THE EFFECT OF VEHICLE-TO-GRID IN FRANCE AND GERMANY, IN A CONTEXT OF MARKET COUPLING BY 2035

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IFP Energies nouvelles

Motivation

- European ambition = common electricity market + decarbonisation of energy production and uses
- Challenges : market design, grid stability
- Need to draw cross section complementarity and smart control

Outline

I. Data

II. EVs and interconnection lines

III. Empirical results

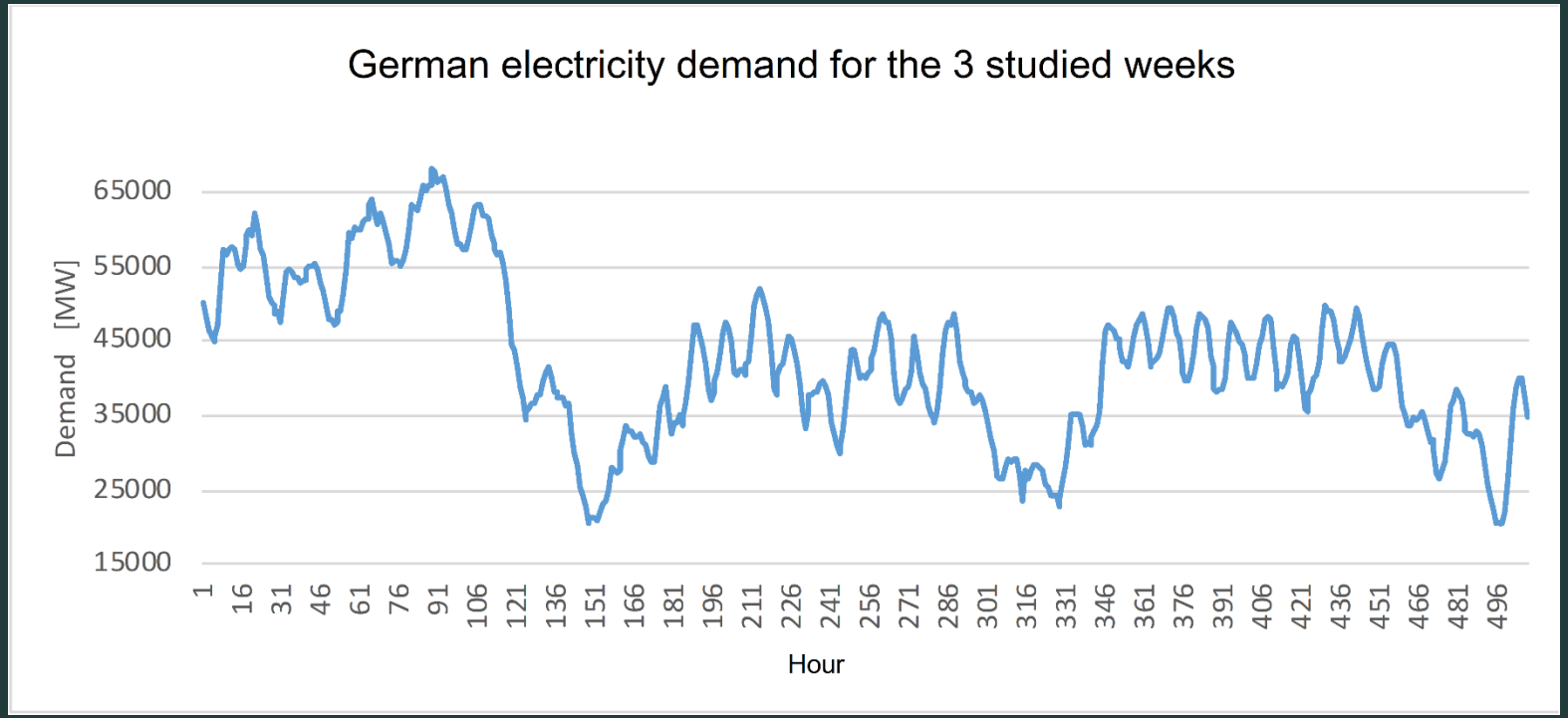
IV. Discussion

Energy demand curve

$$Demand = Production - Import + Export - Production_{REN}$$

Year = 2019 – 3 aggregated weeks

- 3rd of January « *Black Week* »
- 1st of May « Windy »
- 4th of July « sunny »



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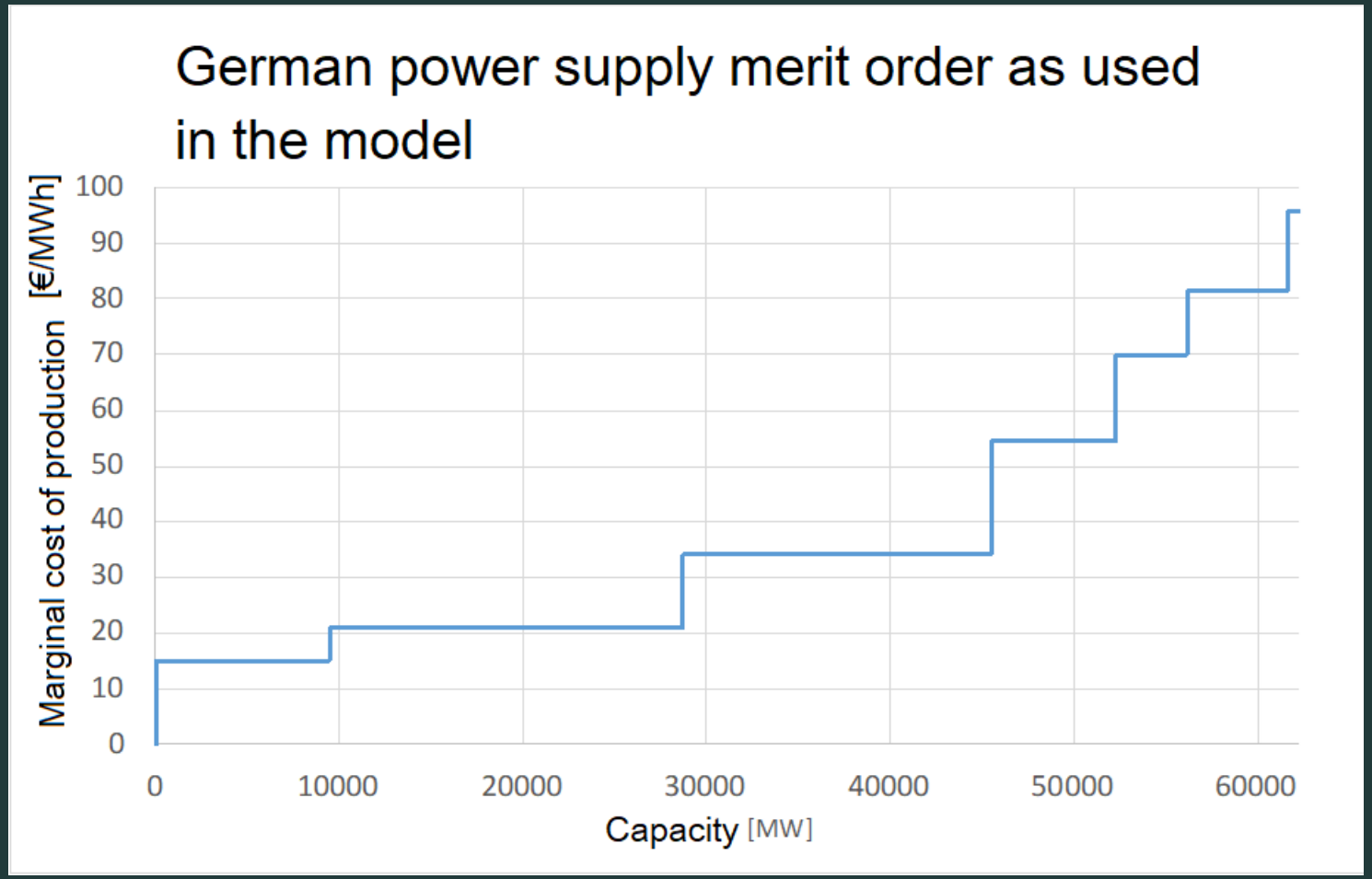
Building of the merit order



Equations

$$min\left[\sum_{i,t}(c_{var,i}\,P_{i,t}) + \; c_l\,K_l + c_{sto}K_{sto}\right]$$

$c_{var} = c_{fuel} + c_{O\&M} + c_{CO_2}$

c_{fuel} : fuel cost

$c_{O\&M}$: Operation & Maintenance

c_{CO_2} : EU-ETS carbon cost

P_i : Power supply of technology $i \in I$

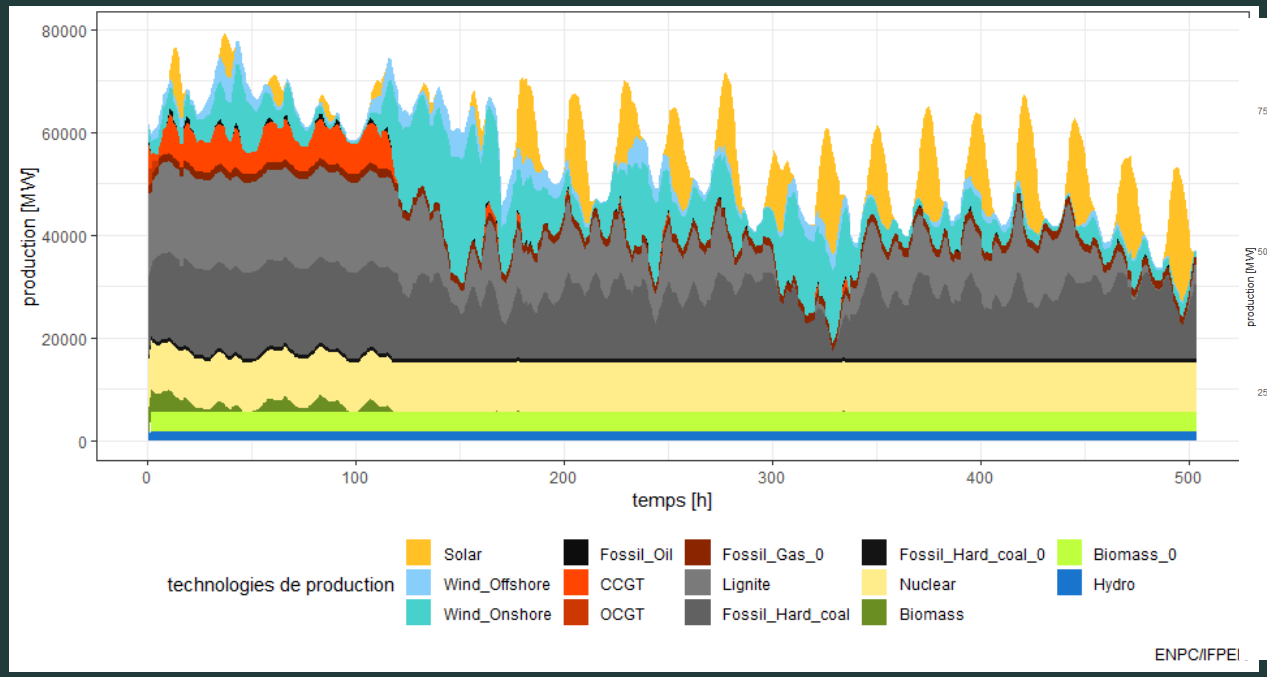
c_l : investment cost in interconnection lines

K_l : Overall capacity of connection lines

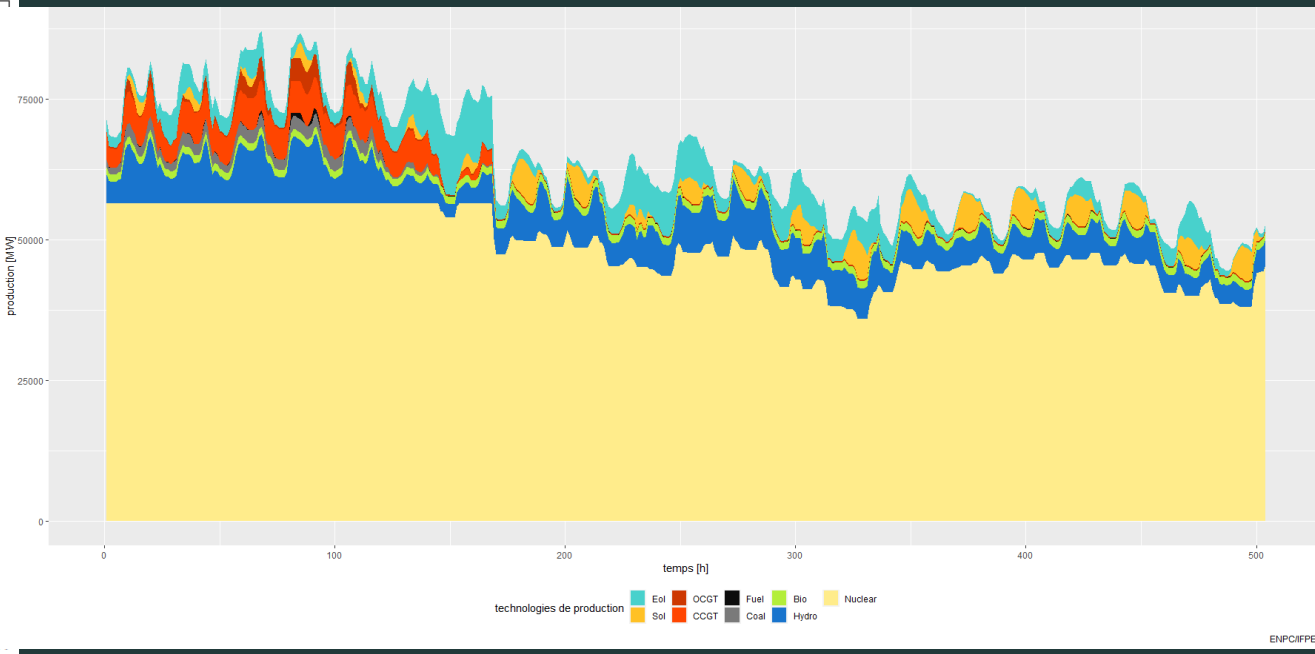
c_{sto} : investment cost in storage capacity

K_{sto} : Overall capacity of storage devices

Running the model



Germany



France

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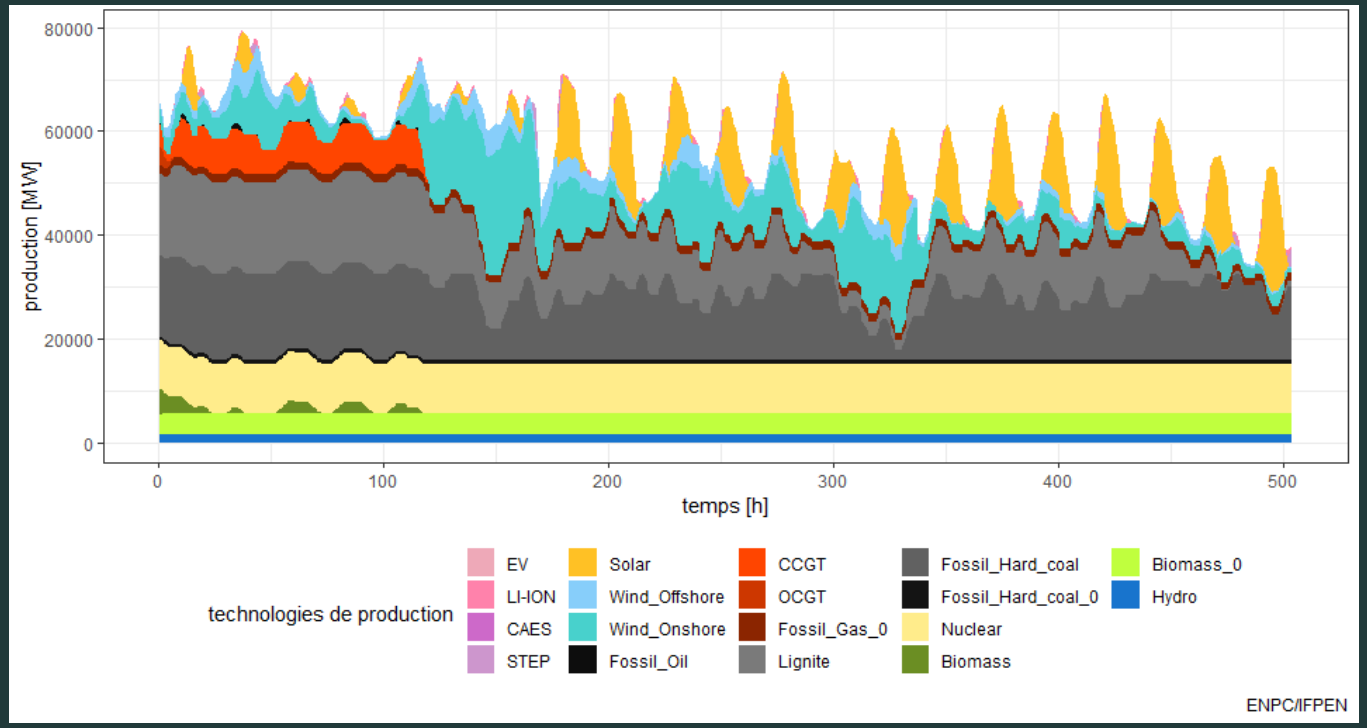
Integration of conventional storage mechanisms

- 4 technologies: STEP, CAES, Li-ion & EVs
- Initial capacities + free investment



German supply curve with storage enabled

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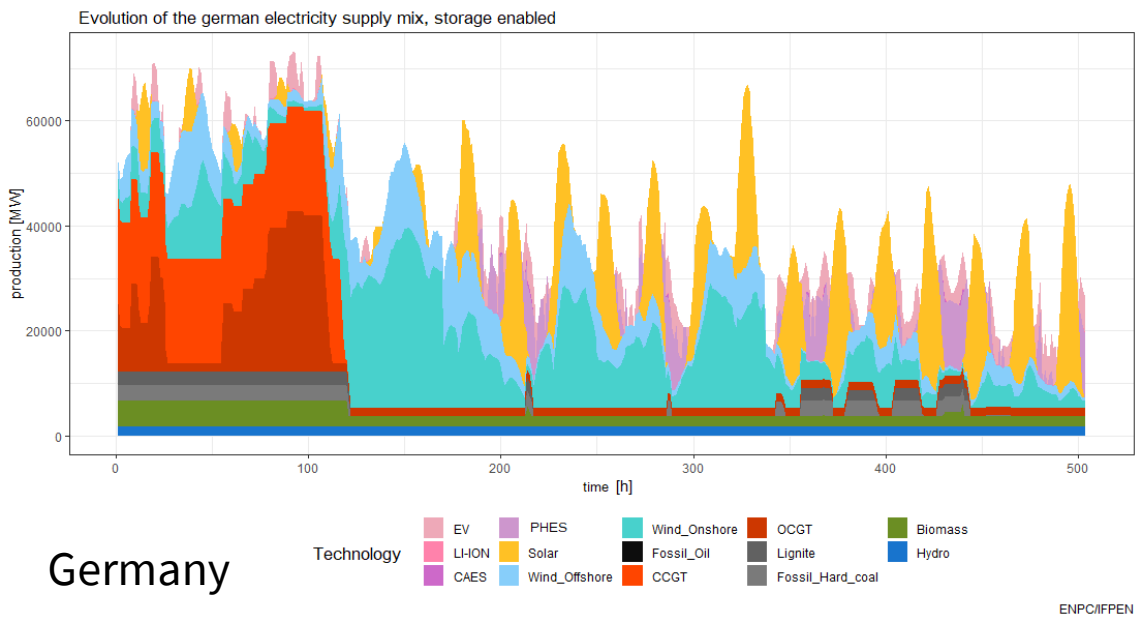
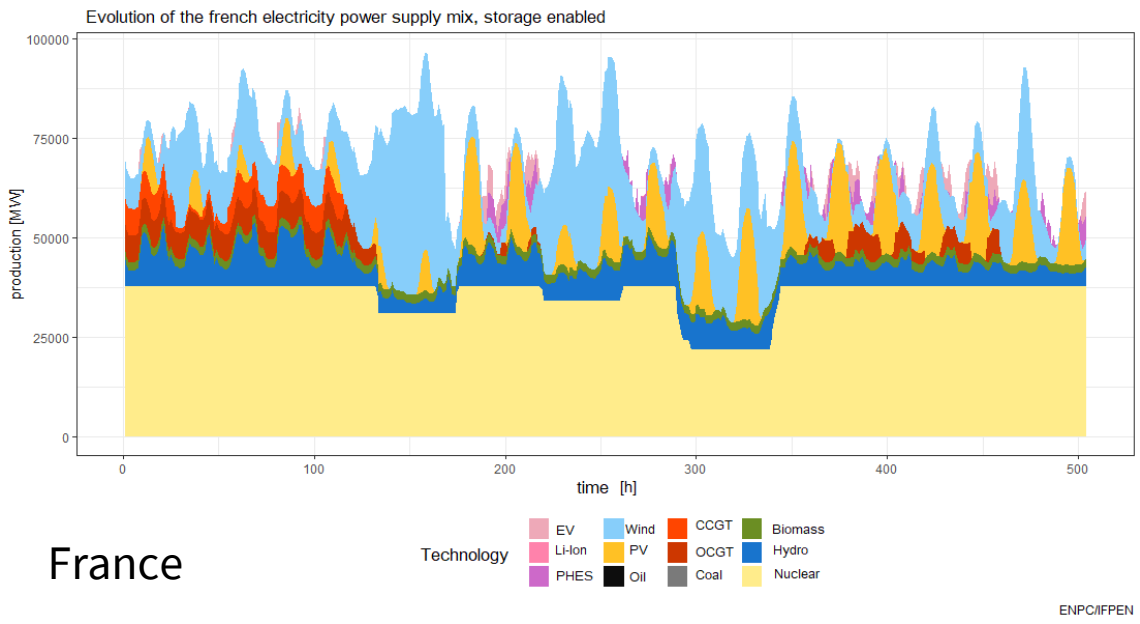
Model let free

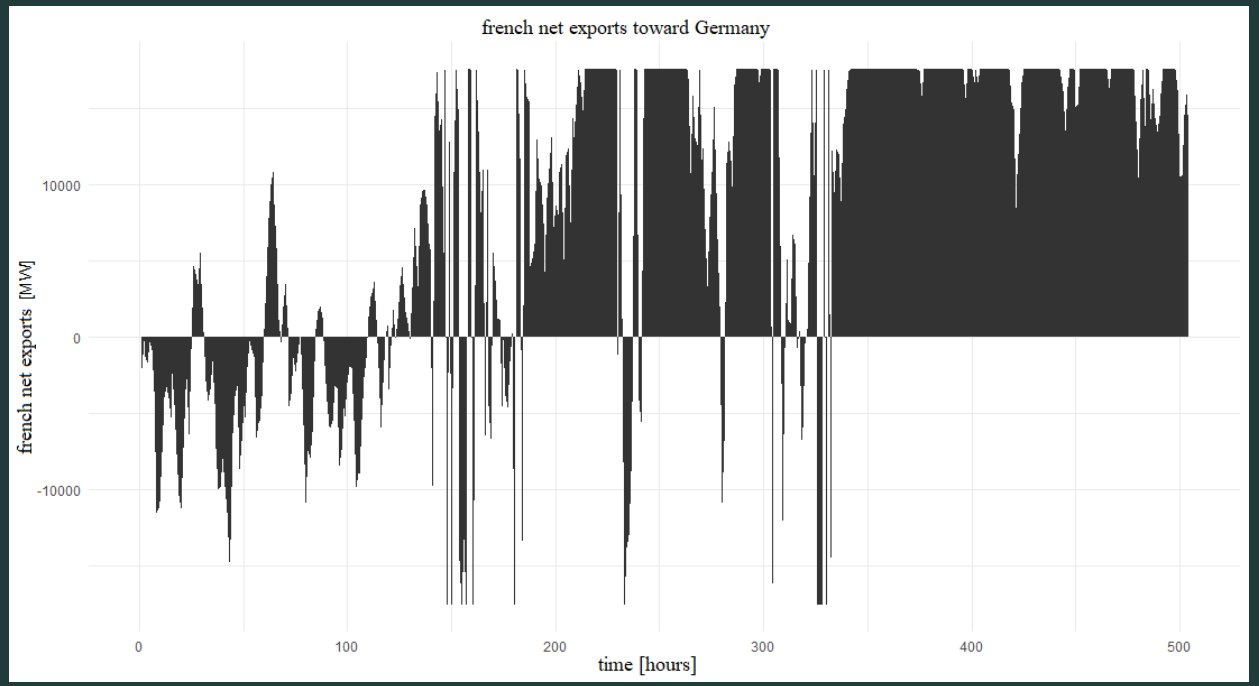


Germany



France

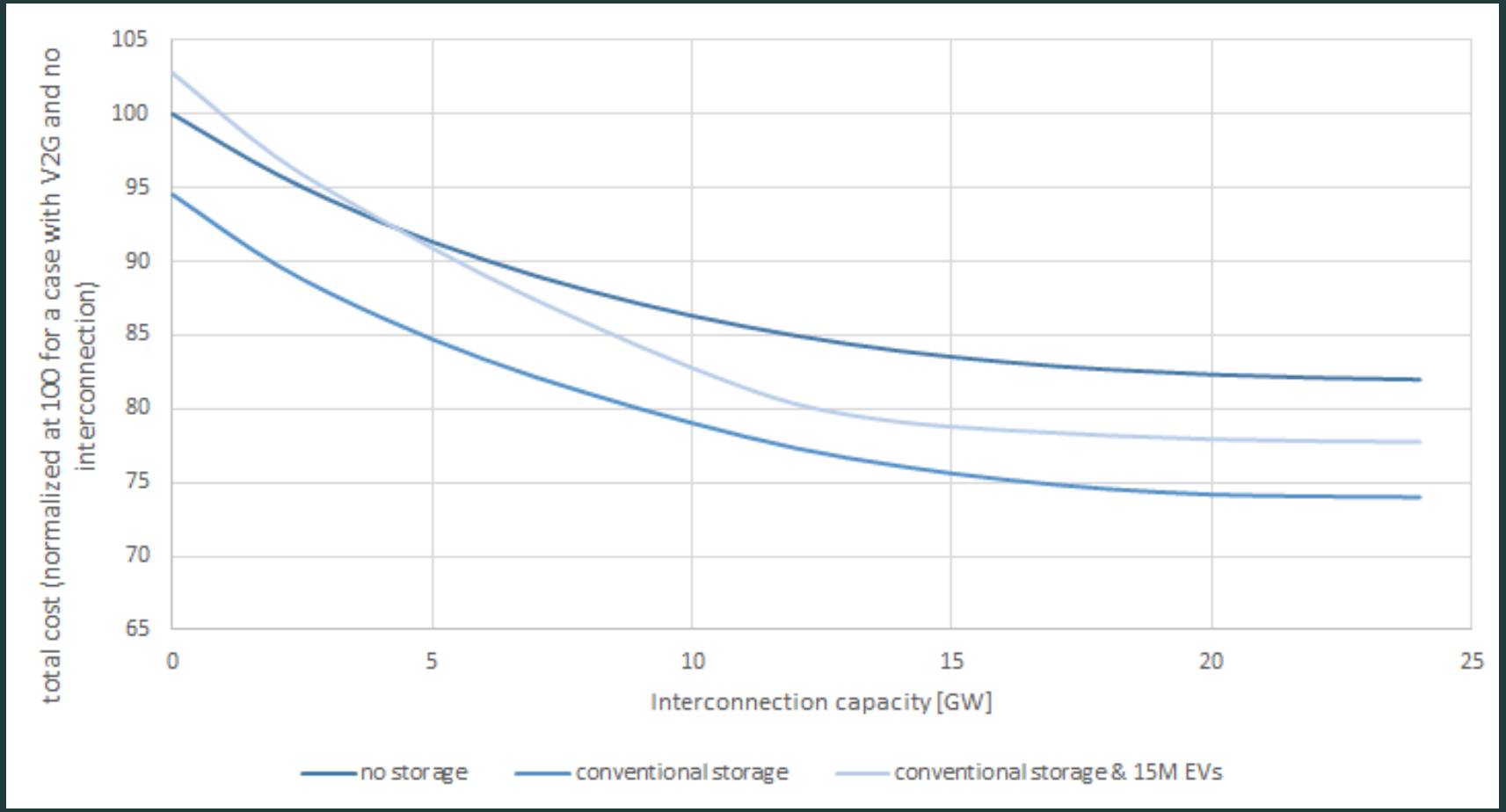
- Storage investment: 2 GW of PHES in France, 6 GW of PHES in Germany. (dual values of -900€ for Germany and -400€ for France)
- Investment in 16 GW of interconnection



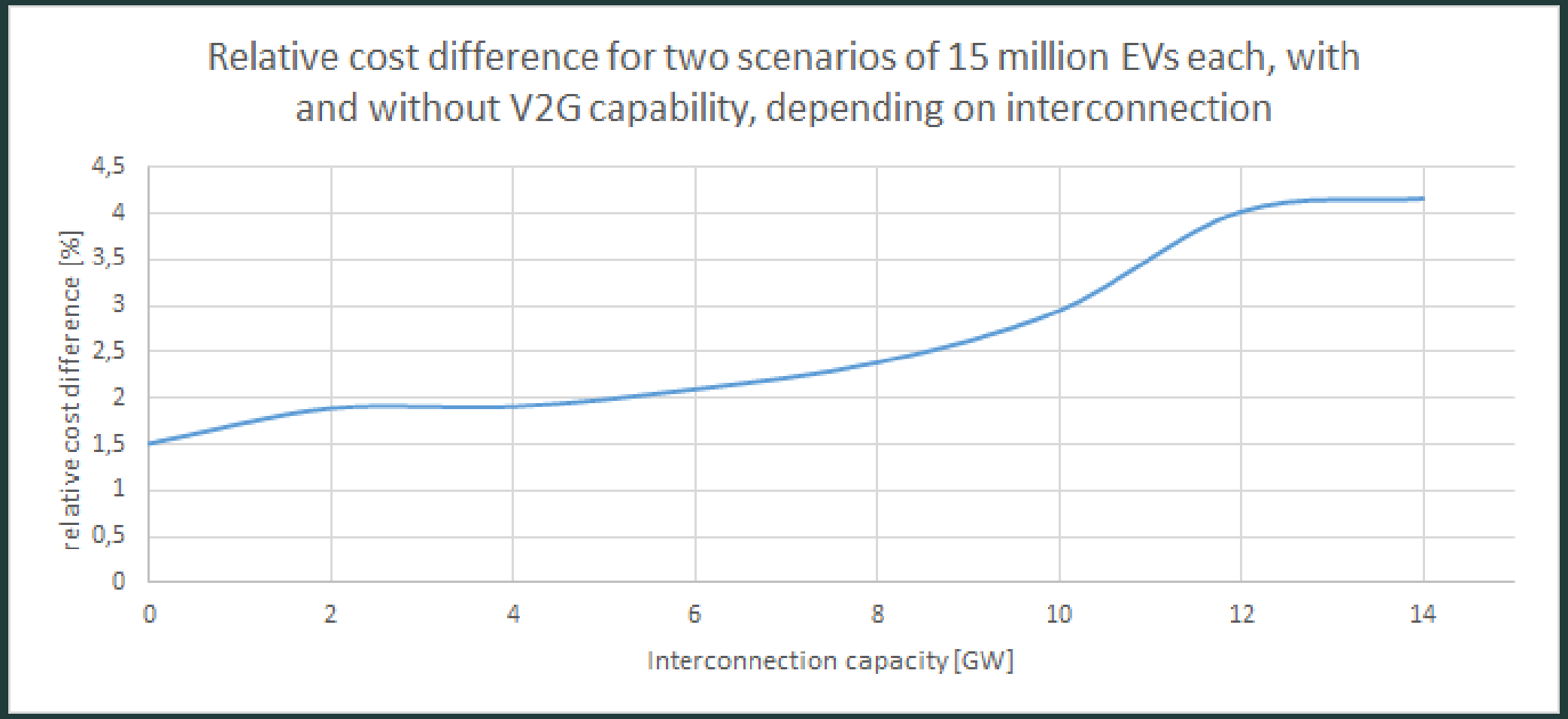
Interconnection and V2G effects on total cost

5 GW investment needed in interconnection lines to change EVs from burden to support

(today $\sim 2\ GW$)



Expected savings



From **1.5%** up to **4%** savings

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Discussion

- Interconnection is at work, effects can be enhanced by flexibility devices (V2G)
- EVs can have a positive impact all others things being equals
- Complementarity between both solutions

Discussion

- Limited area of study
- Deterministic and clear-sighted model
- Simplistic approach of EVs behaviours