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

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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

\[ \text{Demand} = \text{Production} - \text{Import} + \text{Export} - \text{Production}_{\text{REN}} \]

Year = 2019 – 3 aggregated weeks

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

German electricity demand for the 3 studied weeks
Building of the merit order

German power supply merit order as used in the model
Equations

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

\(c_{\text{var}} = c_{\text{fuel}} + c_{\text{O&M}} + c_{\text{CO}_2}\)

- \(c_{\text{fuel}}\) : fuel cost
- \(c_{\text{O&M}}\) : Operation & Maintenance
- \(c_{\text{CO}_2}\) : 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
- \(c_{\text{sto}}\) : investment cost in storage capacity
- \(K_{\text{sto}}\) : 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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- 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 ~ 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