Willkommen
Welcome
Bienvenue

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Flexibility assessment of multi-energy districts

Technology Briefing: Photovoltaics – Technologies, integration and implications

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Empa, Urban Energy Systems Laboratory

Agenda

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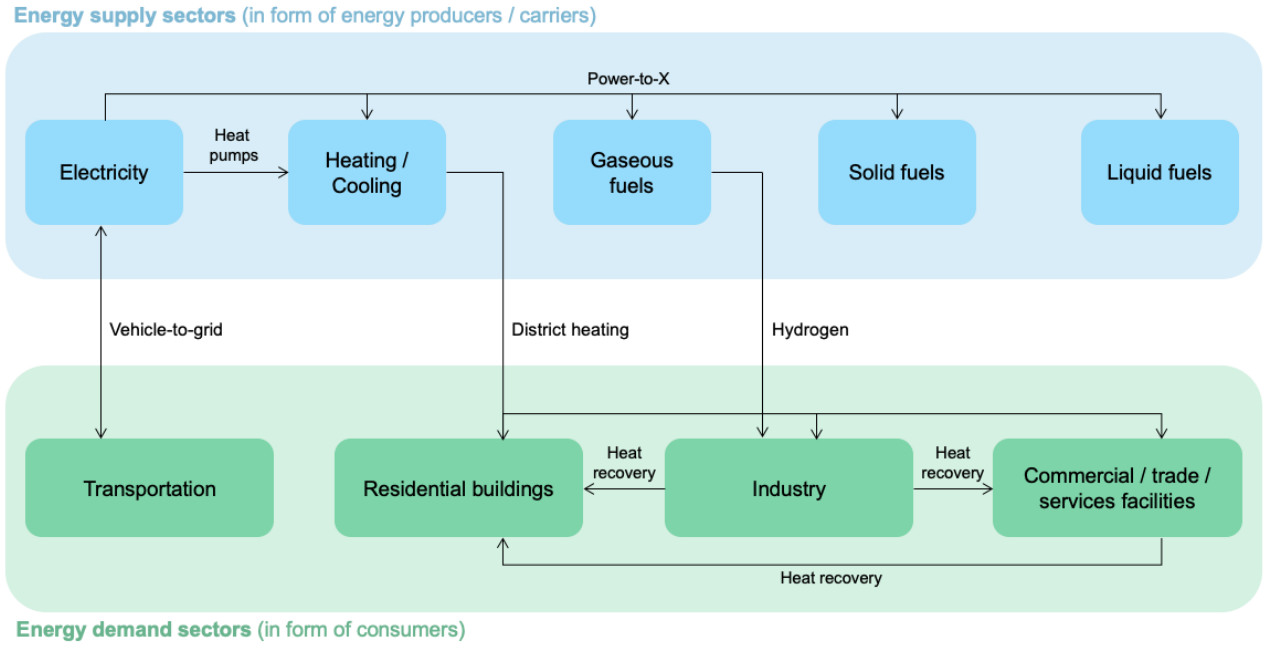
- Energy Flexibility
- Flexibility assessment
  - Power to hydrogen to power (P2H2P)
  - E-mobility
- Take-home messages

Energy Flexibility

- Ability of the energy system to react to the fluctuating needs (supply shortage, increasing renewables, electrification of transport/heating sectors)
- Key means:
  - supply side flexibility (e.g. curtailment, ramp up/down),
  - demand side flexibility (e.g. DSM (heat pumps, **EVs**, data centers, curtailment)
  - energy storage
  - conversion/sector coupling **(e.g. P2H2P)**
  - interconnection/grid reinforcement



Source: SWEET PATHFNDR

Power-hydrogen-power (P2H2P) system

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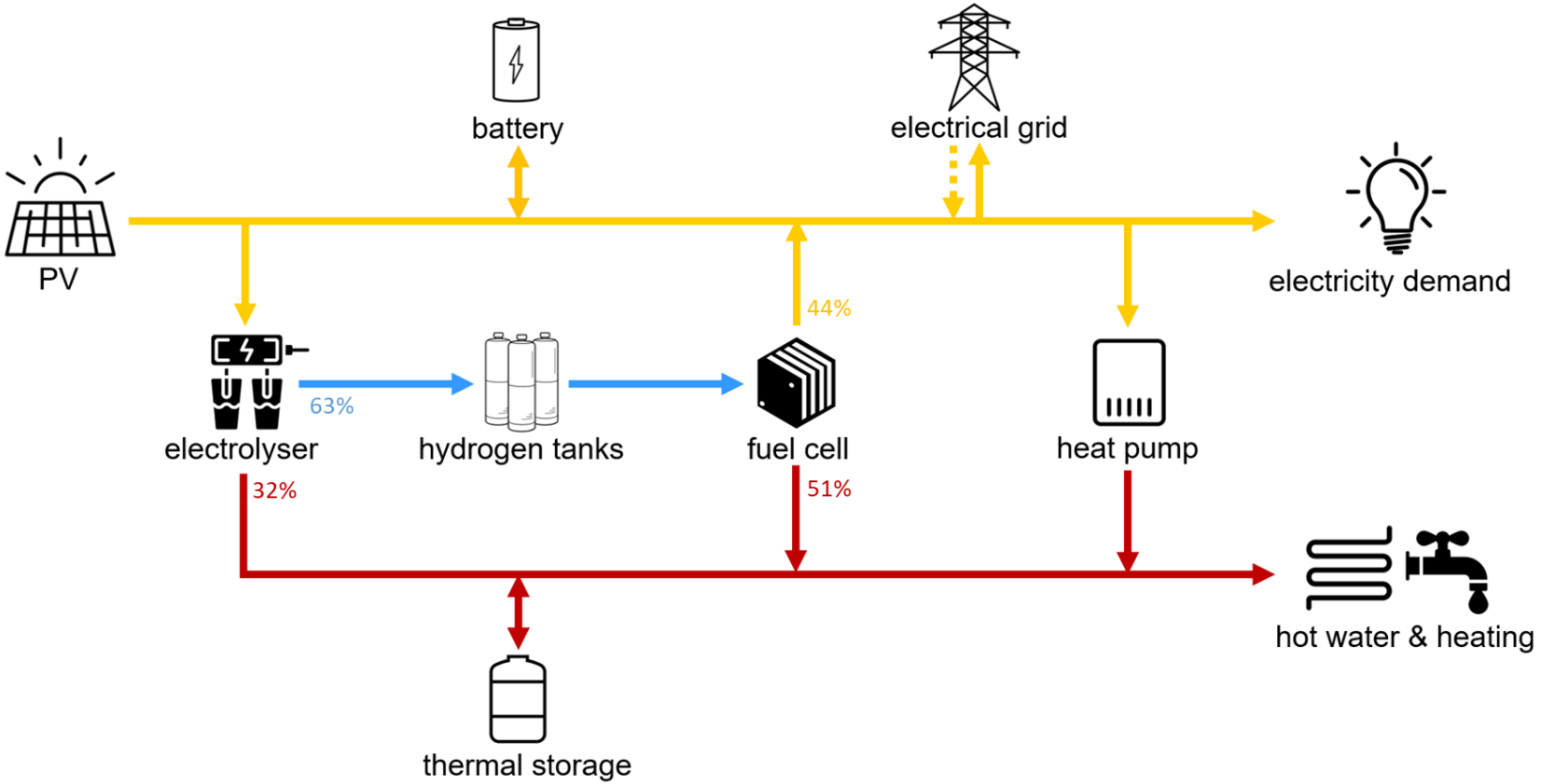

Power-hydrogen-power (P2H2P) system – Brütten (2016)

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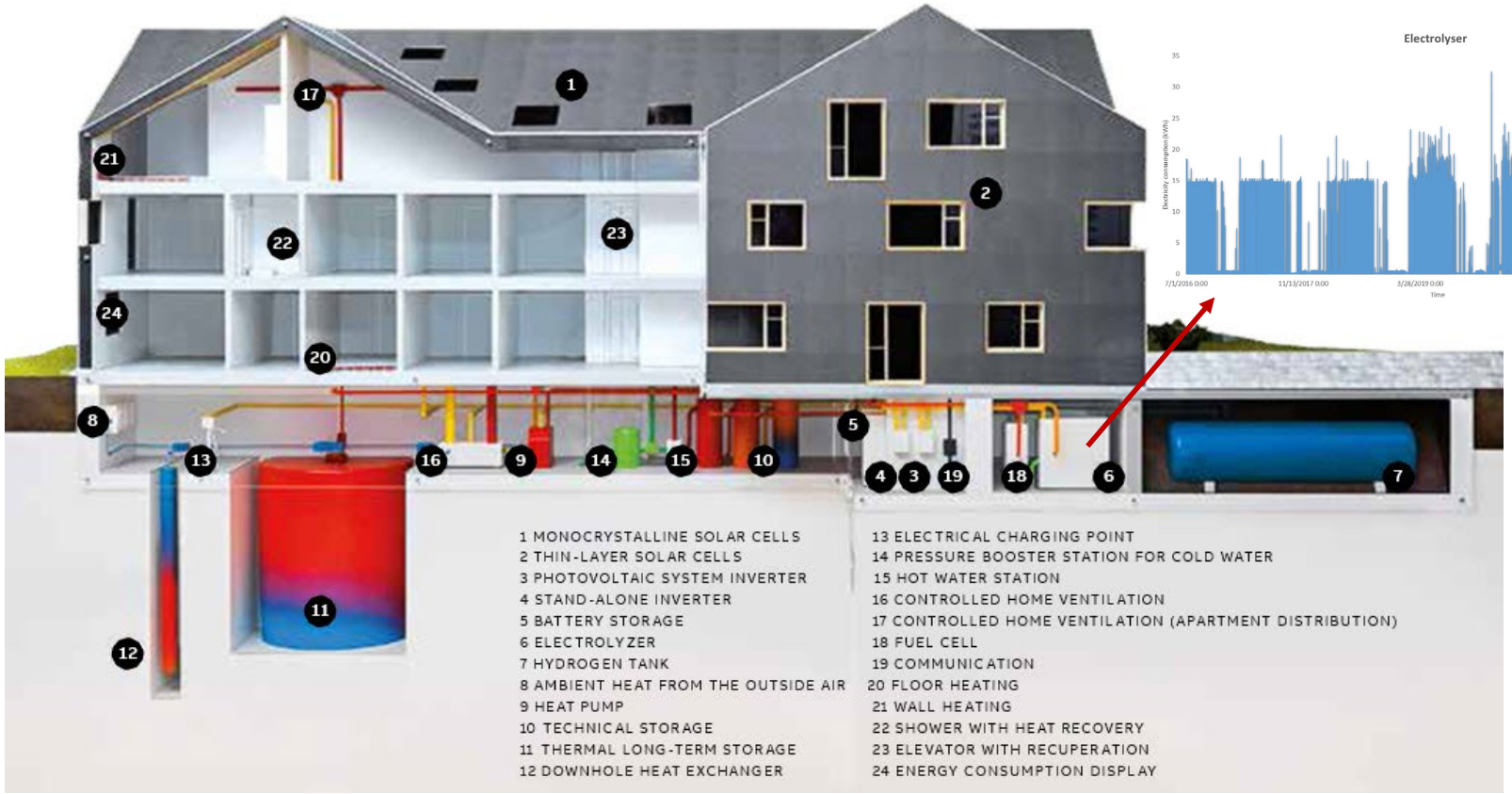
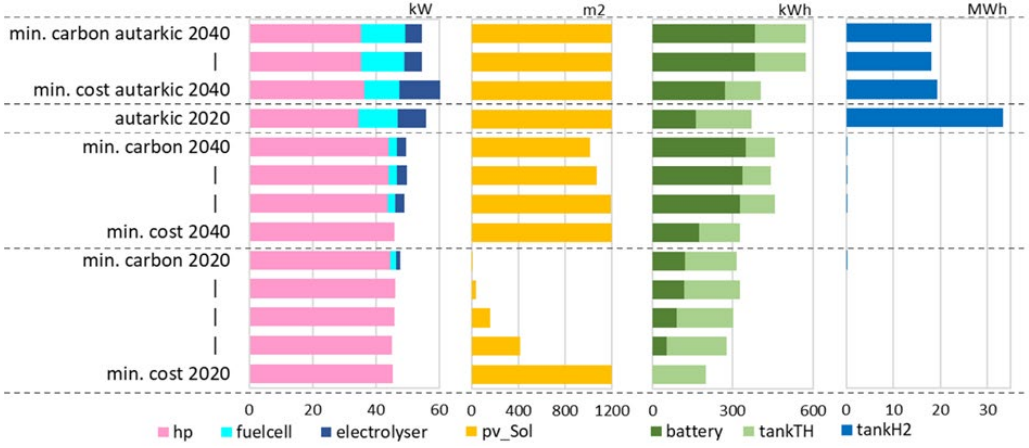
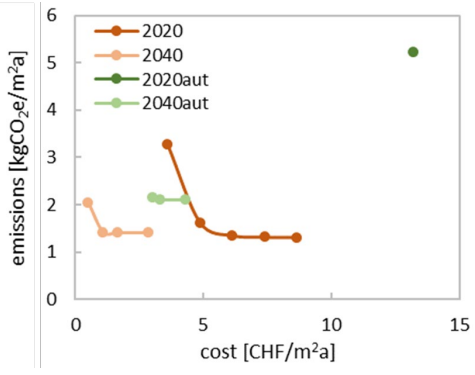


Power-hydrogen-power (P2H2P) system

- A residental P2H2P system is modelled in Ehub tool for a building consisting of 40 apartments.
- All autarkic as well as low carbon solutions use P2H2P system.
- P2H2P systems will be more attractive in 2040 due to higher efficiencies and lower costs.
- Pressurized hydrogen storage presents large cost and embodied emissions due to huge size (2020 – 34 MWh, 280 m3, 9t steel).

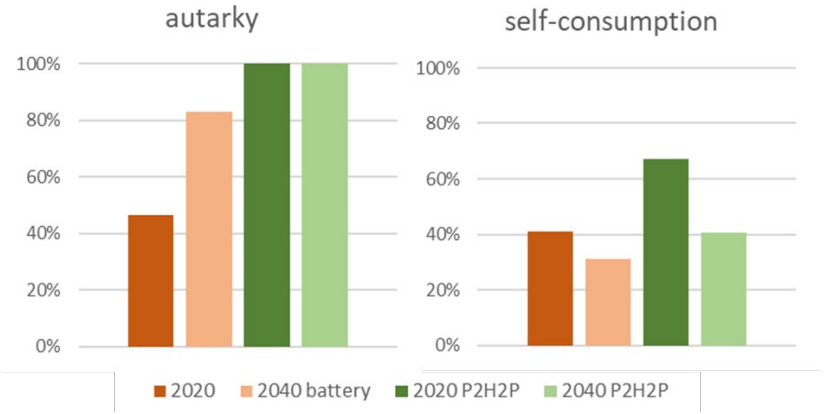


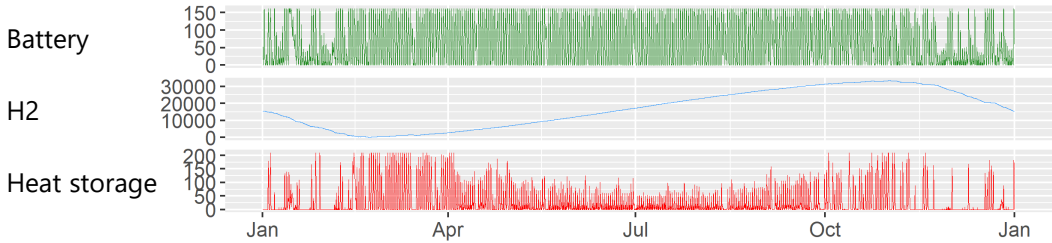


De Koning, Josien and Koirala, Binod; Analysis of a Residential Power-to-Hydrogen-to-Power System using MILP Optimization and the Energy Hub Concept, International Energy Workshop, 25-27 May, 2022, Freiburg, Germany

Power-hydrogen-power (P2H2P) system

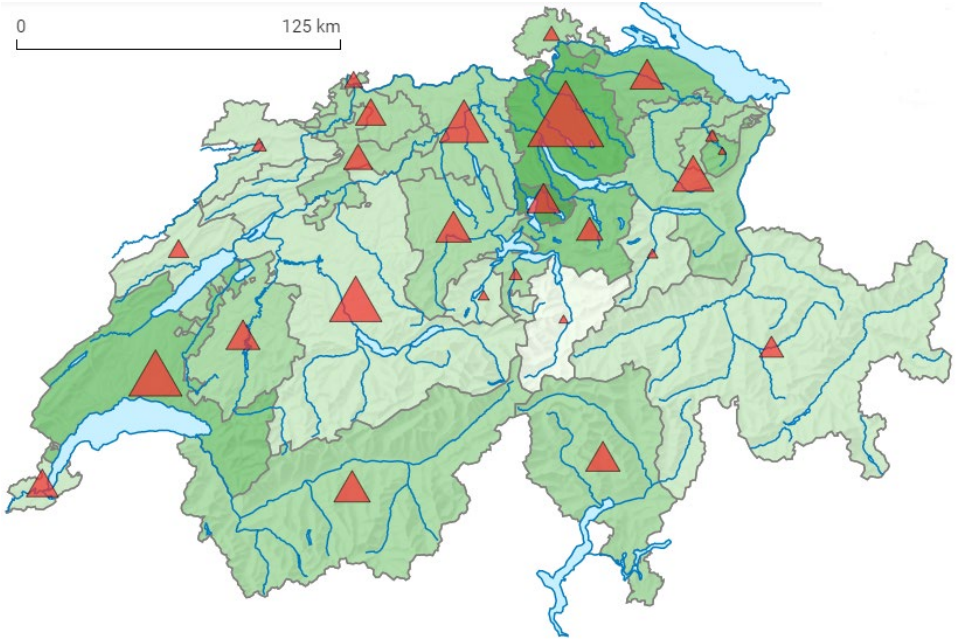
- >80% autarky can already be achieved with a battery, without P2H2P
- P2H2P systems will have higher self-consumption/autarky.
- P2H2P system will be more flexible and can provide seasonal flexibility.





De Koning, Josien and Koirala, Binod; Analysis of a Residential Power-to-Hydrogen-to-Power System using MILP Optimization and the Energy Hub Concept, International Energy Workshop, 25-27 May, 2022, Freiburg, Germany

E-mobility flexibility



Anteil der rein elektrischen Fahrzeuge am Personenwagenbestand, in %*

≥	3,2
2,8	– 3,1
2,4	– 2,7
2,0	– 2,3
1,6	– 1,9
<	1,6

Schweiz: 2,3

Anzahl der rein elektrischen Personenwagen*

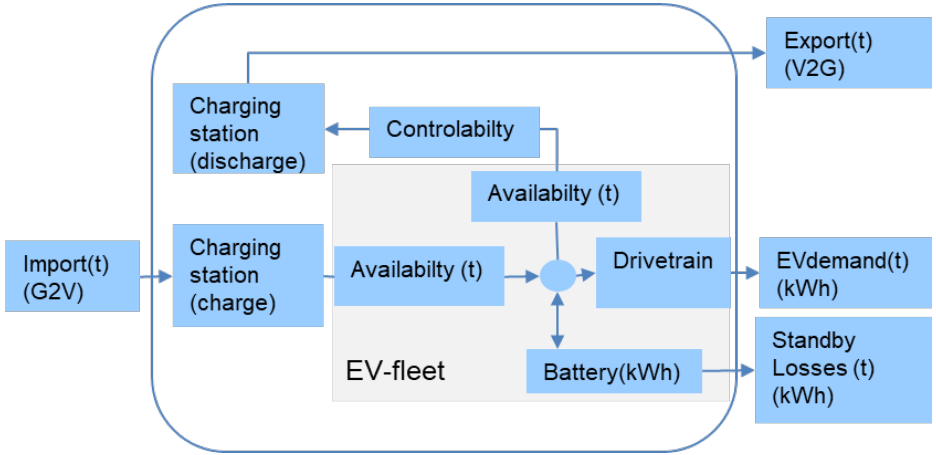
22 302
10 000
2 000
100

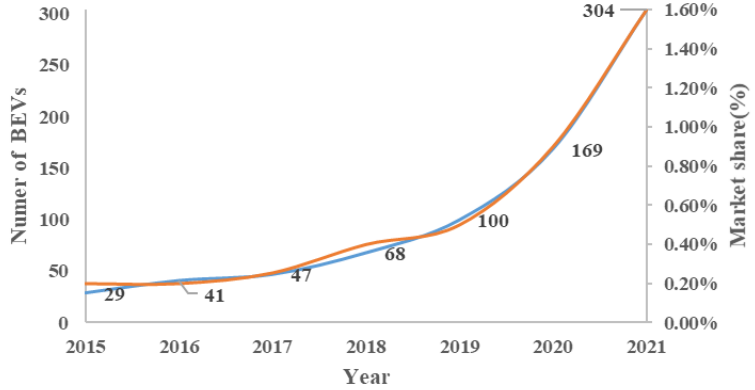
Schweiz: 110 745
* Bestand am 15.10.2022
provisorische Daten

Quelle(n): BFS, ASTRA – Strassenfahrzeugbestand (MFZ)

E-mobility flexibility

- An e-mobility module is developed and integrated into the E-hub Tool.
- Captures the **fleet size, charger size, transport demand, vehicle availability, controllability** and **battery size**.
- The module is tested using the multi-energy system in Chur
  - 304 EVs (1.6% market share, 2021)
  - Avg. annual mobility demand – 12440 km
  - Battery – 60 kWh, controlability – 0.7
  - Charger capacity – 10 kW, min SOC- 0.2
  - Energy demand (E-161 GWh, H-330 GWh)
  - Network (E-104 MW, G-216 MW, H- 9 MW)
  - Electricity mix (renewables (88.7%), nuclear (10.8%) and gas (0.5%)

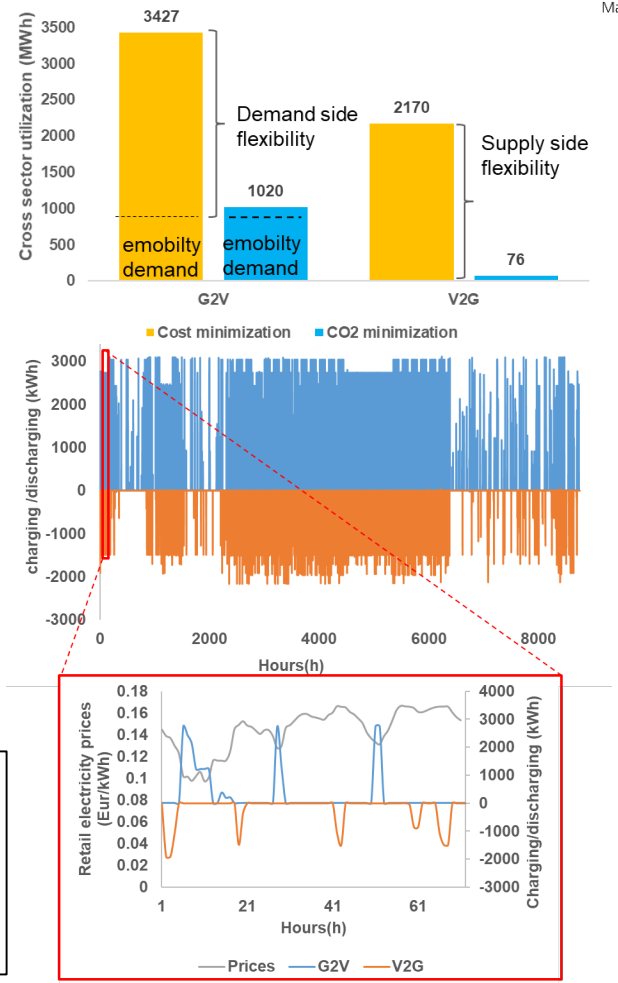




Source: BFS, ASTRA-MFZ

E-mobility flexibility

- Currently, V2G is an attractive solution in a cost optimization over a CO_2 optimization scenario, this may change with higher share of renewables.
- E-mobility and V2G services will add 2.14 and 1.36 % of electricity demand in cost and CO2 minimization scenarios respectively.
- In future – sensitivity analysis will be conducted for different share of EVs/renewables, controlabilty, battery size, charger capacity, etc.



B. Koirala, Mutschler, A. Bartolini, A. Bollinger, and K. Orehouning, "Flexibility assessment of e-mobility in multi-energy districts ," CIRED e-mobility workshop, 2-3 June 2022, Porto, doi: 10.1049/icp.2022.0827

Take-home messages

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- Multi-energy flexibility will be increasingly important in future.

P2H2P

- P2H2P will lead to higher self-consumption/autarky in multi-energy systems.
- P2H2P will be more attractive in 2040 (higher efficiencies, lower costs).
- Cost-effective seasonal storage remains a challenge.

E-mobility

- V2G/G2V (V1G) will be important source of flexibility in future.
- V2G is an attractive solution in a cost optimization scenario over a CO2 optimization scenario, but may change with increasing share of renewables.
- V2G needs to overcome regulatory and operational challenges (e.g. only selected types of Nissan, Mitsubishi, Volkswagen are V2G capable).

Thank you for your attention!
Vielen Dank für Ihre Aufmerksamkeit!

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