H$_2$ storage solutions as backup for power demand in grid disruption events: a case study

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Agenda

- PowerCell Group's presentation
- Introduction to case study
- GT-Suite model used
- Configurations proposed
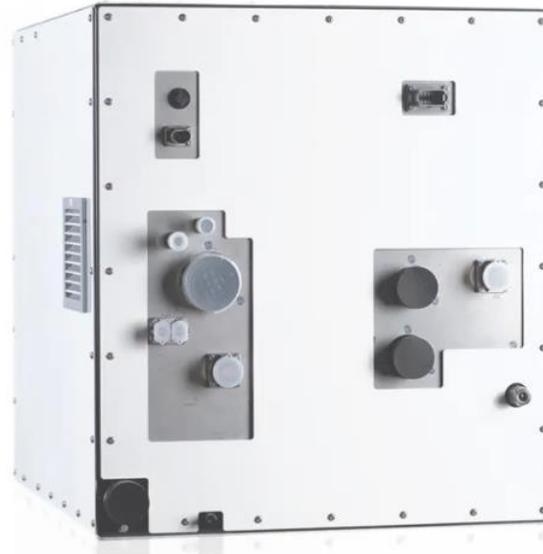- Final comparison

About PowerCell Group

- Fuel cell stacks and systems manufacturer from 5 to 200 kW

- Founded in 2008 as spin-out from Volvo Group

- HQ in Gothenburg, Sweden

PS - 200

VS - 5
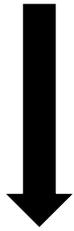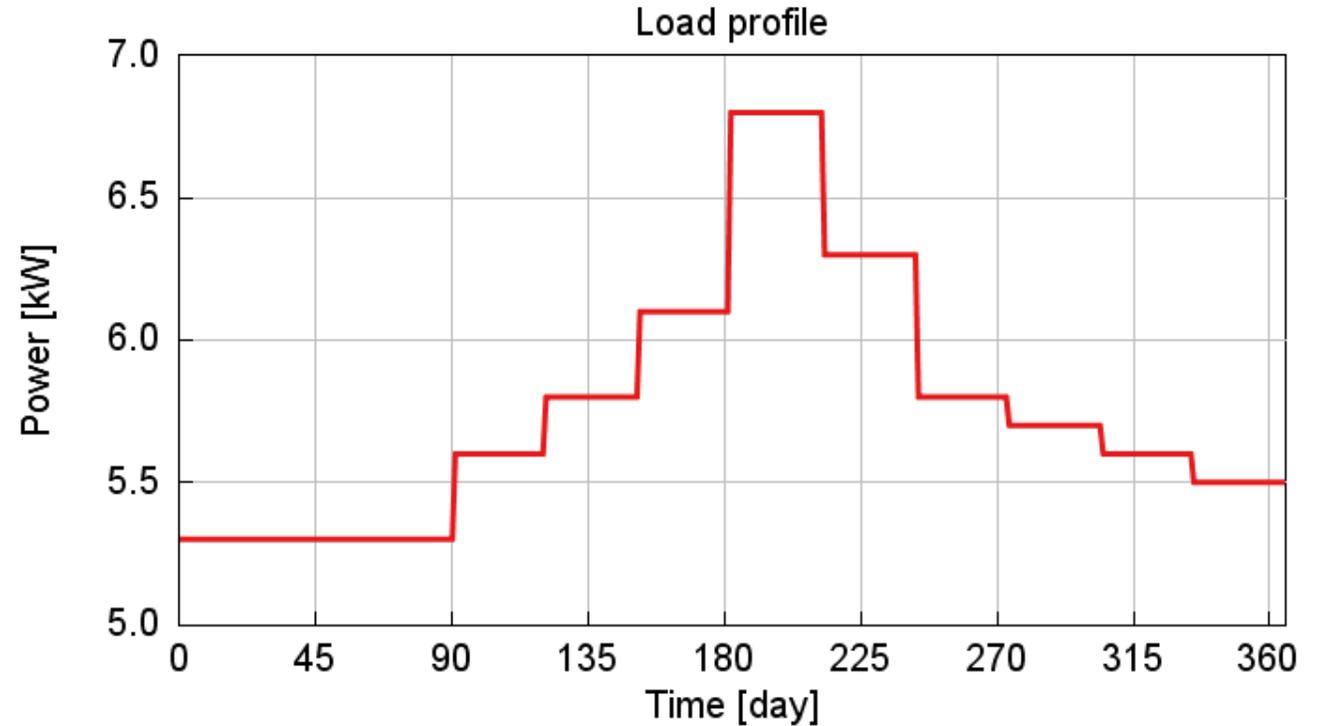
PS - 100

Introduction to case study

- Load in remote location in Sweden
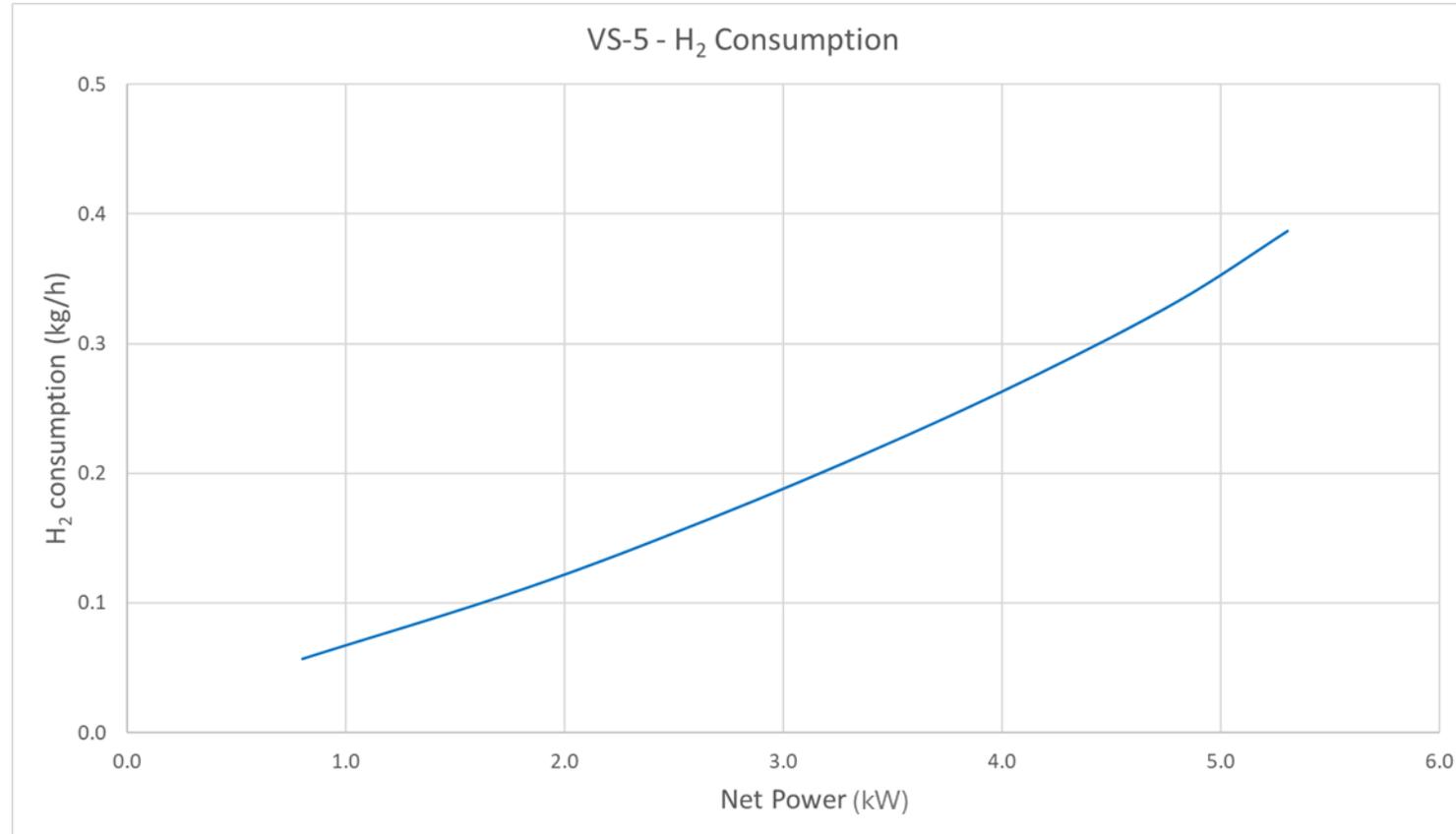
- Power consumption around 6 kW

- 10 kWh battery storage

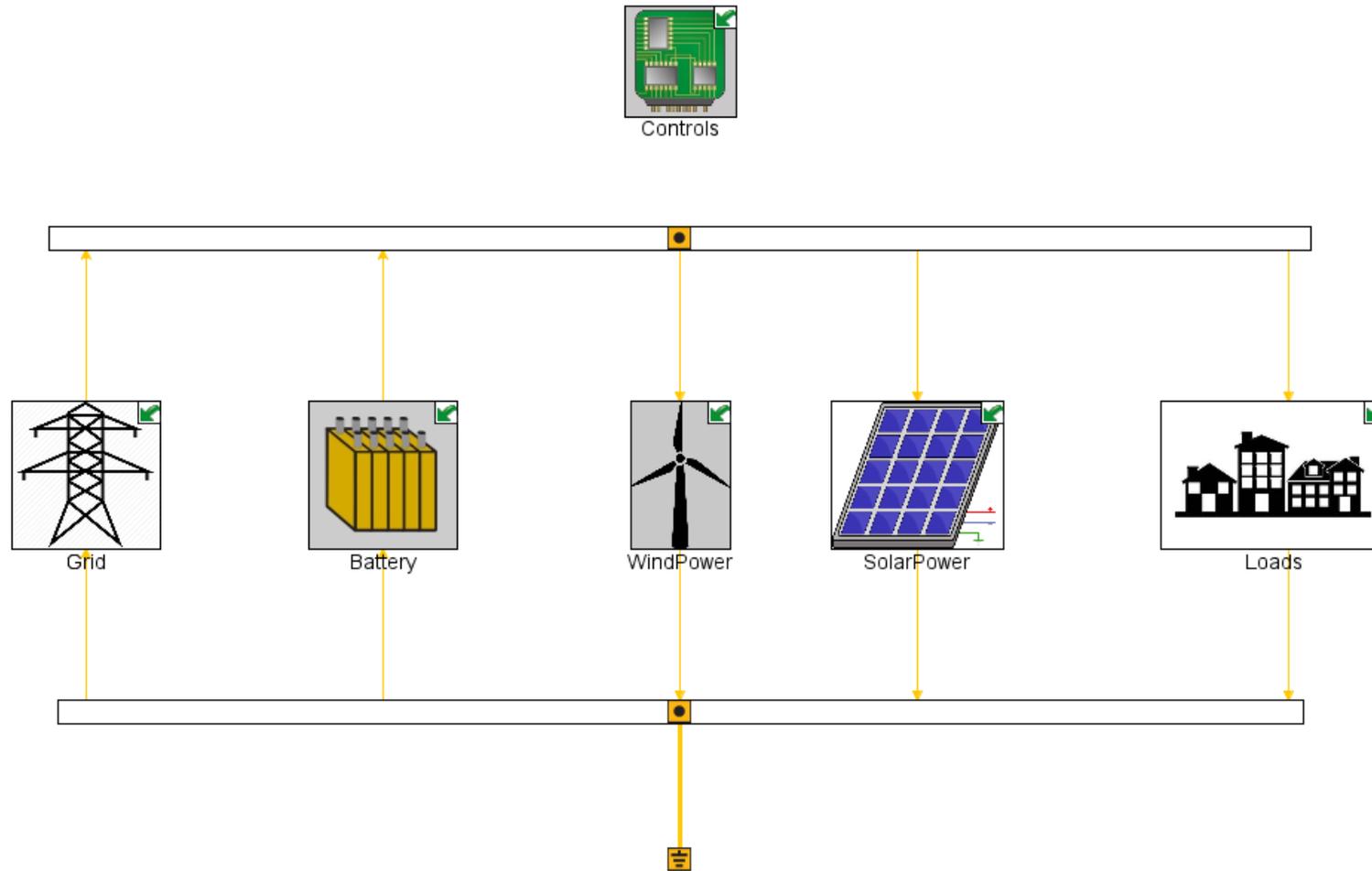Objective:
10-90 days of backup in case
of grid unavailability

Load profile

PowerCell VS-5 fuel cells systems

- In all configurations: two VS-5 systems. Each gives up to 5 kW net power

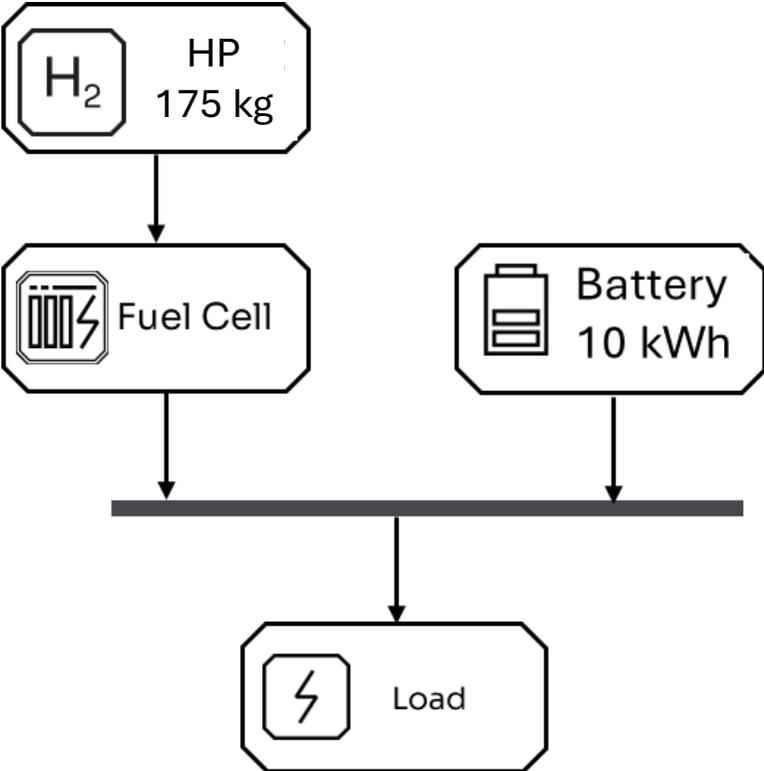VS-5 - H_2 Consumption

PowerCellution

GT-Suite micro-grid model

Configurations
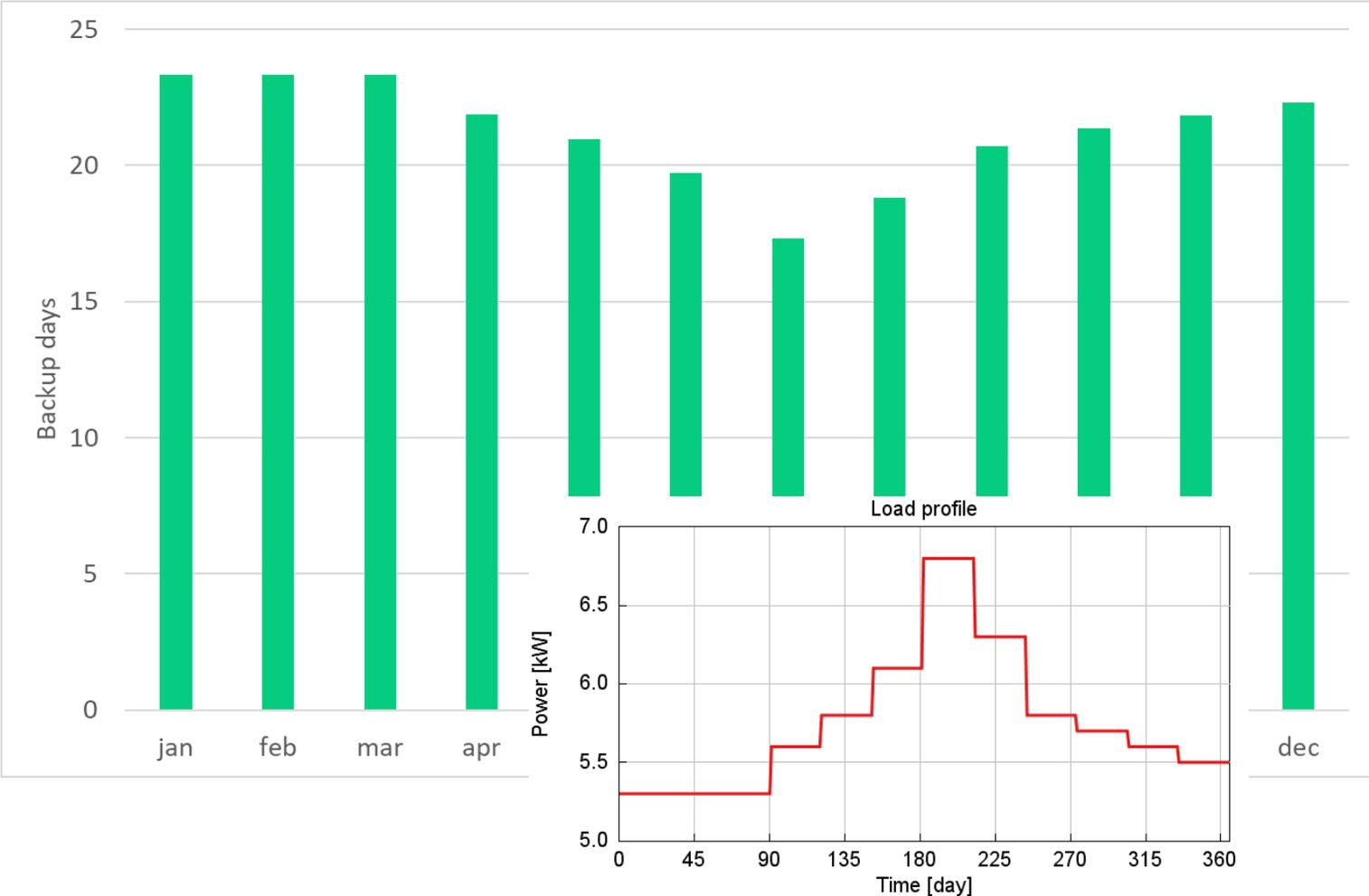
1) Baseline plant: HP H_2 storage and fuel cell

2) Baseline **+ 30 kW PV**
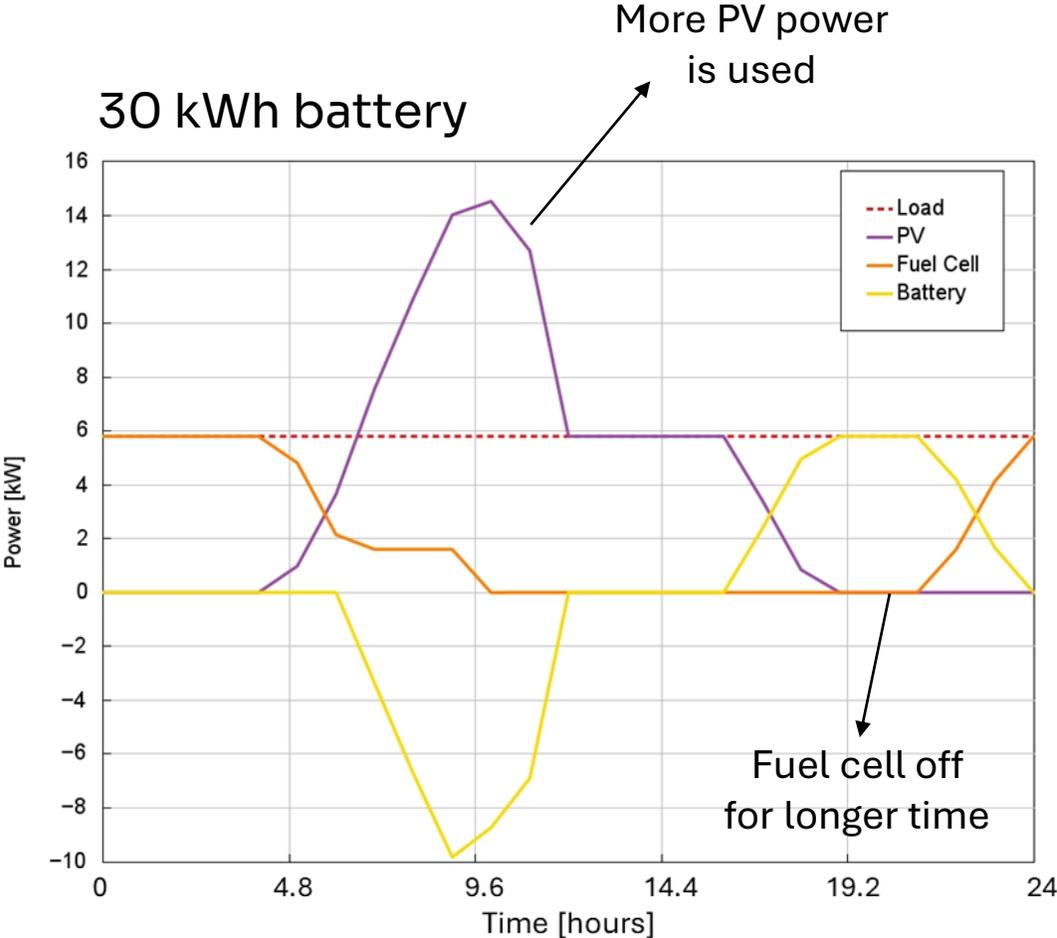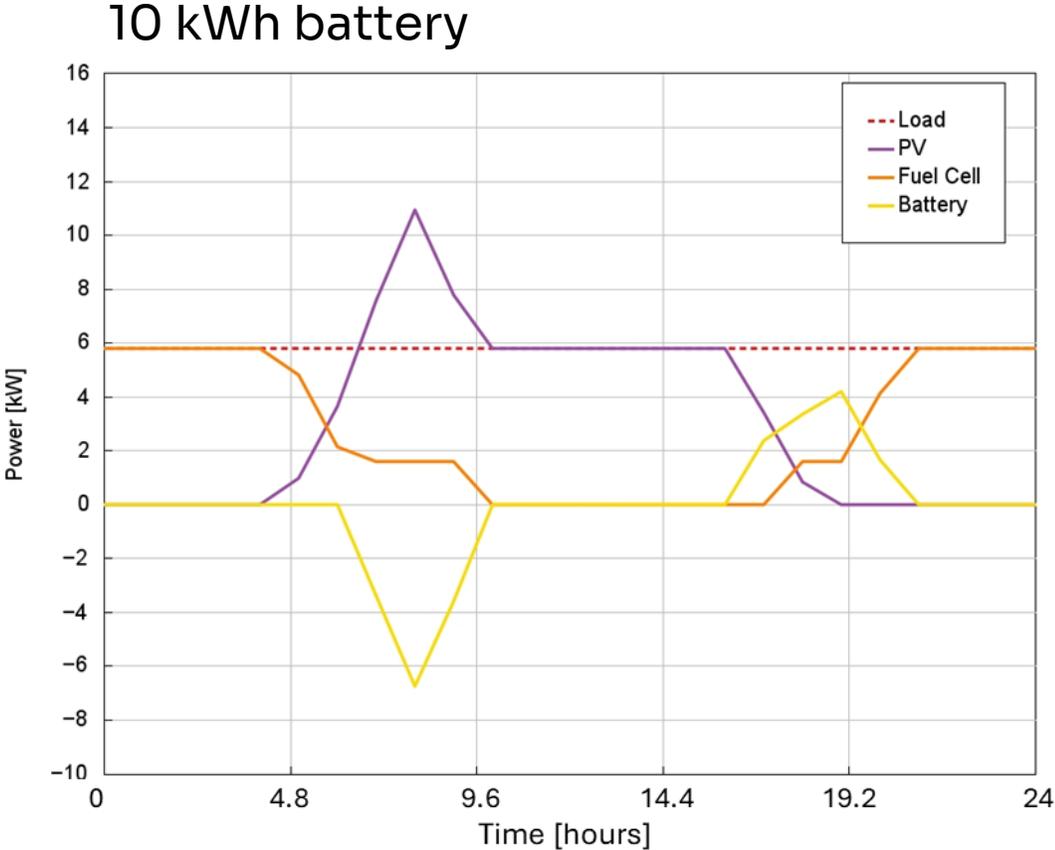
3) Baseline + 30 kW PV **+ increased battery capacity**

4) Baseline + 30 kW PV **+ electrolyzer**
    4.1) H_2 from electrolyzer stored **@ LP**
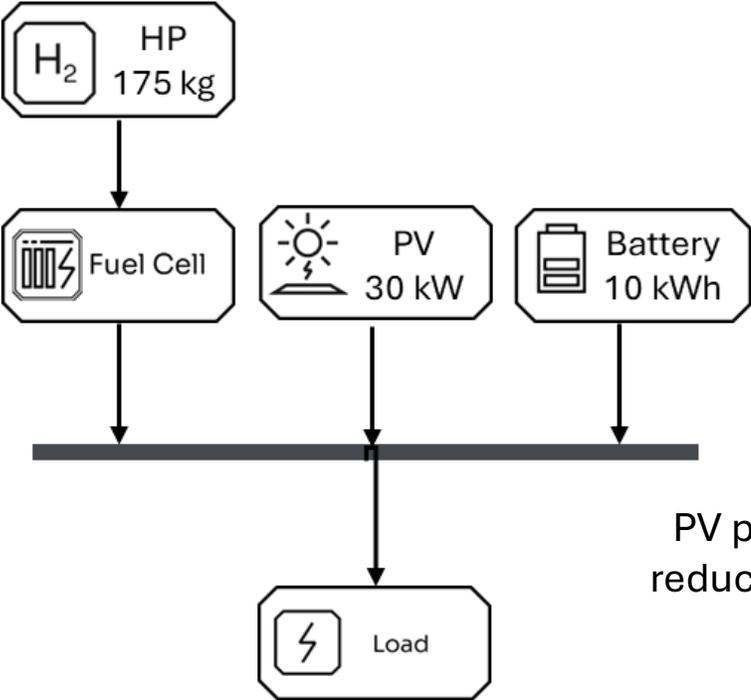   4.2) H_2 from electrolyzer stored **@ HP after compression**

1 - Baseline plant

Grid disruption simulated in each month:

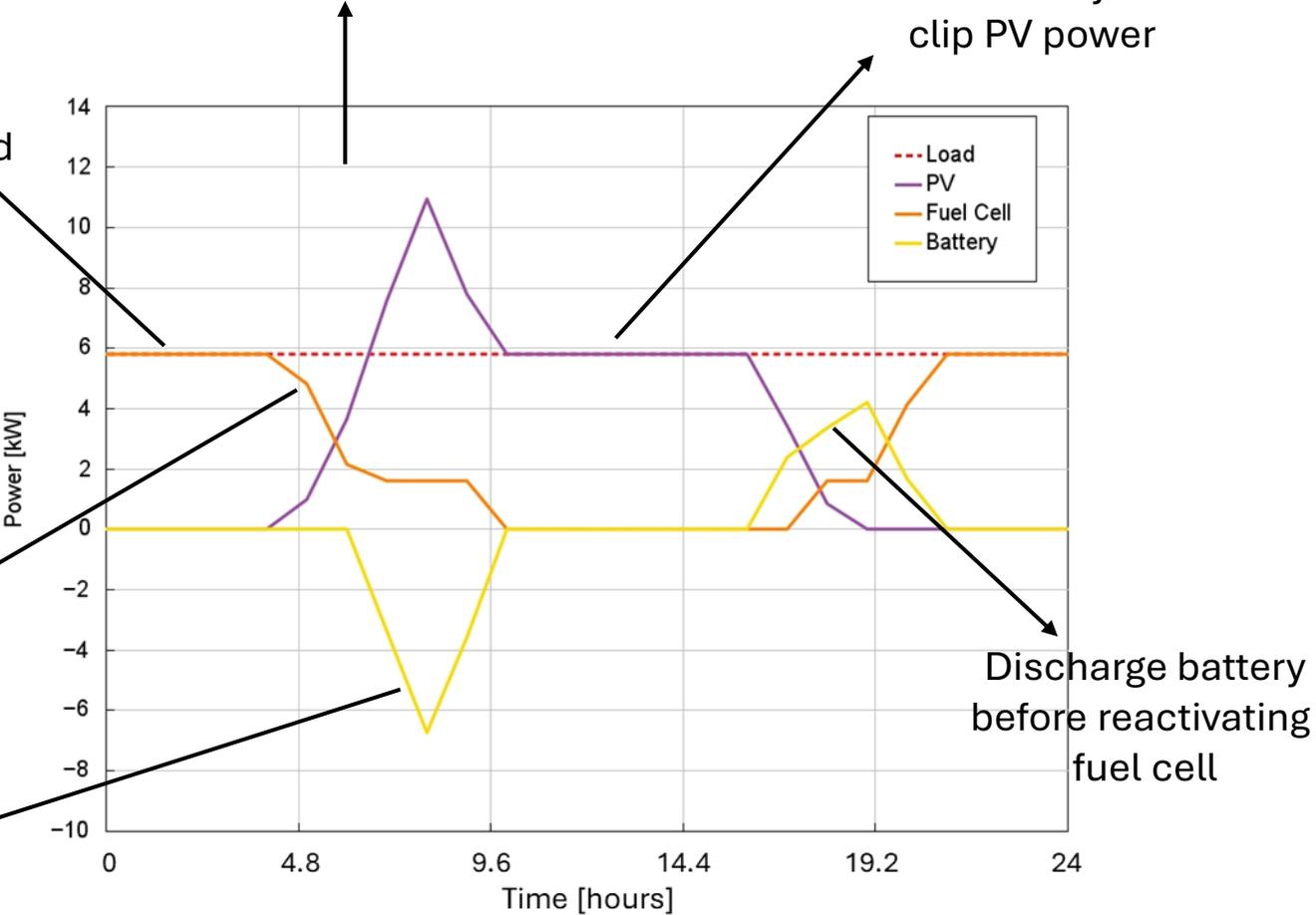Load profile

2 – Baseline plant + 30 kW PV

2 – Baseline plant + 30 kW PV

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3 - Baseline + 30 kW PV + increased battery capacity

10 kWh battery

30 kWh battery

More PV power is used

Fuel cell off for longer time

3 – Baseline + 30 kW PV + increased battery capacity

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4 – Baseline + 30 kW PV + electrolyzer

4.1 – Baseline + 30 kW PV + electrolyzer & LP storage

PV in excess and battery full: start electrolyzer
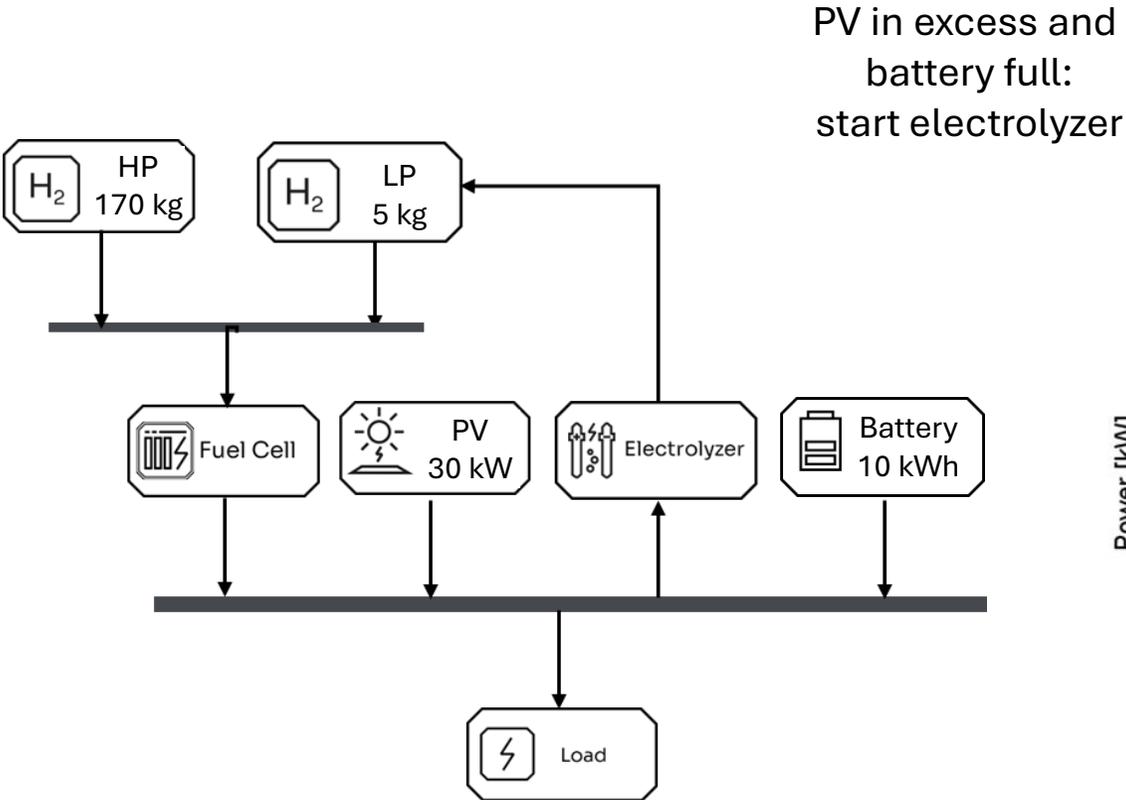
"State Of Charge" of LP storage goes up and down daily. Only used to store H_2 from electrolyzer and emptied before next day

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4.1 - Baseline + 30 kW PV + electrolyzer & LP storage

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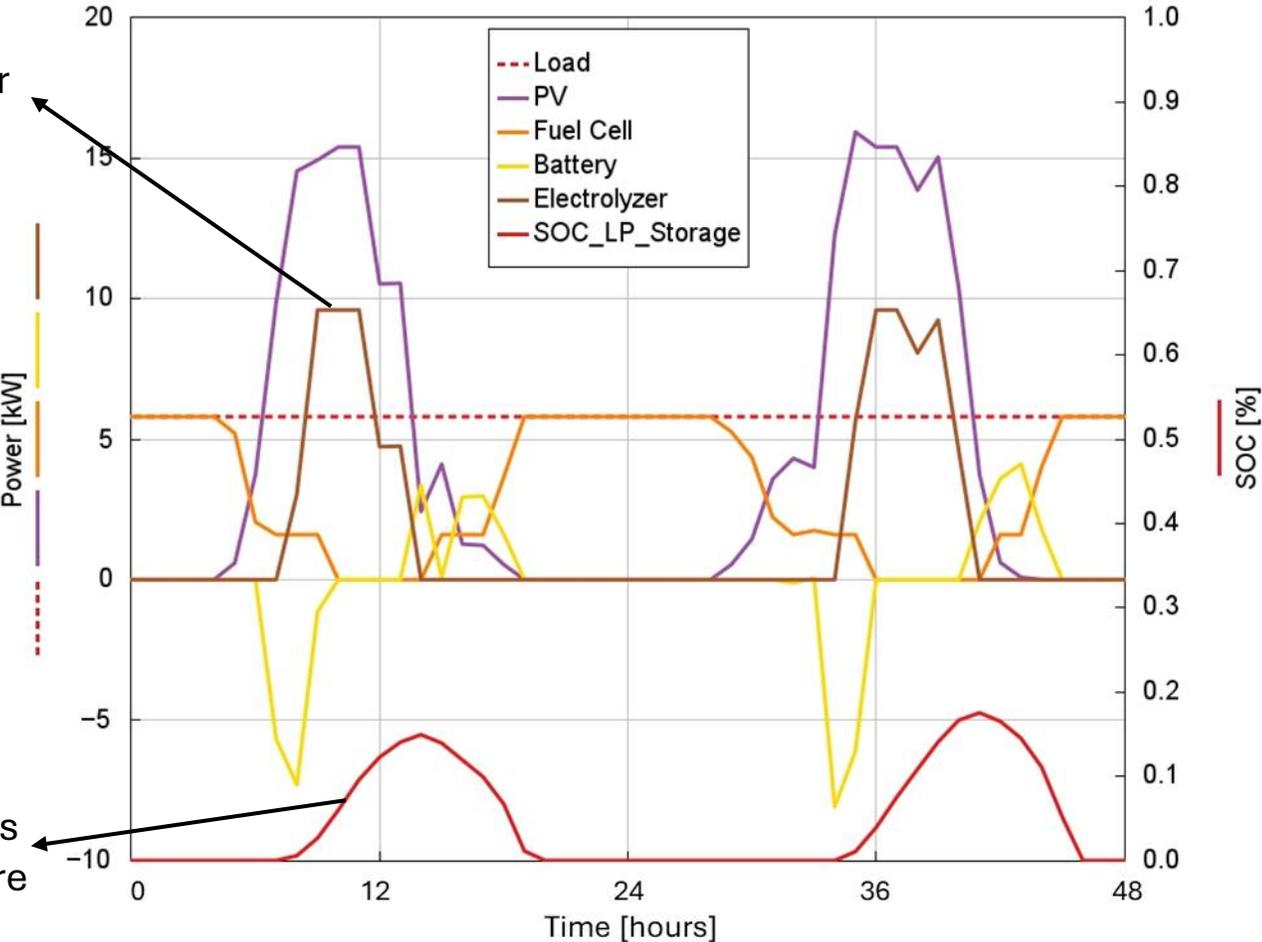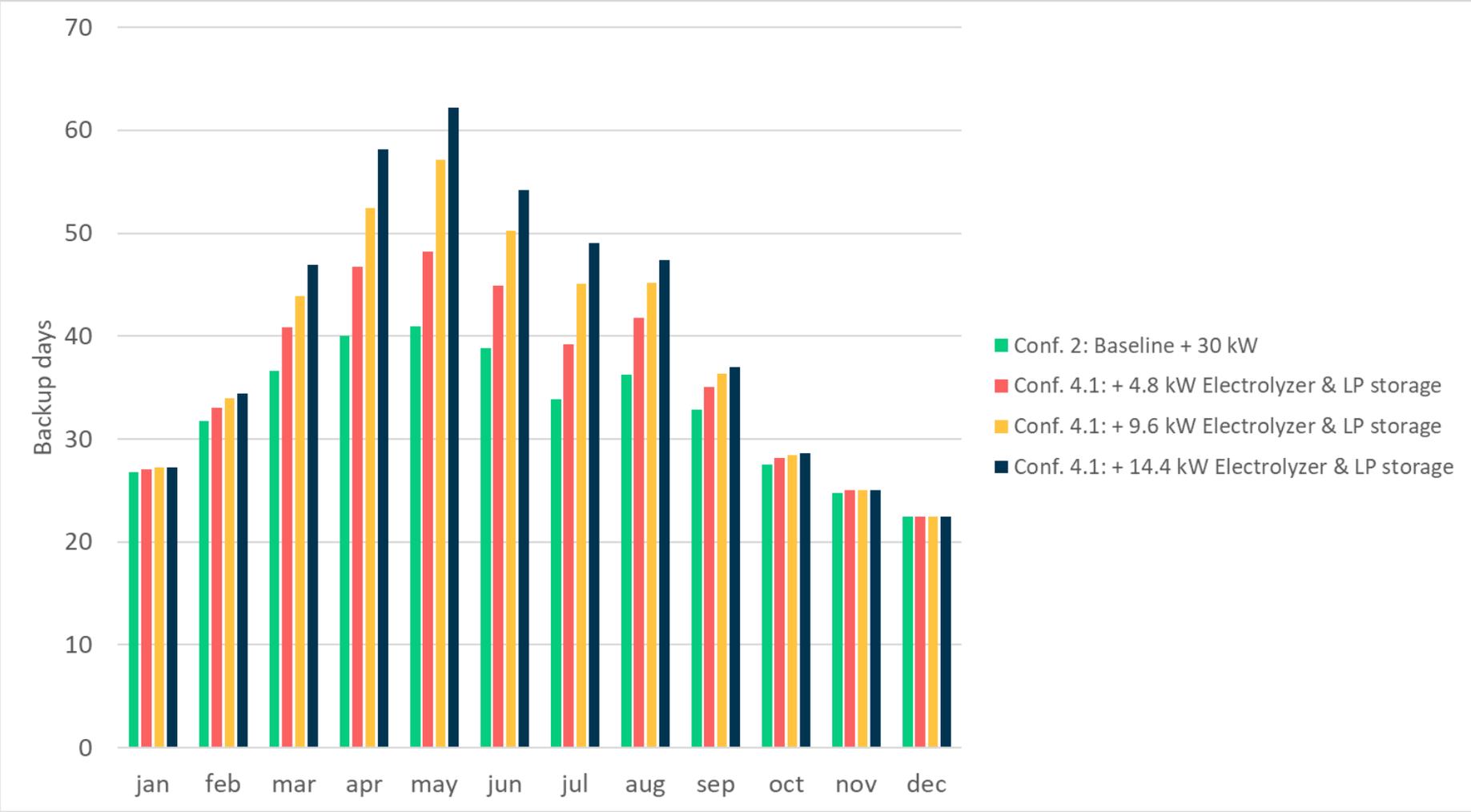
4.2 - Baseline + 30 kW PV + electrolyzer & compressor

☹ Compressing H_2 up to 300 bar costs energy

☺ It enables refill of HP storage without external intervention when grid is back, which is impossible for other configurations. The system becomes completely independent.
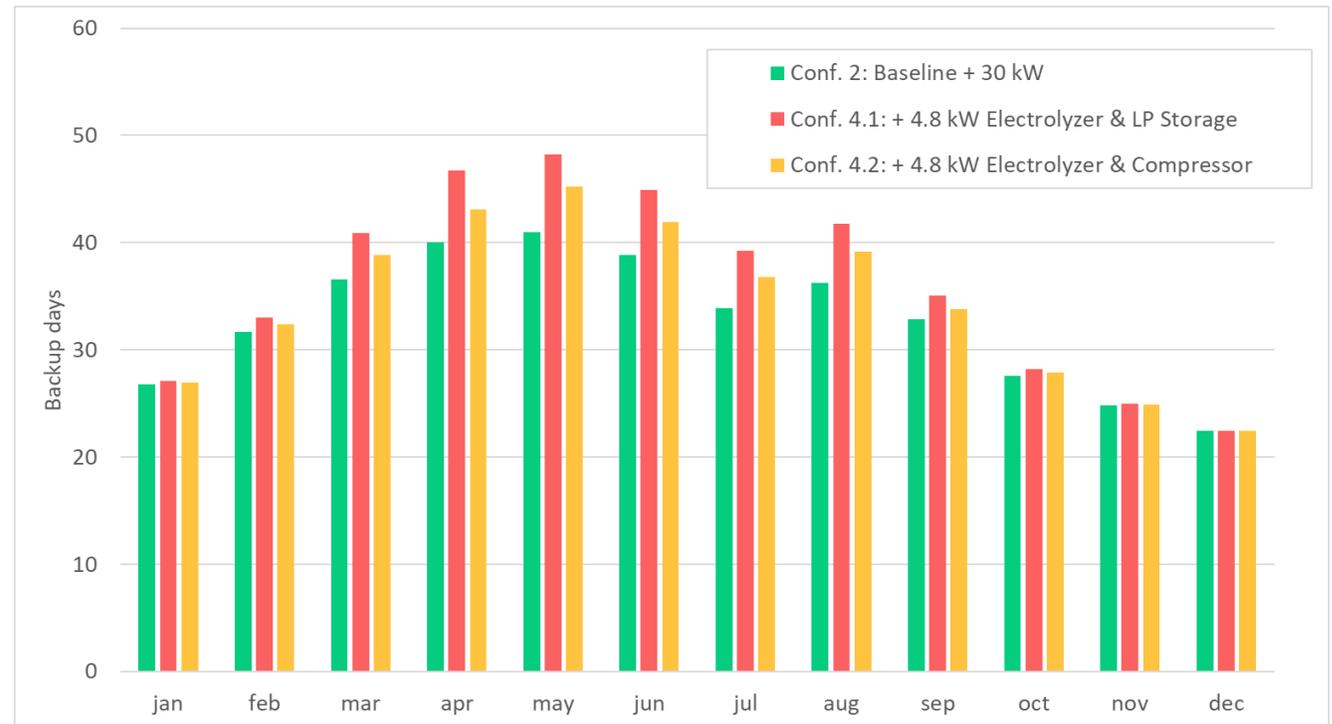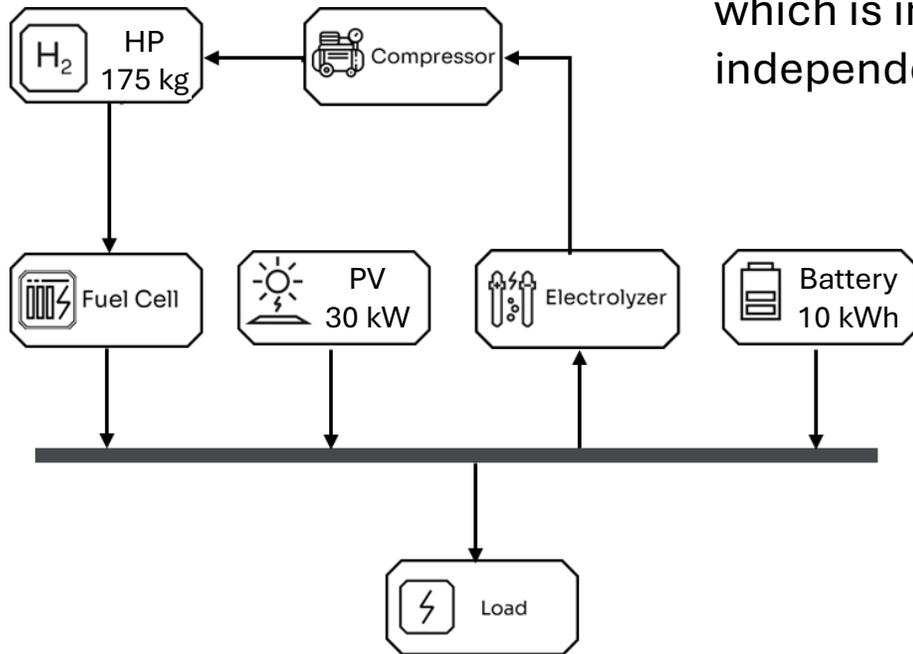
Final Comparison

Configuration	Back up days December	Back up days May
1 – Baseline	22	21
2 – Baseline + 30 kW PV	22	41
3 – Baseline + 30 kW PV + increased battery capacity	22	48/57
4.1 – Baseline + 30 kW PV + electrolyzer + LP Storage	22	48 / 56
4.2 – Baseline + 30 kW PV + electrolyzer + HP Storage + Compressor	22	45 / 50

Conclusion

- H_2 is an effective way to meet the desired 10-90 days backup time
- Baseline plant gives 17 to 23 backup days
- Adding 30 kW PV gives biggest improvement (up to 41 days)
- Increased battery capacity and electrolyzer lead to further but more marginal improvements
- Electrolyzer + compressor was the preferred option, due to highest flexibility enabled
- Role of simulation: estimate performances, make comparisons, guide decision-making

Thank you for the attention!