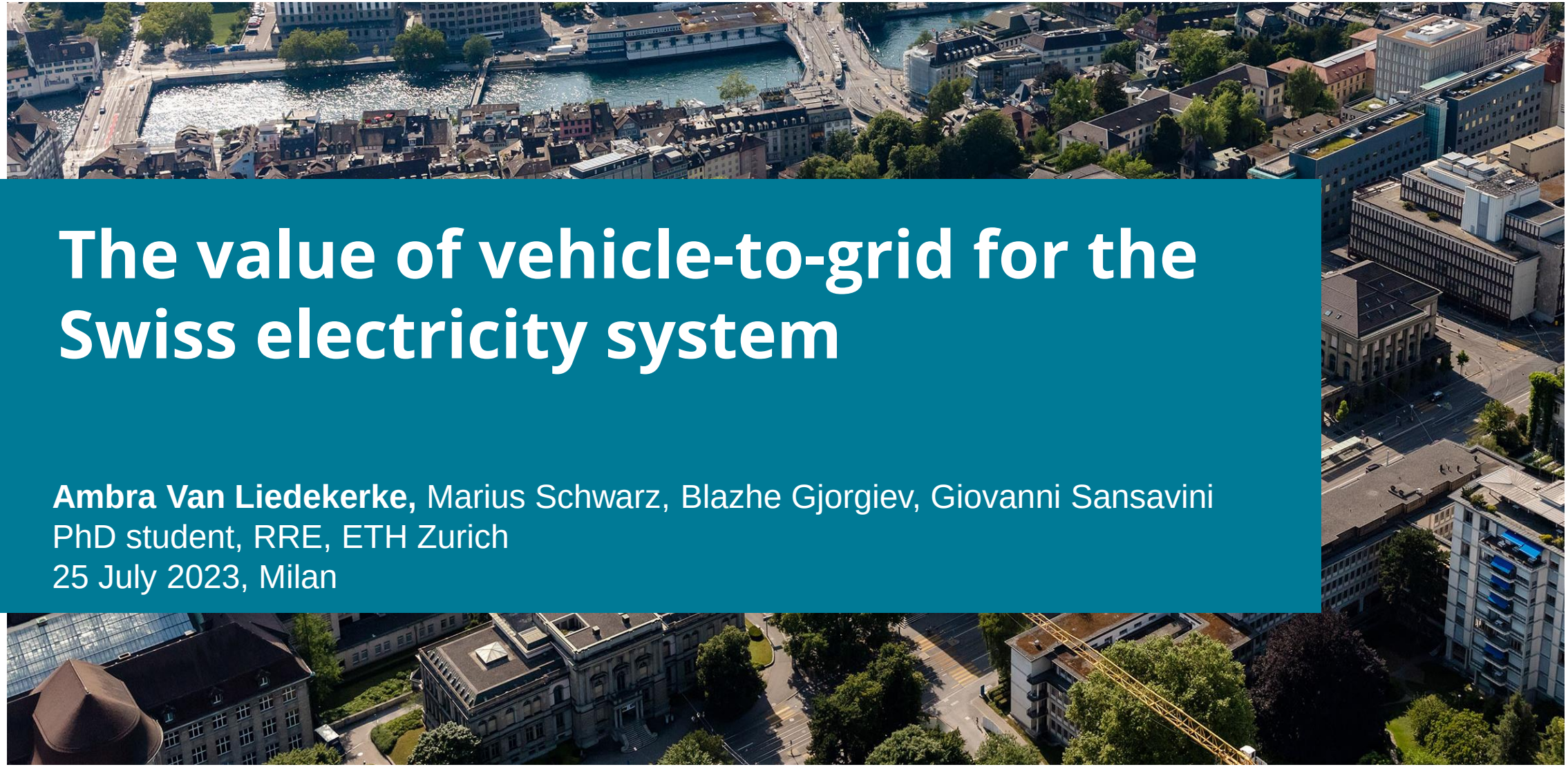


The value of vehicle-to-grid for the Swiss electricity system

Ambra Van Liedekerke, Marius Schwarz, Blazhe Gjorgiev, Giovanni Sansavini
PhD student, RRE, ETH Zurich
25 July 2023, Milan

Motivation

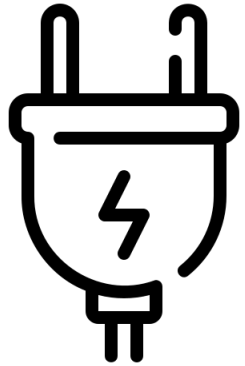
Net 0 emissions

2050

Transport & heat electrification

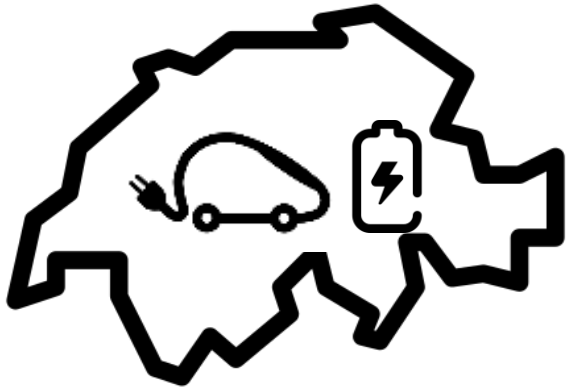
4.5 M EV in 2050

Load increase



40% load increase from 2020 to 2050

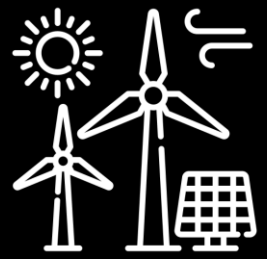
V2G



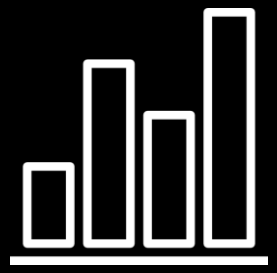
A mitigation strategy?

What are the benefits of V2G for the Swiss electricity system?

1. Curtailment



2. Dispatch



3. Costs

Agenda

1. Introduction and research question
2. Methodology
3. Results
4. Discussion and conclusions

The optimization model

Input

Techno-Economic

Electricity demand [GW]

Generators [GW]

Electricity generation and fuel costs [EUR]

Weather [Wind, Irradiance]

Transmission system [Lines, Transformers]

V2G

Available storage capacity [GWh]

Available power [GW]

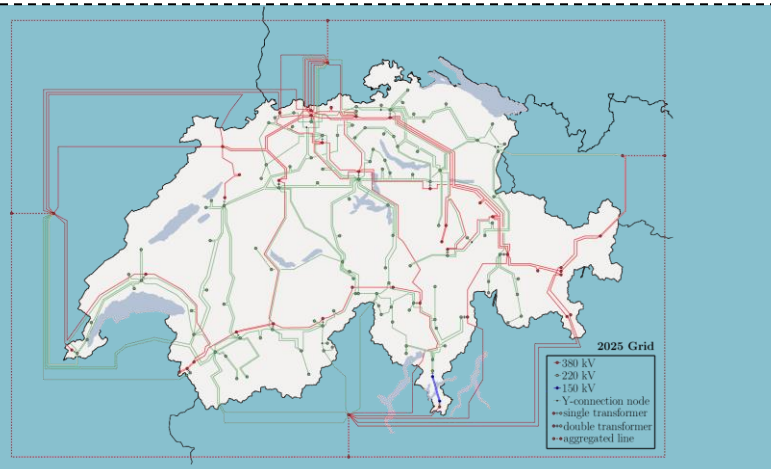
Model

2020-2050

Obj. Function: cost optimal dispatch of generation and flexible demand

Method: LP

Resolution: 1h, nodal



Output

Technologies

Dispatch [GWh]

Curtailment [GWh]

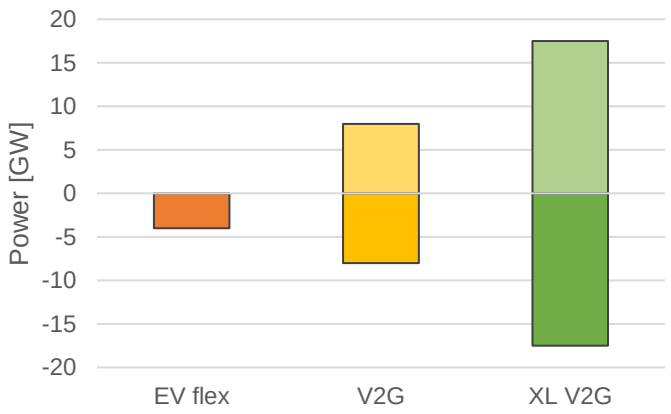
Electricity system

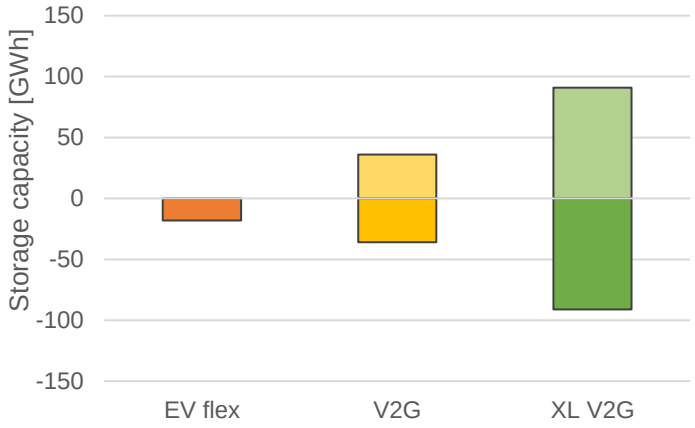
Electricity cost [EUR/MWh]

Imports / exports [TWh]

Grid loading [GW]

Scenarios





2020-2050

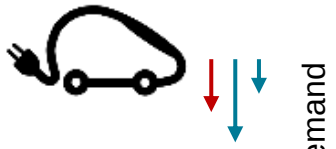
EV

EV charging is part of the demand

Reference scenario

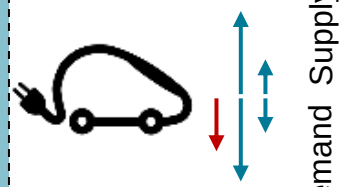
EV flex

EV charging is flexible with 0 costs



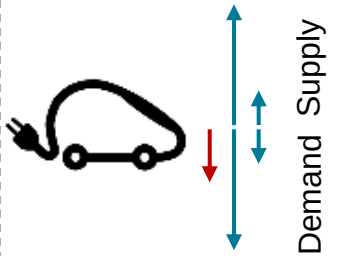
V2G

V2G with 0 costs is implemented



V2G XL

XL V2G with 0 costs is implemented



Agenda

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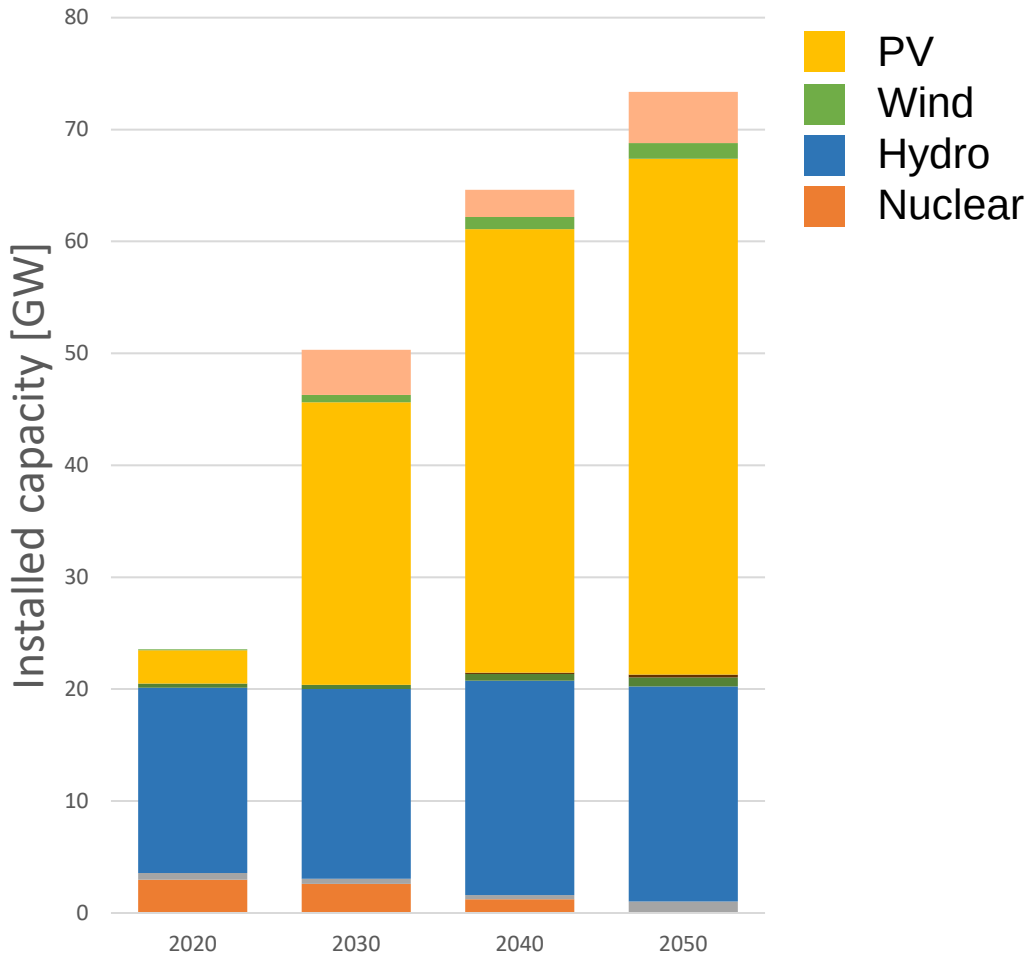
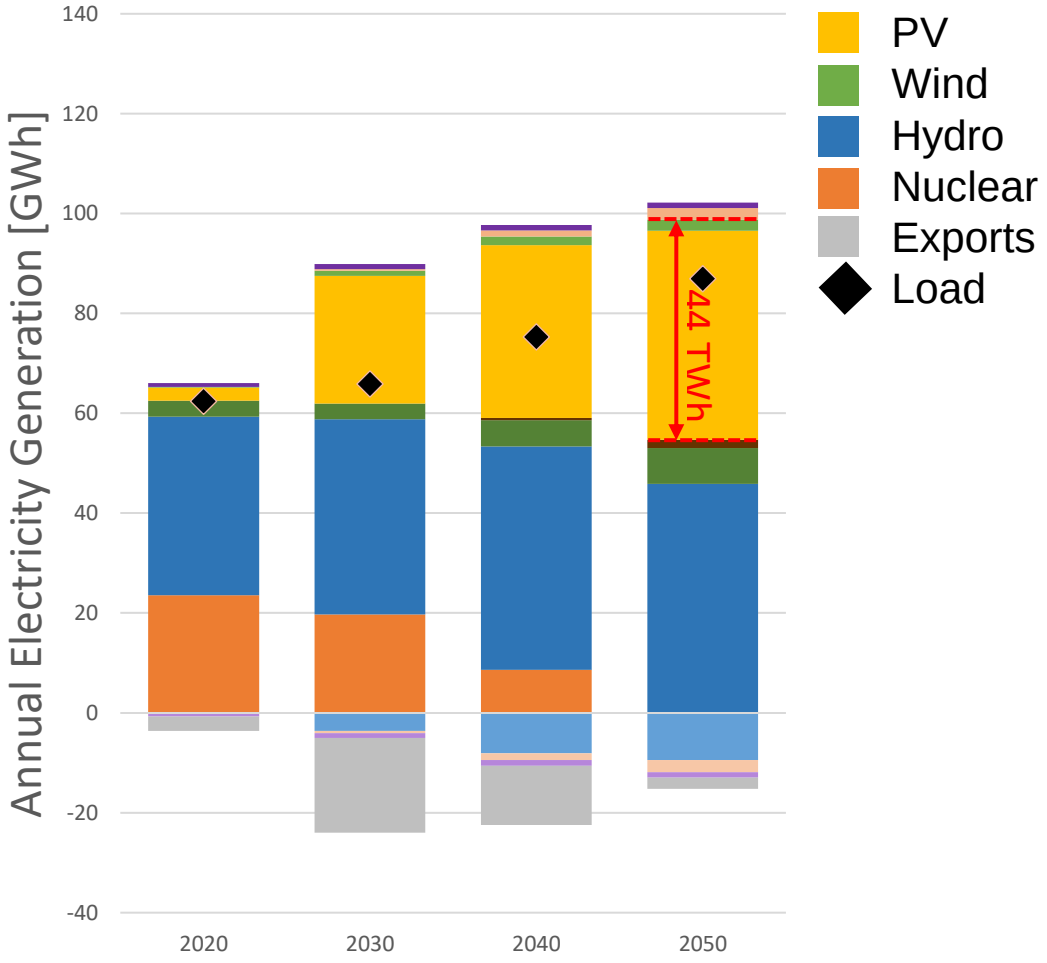
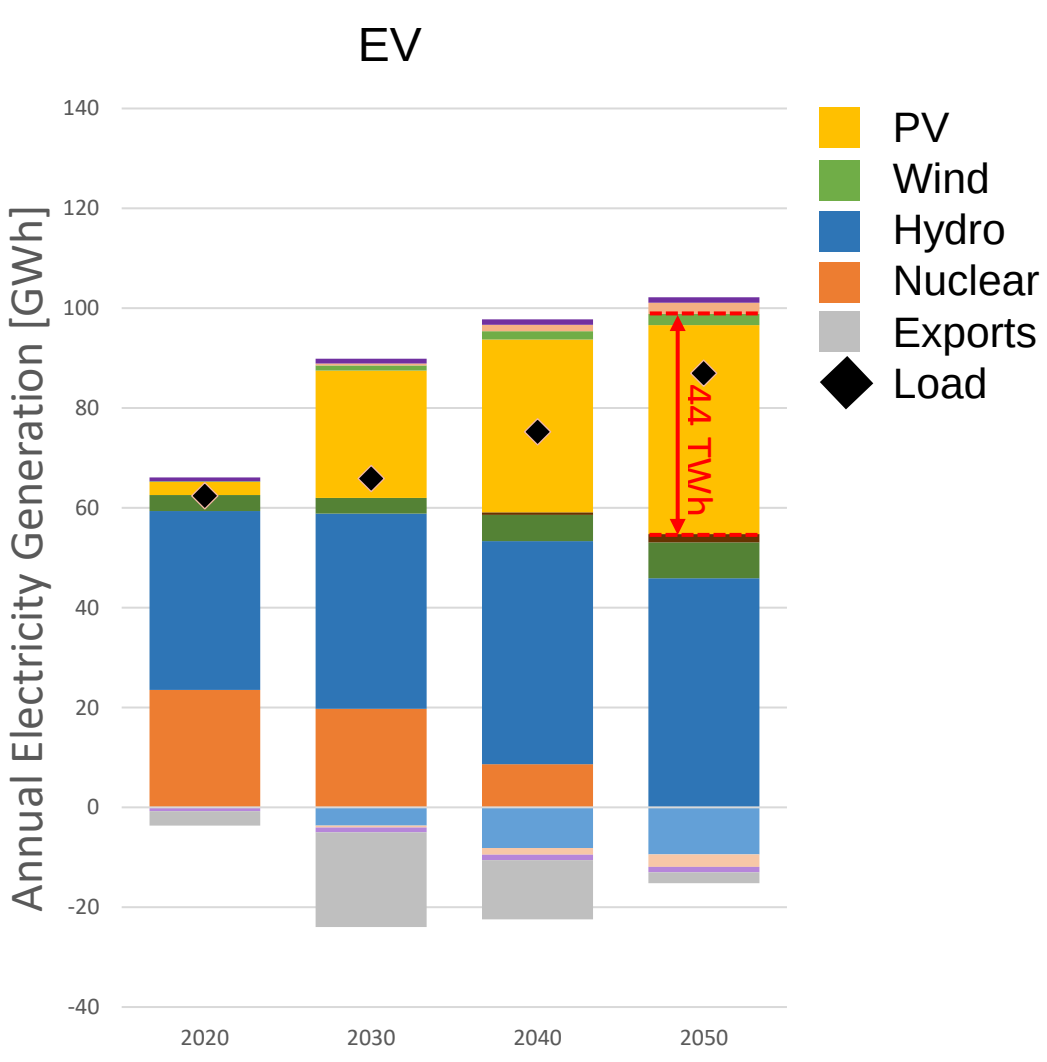
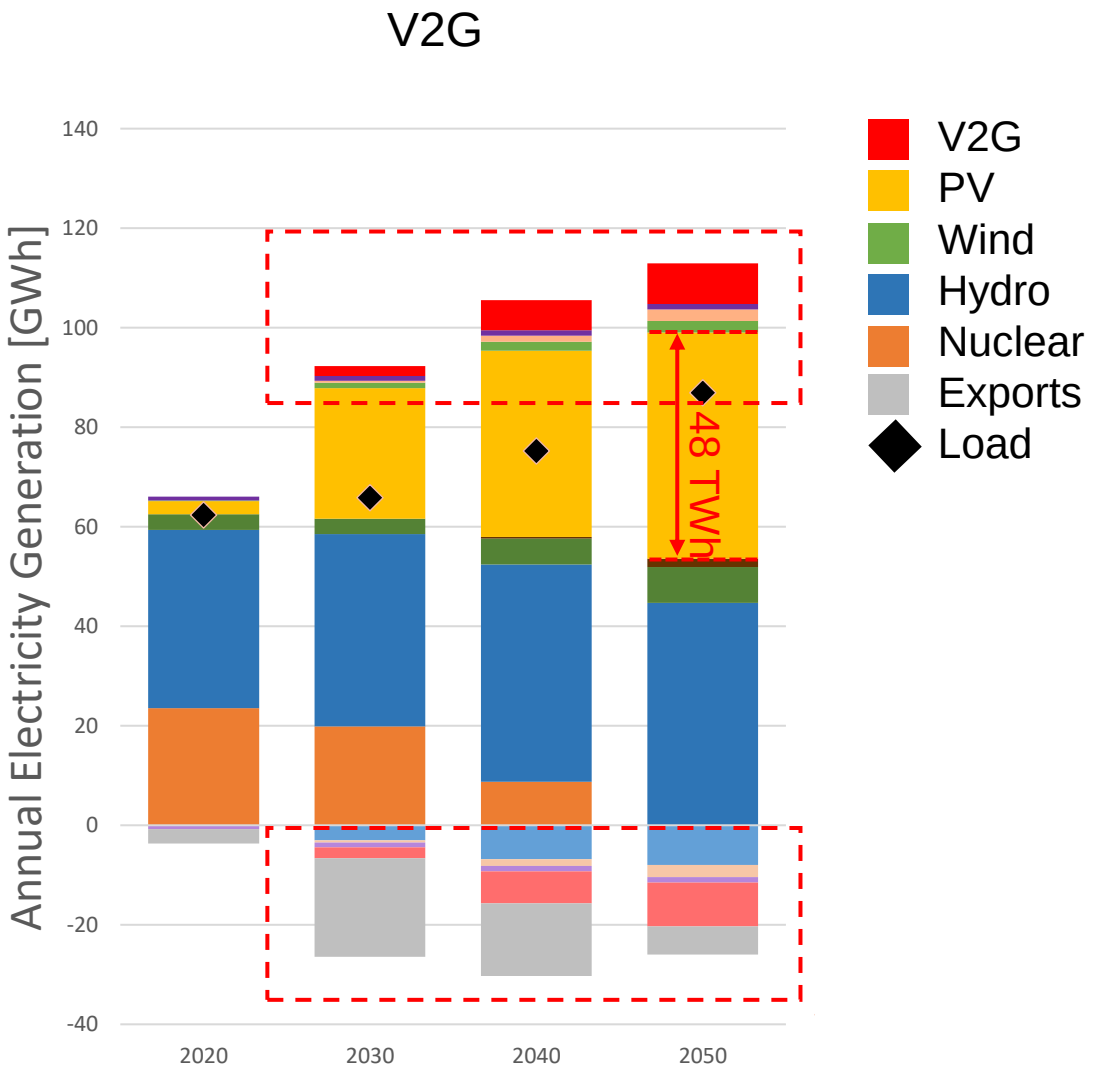
Reference (EV) scenario





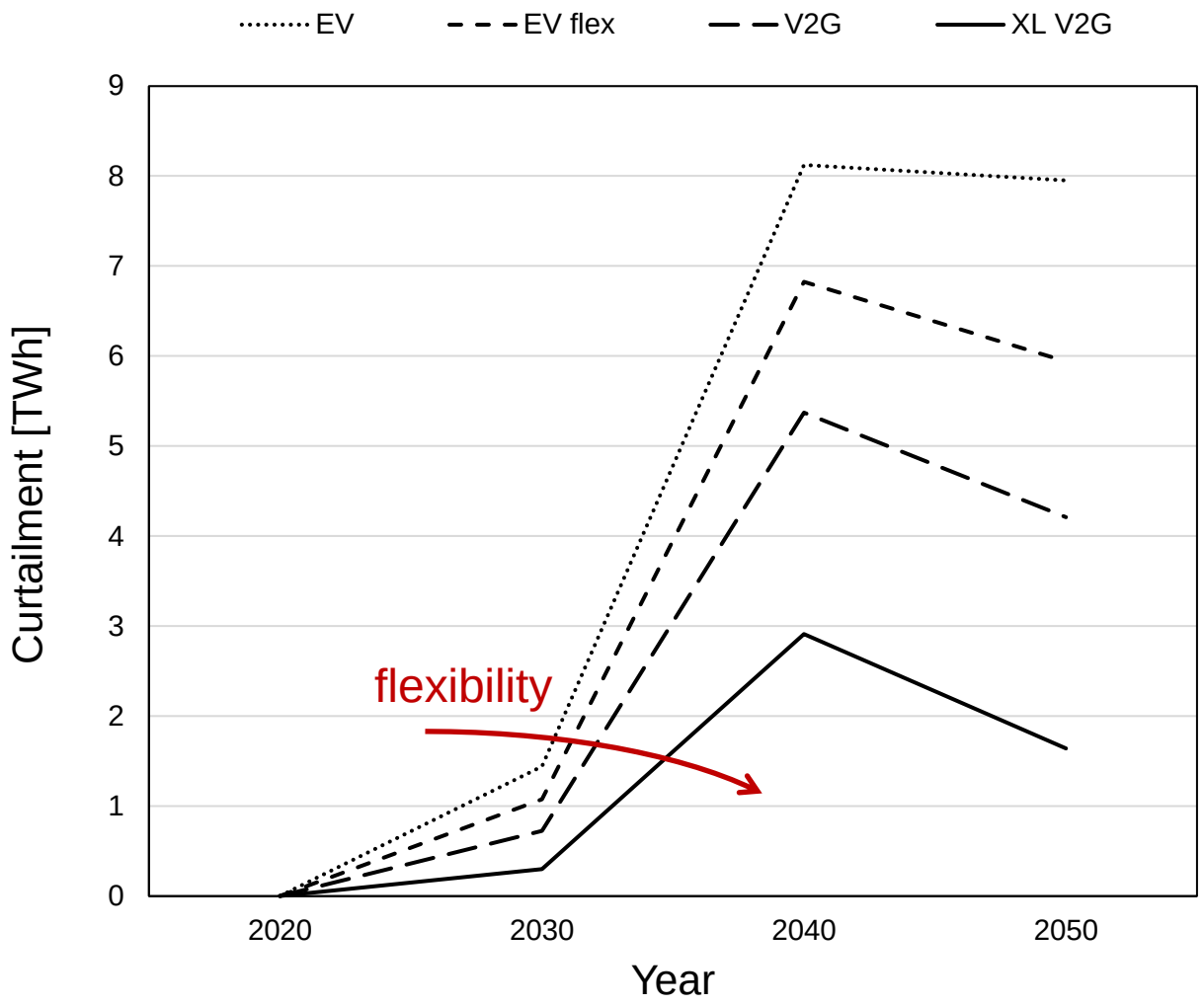
Reference (EV) scenario





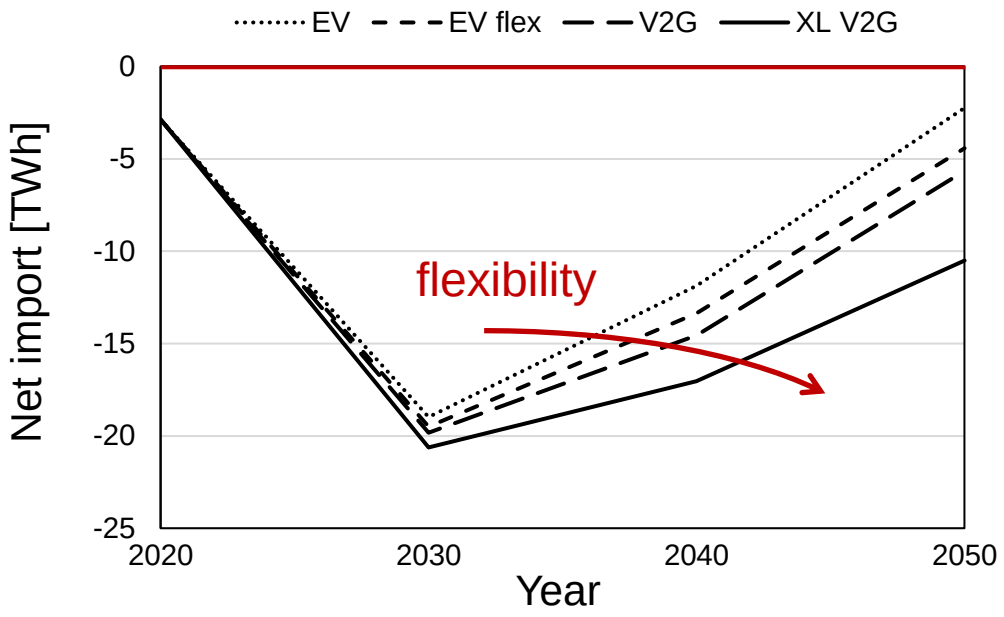
Curtailment

EV-offered flexibility reduces curtailment, favoring the integration of VRES



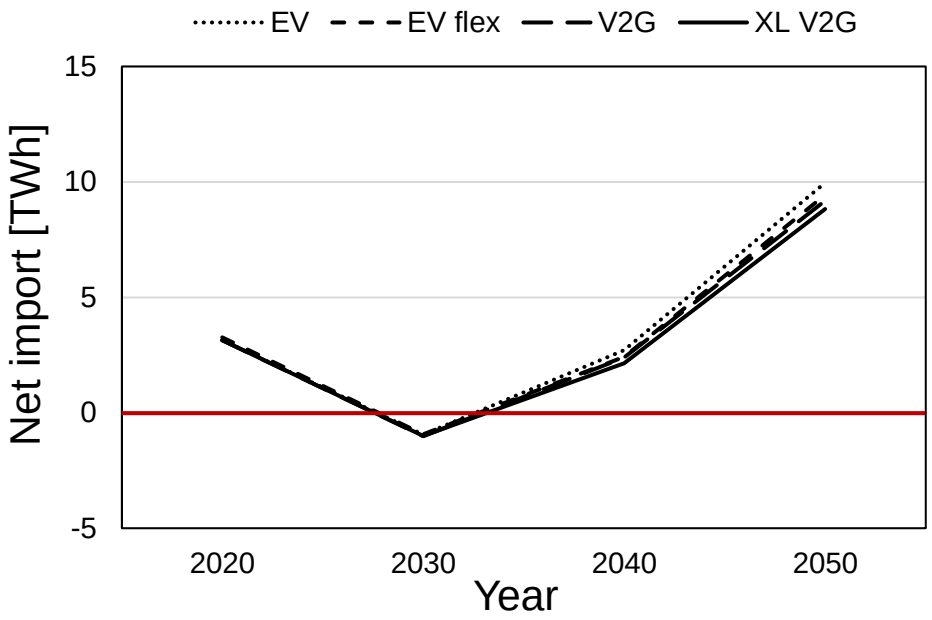
Imports/ exports

Year



Yearly exports are increased with higher EV-offered flexibility

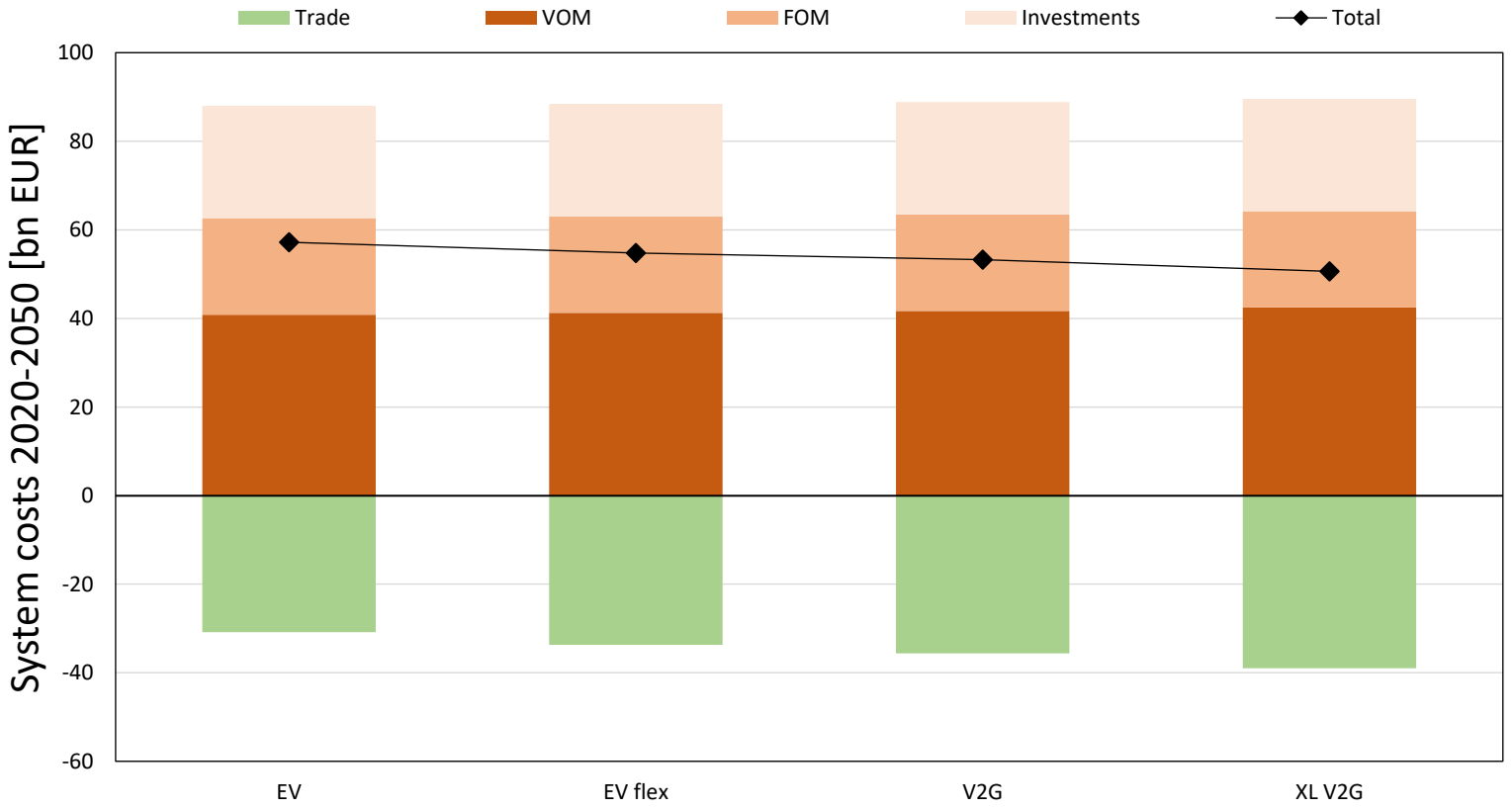
Winter



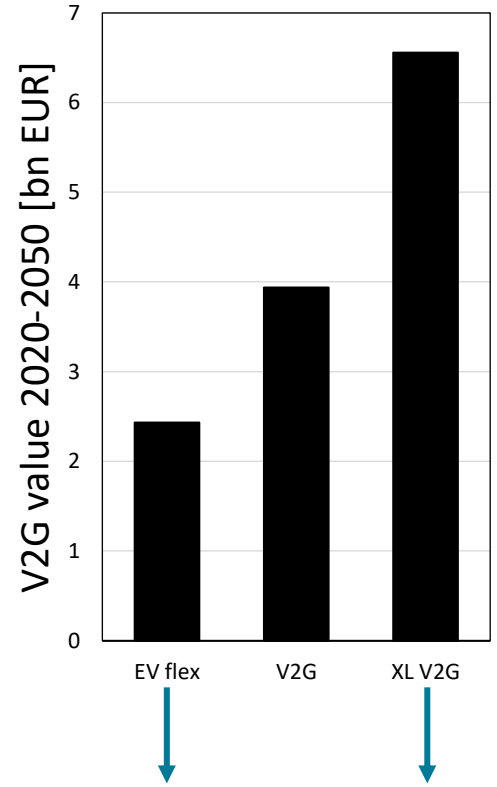
EV-offered flexibility doesn't impact the winter imports

System costs

System costs are reduced with higher EV-offered flexibility



Range of system cost reduction across all V2G scenarios: 64 – 107 EUR/car/y

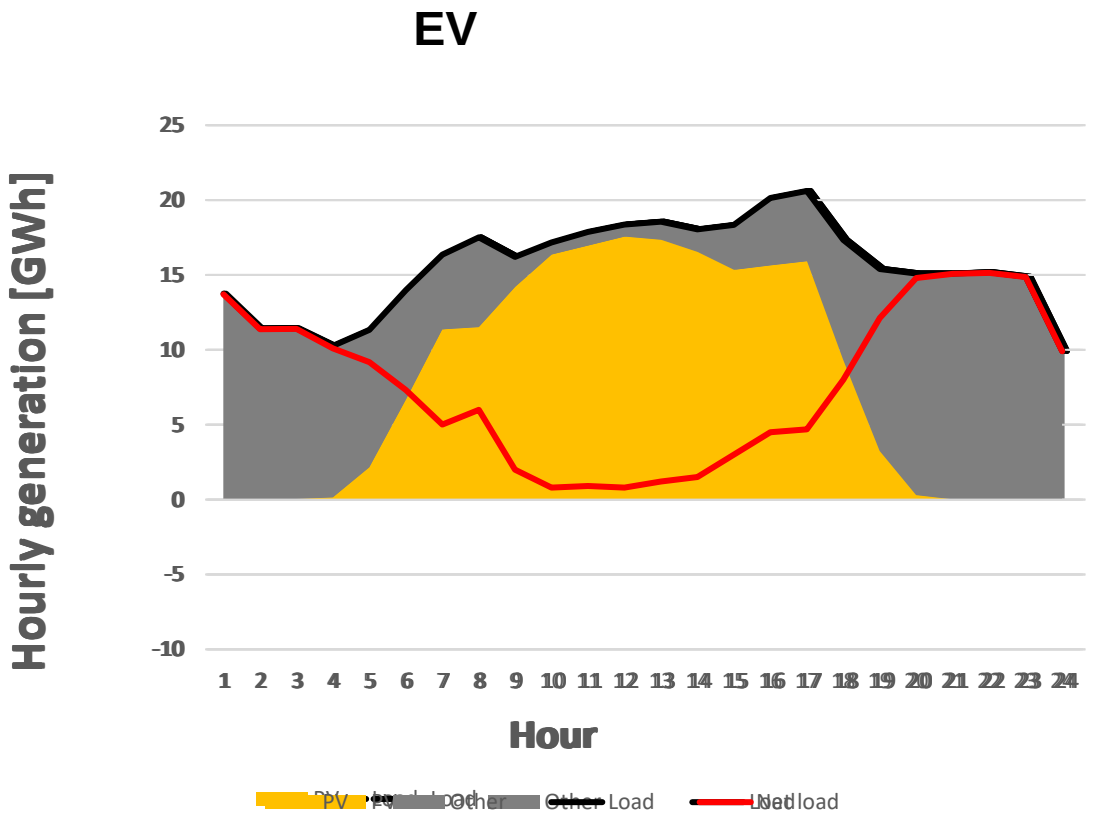


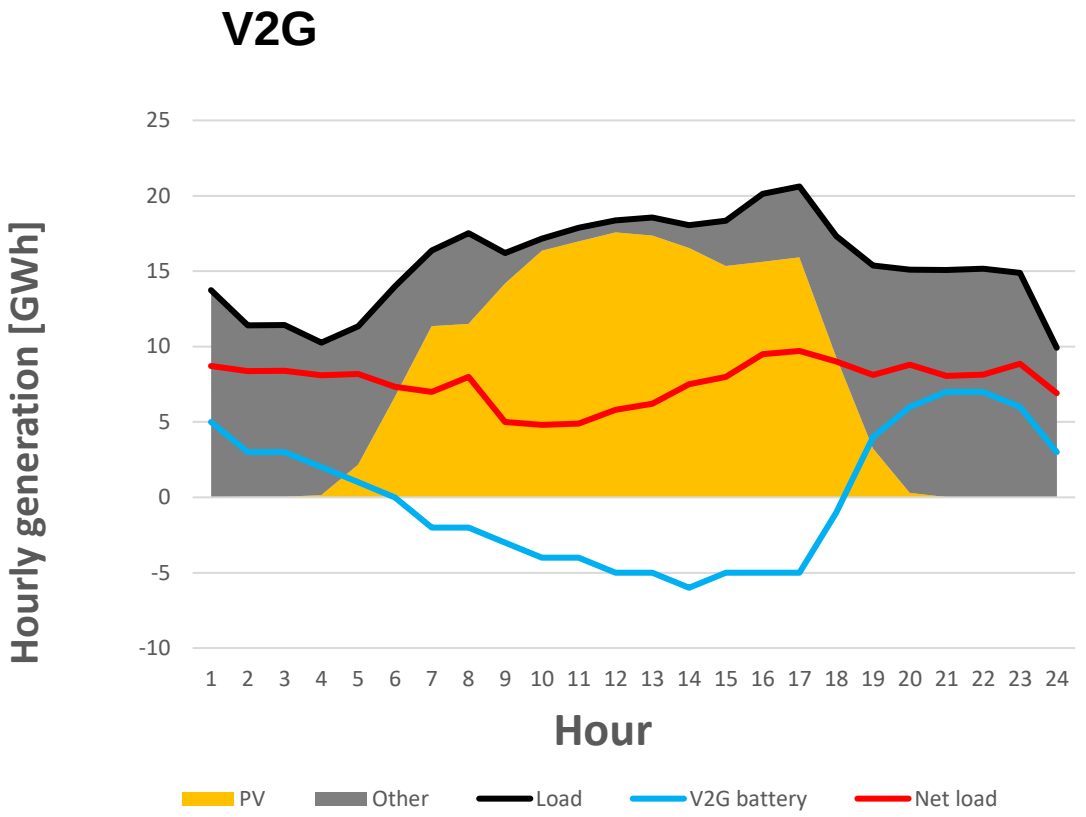
38 EUR/car/y

92 EUR/car/y

Net load variability

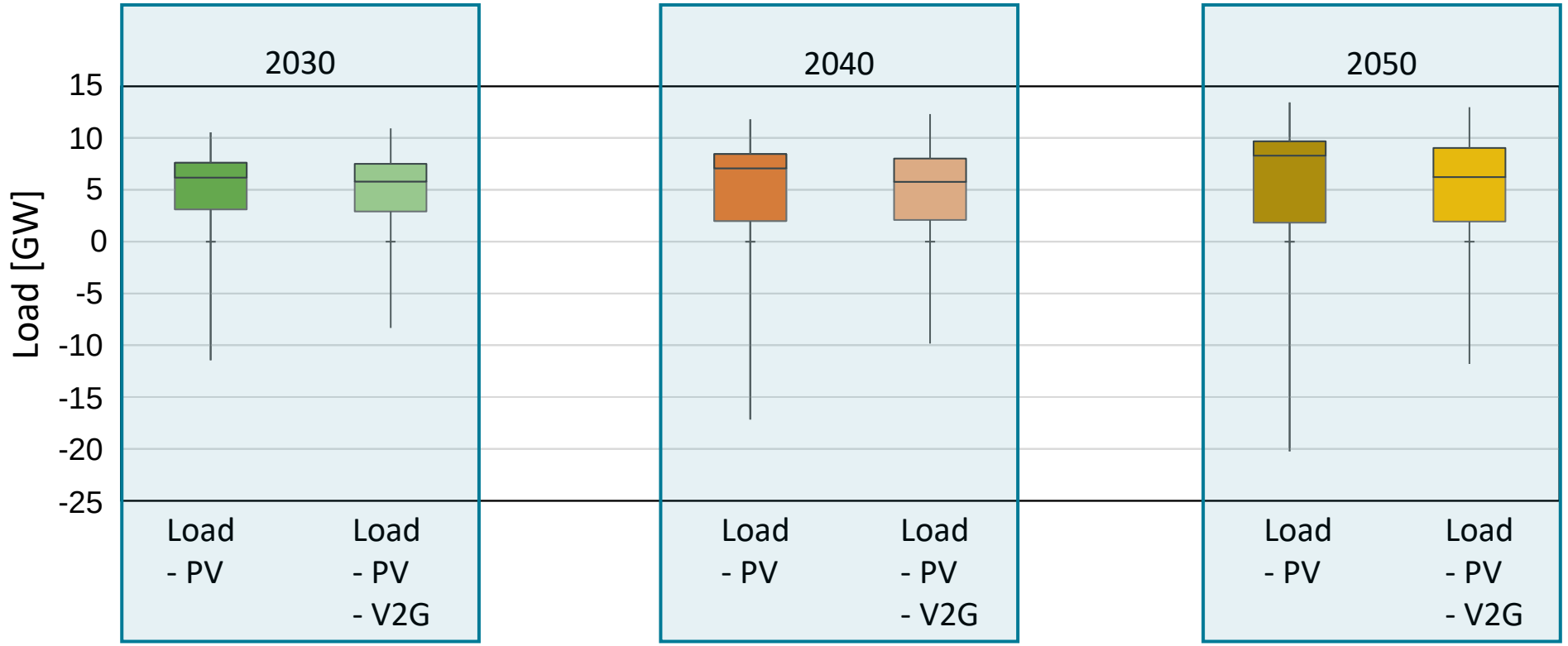
Net load = Load – VRES generation





Net load variability

EV-offered flexibility reduces net load variability



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Discussion

What can be improved:

- Include an electricity market model
- Study the impact of V2G participation in the balancing market
- Study the effect of V2G on the distribution grid
- More research on EV behavior and V2G availability

Conclusion

- V2G scenarios allow us to observe its benefits for the electricity system
- Benefits are observed in dispatch, trade, curtailment and system costs
- Additional flexibility favors the integration of VRES
- Is it economically viable?

Thank you for your attention!

Questions?

Interactive web-viewer