BEHAVIOUR-DRIVEN ELECTRIC VEHICLE CHARGING DECISIONS AND ITS IMPLICATIONS ON DEMAND RESPONSE FLEXIBILITY FOR THE INTEGRATION OF RENEWABLE ENERGIES IN GERMANY

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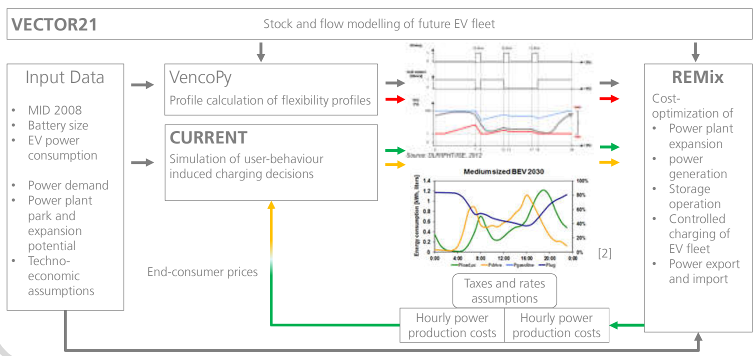
Motivation

- Future electric vehicle (EV) fleets pose **both challenges by increasing power demand and opportunities by providing short-term load shifting potential** for the integration of fluctuating renewable energy sources into power systems [1,2]
- **Individual charging decisions of EV car owners** limit the load shifting potential of future EV fleet batteries [4] but are seldomly explicitly taken into account in power system modelling
- We for the first time **present a modelling framework to assess user-behaviour induced charging decisions** and apply it in a case study of the German power system including neighbouring countries in 2030
- Different methods of **harmonization of models' scopes** depending on respective models' dimensionalities

Methodological Framework

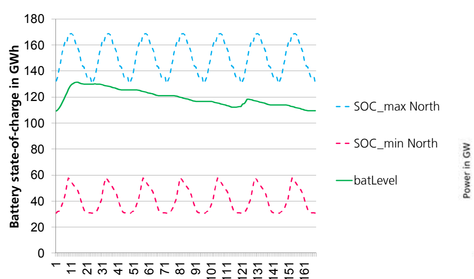


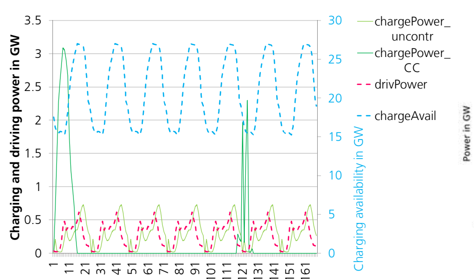
MODEL RUNS (MR)

MR0
MR1
MR2.1
MR2.2

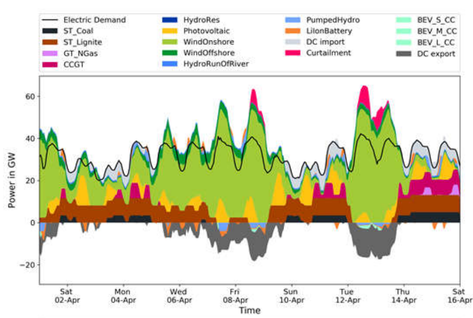
Results

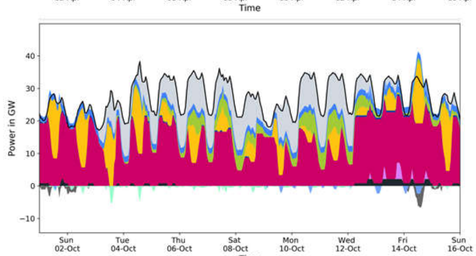
VencoPy profiles (dashed) and REMix results (green solid lines) for first 10 days of modelling period (Jan, 1st-10th)



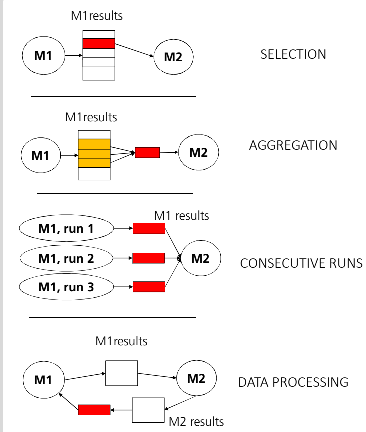


Optimal dispatch for northern (top) and southern (bottom) Germany





Model harmonization



EXAMPLES OF MODEL DIMENSIONALITY HARMONIZATION

Dimension	CURRENT	REMix	Harmoniz. method
Spatial resolution	1 node	Germany in 2 nodes, others in 1 each	Consecutive runs
Temporal horizon	10 days in 2030	1 year in 2030	Cloning
Technol. resolution	1 technology	Transport: 3 technologies	Consecutive runs

Conclusions

Model harmonization has been carried out and methodological framework demonstrated

An EV fleet of 9 Mio. BEVs with an annual power demand of 5.3 TWh in 2030 may lead to

- Reduction of curtailment by 18% in Germany
- Increased PV (38% in southern Germany) and wind power (8% in northern Germany) capacities

Sources

[1] Taljegard, M., Goransson, L., Odenberger, M. & Johnsson, F. (2019). Impacts of electric vehicles on the electricity generation portfolio – A Scandinavian-German case study. In: *Applied Energy, 235,* 1637-1650. https://doi.org/10.1016/j.apenergy.2018.10.133

[2] Pregger, T. & Luca De Tena, D. (2018). Impact of electric vehicles on a future renewable energy-based power system in Europe with a focus on Germany. Int J Energy Res. 42, 2670–2685. DOI: 10.1002/er.4056

[3] Steck, F., Anderson, J.E., Kuhnimhof, T. & Hoyer-Klick, C. (2019). *Comprehensive transportation and energy analysis: A price senstive, time-specific microsimulation of electric vehicles.* Transportation Research Board 98th Annual Meeting. Washington, D.C.

[4] Gils, H.C., Scholz, Y., Pregger, T., Luca de Tena, D. & Heide, D. (2017). Integrated modelling of variable renewable energy-based power supply in Europe. In: *Energy, 123*, 173-188. http://dx.doi.org/10.1016/j.Energy.2017.01.115

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