



Boosting decarbonization of mobility through EVs

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HELLO

My name is

Giacomo Pareschi

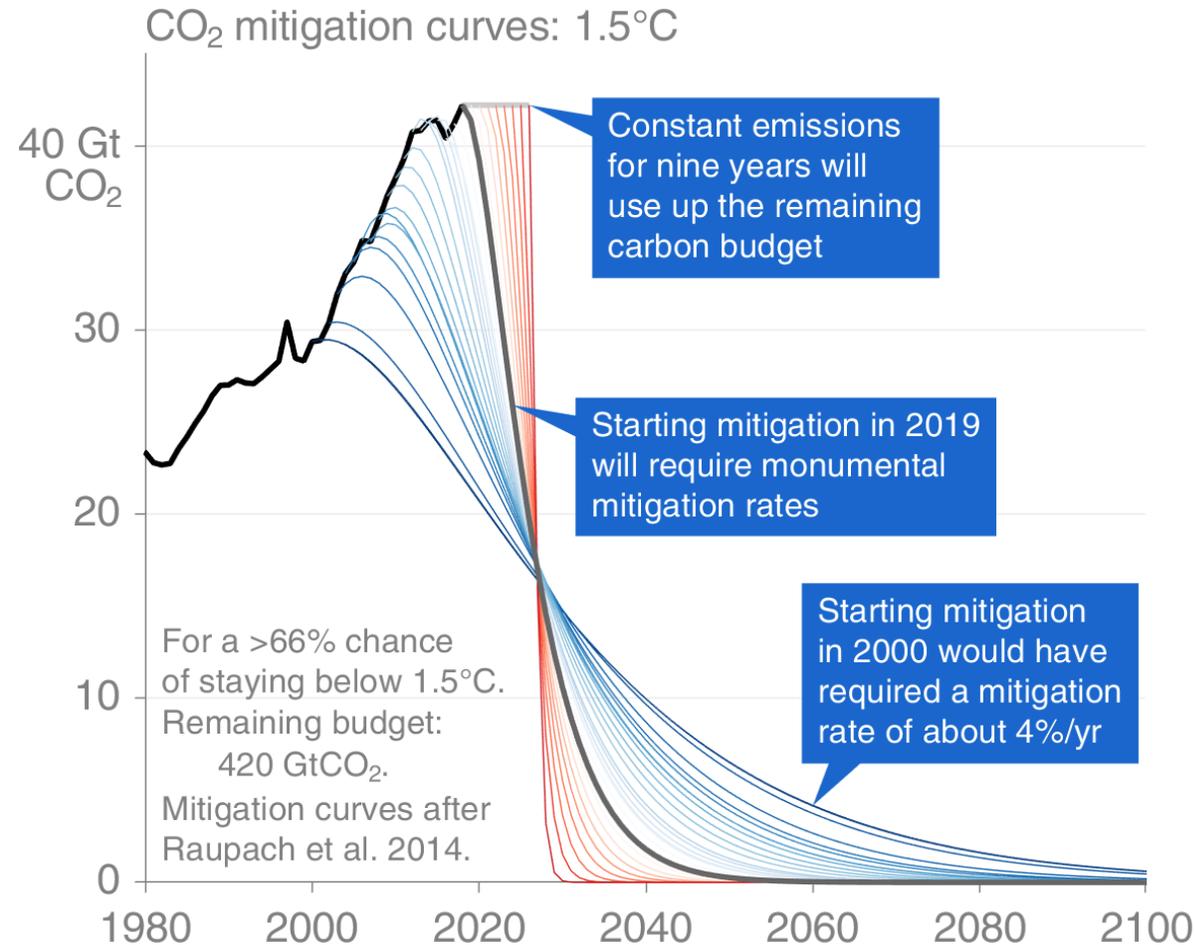


- BSc at Politecnico di Milano in Energy Engineering
 - MSc at ETH in Energy Science & Technology
 - PhD Candidate in LAV's Energy Systems Group
 - Impact and potentials of fleet-wise interventions
 - From passenger cars to aircrafts
 - From electricity to synthetic fuels
- ↓
- Role of EVs for passenger cars



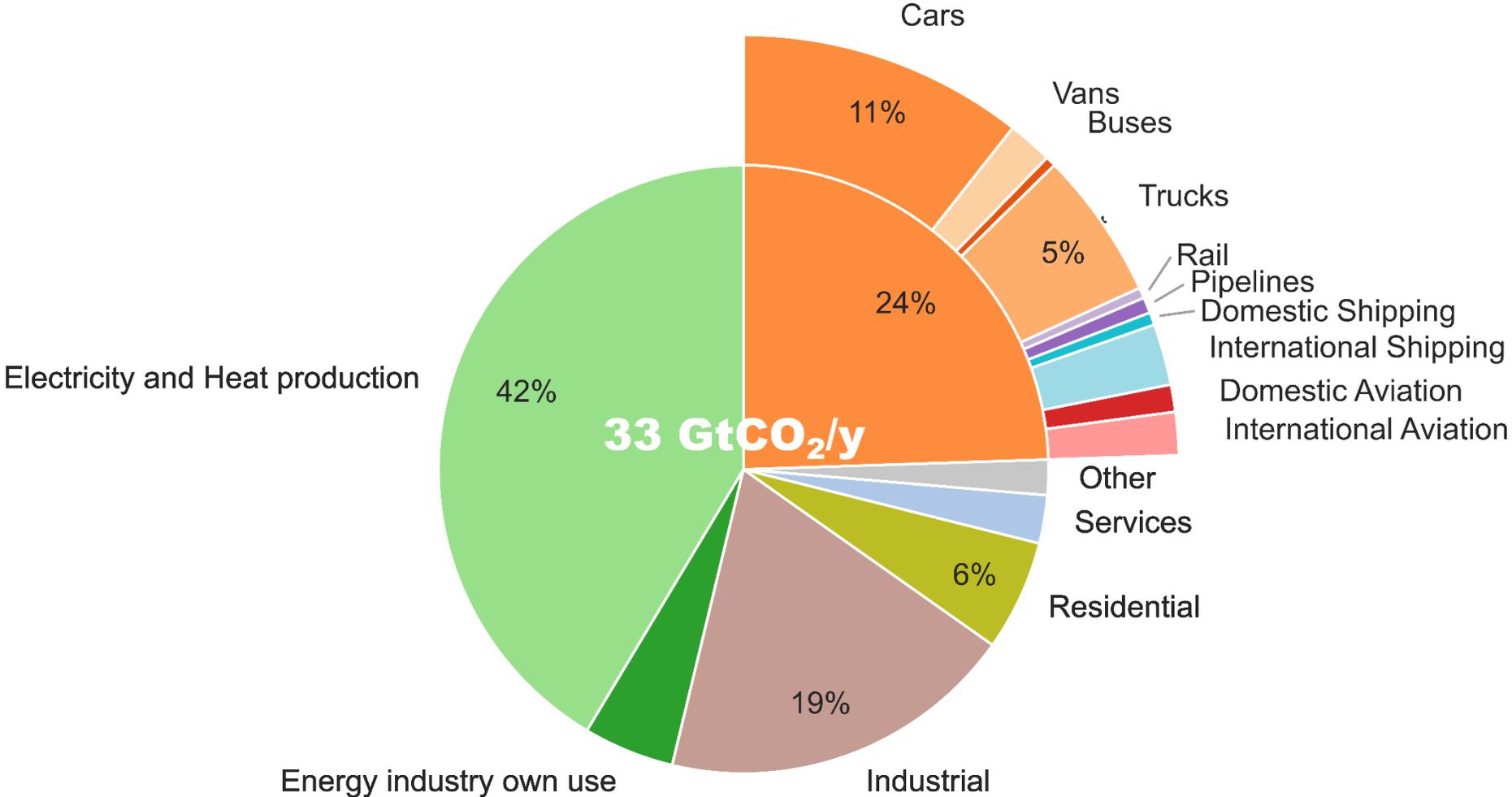
Are we in a hurry?

Remaining global carbon budget on 1.1.2019: ~**380 Gt CO₂**.



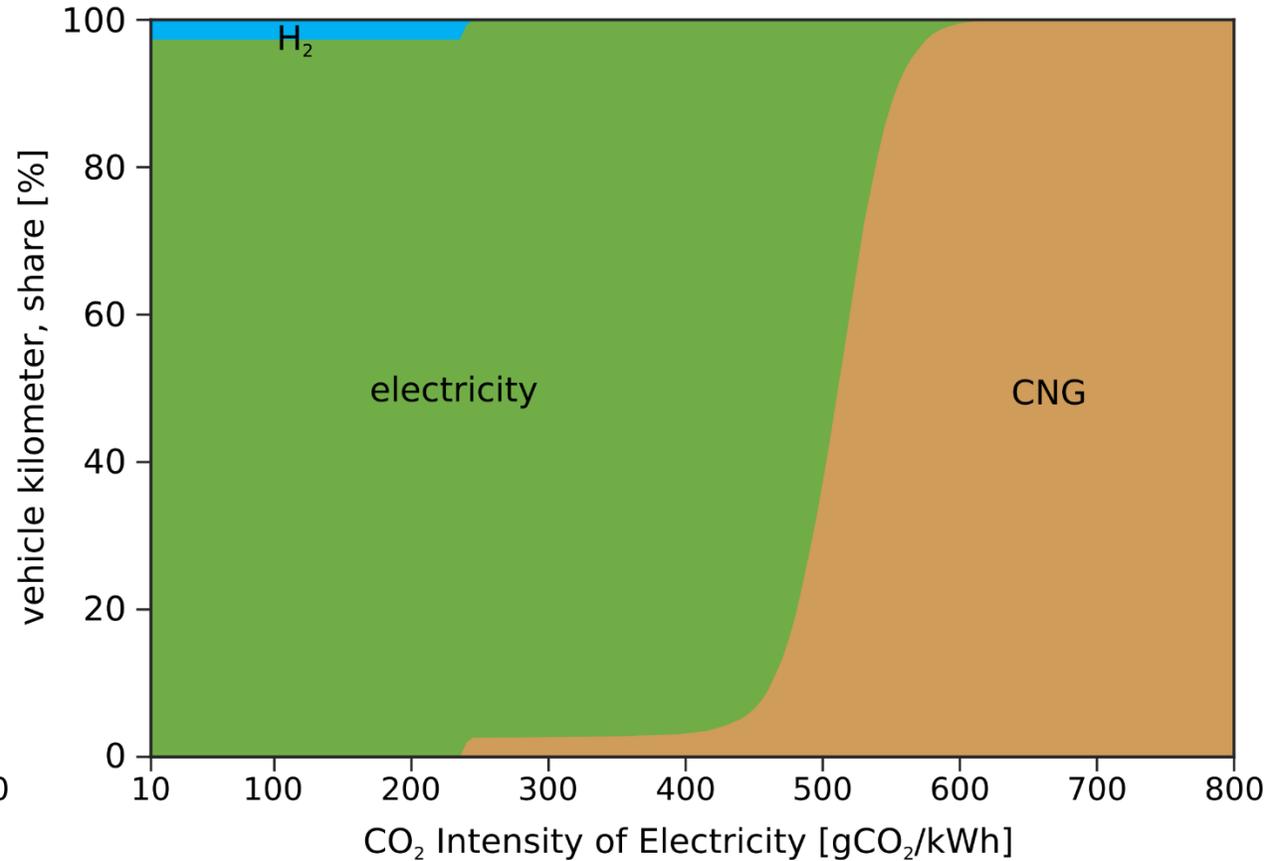
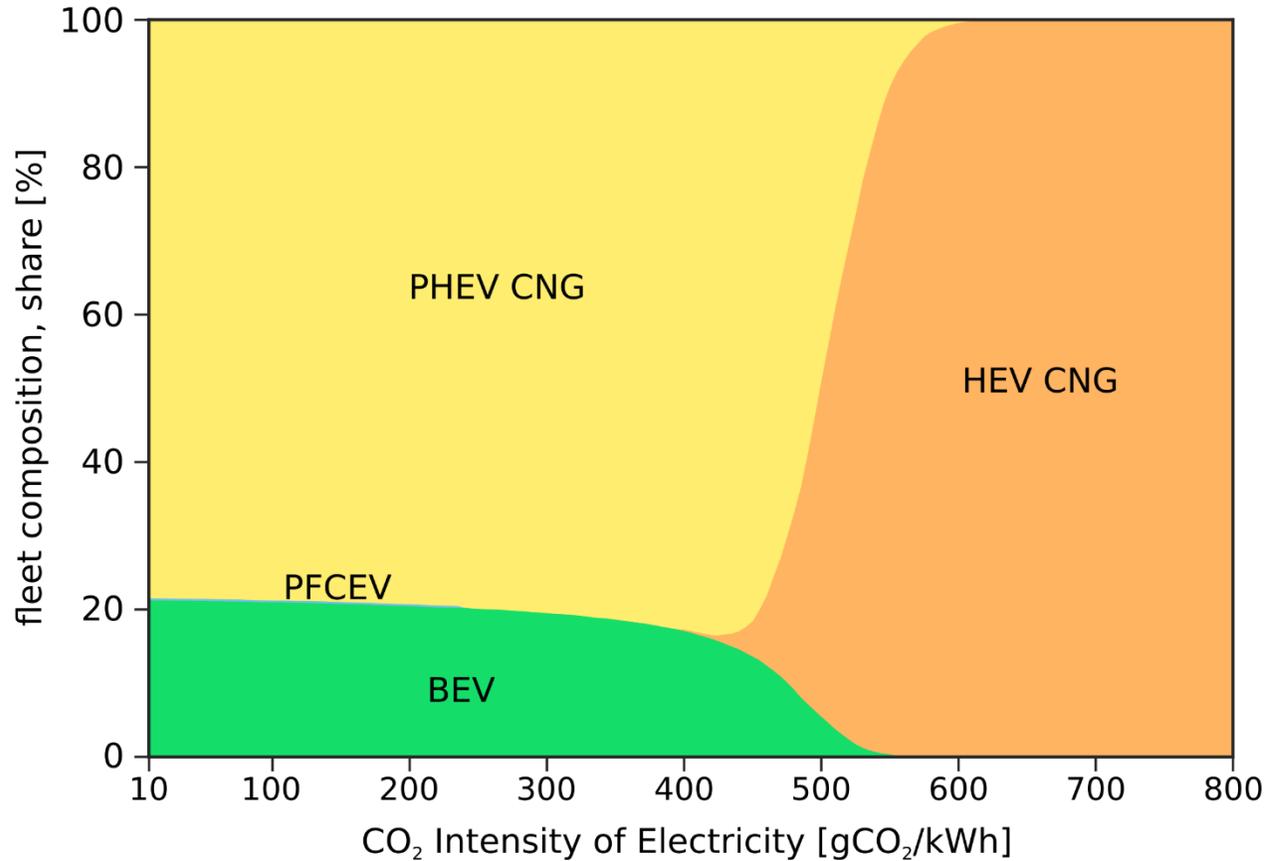
Passenger cars responsibility

CO₂ emission from fuel combustion in 2017



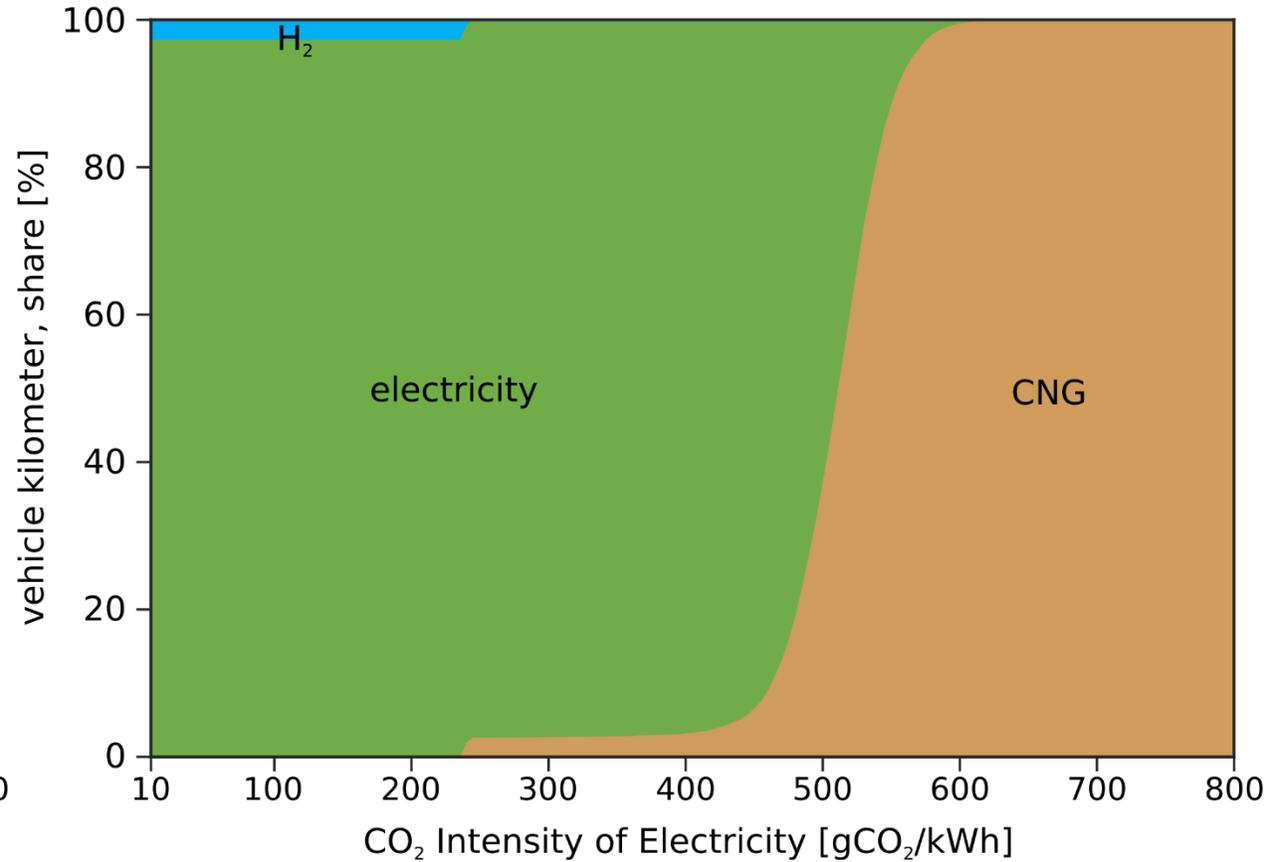
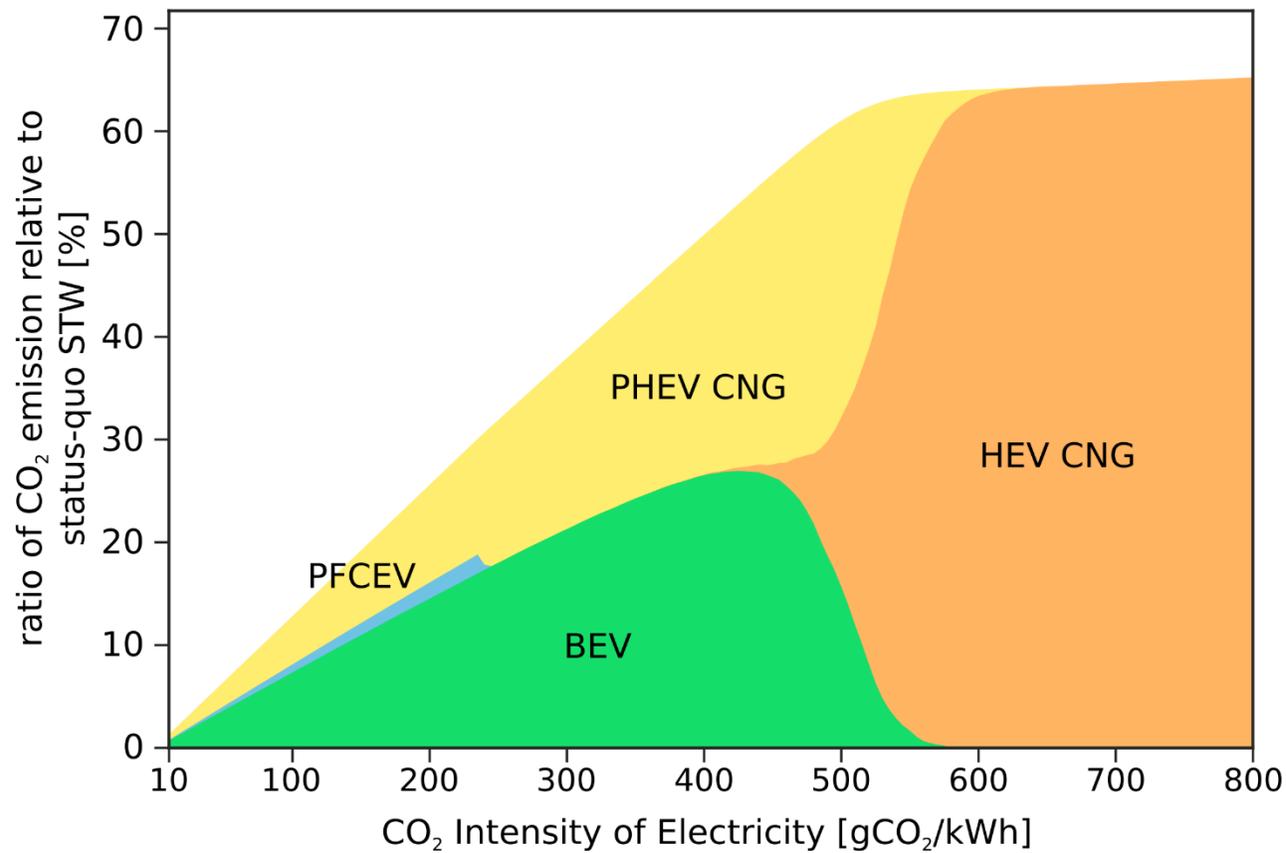
What should we ideally do?

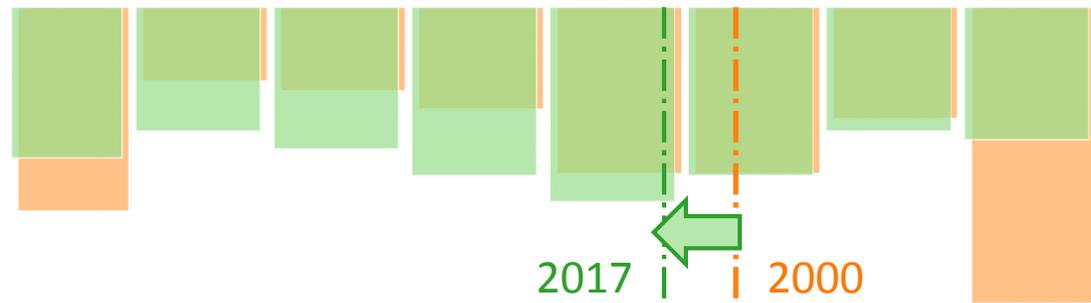
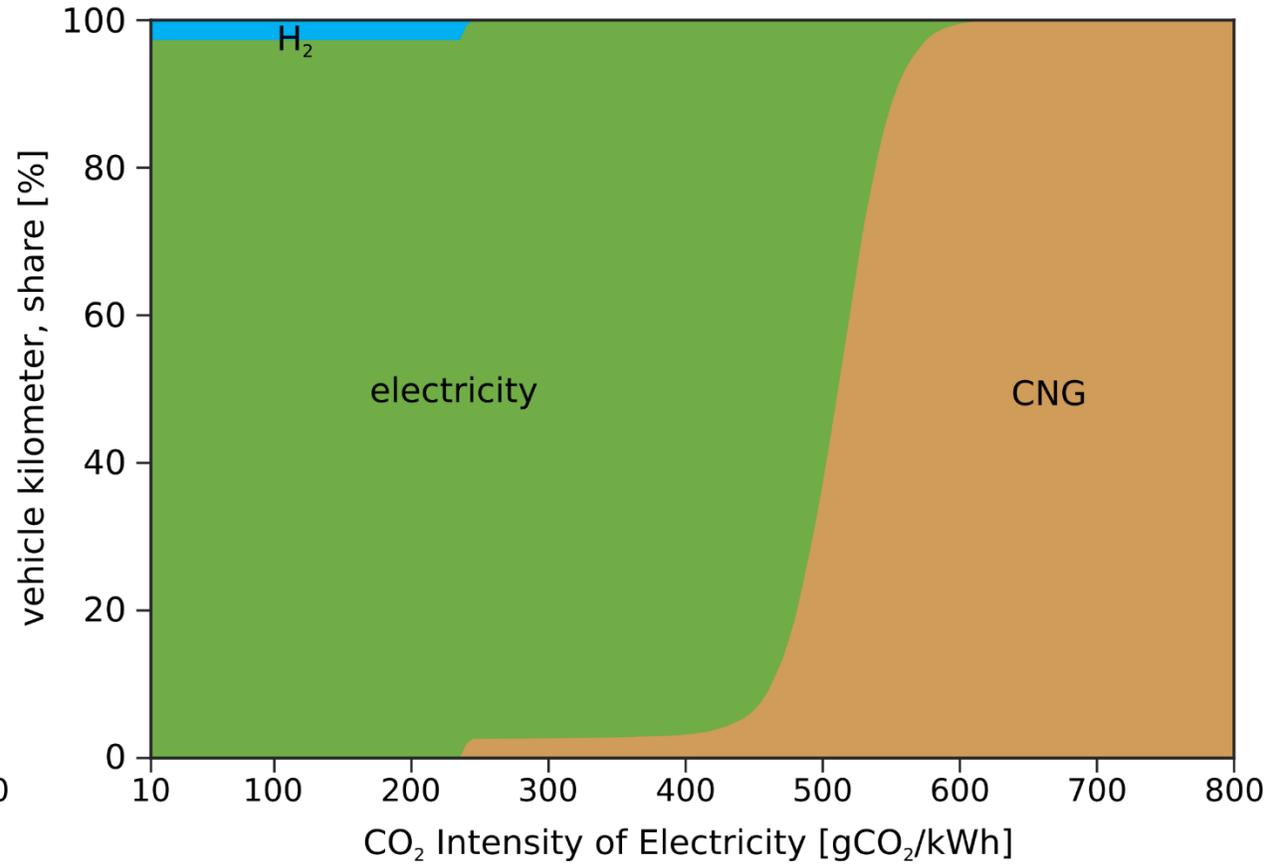
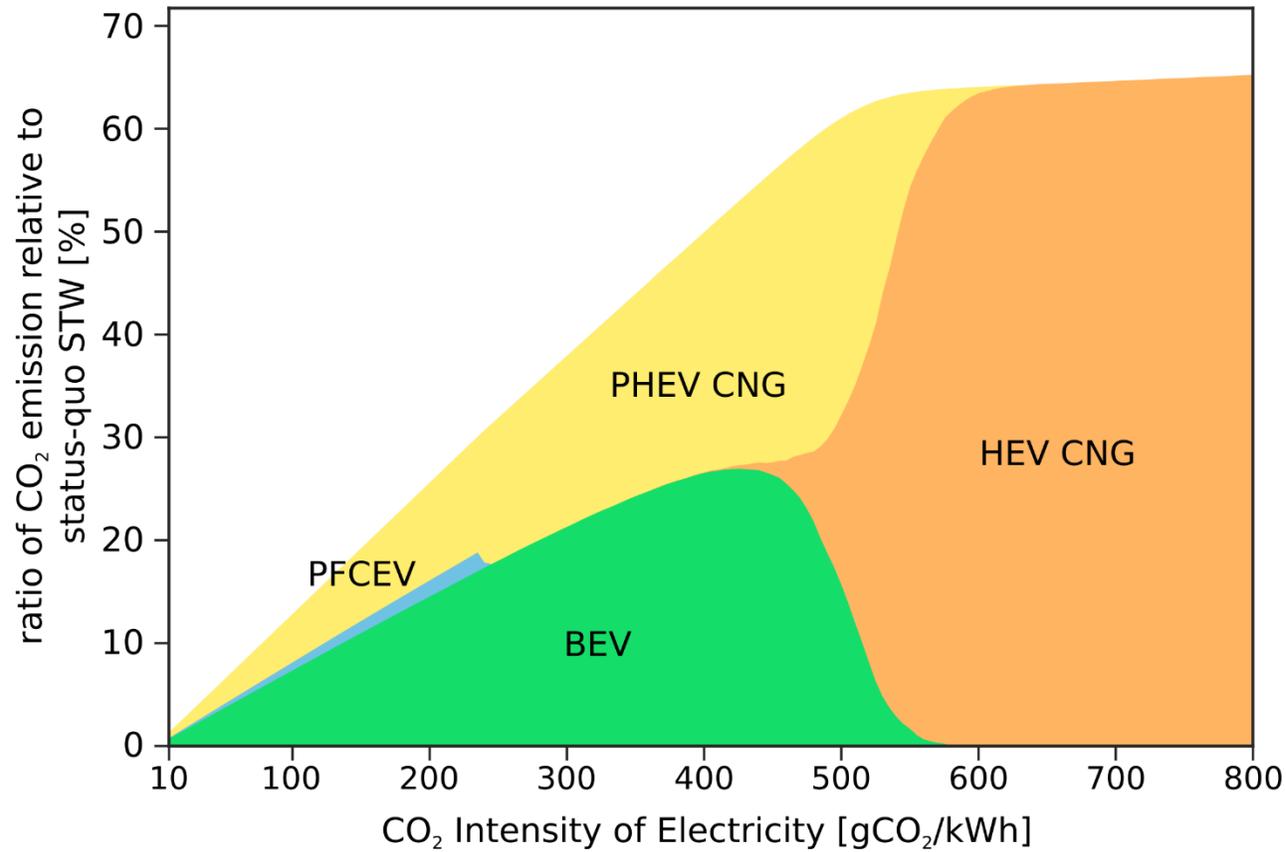
Optimal fleet composition for given electricity mix



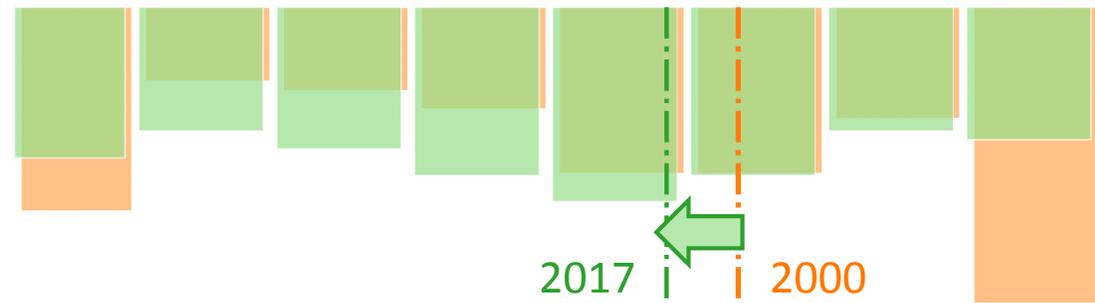
What should we do?

Optimal fleet composition for given electricity mix





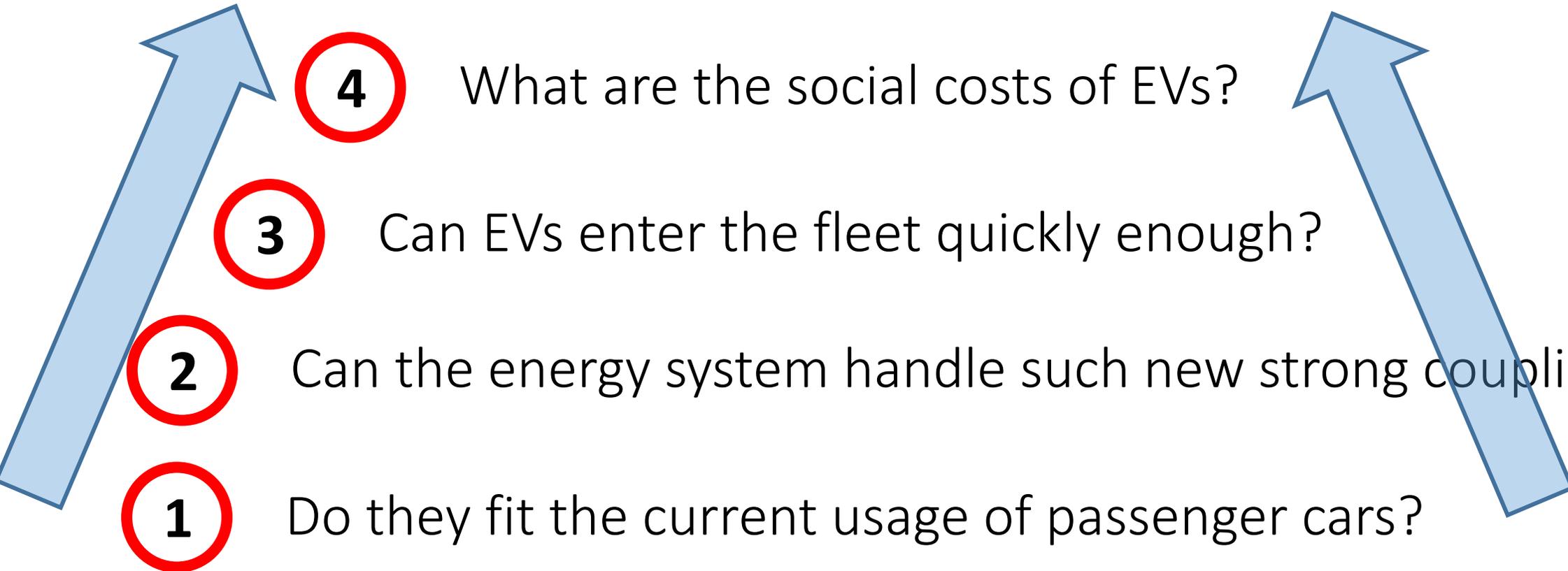
World countries distribution



World countries distribution

But EVs come with challenges:

explorable with a **bottom-up** approach

- 
- 1** Do they fit the current usage of passenger cars?
 - 2** Can the energy system handle such new strong coupling?
 - 3** Can EVs enter the fleet quickly enough?
 - 4** What are the social costs of EVs?

How to investigate a phenomenon:

- ~~Theoretical derivations~~

- Physical experiments



Public EV trials

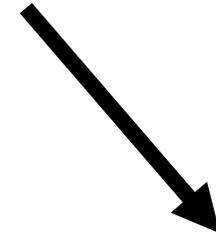
- Numerical simulations



EV usage models

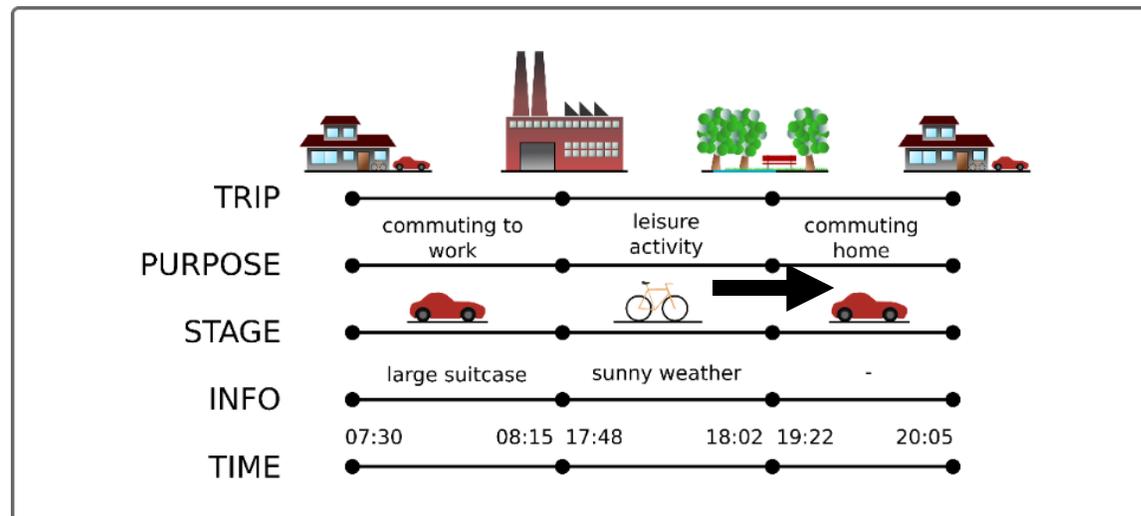
3 typical research strategies

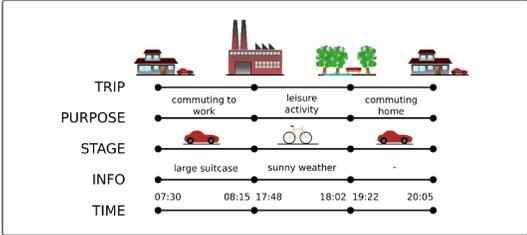
100% experimental



Analyses
&
Results

ATS: Activity-Travel Schedule





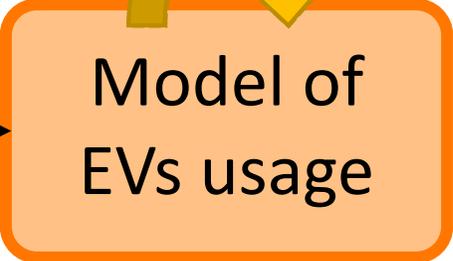
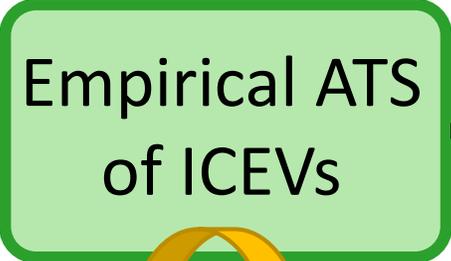
3 typical research strategies

100% experimental



Validation

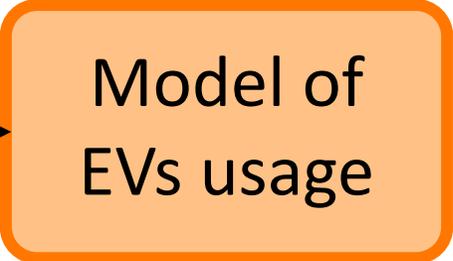
50/50



Analyses & Results

Validation

100% simulations



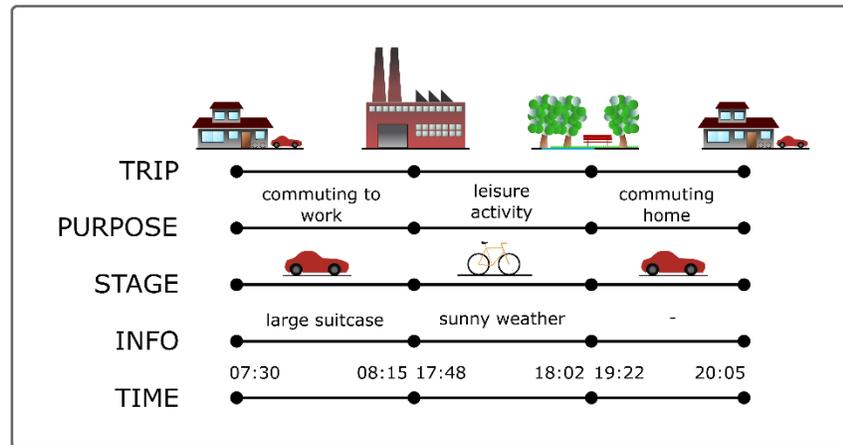
Our methodology in detail

Empirical ATS
of ICEVs

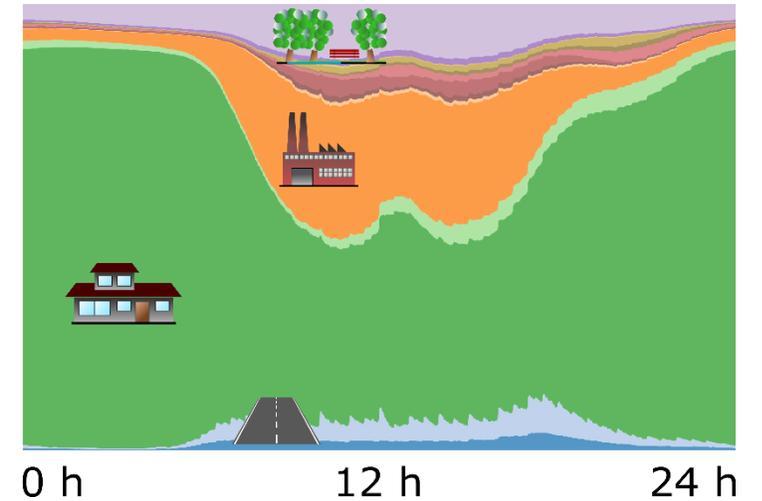
MZMV 2015



Activity-Travel Schedule respondents' perspective

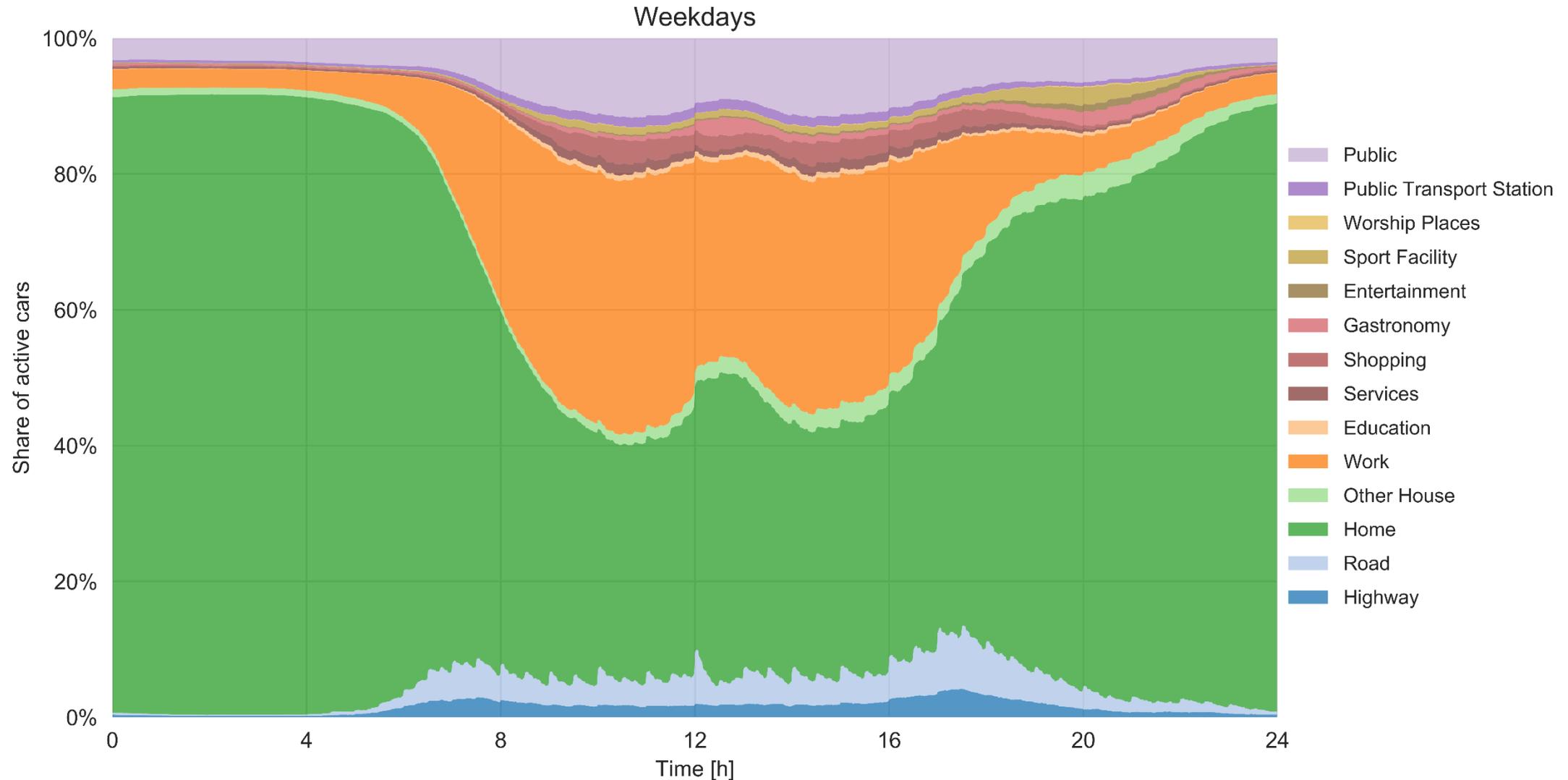


Activity-Travel Schedule cars' perspective



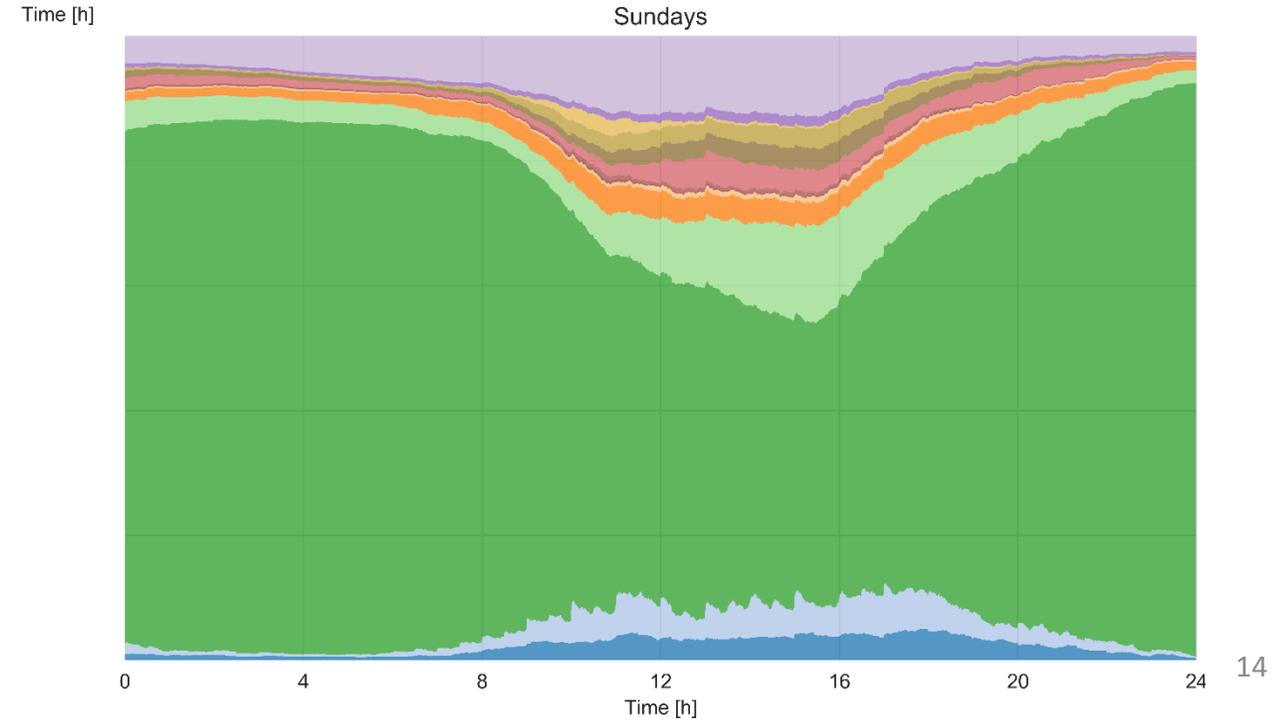
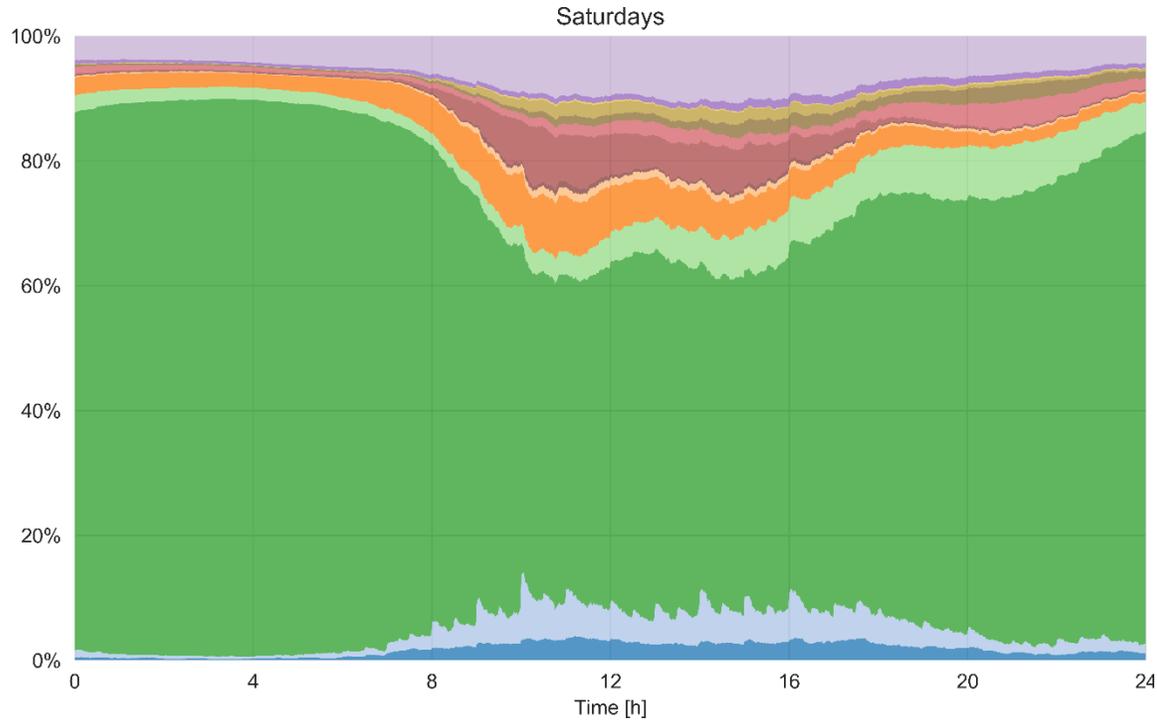
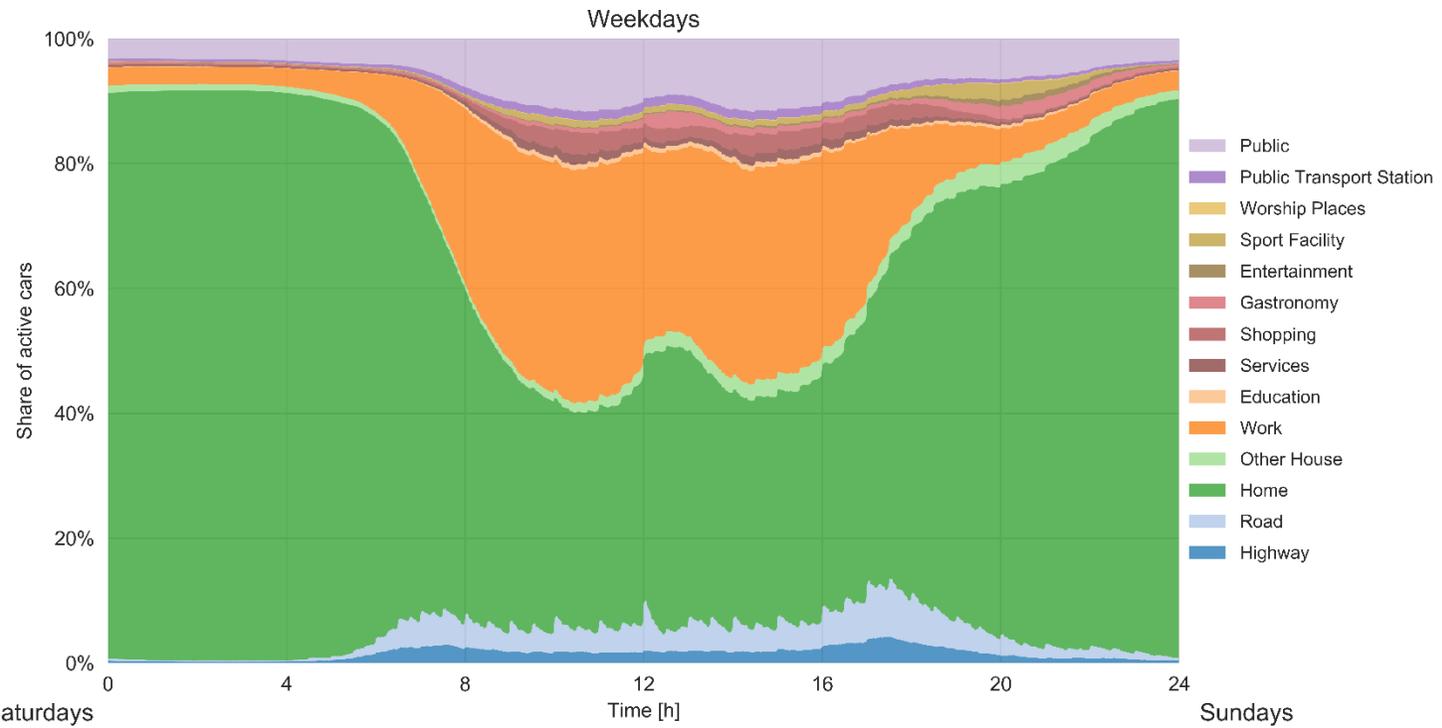
Cars ATS: locations by time of the day

Empirical ATS
of ICEVs



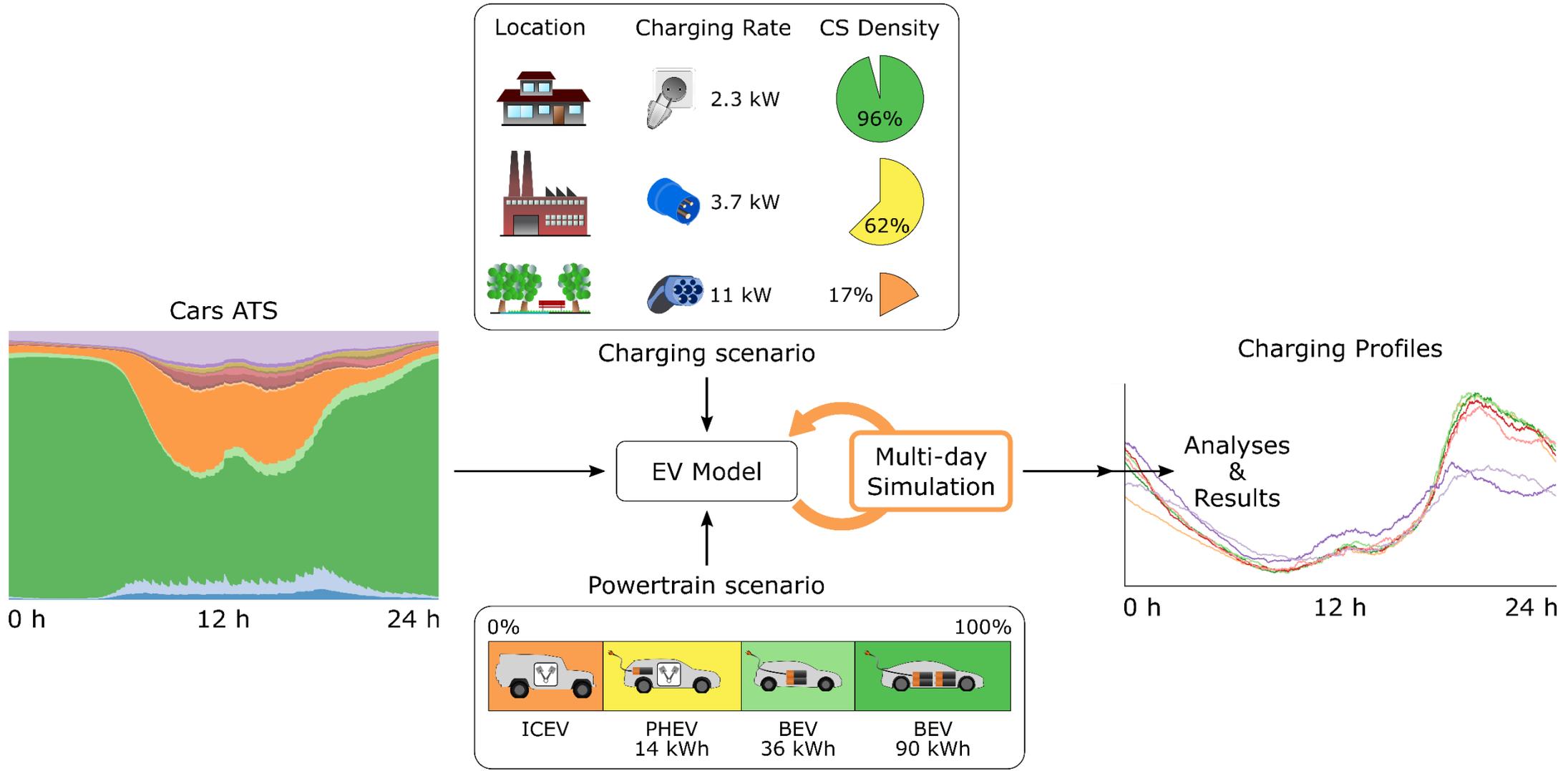
Cars ATS

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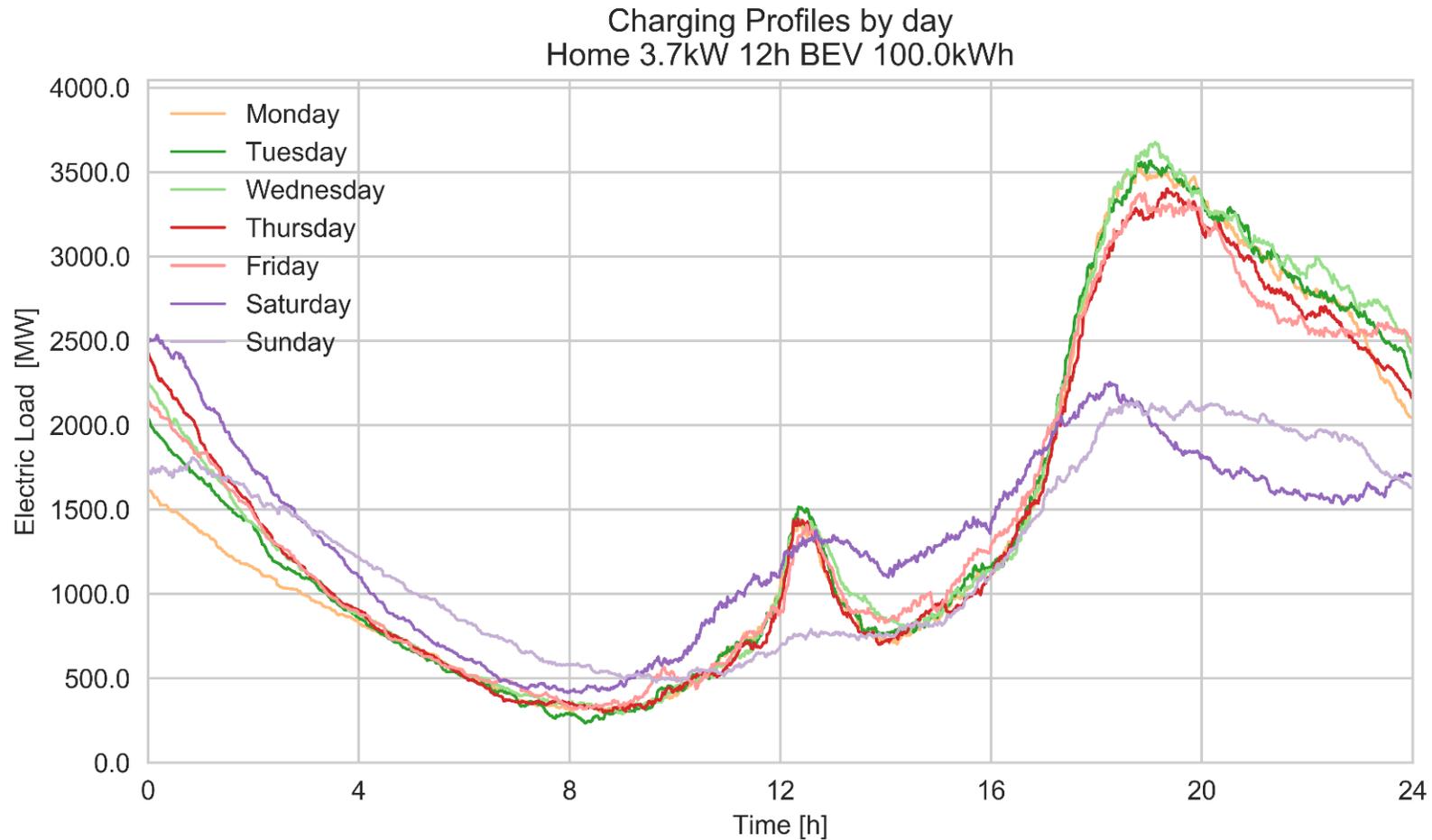


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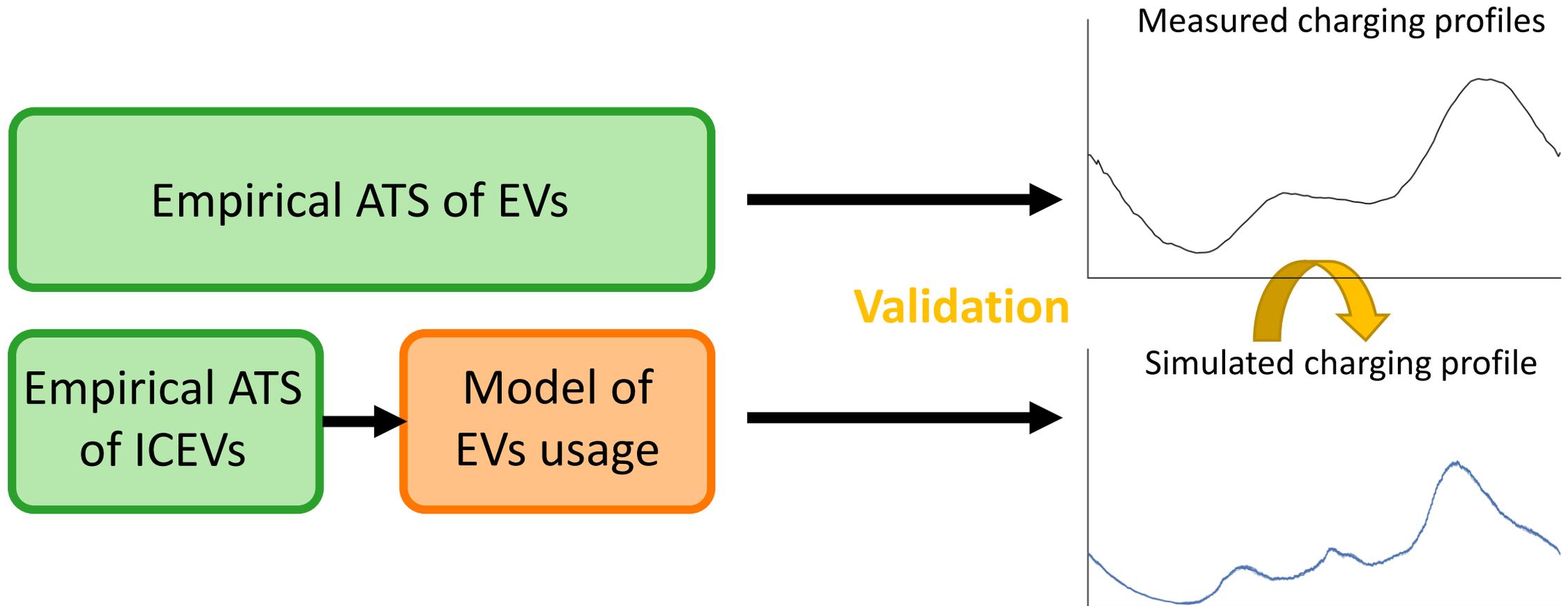
Model of EVs usage



What do charging profile look like?

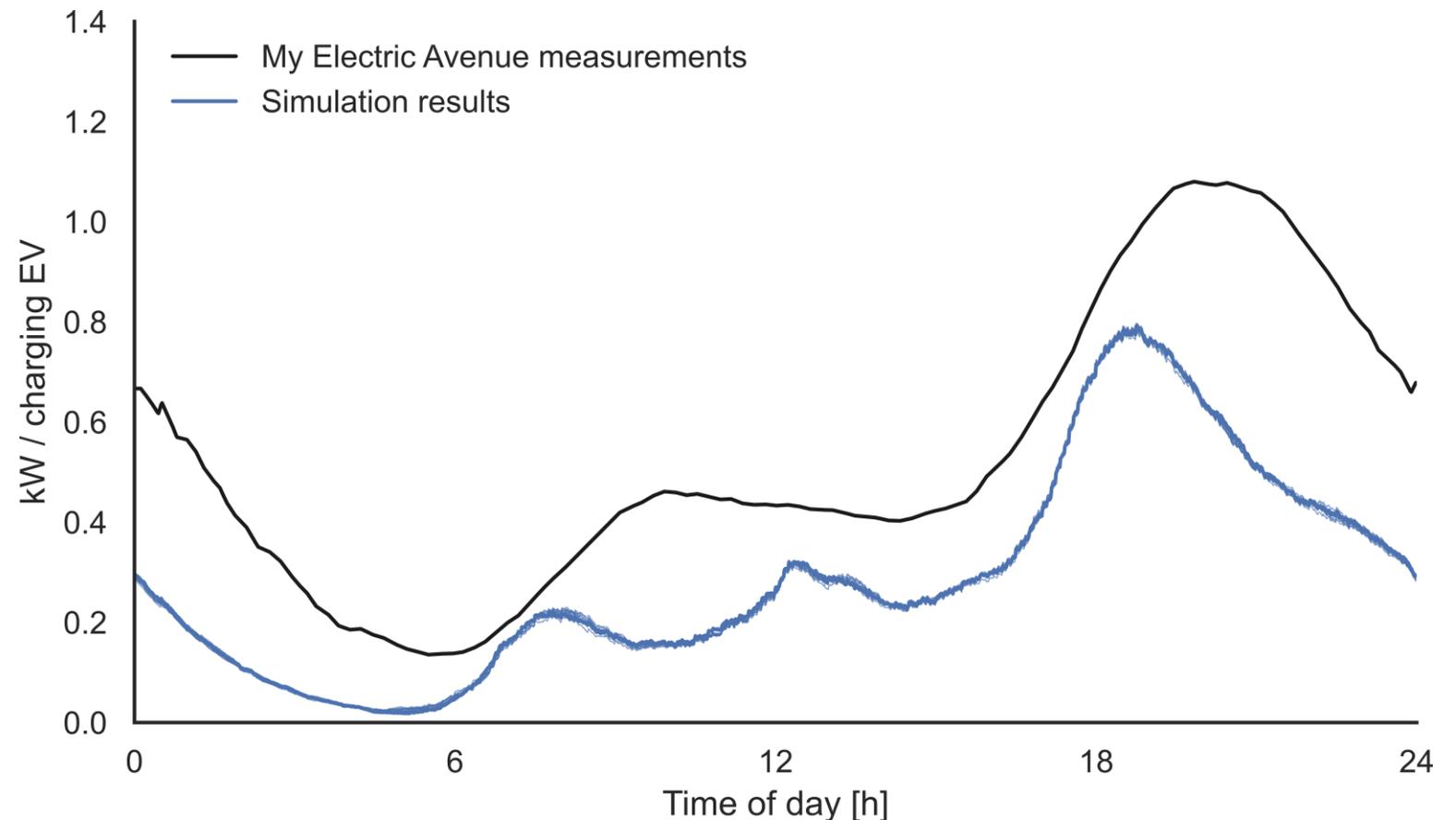


What about that validation?



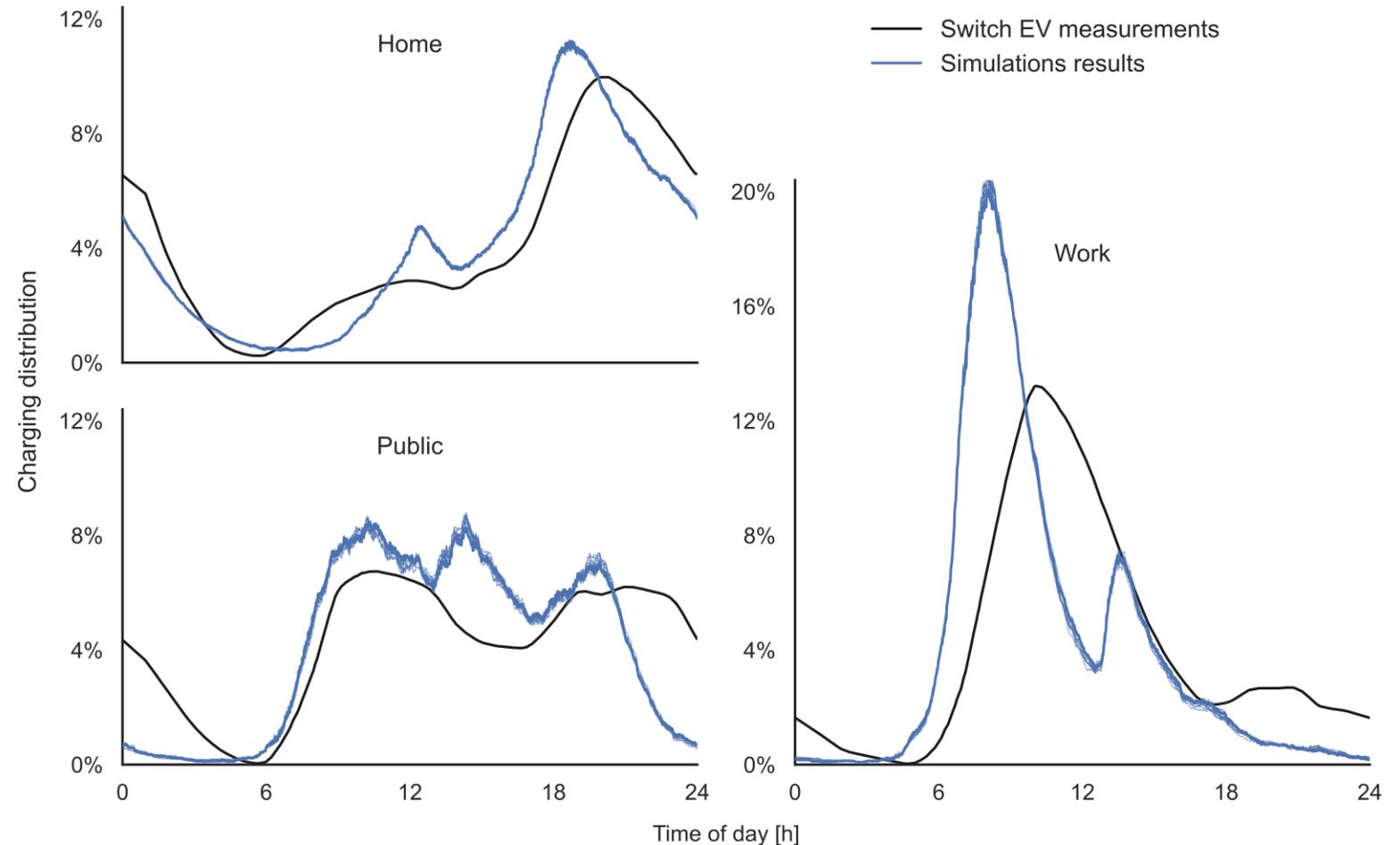
Comparison with the My Electric Avenue trial:

- Only BEVs with 24 kWh battery
- Mostly home charging, with fewer opportunities at work
- All chargers at 3.6 kW



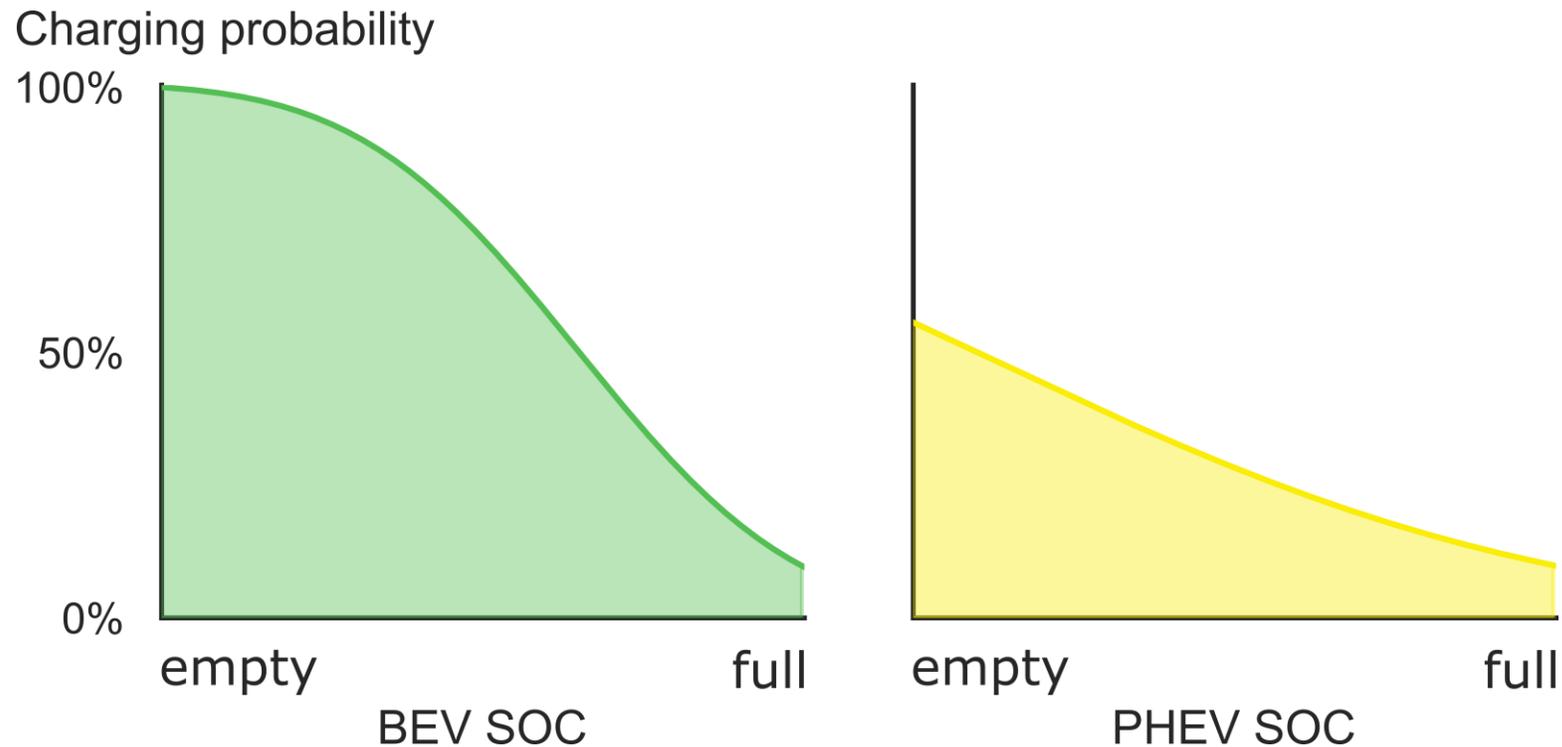
Comparison with the Switch EV trial:

- 43% BEVs with 24 kWh battery, 57% BEVs with 18 kWh battery
- Possibility to charge almost anywhere
- All chargers at 2 kW



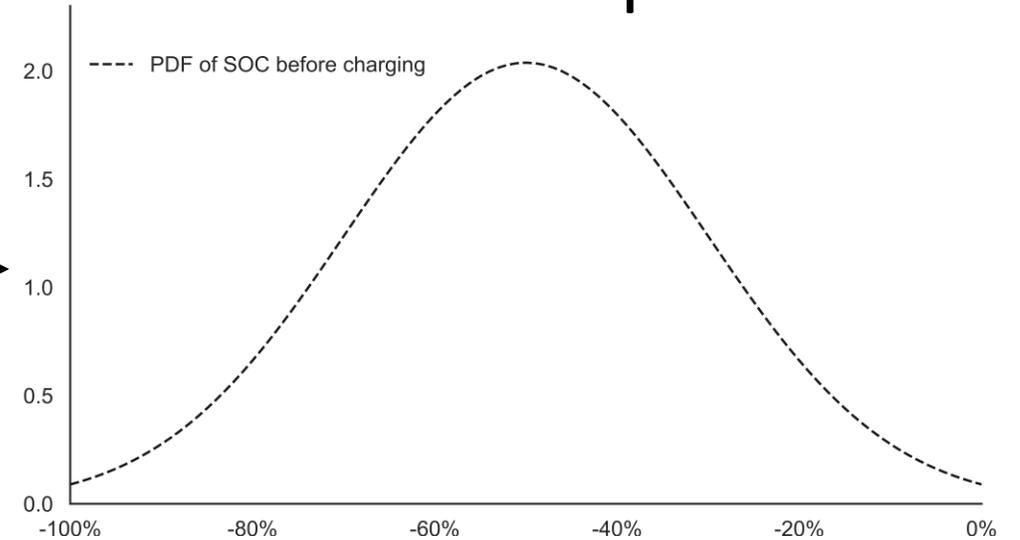
Need for a behavioral model

We model behavior in terms of User-Battery Interaction Style, i.e. the driver propensity to charge for a given SOC



Derivation of behavior: no tuning, but distillation from the empirical trials

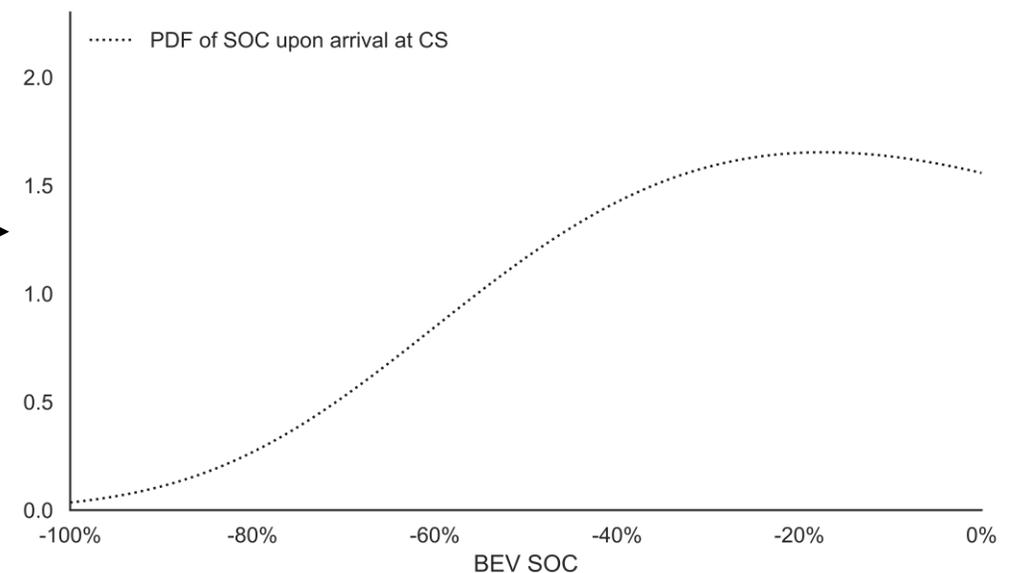
Empirical ATS of EVs



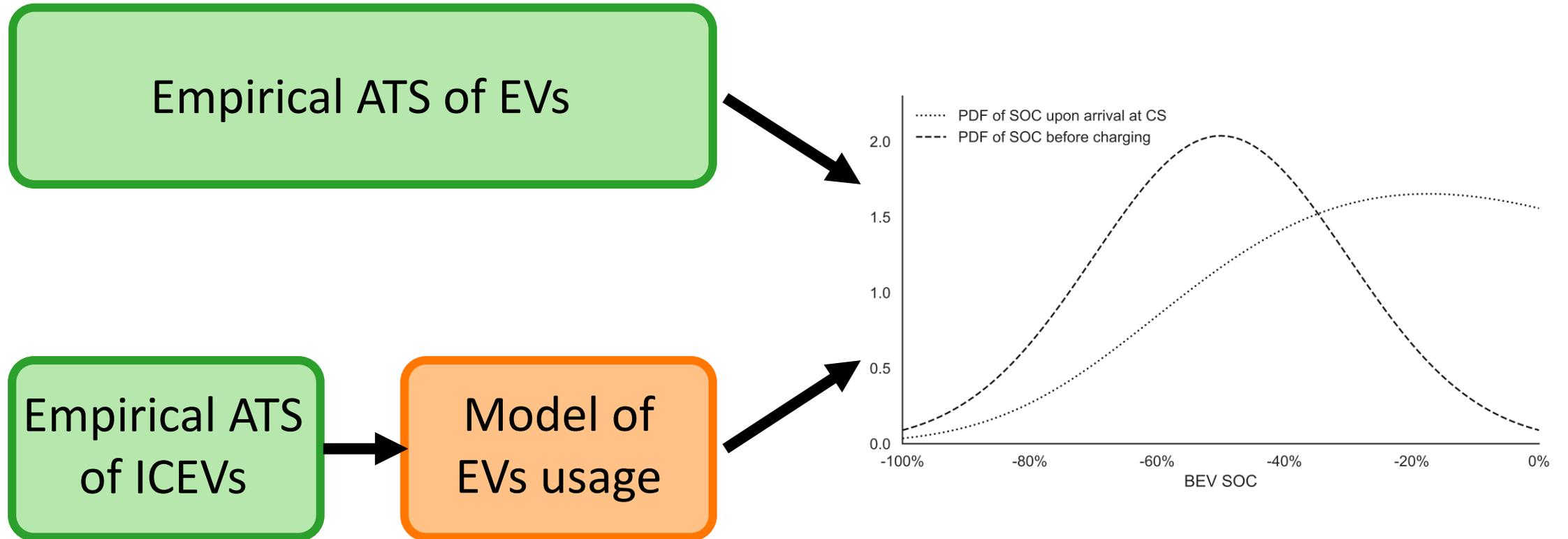
Empirical ATS
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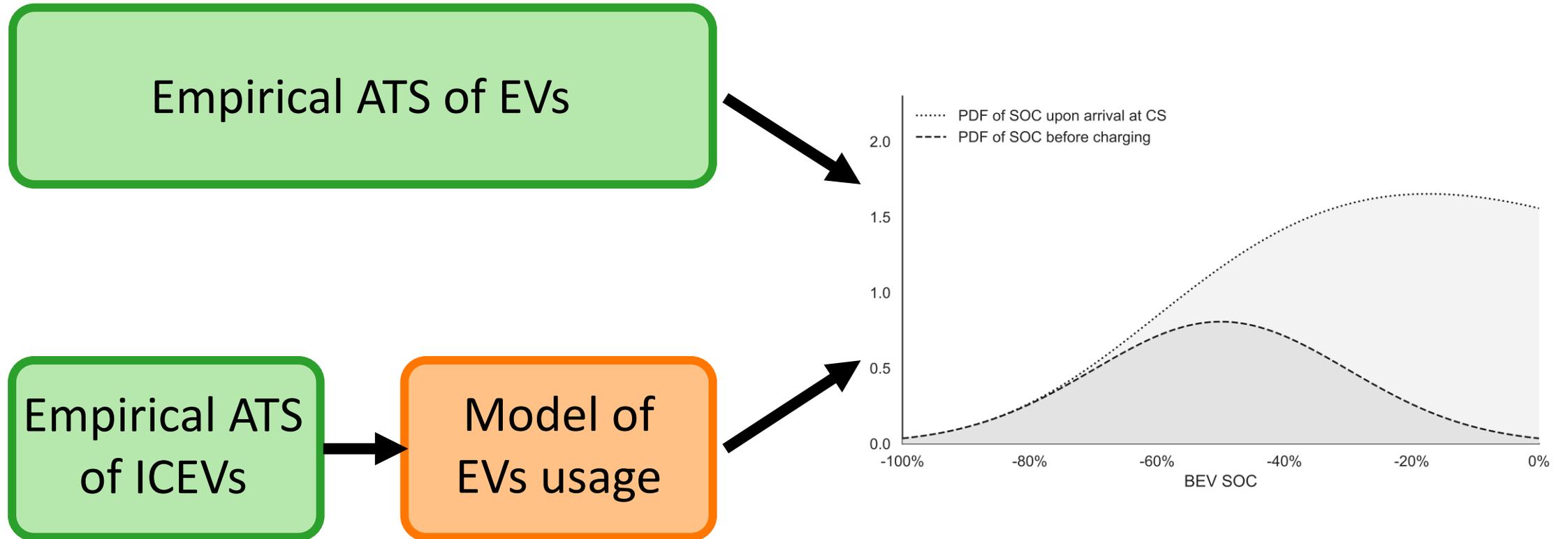
Model of
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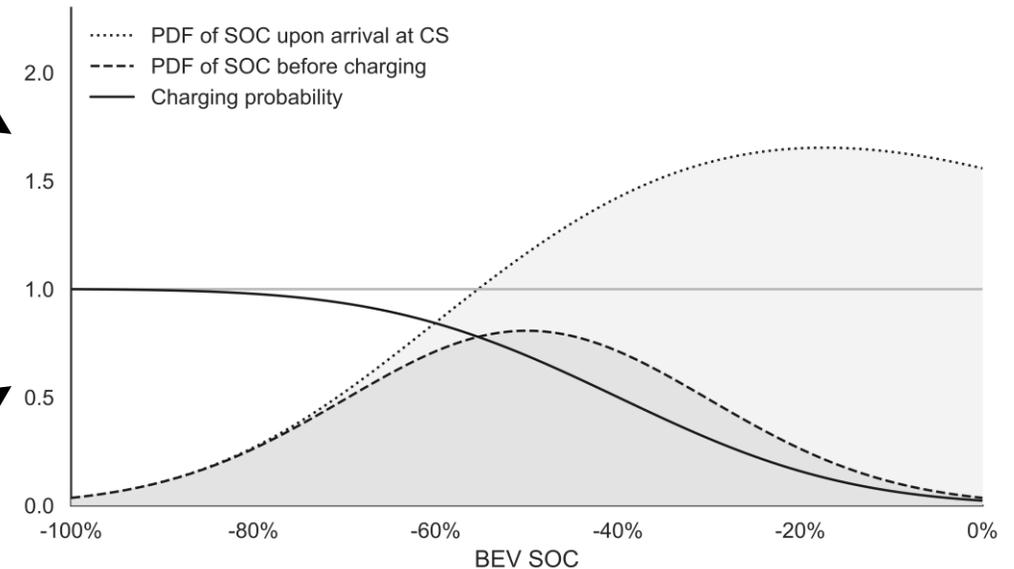


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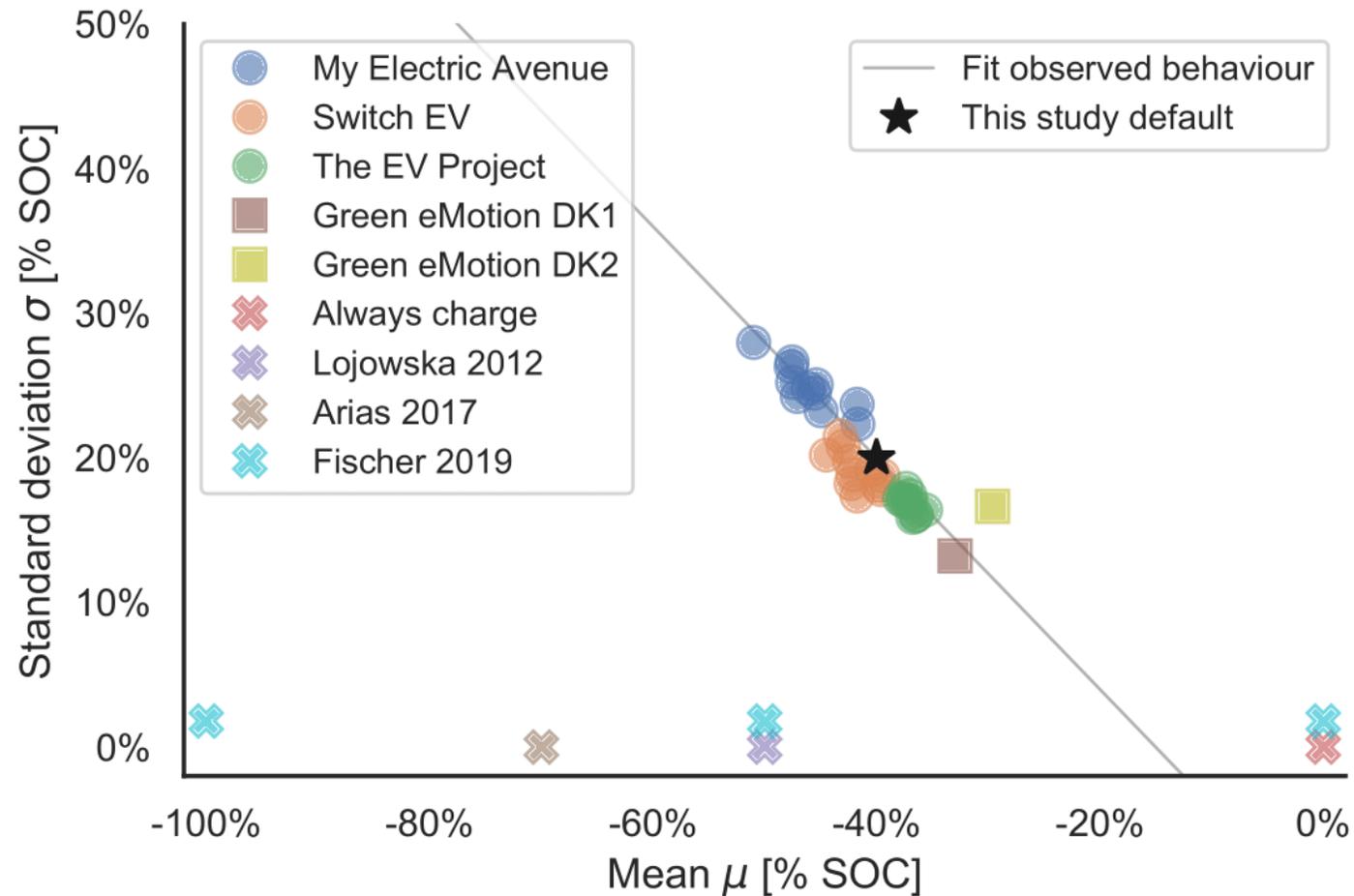
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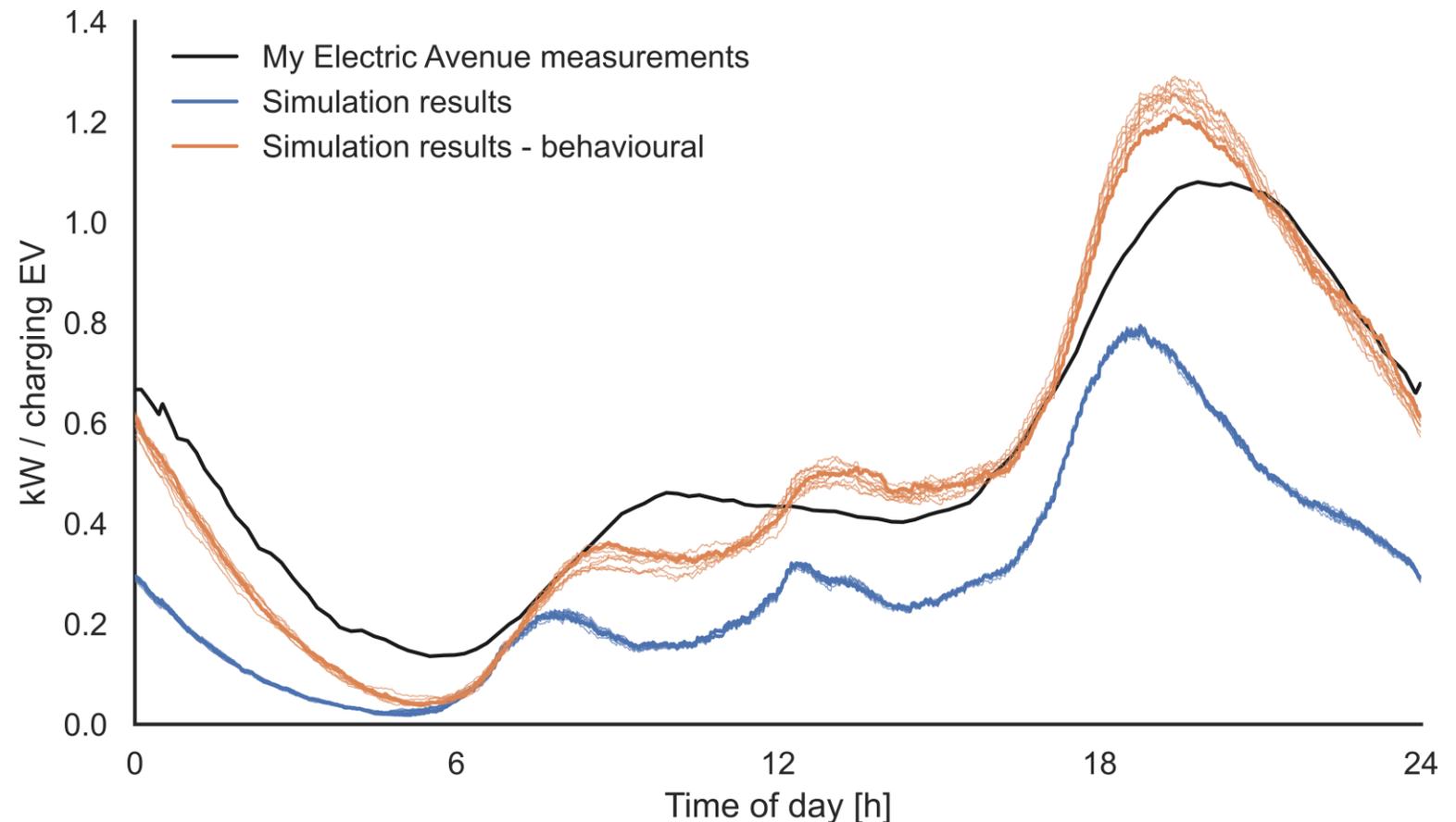


Empirical charging behavior:



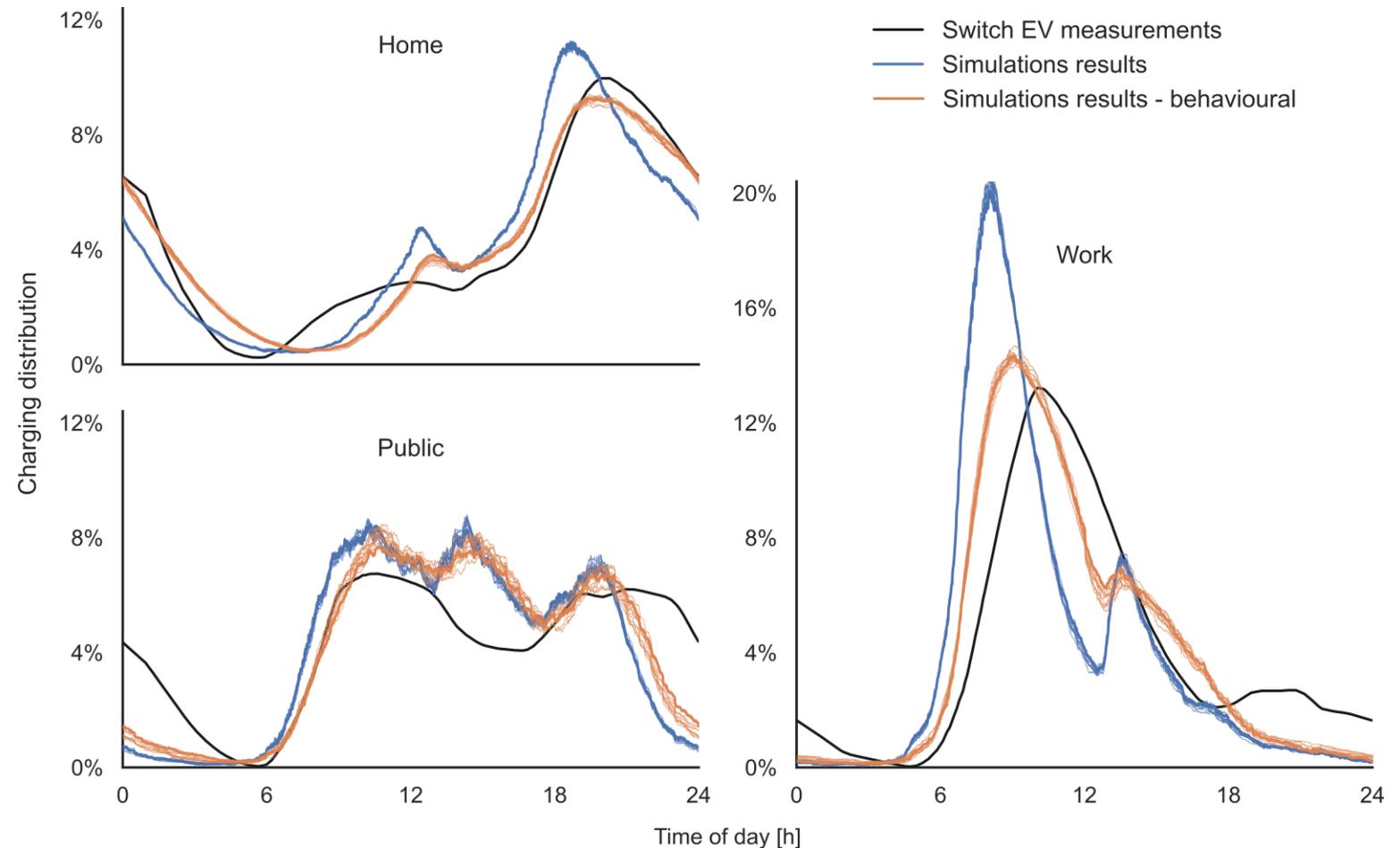
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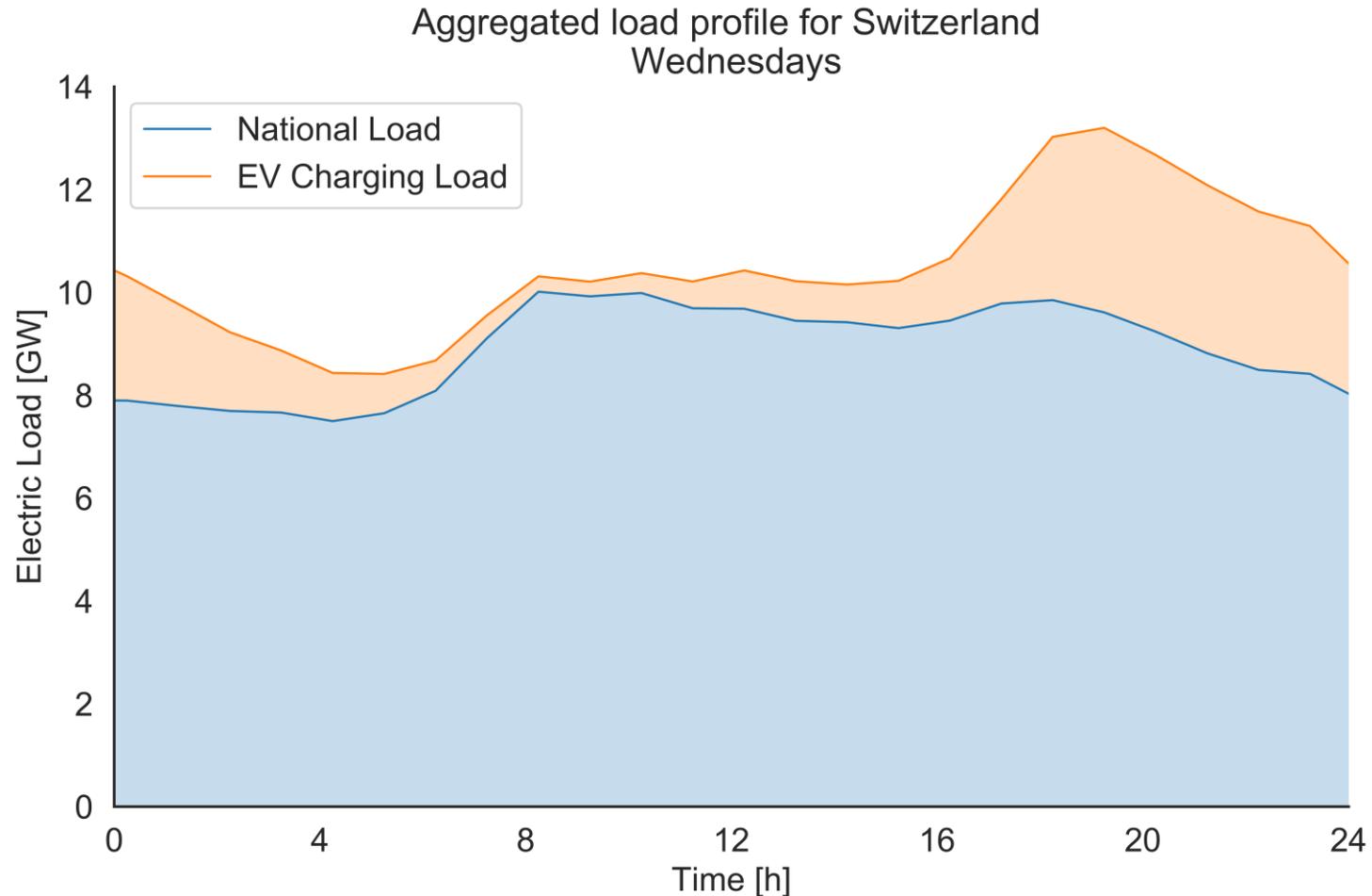
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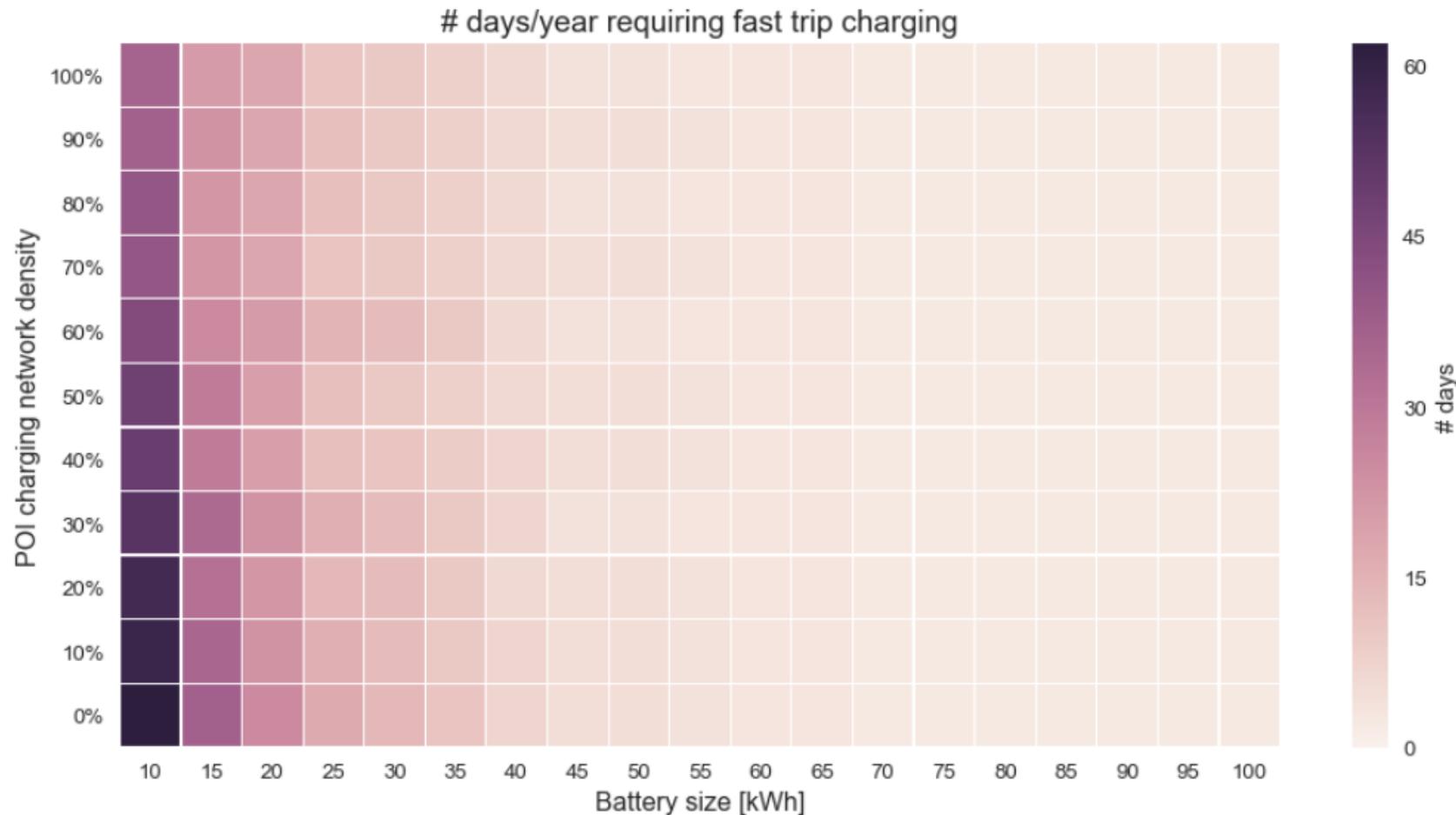
A glimpse of the applications

- Aggregated load demand for national scenarios



A glimpse of the applications

- Techno-economical analyses for optimal policy design



Conclusions

- Conventional ATS (e.g. national household travel surveys can describe the mobility behaviour of EVs
- Plug-and-charge schemes cause a charging peaks:
 - At home in the evening
 - At work in the morning
- Drivers' decision to charge is similar throughout different empirical contexts
- Charging behaviour is stochastic and dependant on EVs' state of charge
- Current driving schedules can be fulfilled by EVs with reasonably large battery sizes
- Most of existing electric grid can sustain the additional electricity load from EVs

Thank you all

