XX Internation European Energy Markets,

10-12 June, 2024, Istanbul, Türkiye

PS 4B

Self-Scheduling for a Hydrogen-Based Virtual Power Plant in Day-Ahead Energy and Reserve Electricity Markets

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This research was supported by the Ministry of Science and Innovation/State Research Agency (10.13039/501100011033), through the Public-Private Partnerships program, utilizing Next Generation EU/PRTR funds under grant CPP2021-008786 for the DEFINER project.

Background and Motivation

- Hydrogen-based Virtual power plant (H2-VPP): Solar-PV+Battery+eletrolyzer+tank
- Coordination: Electricity & H2 production → Hydrogen demand, Electricity market

Research Questions

How does the…

1. Use of a H2 tank and battery (BESS) for energy storage affect H2-VPP's profits?
2. The interplay between electricity and H2 affect H2-VPP's operation?

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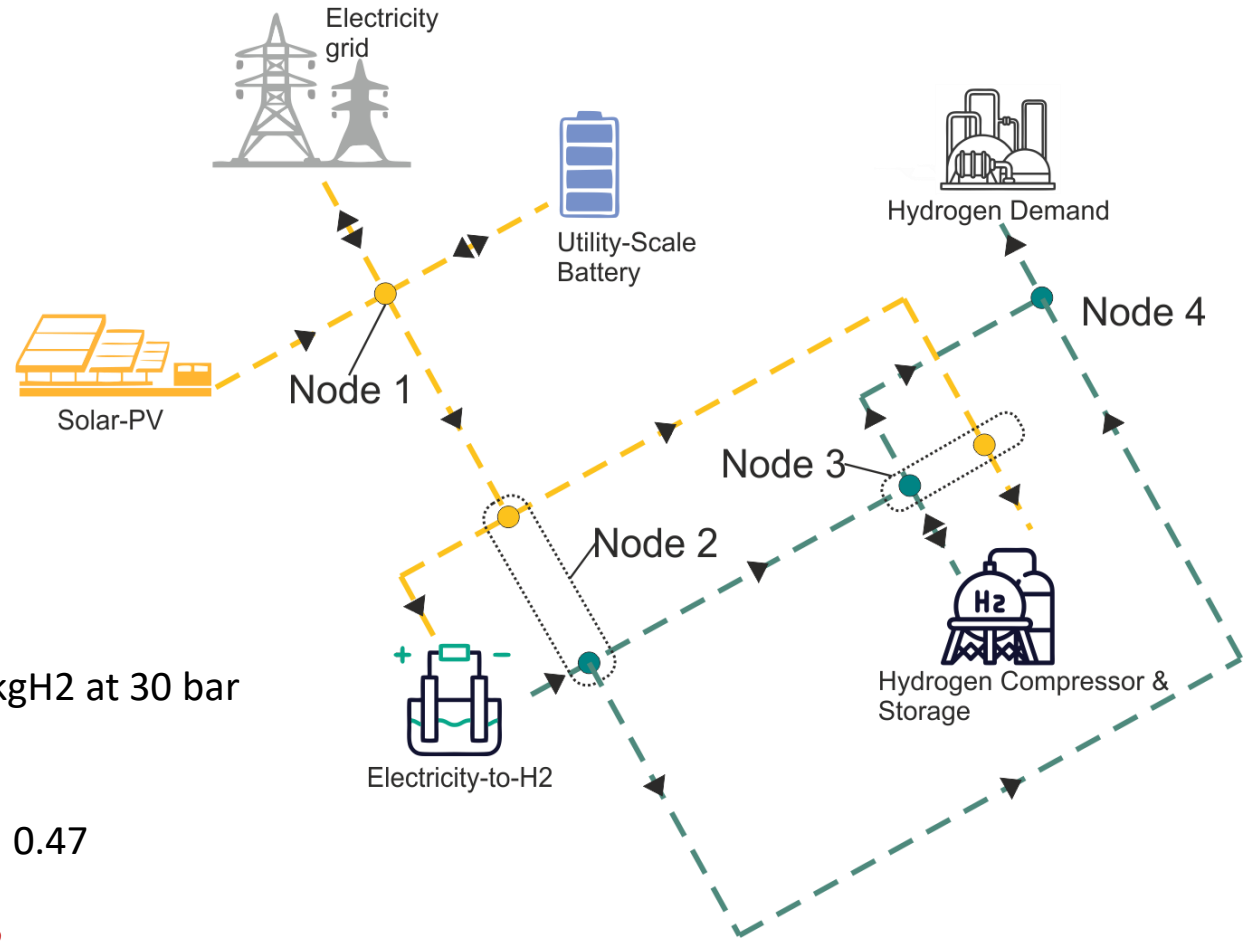
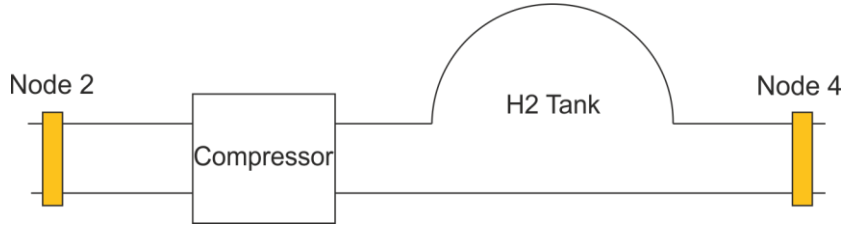
H2-VPP

- Electricity:
  - Solar-PV:
    - **Max. power: 30 MW**
  - BESS:
    - **Max. Charge/discharge: 5 MW**
    - **Max storage: 20 MWh**
  - Electricity connection:
    - Max. flows: 30 MW
- Hydrogen:
  - Electrolyzer:
    - **Efficiency: 60 kWh/kgH2**
    - Max./Min. production: 333 kgH2-80 kgH2 at 30 bar
    - Min. up-time: 8 hours
  - Tank:
    - Compressor electricity consumption: 0.47 kWh/KgH2
    - **Max./Min. storage: 7.5 tH2 – 3.5 tH2**
    - **Max. Charge/discharge: 220 kgH2 at 60 bar**
  - Customer:
    - **Daily demand: 3 tH2**
    - **Max absolute ramp: 90 kgH2**





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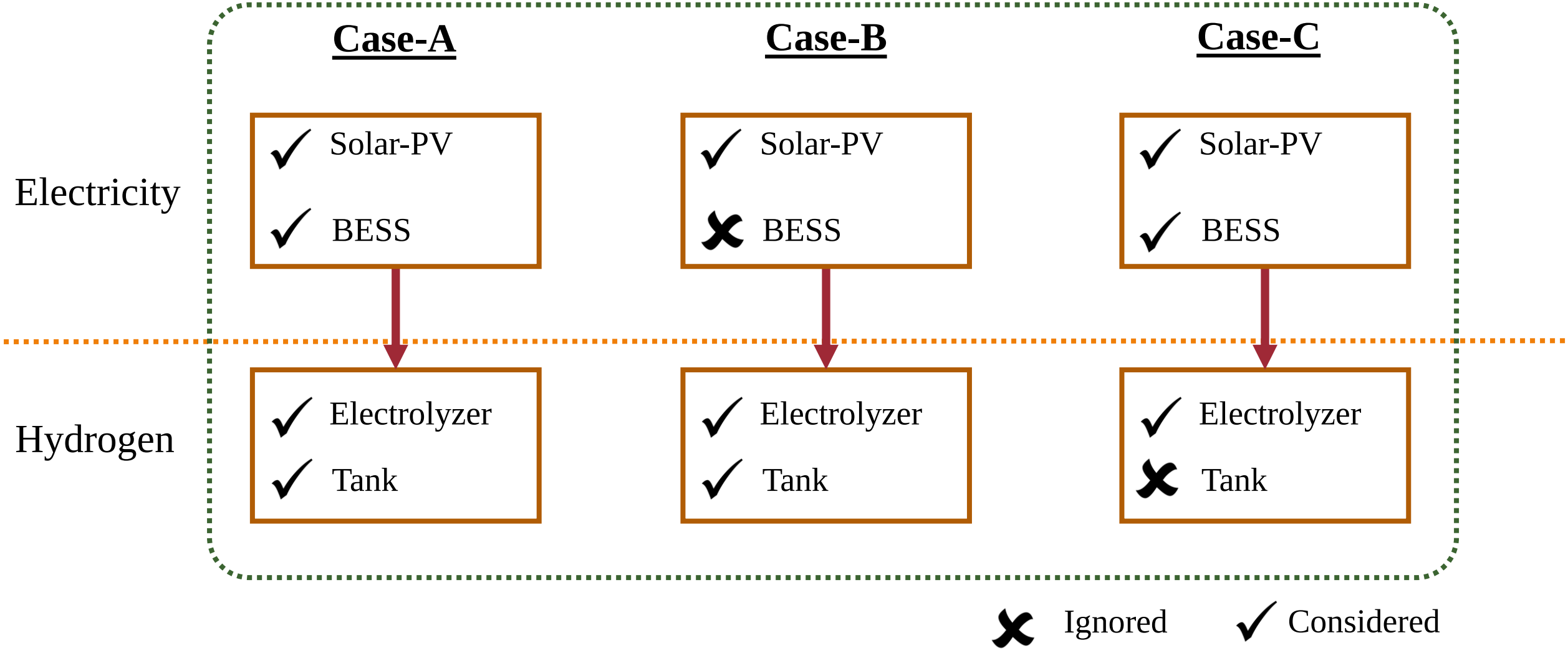
Study Cases

Scenarios: 1 week in hourly resolution of each season



*BESS and electrolyzer contribute to operating reserve

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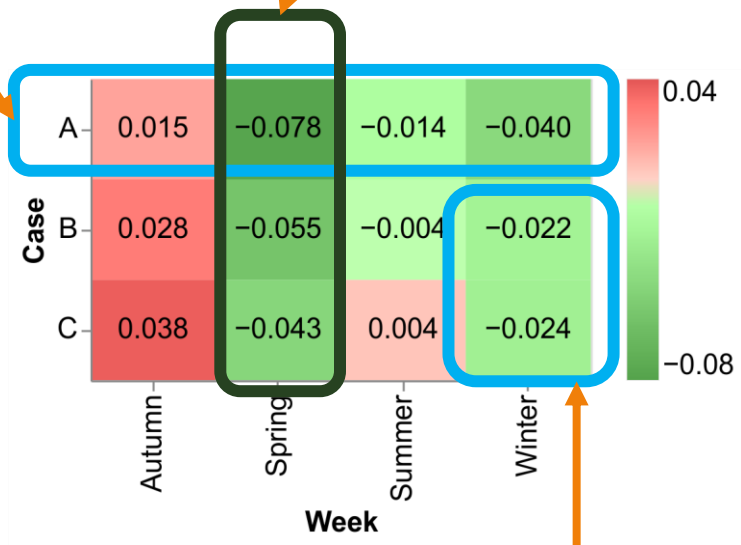
Results: Total operation cost [MEUR]

- Market cost: Incomes from arbitrage
- Reserve cost: Incomes from operating reserve contributions

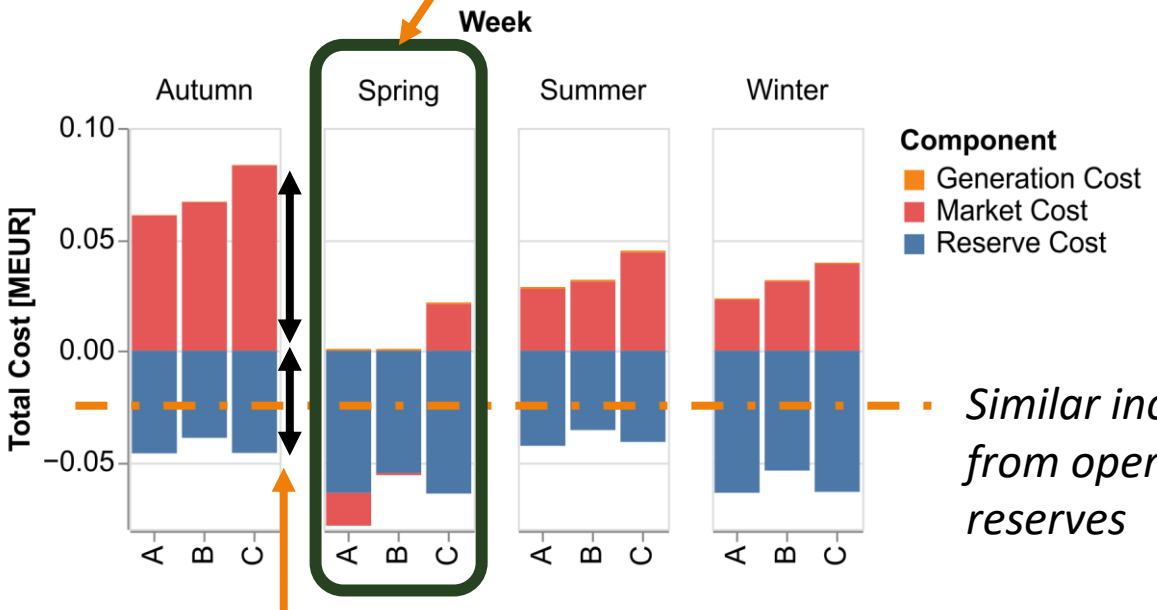
Impact of prices and RES availability

Q1: *Profit reduction of 30% and 45% in cases B and C with respect to A*



Similar profit reductions in cases B and C with respect to A

Different market cost in cases A and C



Similar incomes from operating reserves

Higher market costs in Autumn

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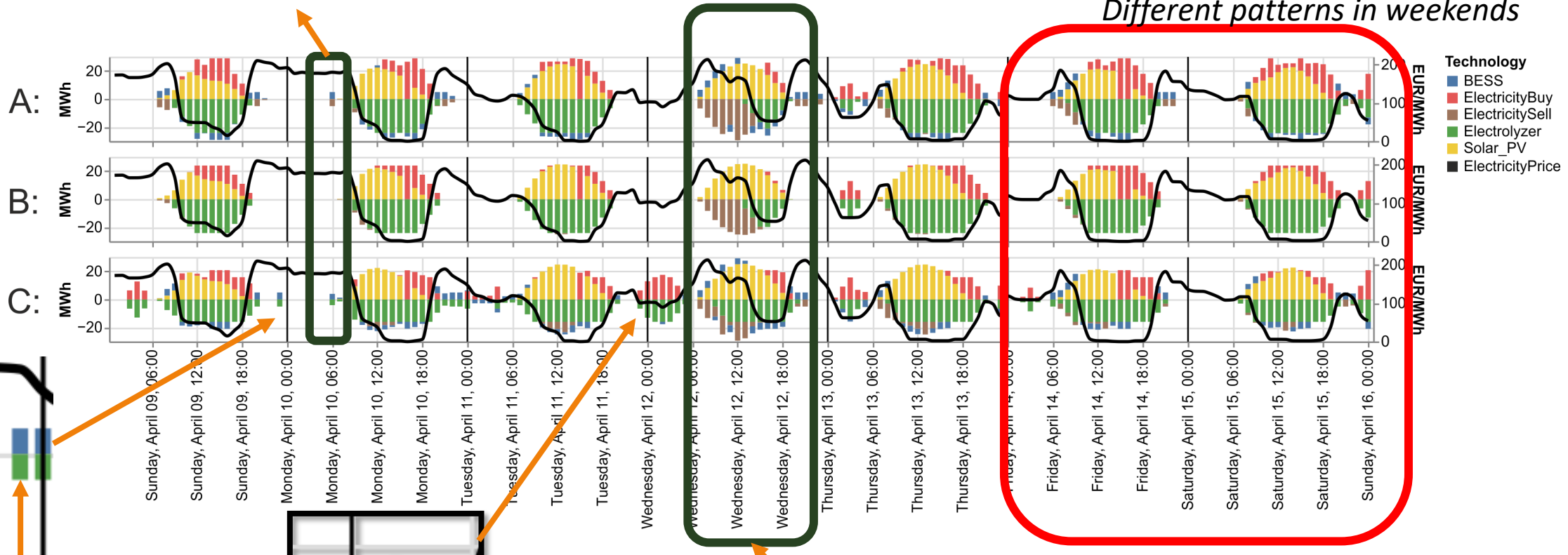
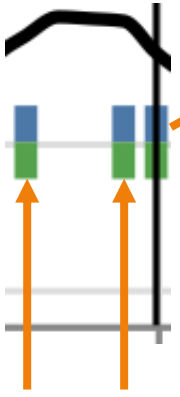
Results: Electricity Balance – Spring week

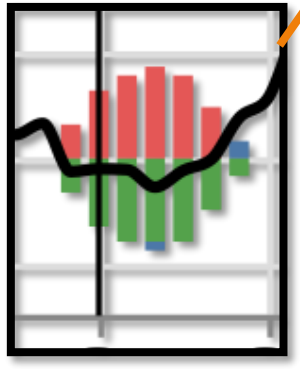
Different strategies for Case A and B

Different patterns in weekends





BESS discharge for H2 production



Electricity purchased at high prices in Case C

Large amounts of sold electricity, higher in Cases A and B

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Conclusions

1. Lacking BESS impairs the system's ability to swiftly adapt, leading to increased operational costs in the range of 29-87%,
2. Absence of H2-tank increases operational costs by 40-153% as significant amount of excess energy cannot be stored,
3. Without BESS, the H2 VPP tends to get high peaks of electricity purchases. And more total purchases when there is no tank.

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Thank You!

DEFINER

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