Effects of EV fleet charging representation on power system flexibility provision

Niklas Wulff[1*], Felix Steck[2], Hans Christian Gils[1], Carsten Hoyer-Klick[1], Bent van den Adel[3], John Anderson[2]

1 Department of Energy Systems Analysis, Institute of Engineering Thermodynamics, German Aerospace Center, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany

2 Department of Passenger Transport, Institute of Transport Research, German Aerospace Center, Rudower Chaussee 7, 12489 Berlin, Germany; felix.steck@dlr.de (F.S.); john.anderson@dlr.de (J.E.A.)

3 Department of Vehicle Systems and Technology Assessment, Institute of Vehicle Concepts, German Aerospace Center, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany; bentvdadel@googlemail.com

*corresponding: niklas.wulff@dlr.de

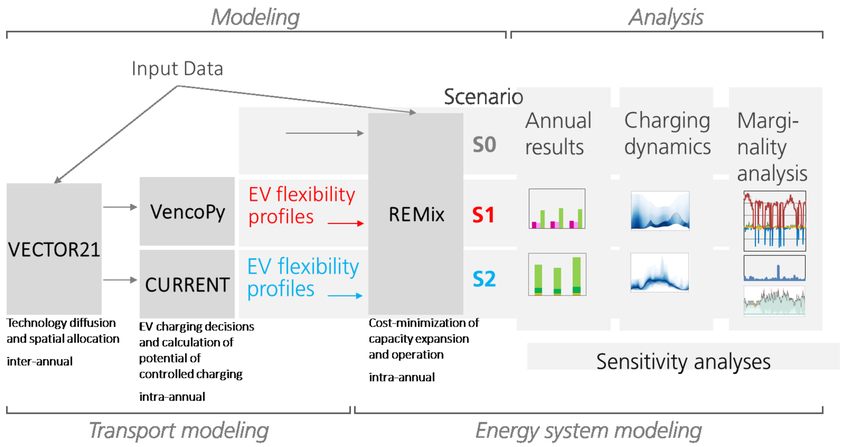
energies

This poster is based on a journal paper publication available as open access in the energies special issue on Model Coupling and Energy Systems:

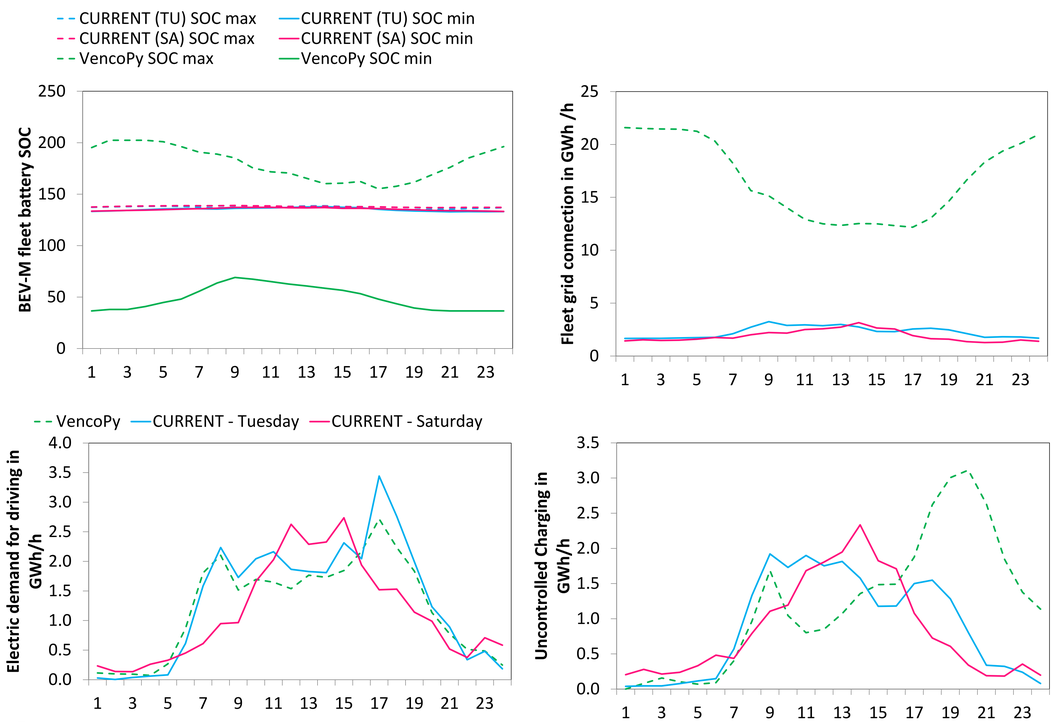
https://www.mdpi.com/654148

Research question & setup

How do user-oriented EV fleet charging decisions affect the flexibility of future EV fleets and what implications does this have on cost-optimal power system results?



Profiles for user-oriented (blue and pink) and power system oriented (green) EV charging modeling

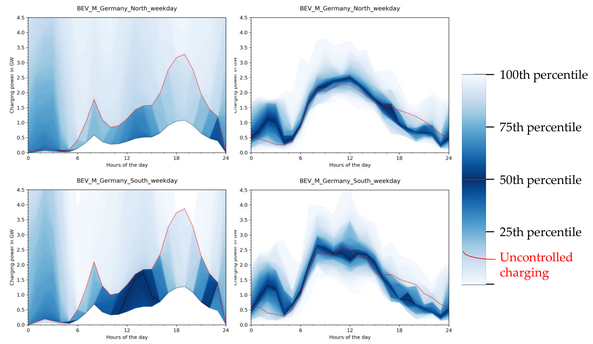


Results

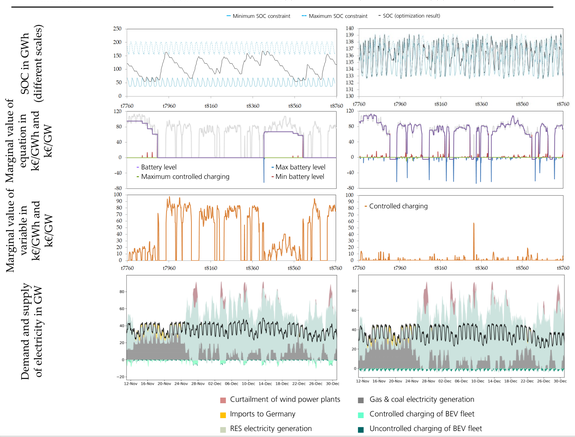
Scenario definitions			Results									
Scenario	Annual electricity demand from BEV fleet in TWh	Controllable share in %	Total system costs in bn. €	Shifted load by German BEV fleets in TWh	Peak load in GW	Fluctuating RES capacity additions in GW	Gas power plant capacity additions in GW	Annual fluctuating RES power generation in TWh	VRE share in total power generation in %	Annual VRE curtailment in TWh	Imports to Germany in TWh	Exports from northern G to southern G in TWh
S0	0	-	68.4	0	83.9	46.2	31.3	279	55.7	2.9	45.9	64.7
S1a	*27*	*0*	*71.7*	*0*	*91.1*	*49.0*	*39.0*	*284*	*54.1*	*3.6*	*50.3*	*62.9*
S1	27	66	71.2	24.2	86.3	51.5	35.5	291	55.3	2.6	51.3	65.1
S2a	*27*	*0*	*71.7*	*0*	*93.5*	*48.8*	*37.9*	*284*	*54.2*	*3.5*	*51.6*	*62.4*
S2	27	30	71.7	8.4	87.6	48.8	37.2	284	54.2	3.4	51.6	62.2

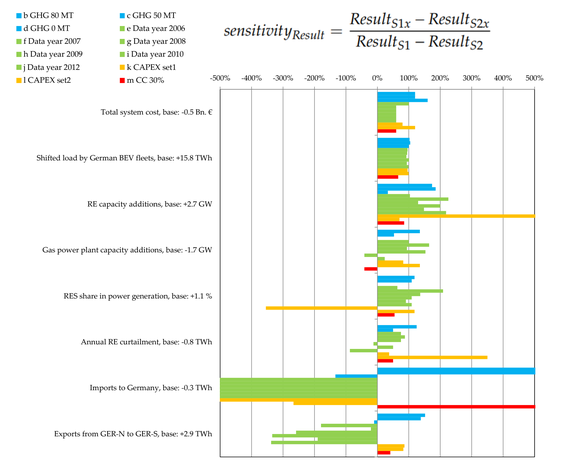
- Fast charging and reduced BEV fleet battery capacities in S1 reduce flexibility provision from 24 TWh to 8 TWh
- Curtailment (+31%) and gas power plants (+5% in capacity additions) compensate for lower flexibility
- Gas turbine additions in S2 are twice as high in northern Germany due to the absence of inter-day flexibility
- Installed capacities are approximately at 214-224 GW in 2030 with 153-159 GW RES installations and t.

- Lower BEV fleet battery capacity available for load shifting significantly reduces charging variability
- Higher daytime charging peak through public charging infrastructure, fast charging and a non-choice for charging at home
- Accounting for differences between weekend and workday results in higher daytime peaks at the weekend (+40% in Northern and +12% in Southern Germany)



Constraint	Cutoff Marginal Value	S1 GER-N	S1 GER-S	S2 GER-N	S2 GER-S
maxCC	**>1000€**	6	88	90	63
batLevBal	**>1€**	34	227	185	126
	<1000€	1135	0	500	0





Outlook

- Detailed analysis of interplay between weather years and EV battery capacity available for load shifting
- More insights into the role of dual variables → merit order of dual variable values