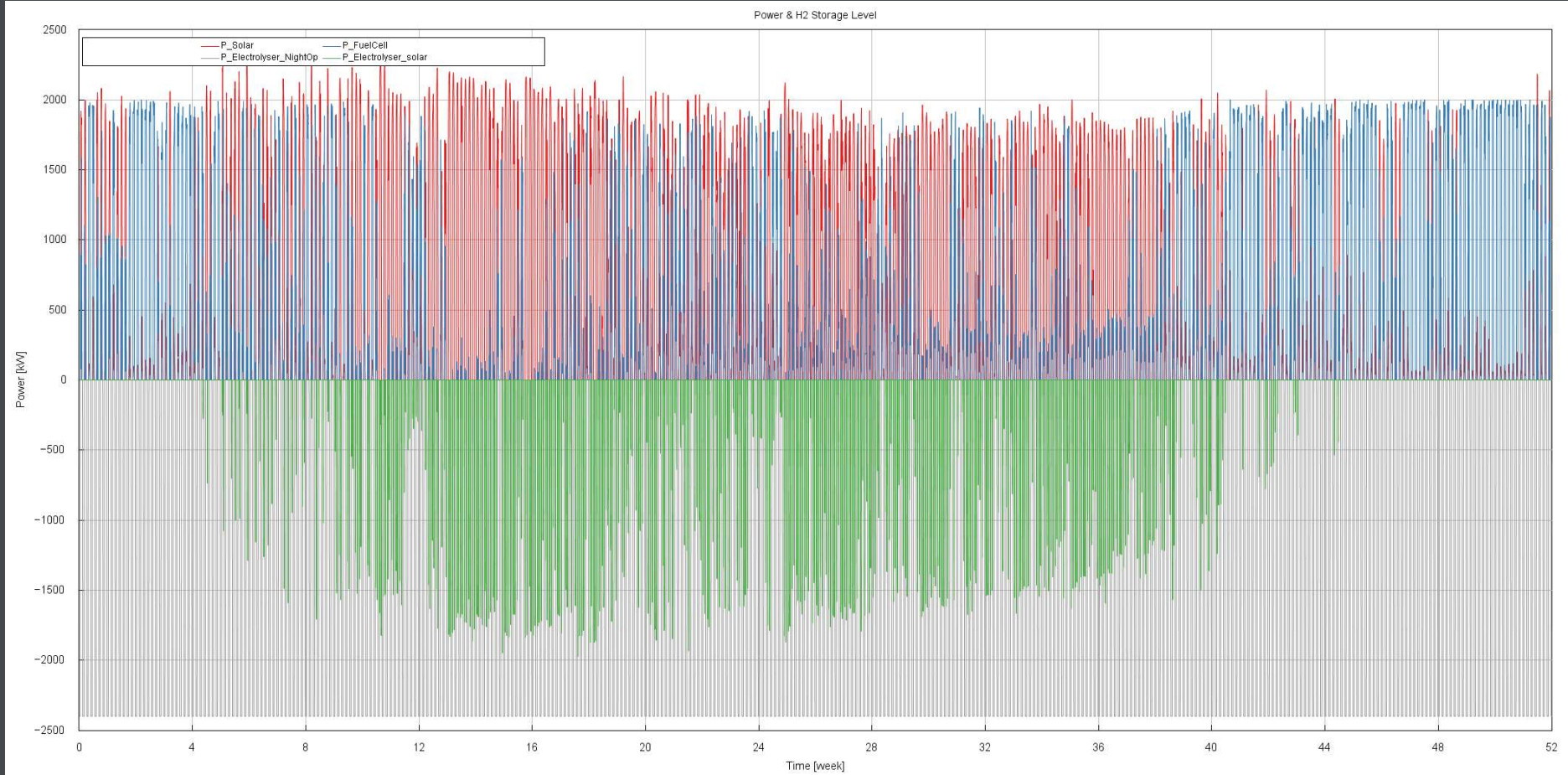
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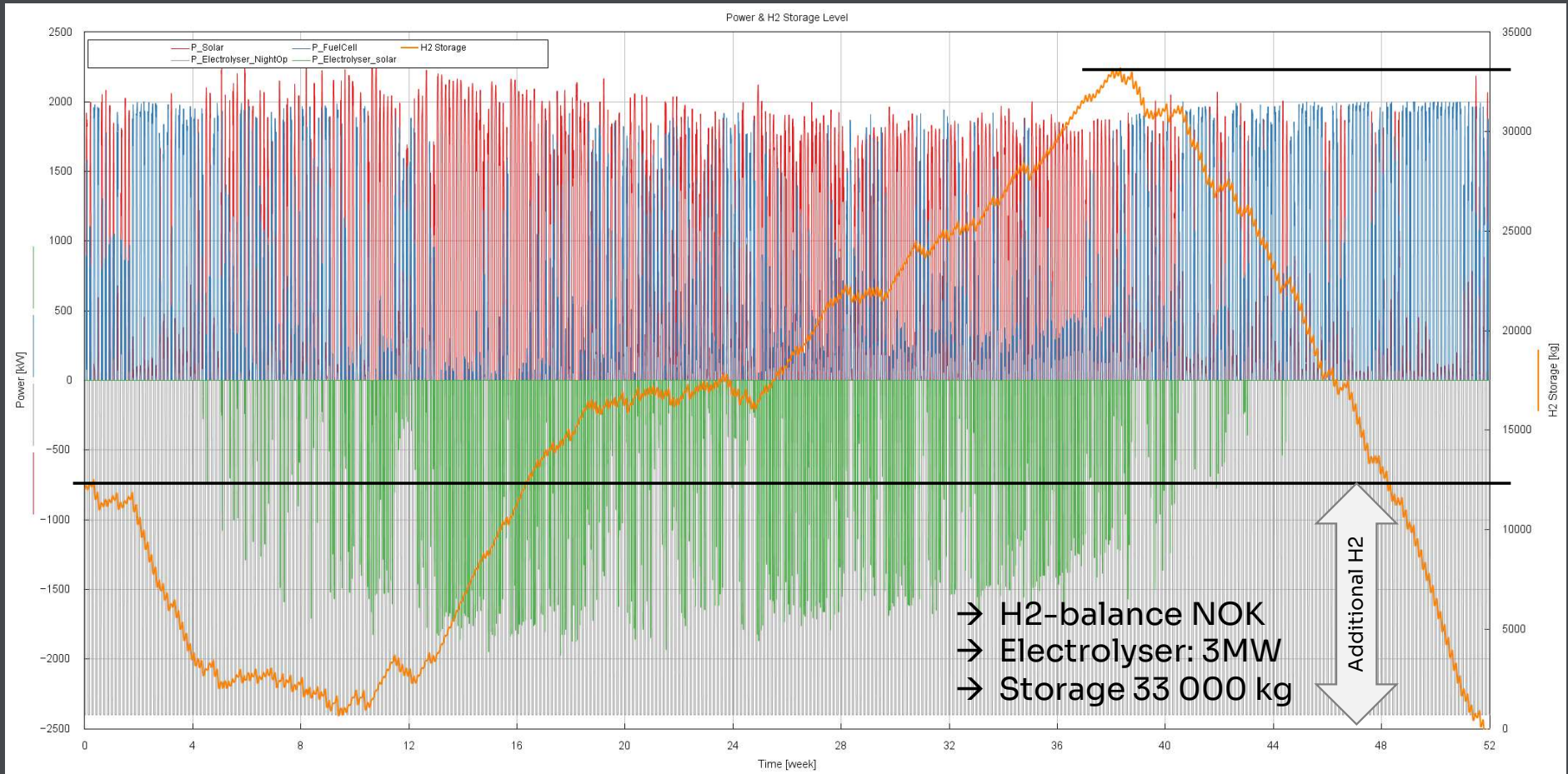
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Rules:

- Total electricity upload:
2 MW @ 1500 hrs / year → ~4 hrs/day
- Max. continuous Power Supply:
2 MW for max. 8 hrs / day → 2920 hrs /a

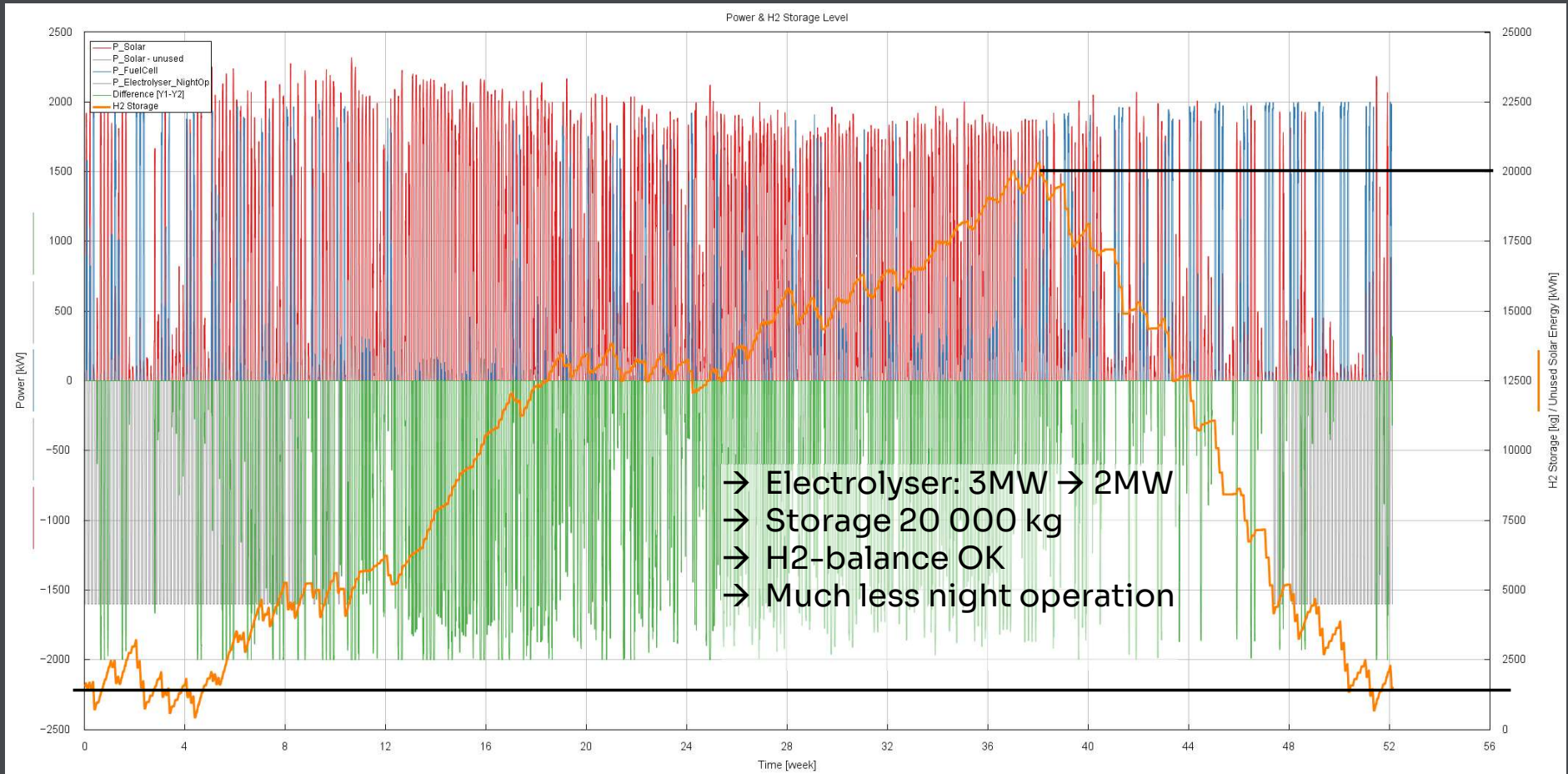
→ Rule 2 violates rule 1!

→ Proposal: 2MW /8hrs, 3 days/week → 1245 hrs

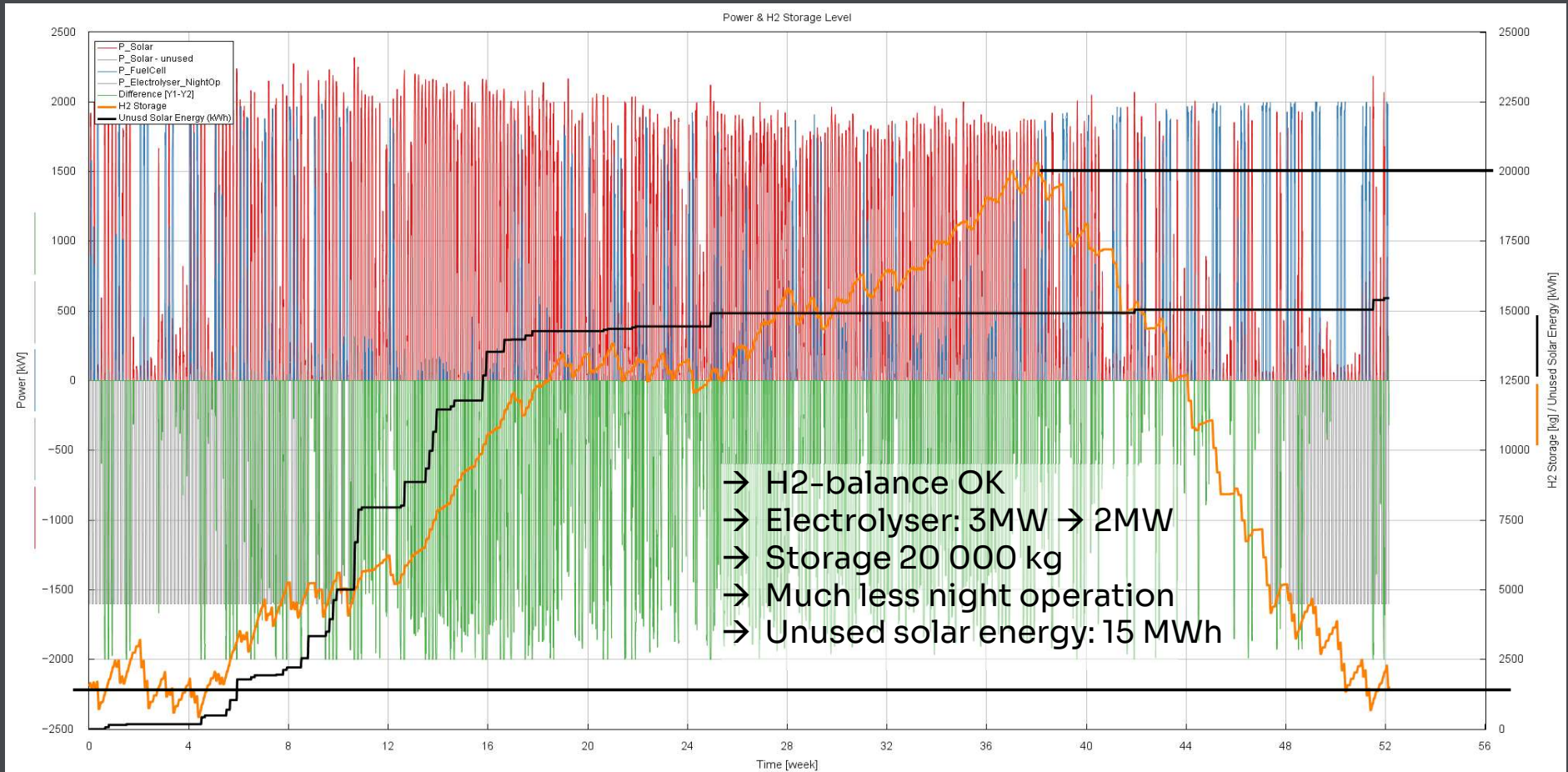
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- Electrolyser Capacity?
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- Feasibility?



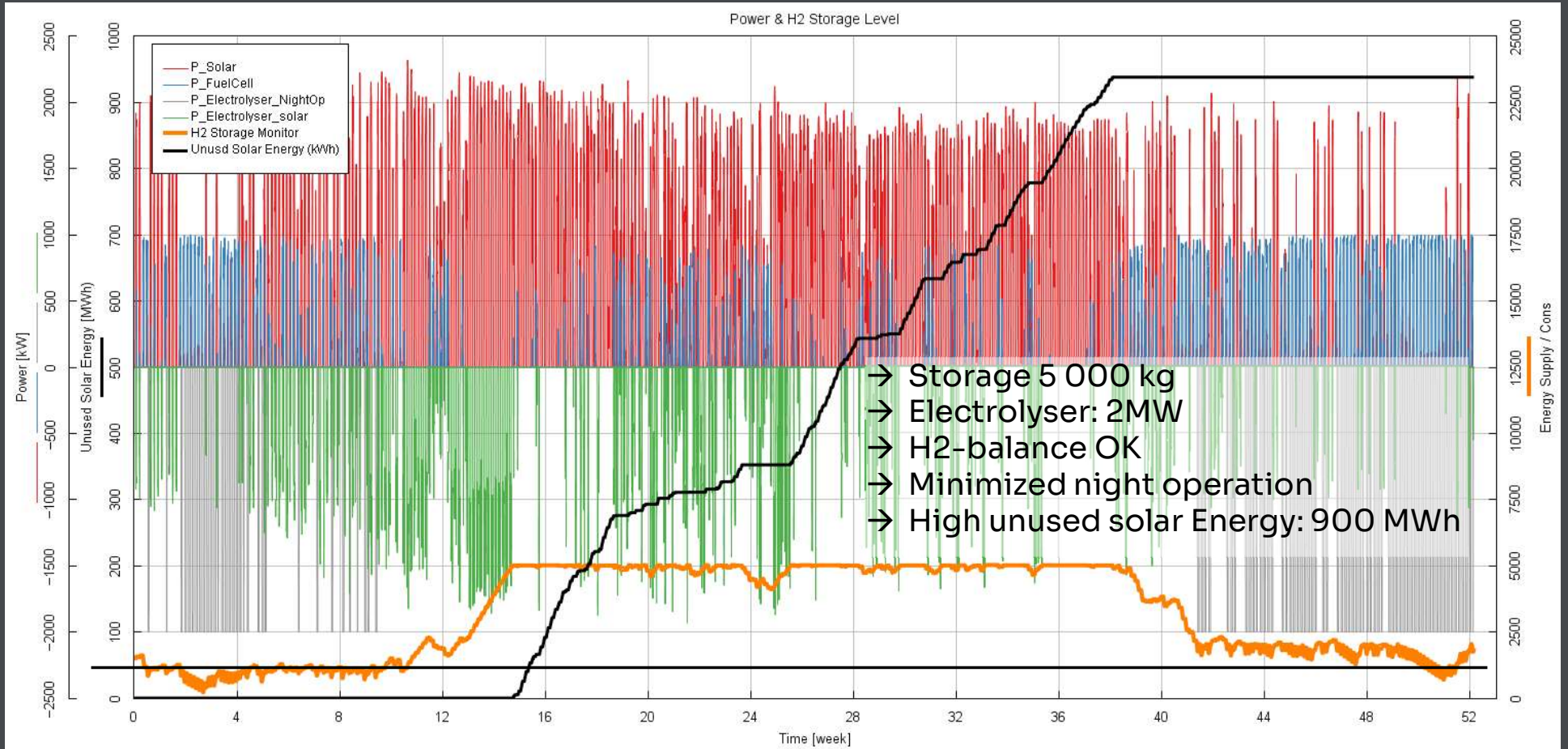
High Load Case: 2MW @ 8 hrs/d; 3d/week (7:00 – 15.00):



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Low Storage Capacity: 1MW @ 8 hrs/d; 7d/week (7:00 – 15.00):

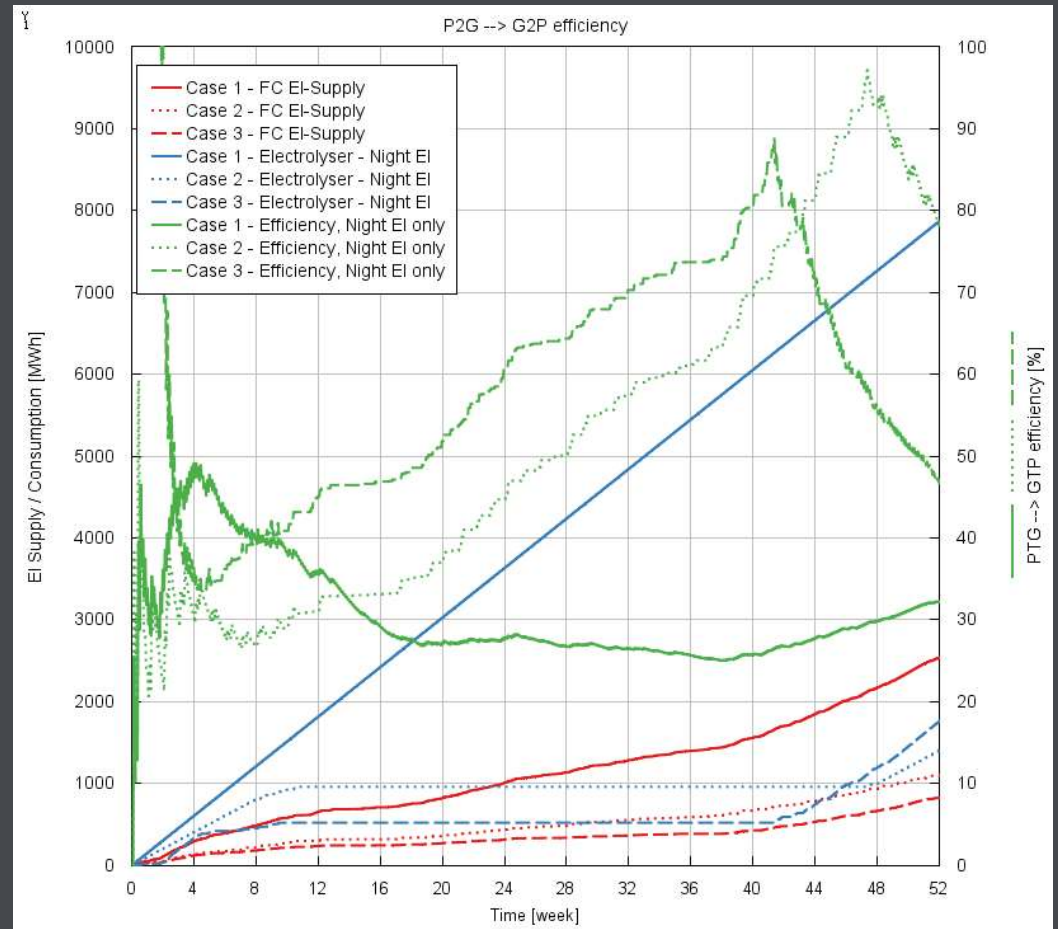


Summary

- The Powergrid model helps us and our customers to understand the situation
- Analysis of different potential scenarios
- Biasing expectations and possibilities

Learnings:

- Onsite hydrogen storage is challenging
- There is no standard use case – solutions need to be adapted to customer and market prerequisites
- There is no easy way to evaluate the results
- Electricity prices and available energy are always based on historical data – may change in the future and impact operating strategy and configuration of the proposed solution



Next steps

Model improvements:

- Implementation of a storage model
- Implement degradation model(s)
- Control strategies for plant
- Add more physics (FC-system, Electrolyser, Grid and Power Electronics, Battery)
- Statistical models

Further utilization:

- Waste heat utilization
- Optimisation for specific customer cases
- Development of business models (leasing, maintenance contracts,...)
- “Digital Twin”, usage for maintenance and controls



Kudos:

Alice Karlsson, Master Thesis Student, Uppsala University

Stefano de Luca, Internship student, PowerCell Group

Jan Thorsson, Sales – Stationary Applications, PowerCell Group

Euromekanik AB, Hydrogen Infrastructure & H-Tec Electrolyser redistributor

Interested in collaborating?

Please contact me:

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