

Potential value of smart charging electric vehicles

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Electrification of transportation adds flexible electric vehicles to the energy system



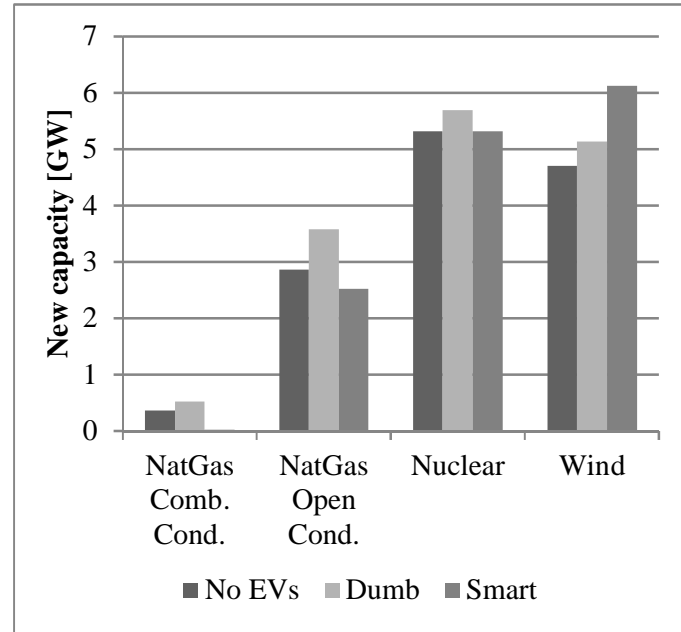
Impacts both the investment and operational decisions in energy systems

- ***How EVs interact with the energy system is key***
 - "Dumb": full charge immediately when plugged in
 - Smart: vehicle-to-grid charging and discharging according to the needs of the system
- ***Balmorel for investments***
 - Optimizes investments into generation capacity with significant amount of EVs assumed.
 - Hourly time resolution, representative weeks
- ***WILMAR for operations***
 - Stochastic unit commitment and economic dispatch
 - Full-year rolling horizon optimization with updating forecasts.

Distribution grids weren't considered!

Balmorel results: EV flexibility allows for more variable renewable generation

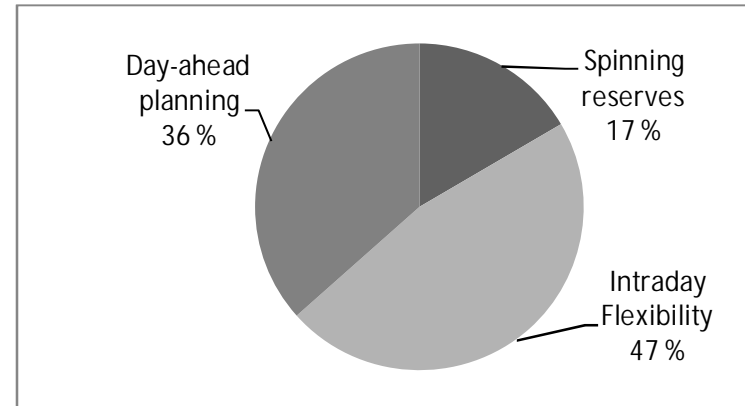
- Case study for Finland in 2035
 - Extreme cases: Either all EVs are "dumb" or smart
- ***With smart EVs, the system replaces investments into condensing coal and gas power plants with wind***
- "Dumb" EVs simply increase investments into all capacity due to increased energy demand



Balmorel + WILMAR results: Smart charging reduces the energy system costs

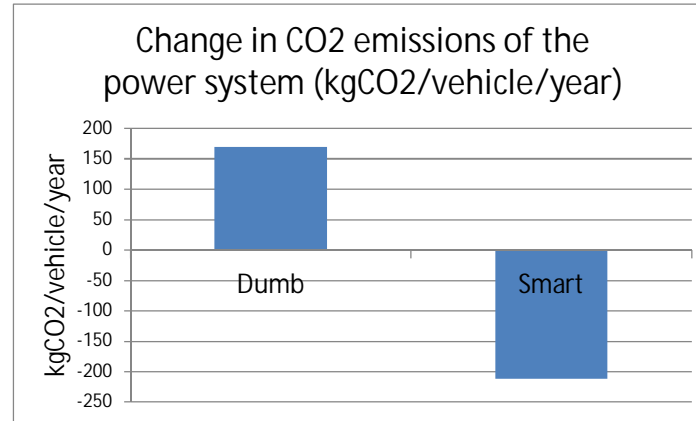
- Case study for Finland in 2035
 - Extreme cases: Either all EVs are "dumb" or smart
- **Most system cost savings of smart EVs come from intra-day flexibility**

Total annualized system cost savings:
227 €/EV/year,
Operational yearly savings:
125 €/EV/year,
compared to "dumb" charging



Balmorel + WILMAR results: Smart charging allows for reduced CO2 emissions

- Case study for Finland in 2035
 - Extreme cases: Either all EVs are "dumb" or smart
- **Smart charging of EVs can reduce energy sector CO2 emissions despite of the increased energy demand.**
 - Generation portfolio changes were the major driver behind the difference.



In conclusion:

- ***Smart charging of EVs can help integrate more variable renewable energy into our energy systems.***
- ***However, the system savings of ~200 €/EV/year of smart charging compared to "dumb" charging are quite meagre.***
 - Furthermore, these savings are distributed between different market participants, not only the EV aggregators or owners.
 - Is this enough for aggregators to operate, or for engaging EV owners to participate in demand-side management?
- ***Smart charging of EVs can help reduce energy sector CO2 emissions despite the increased demand for energy.***
 - Most effective if considered already at the investment stage.

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the obvious

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