



# Boosting decarbonization of mobility through EVs

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PhD candidate at LAV

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# HELLO

My name is

## Giacomo Pareschi

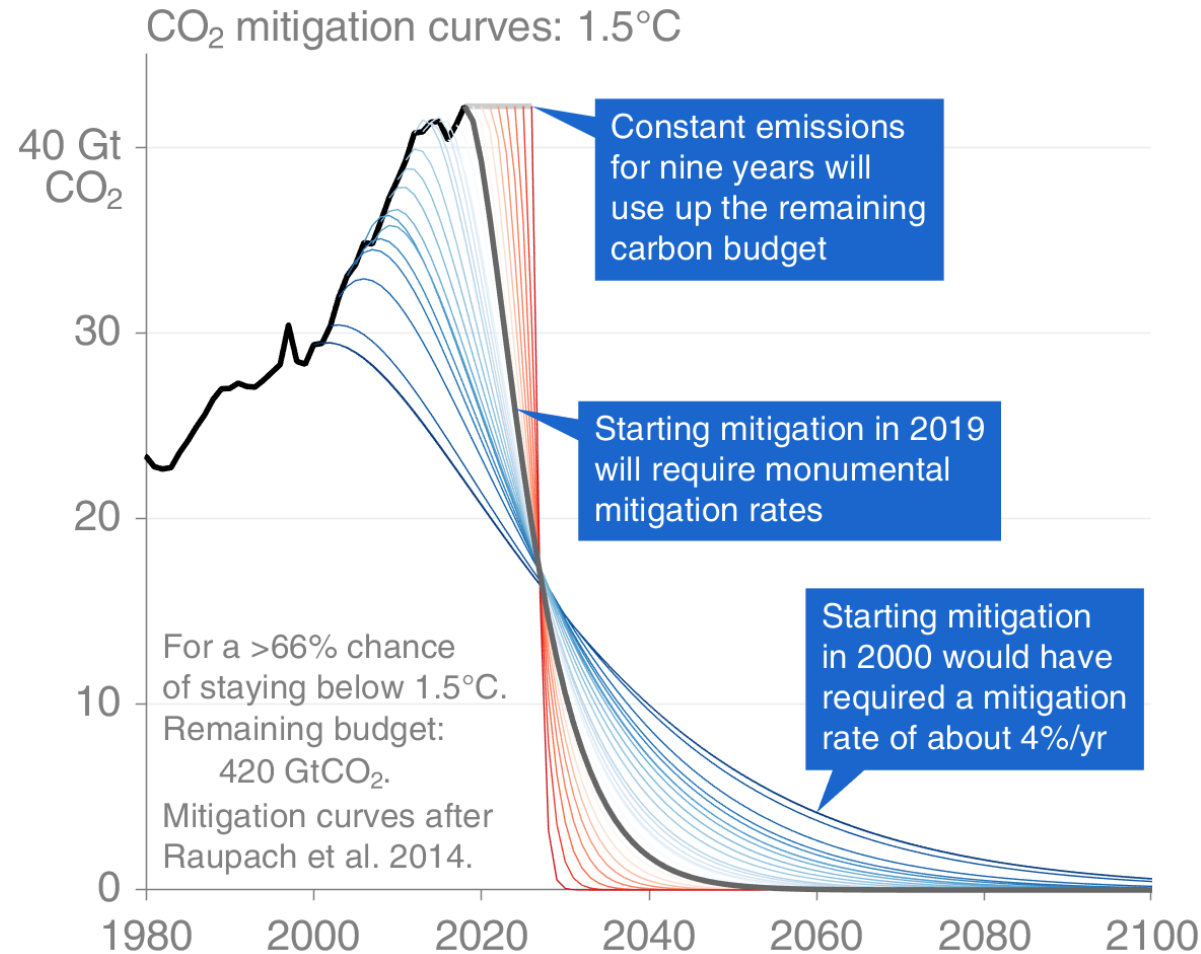


- BSc at Politecnico di Milano in Energy Engineering
  - MSc at ETH in Energy Science & Technology
  - PhD Candidate in LAV's Energy Systems Group
    - Impact and potentials of fleet-wise interventions
    - From passenger cars to aircrafts
    - From electricity to synthetic fuels
- ↓
- Role of EVs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



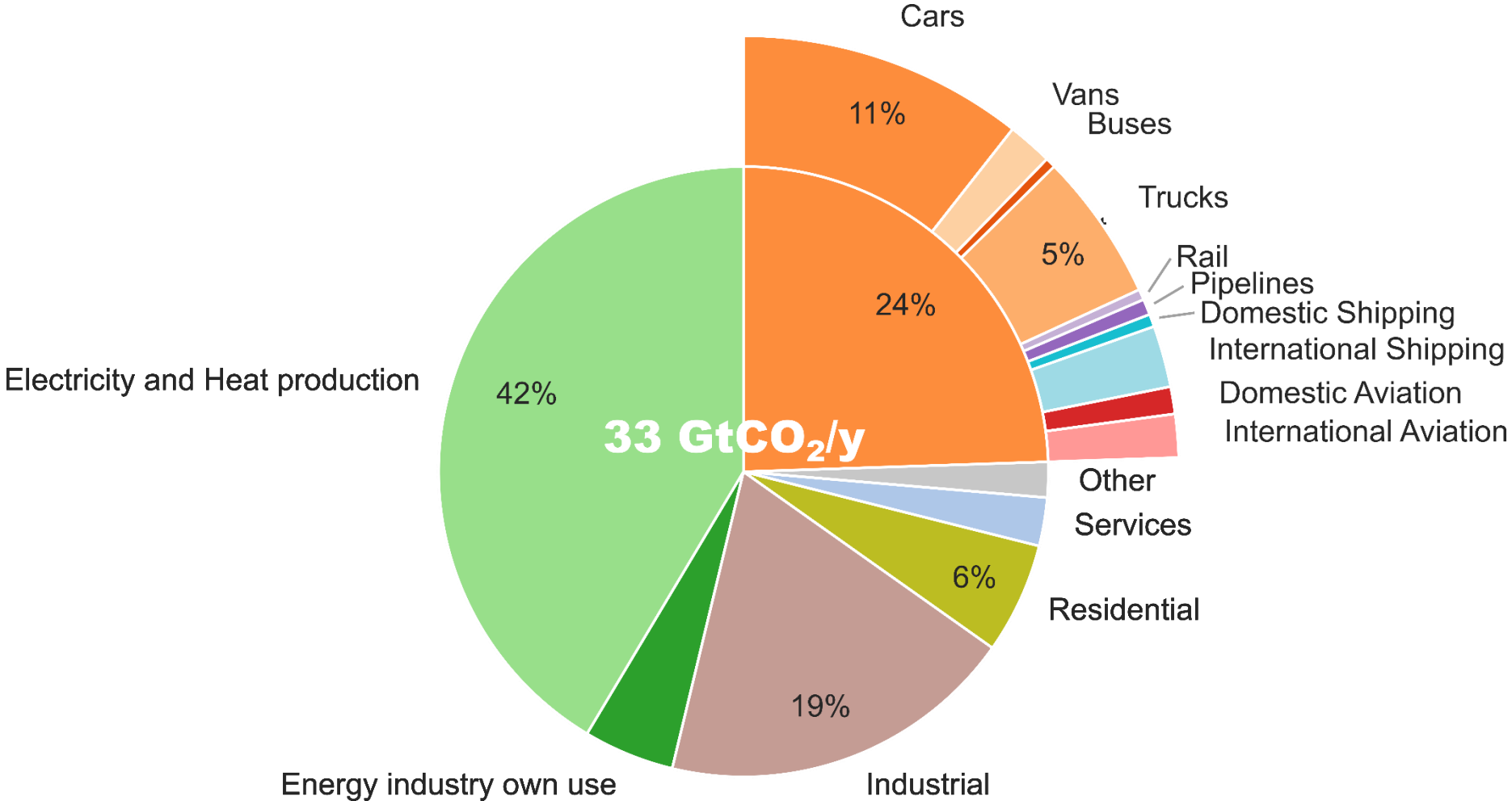
# Are we in a hurry?

Remaining global carbon budget on 1.1.2019: ~**380 Gt CO<sub>2</sub>**.



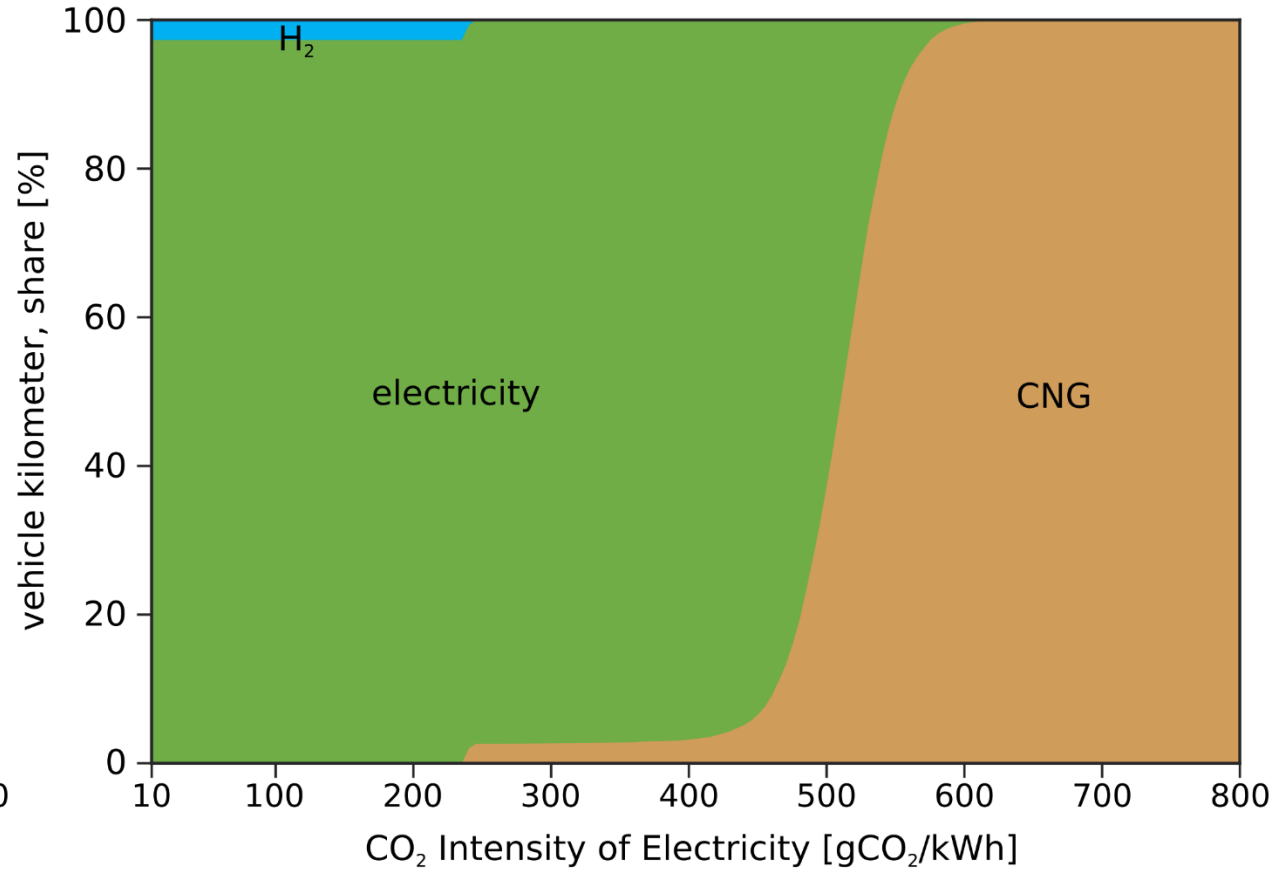
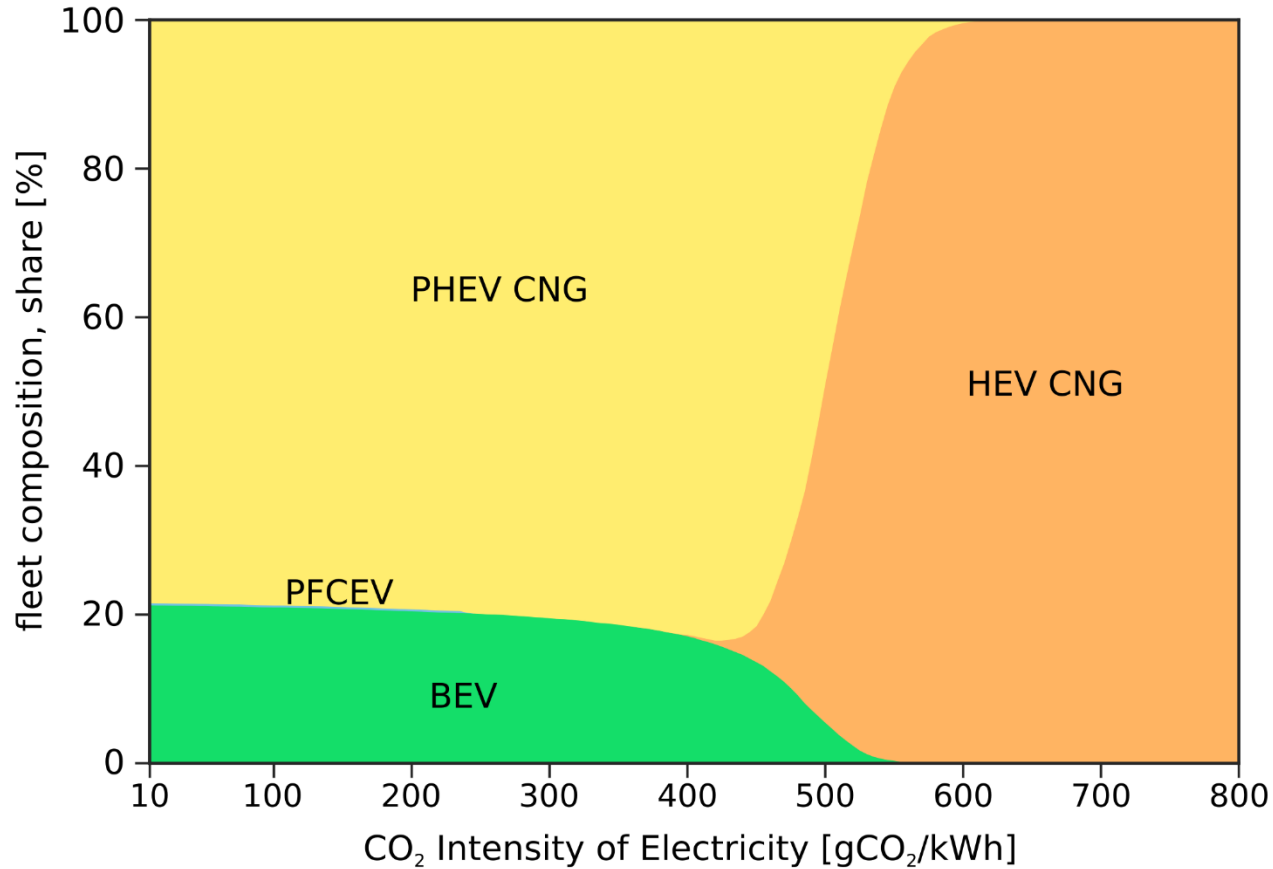
# Passenger cars responsibility

CO<sub>2</sub> emission from fuel combustion in 2017



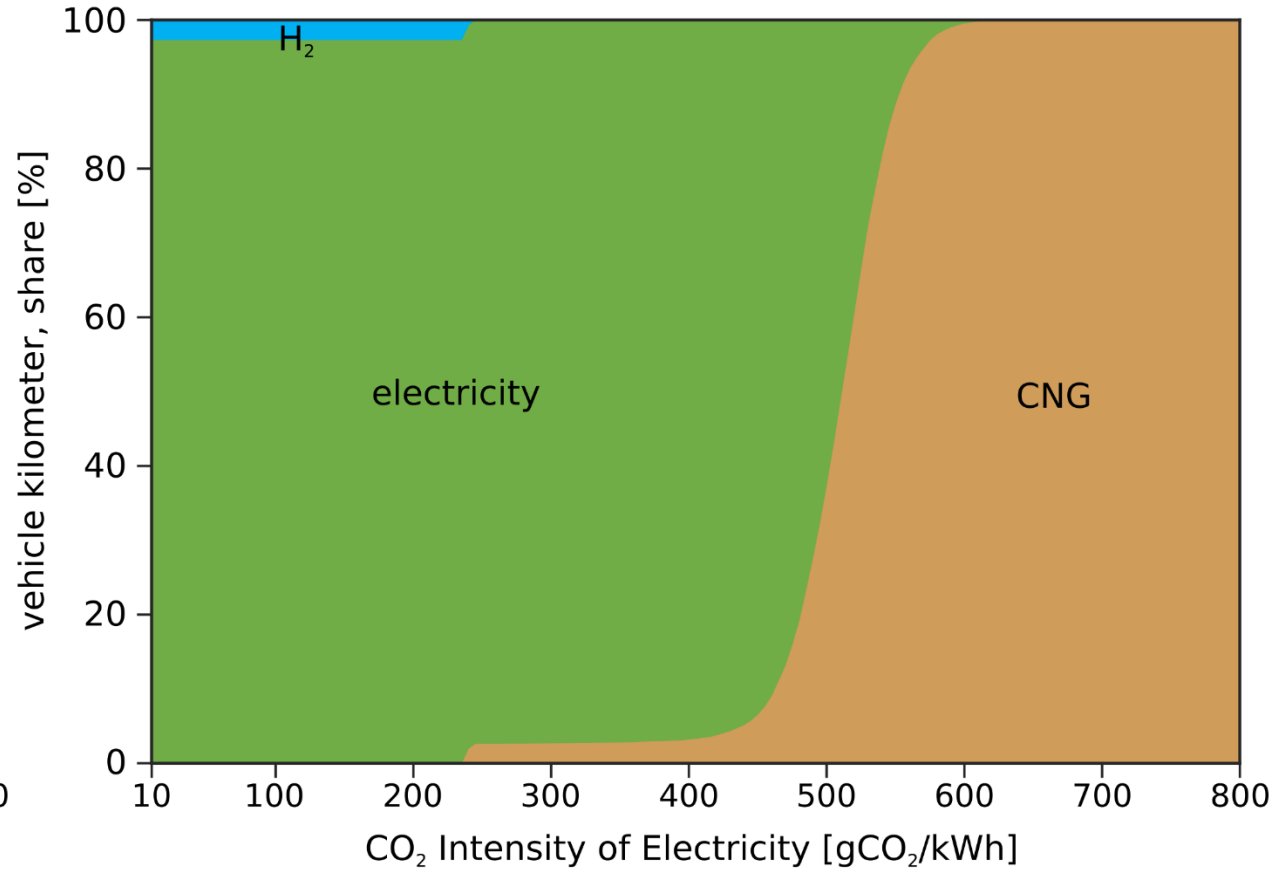
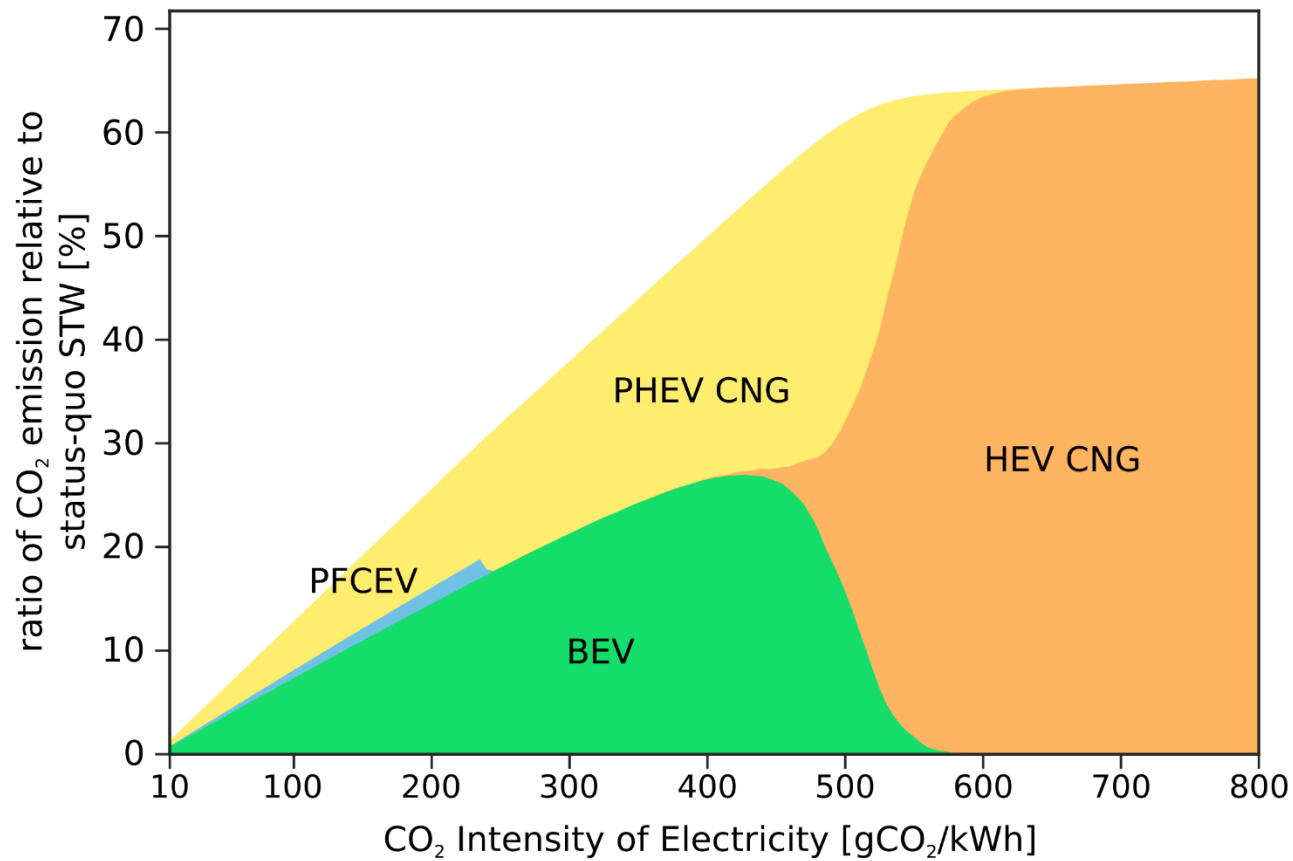
# What should we ideally do?

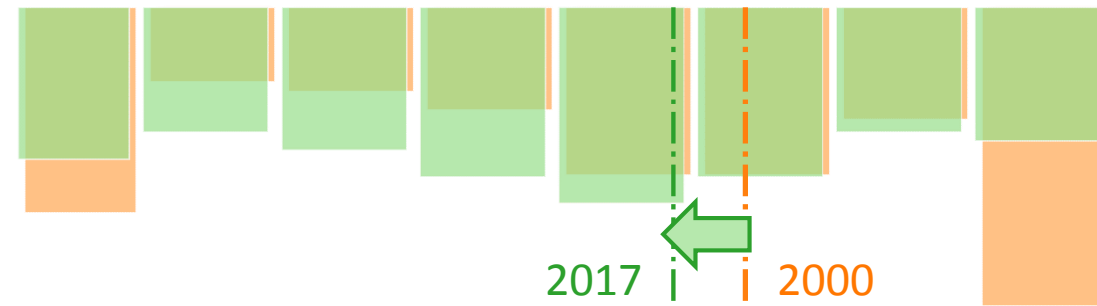
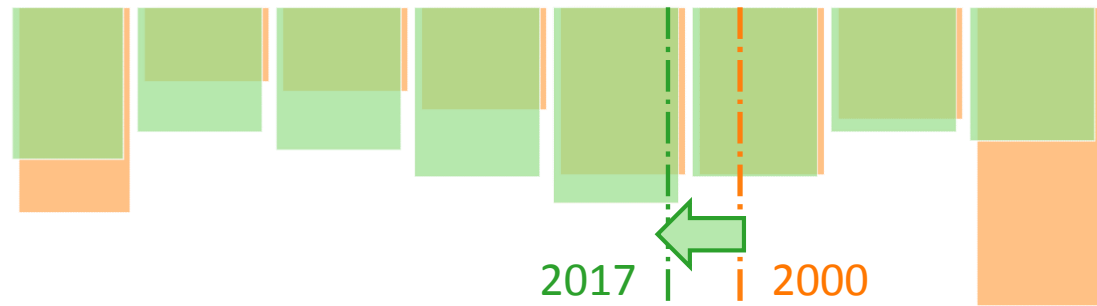
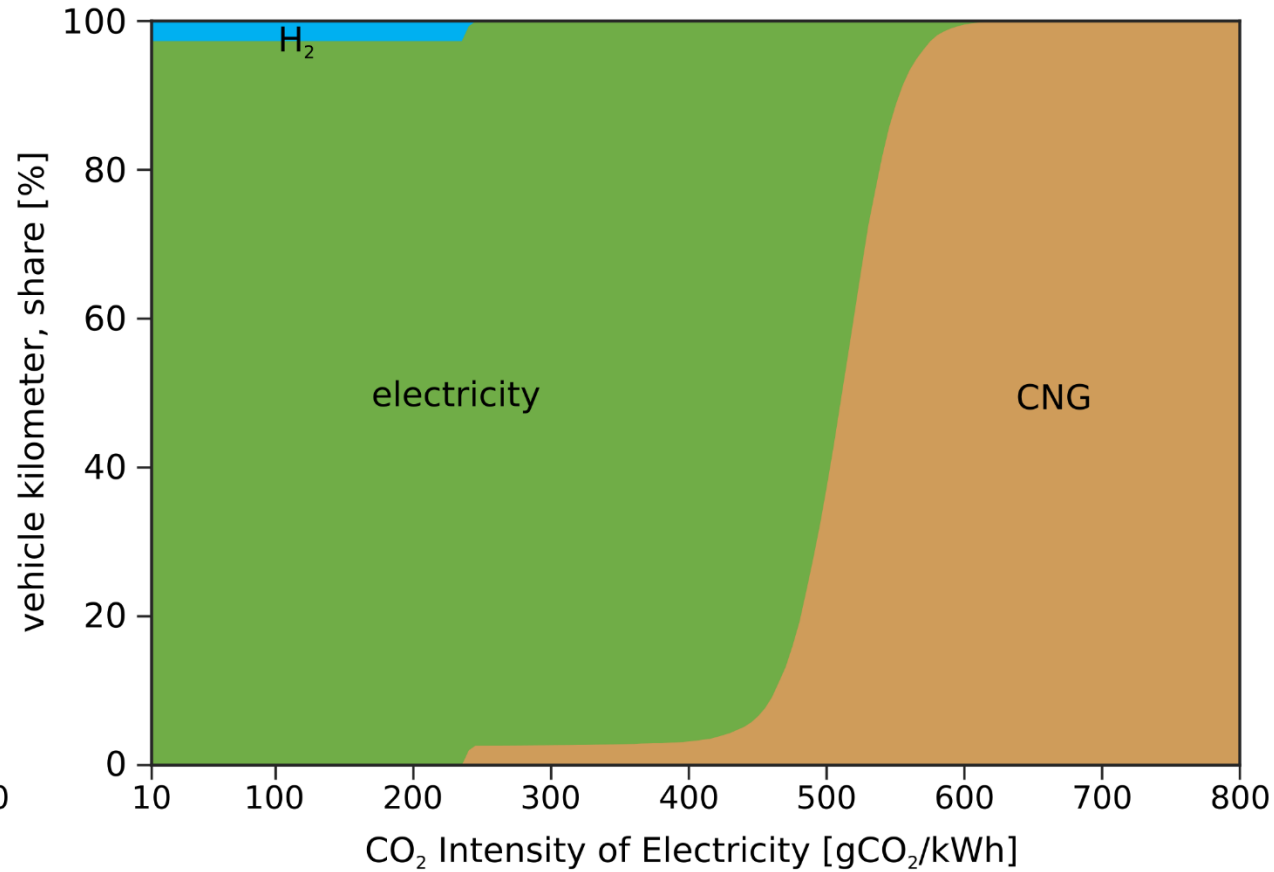
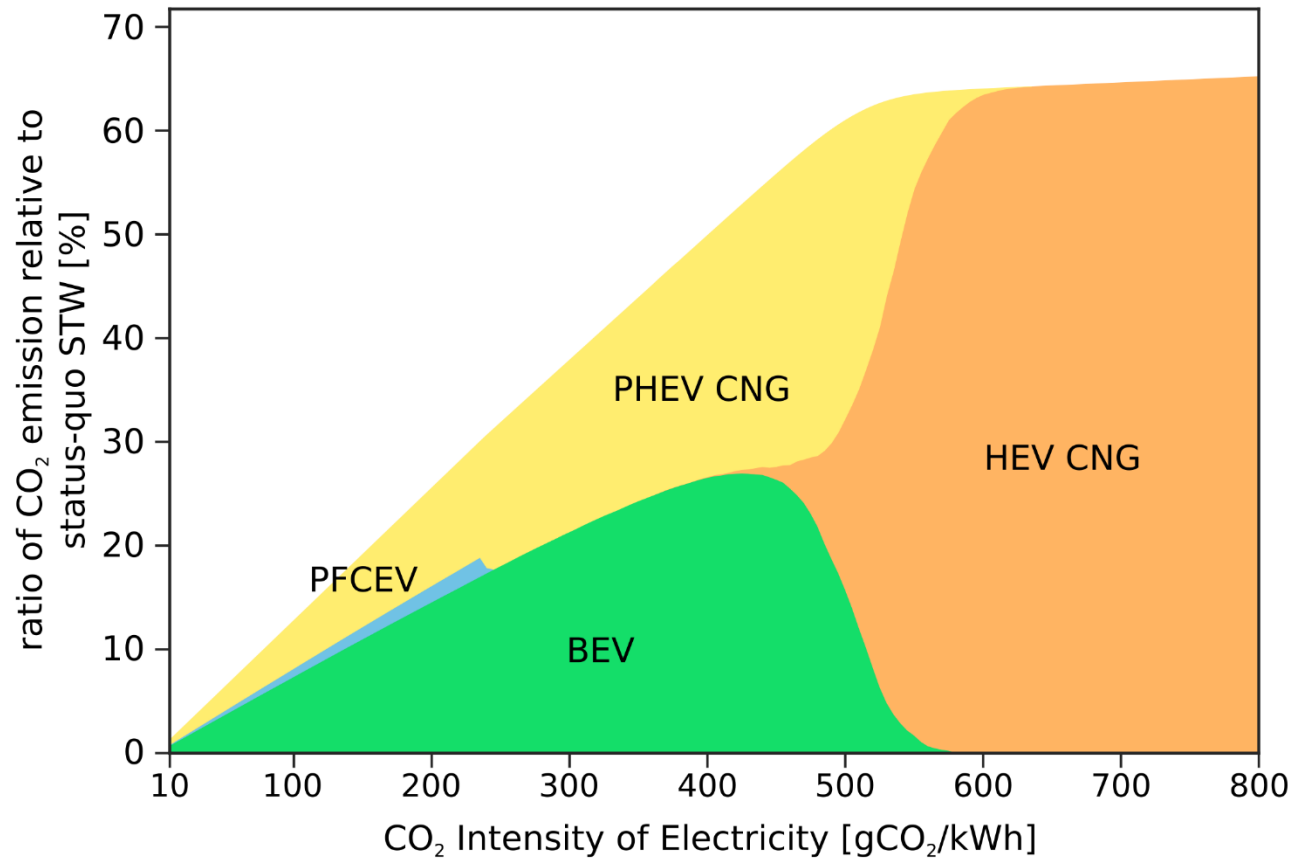
Optimal fleet composition for given electricity mix



# What should we do?

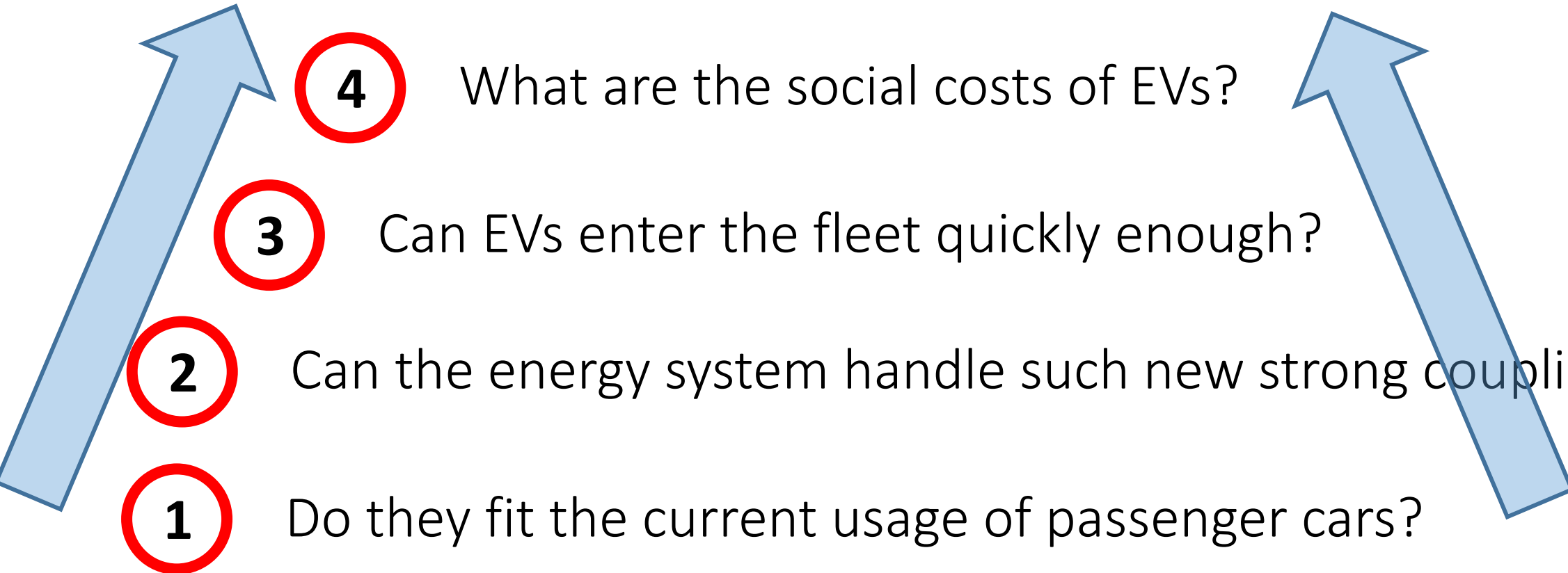
Optimal fleet composition for given electricity mix





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

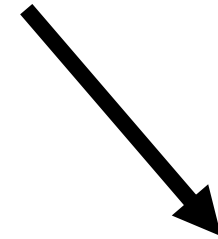
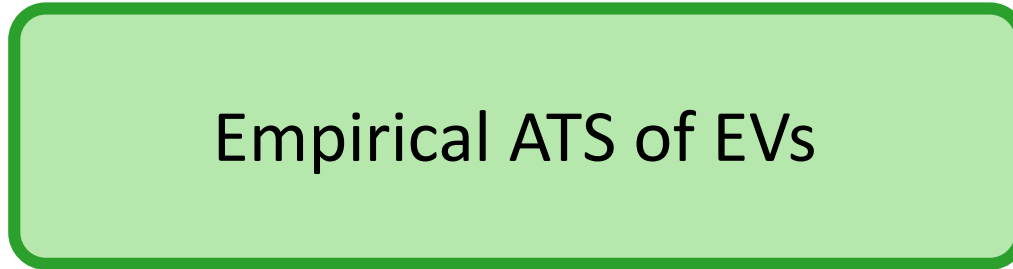
- Numerical simulations



EV usage models

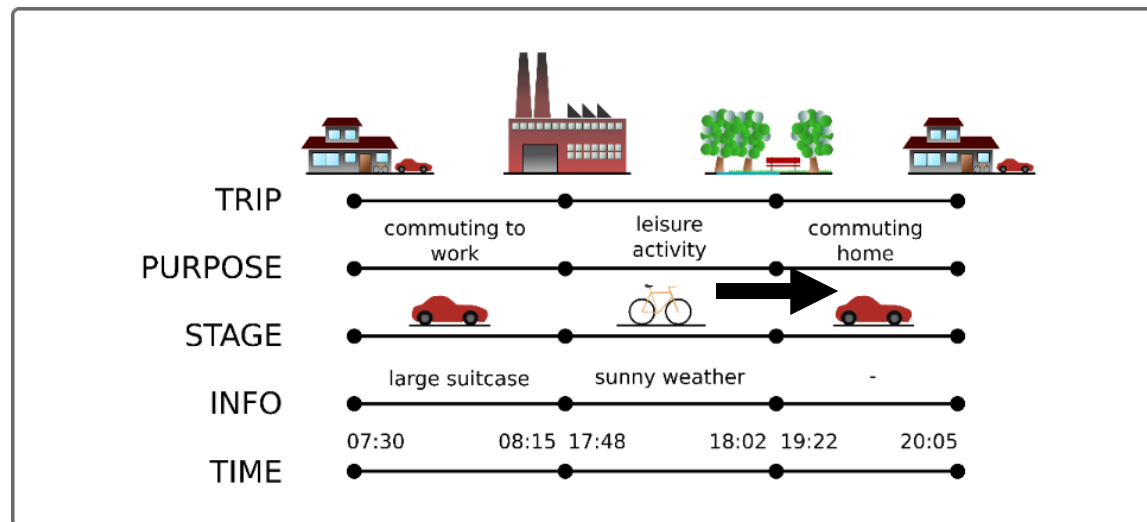
# 3 typical research strategies

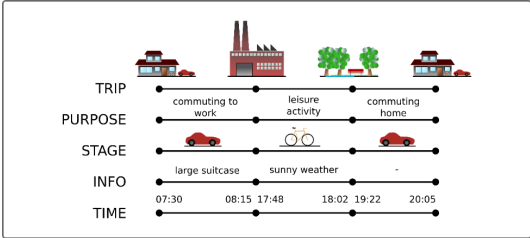
100% experimental



Analyses  
&  
Results

## ATS: Activity-Travel Schedule





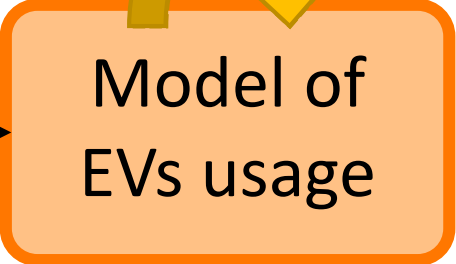
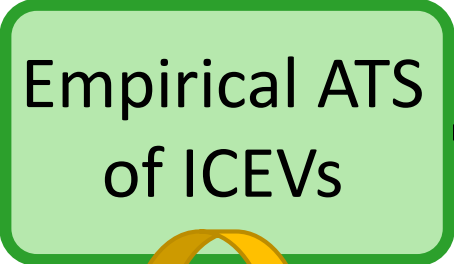
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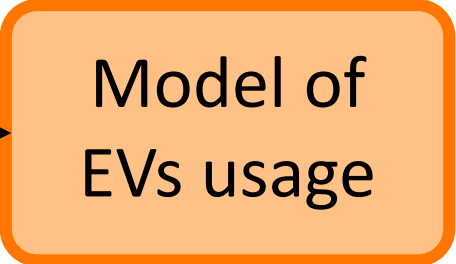
Validation

50/50



Validation

100% simulations



Analyses & Results

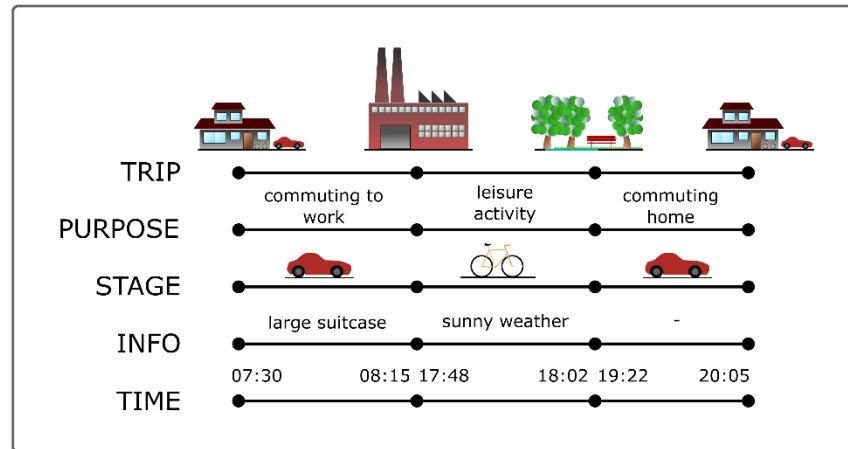
# Our methodology in detail

Empirical ATS  
of ICEVs

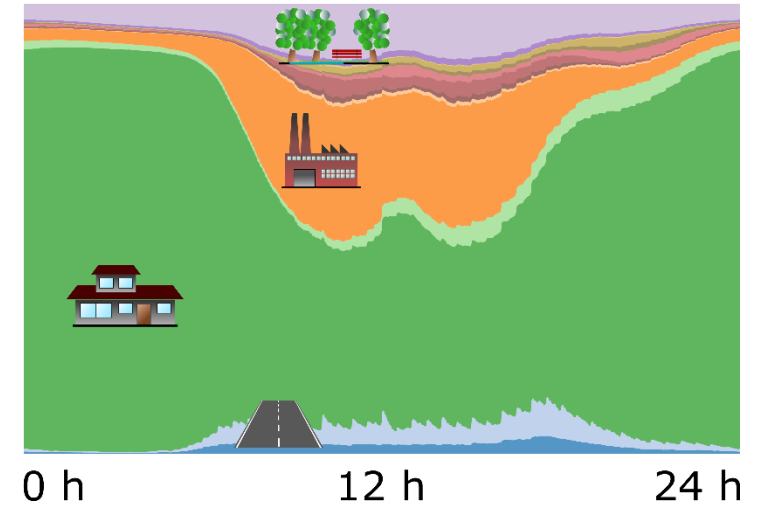
MZMV 2015



Activity-Travel Schedule  
respondents' perspective

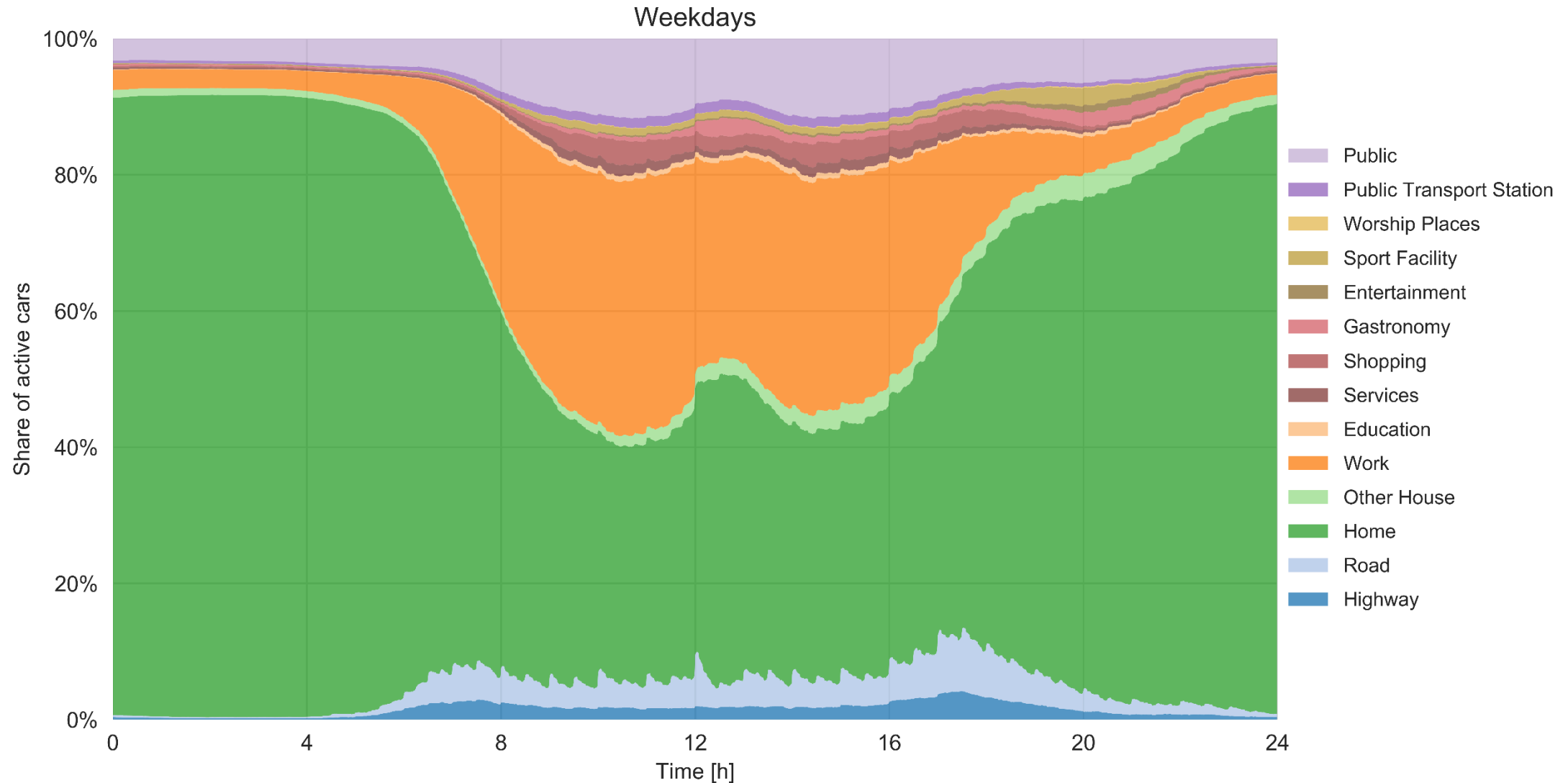


Activity-Travel Schedule  
cars' perspective



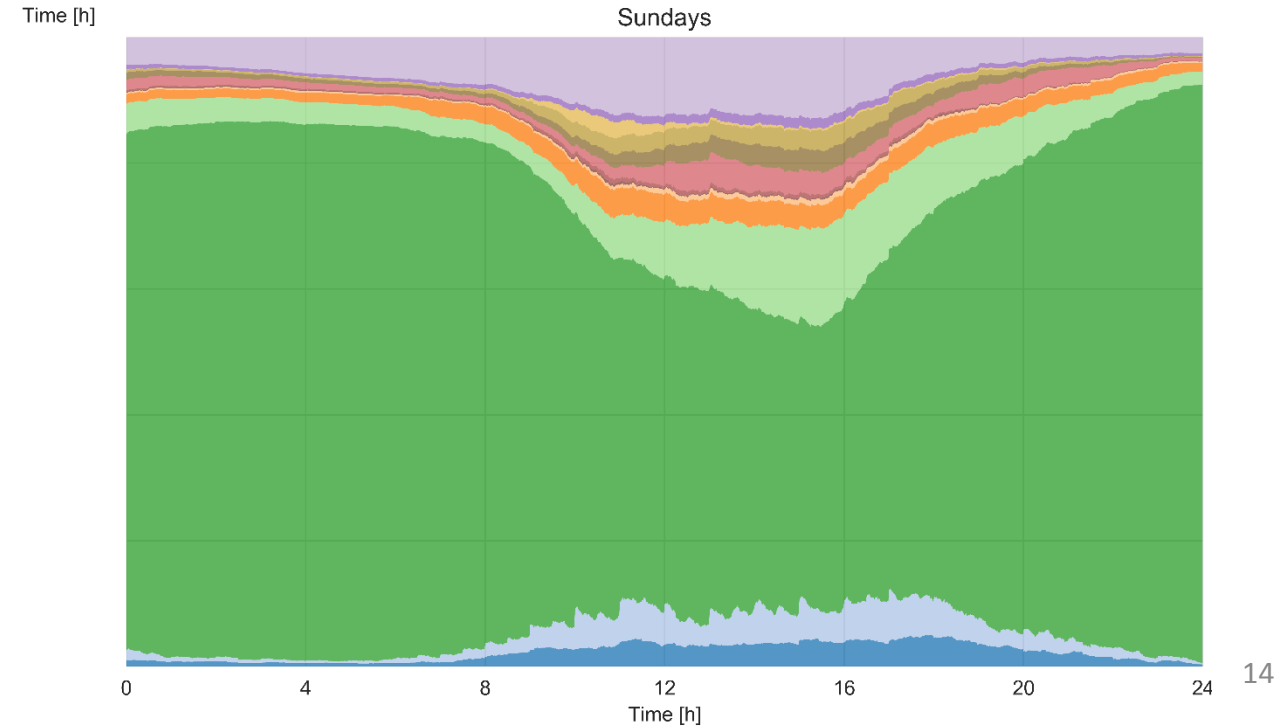
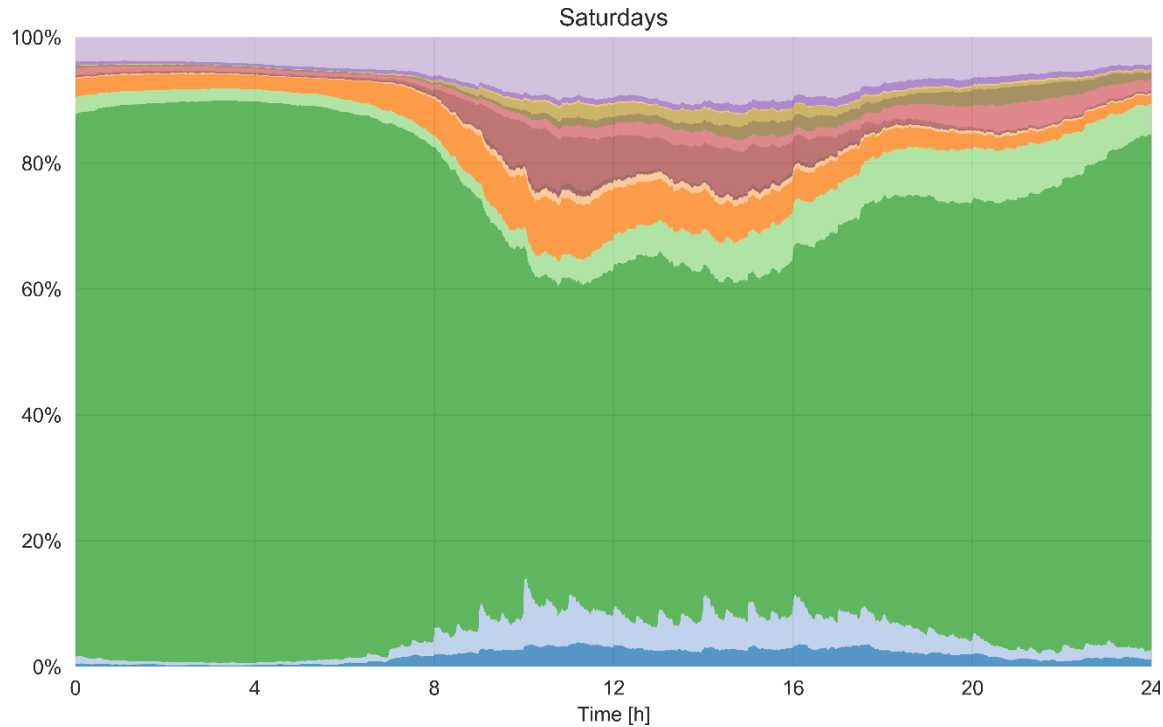
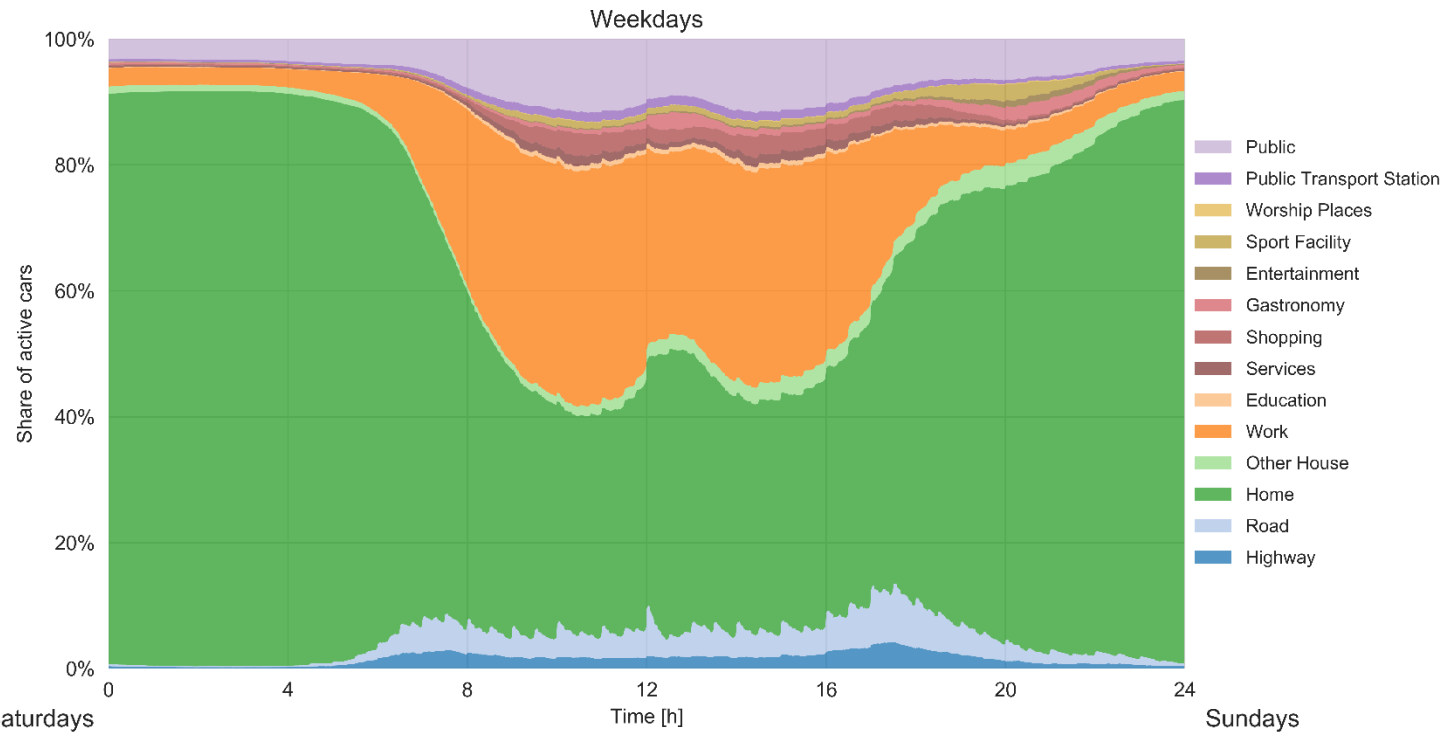
# Cars ATS: locations by time of the day

Empirical ATS  
of ICEVs



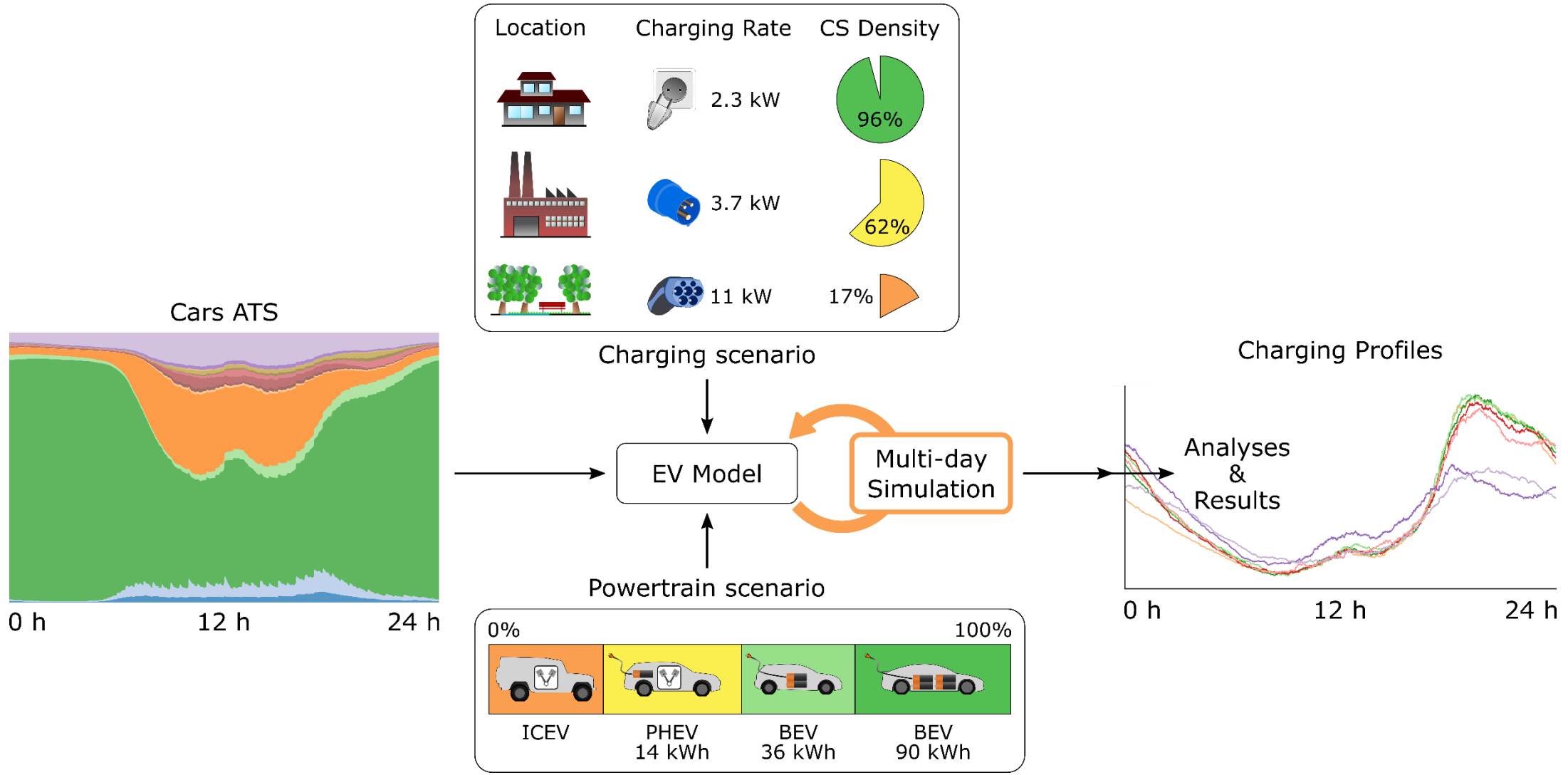
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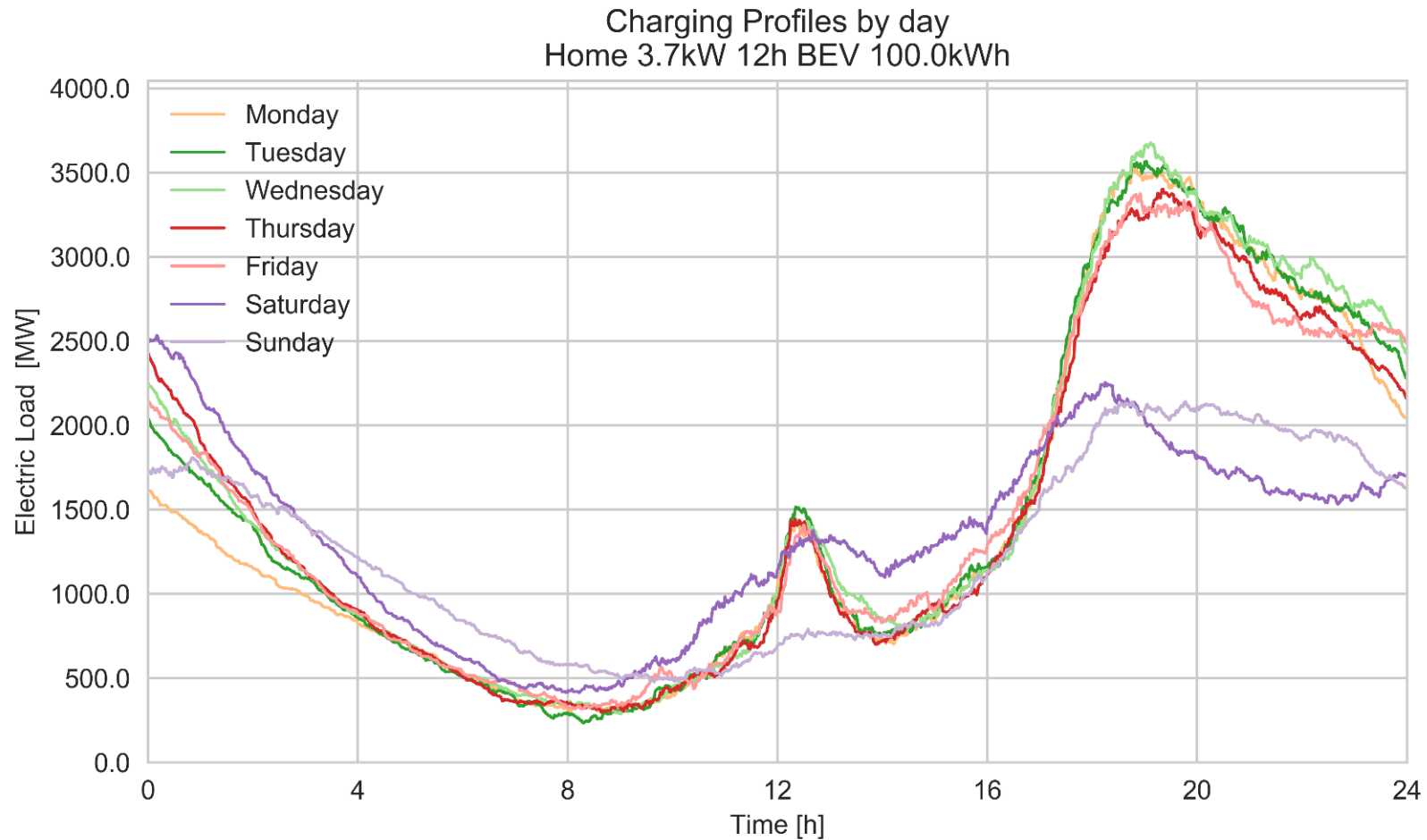


# Our methodology in detail

Model of EVs usage

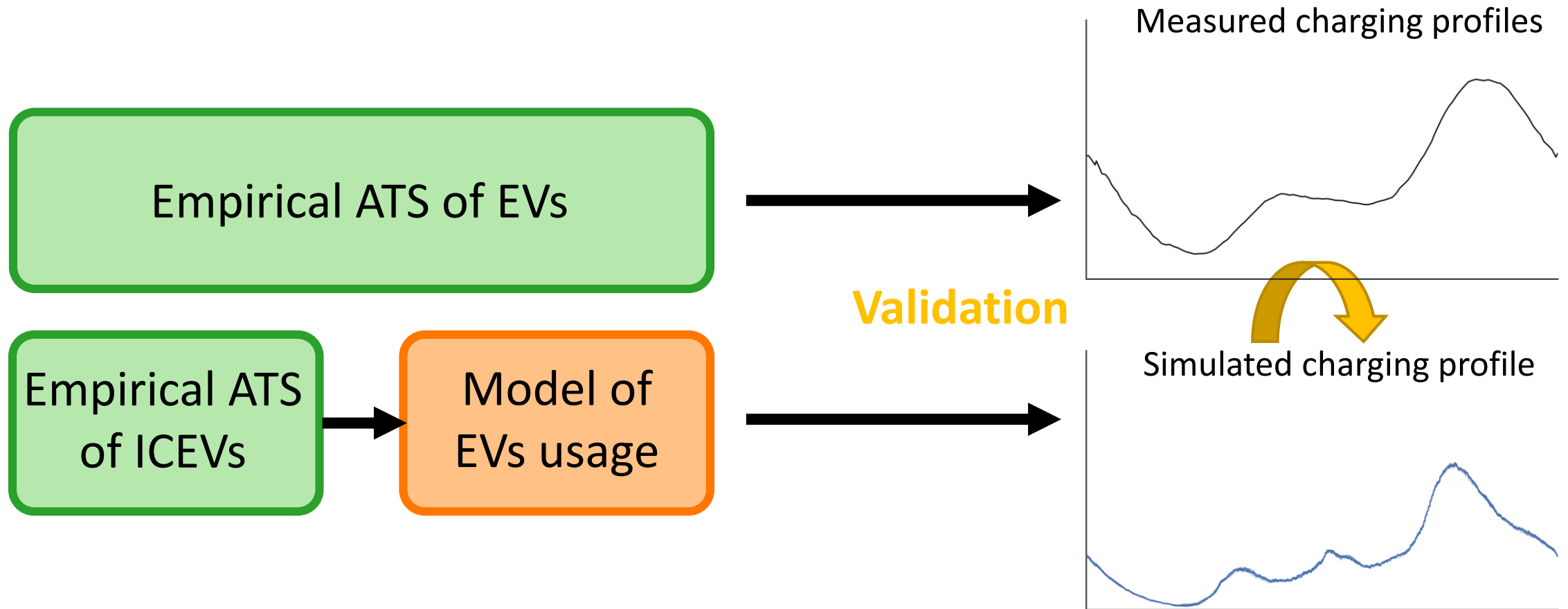


# What do charging profile look like?



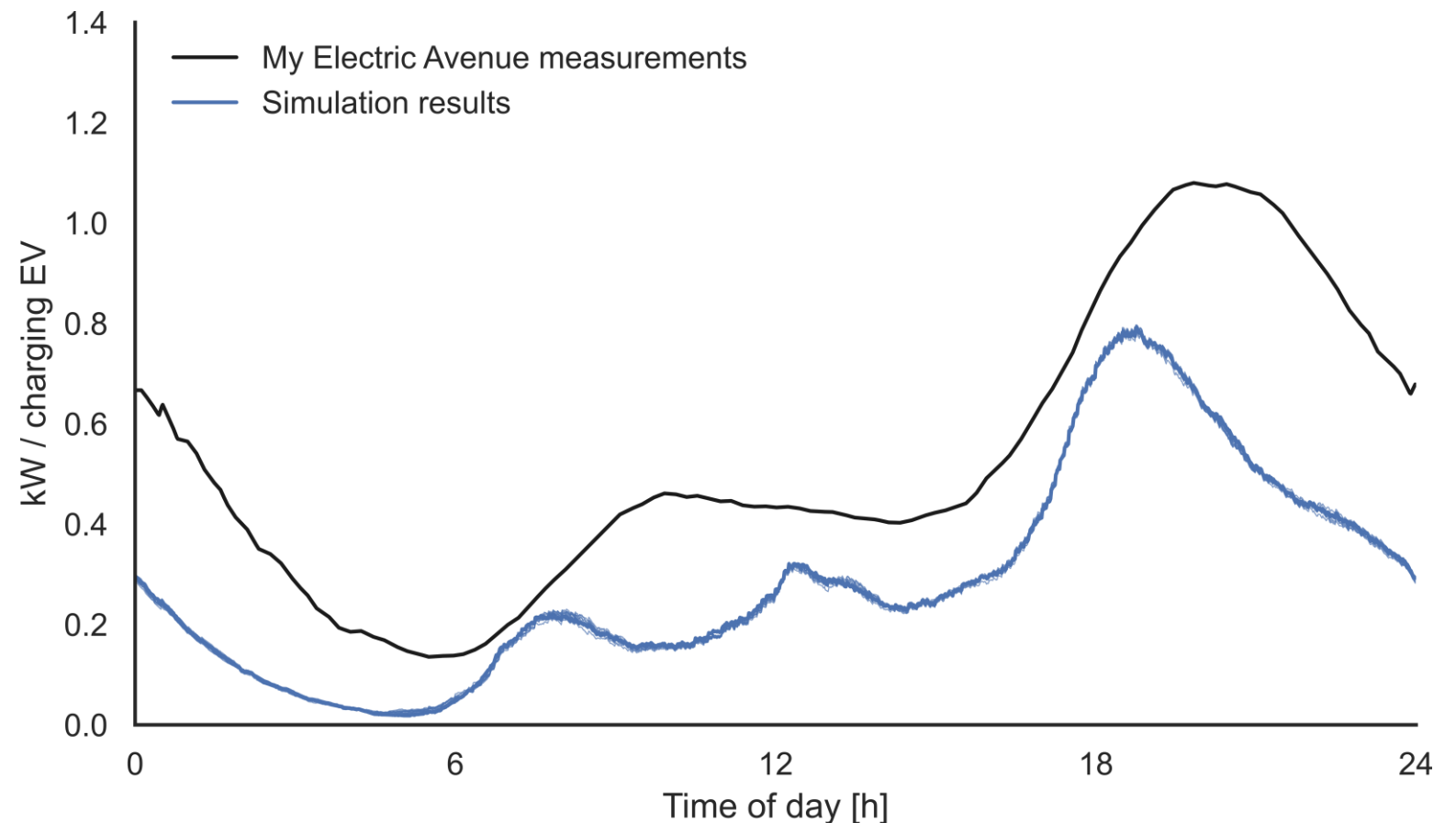


# What about that validation?



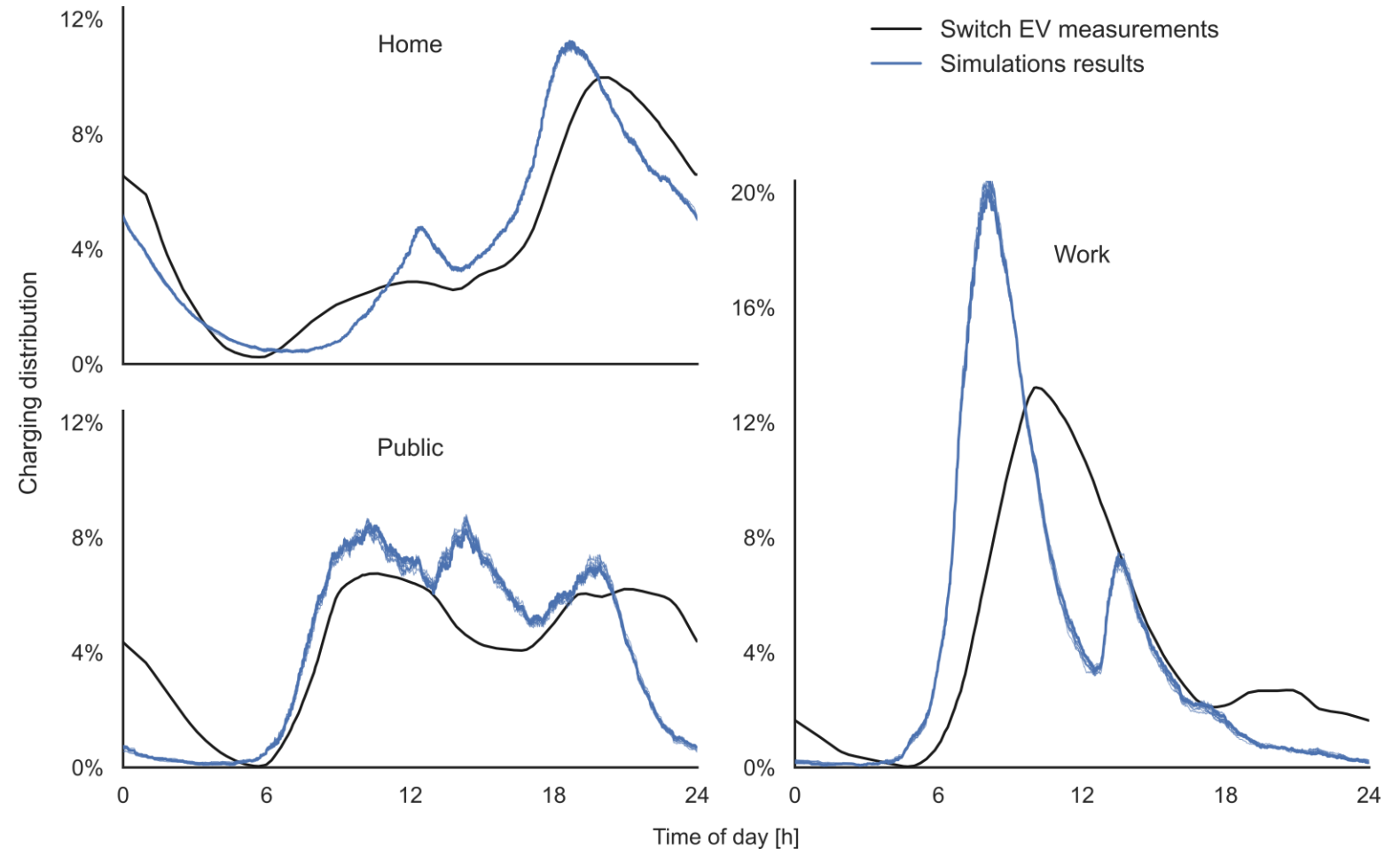
# Comparison with the My Electric Avenue trial:

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



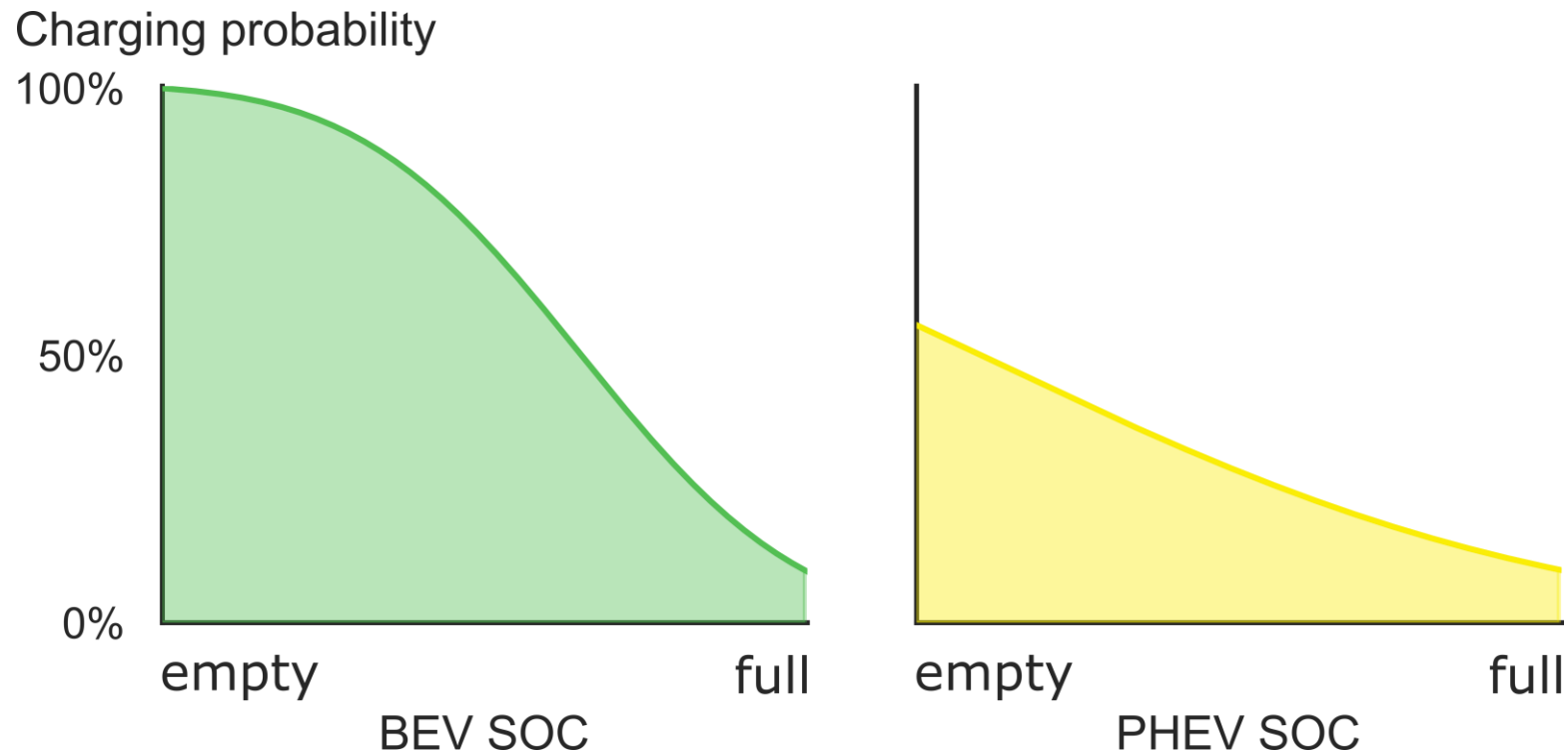
# Comparison with the Switch EV trial:

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



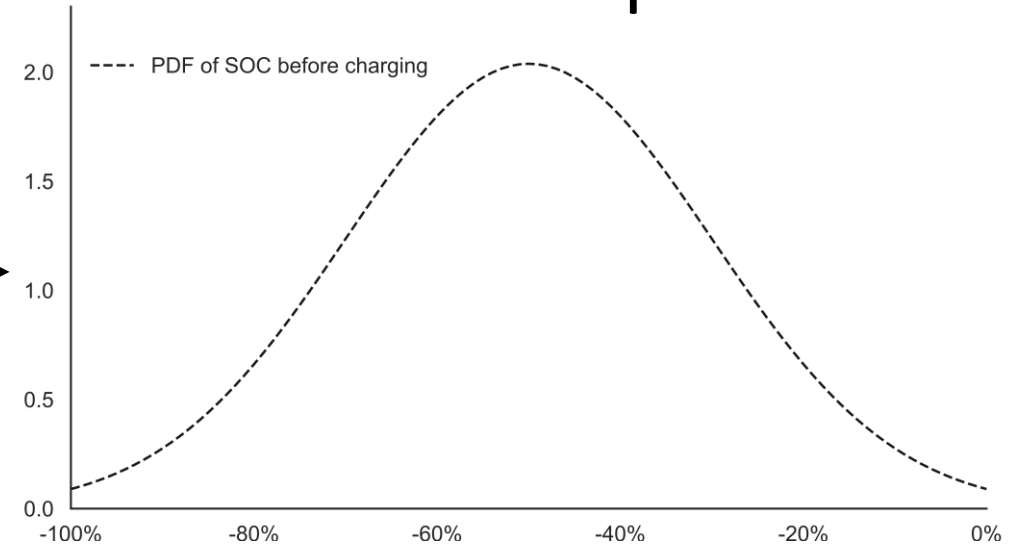
# Need for a behavioral model

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

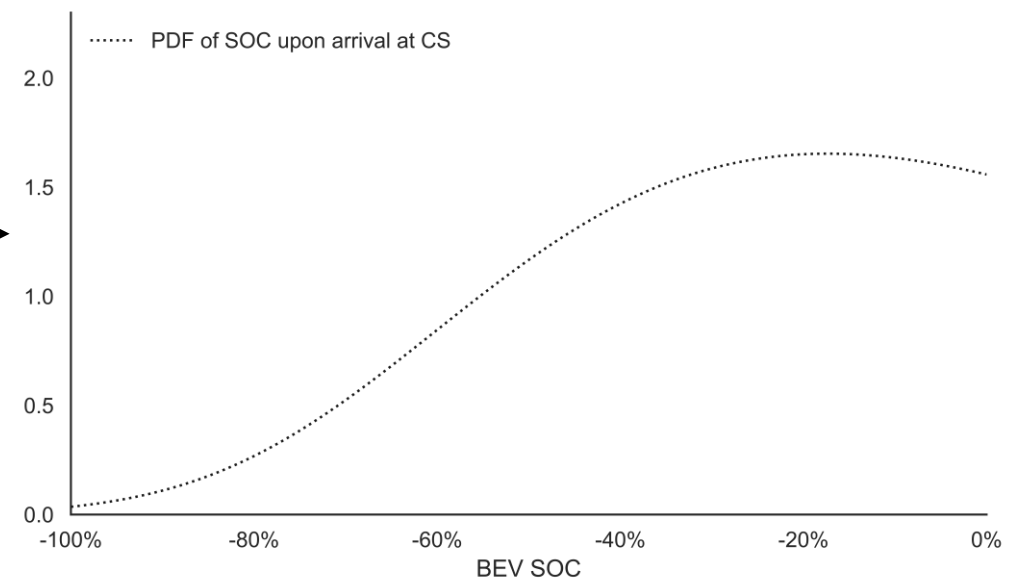
Empirical ATS of EVs



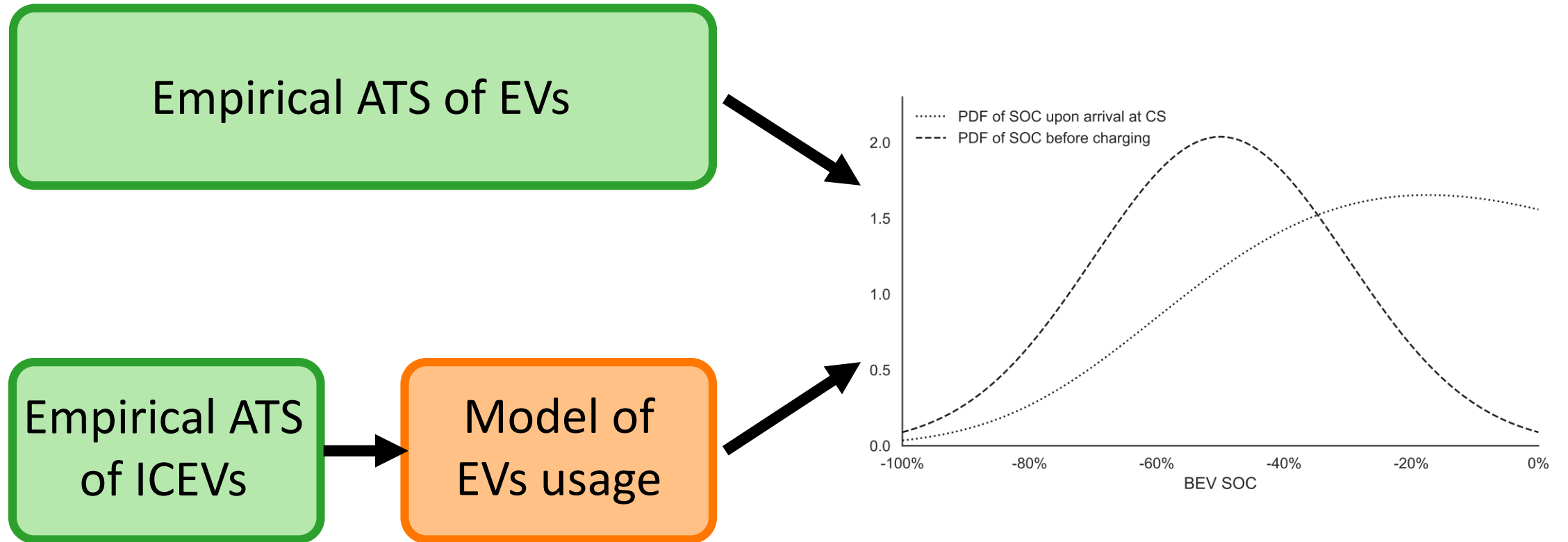
Empirical ATS of ICEVs



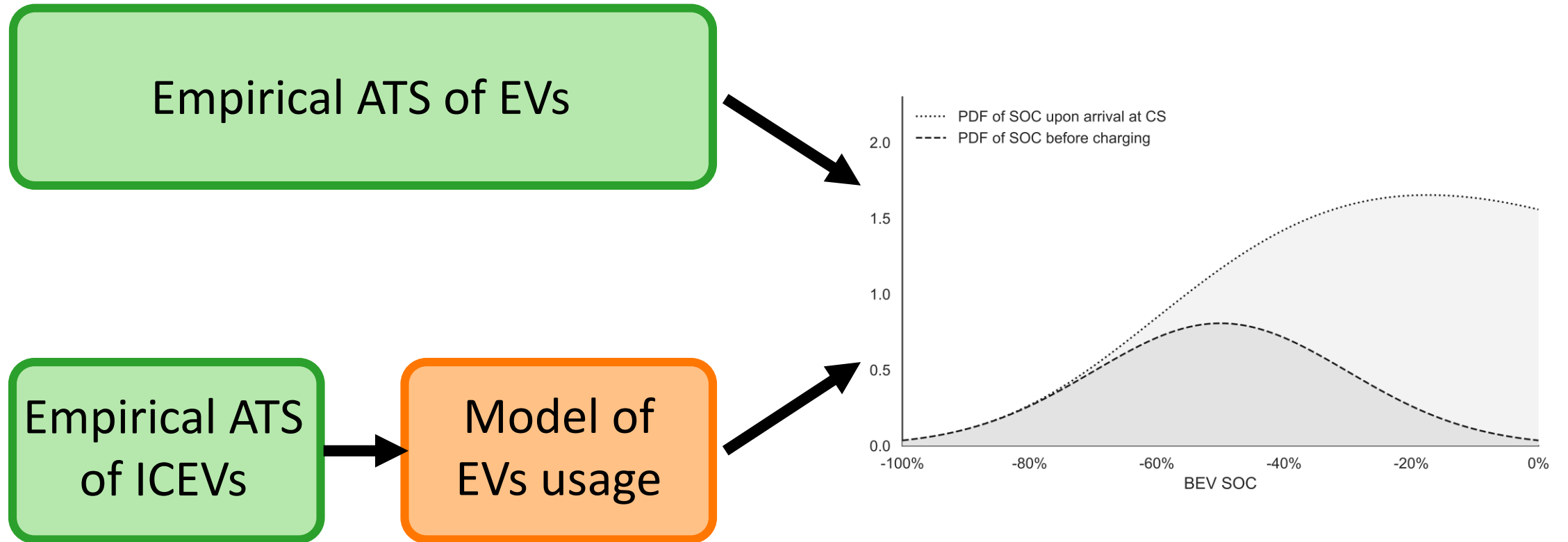
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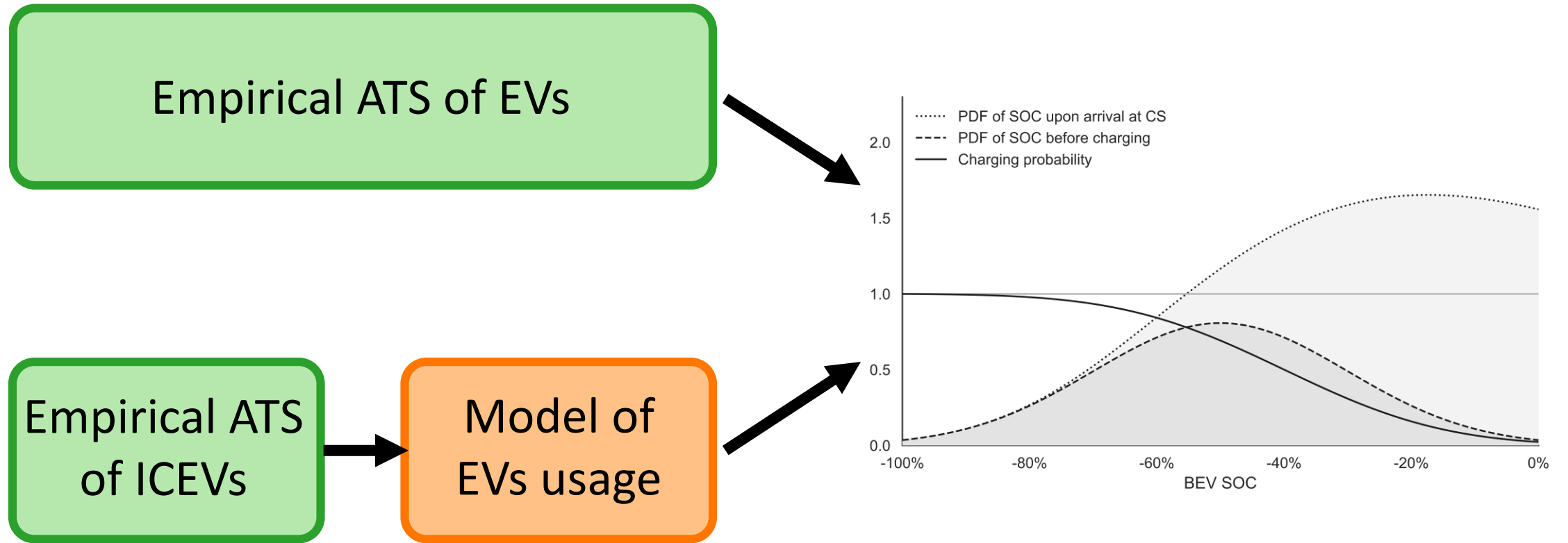
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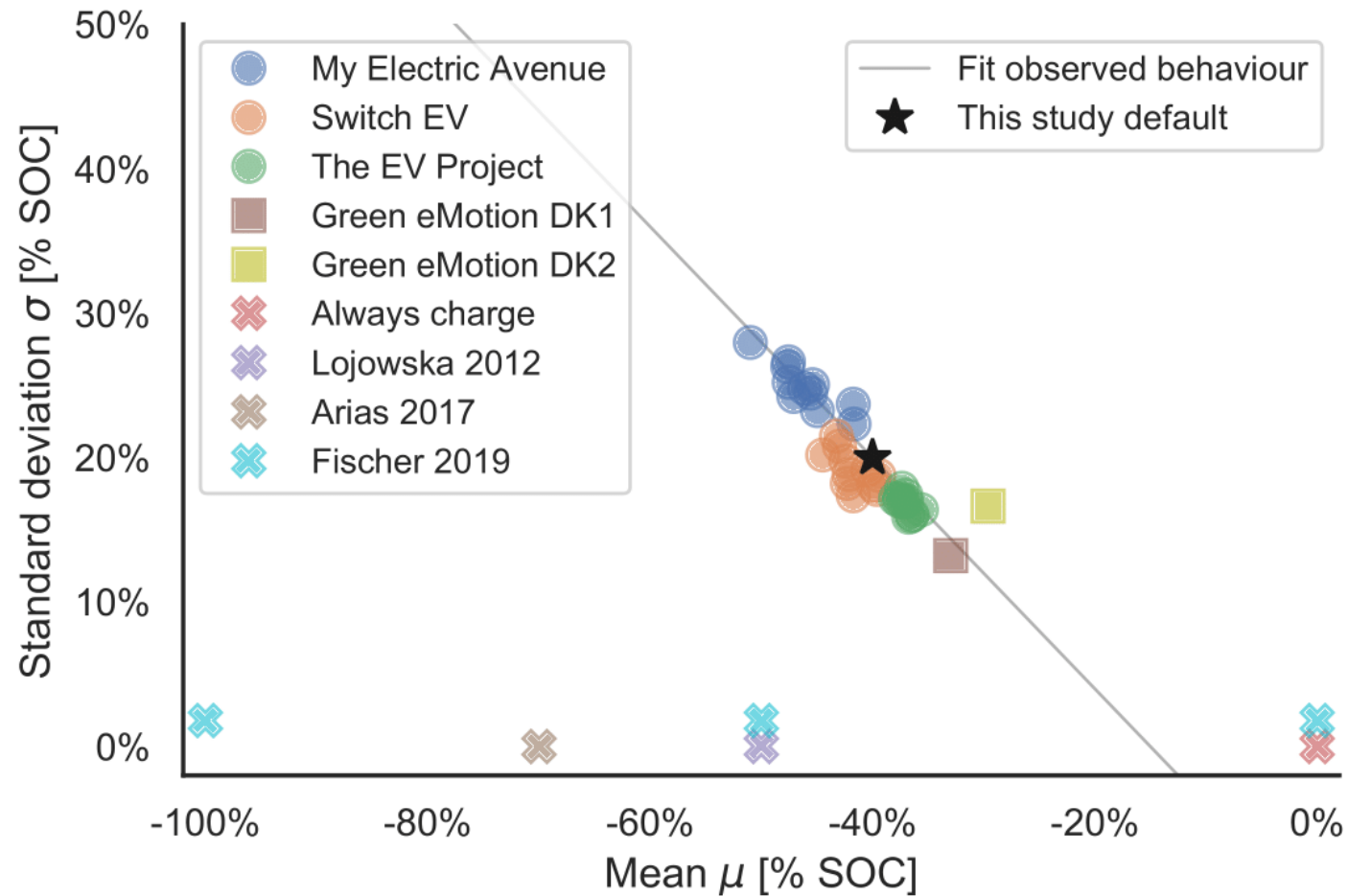


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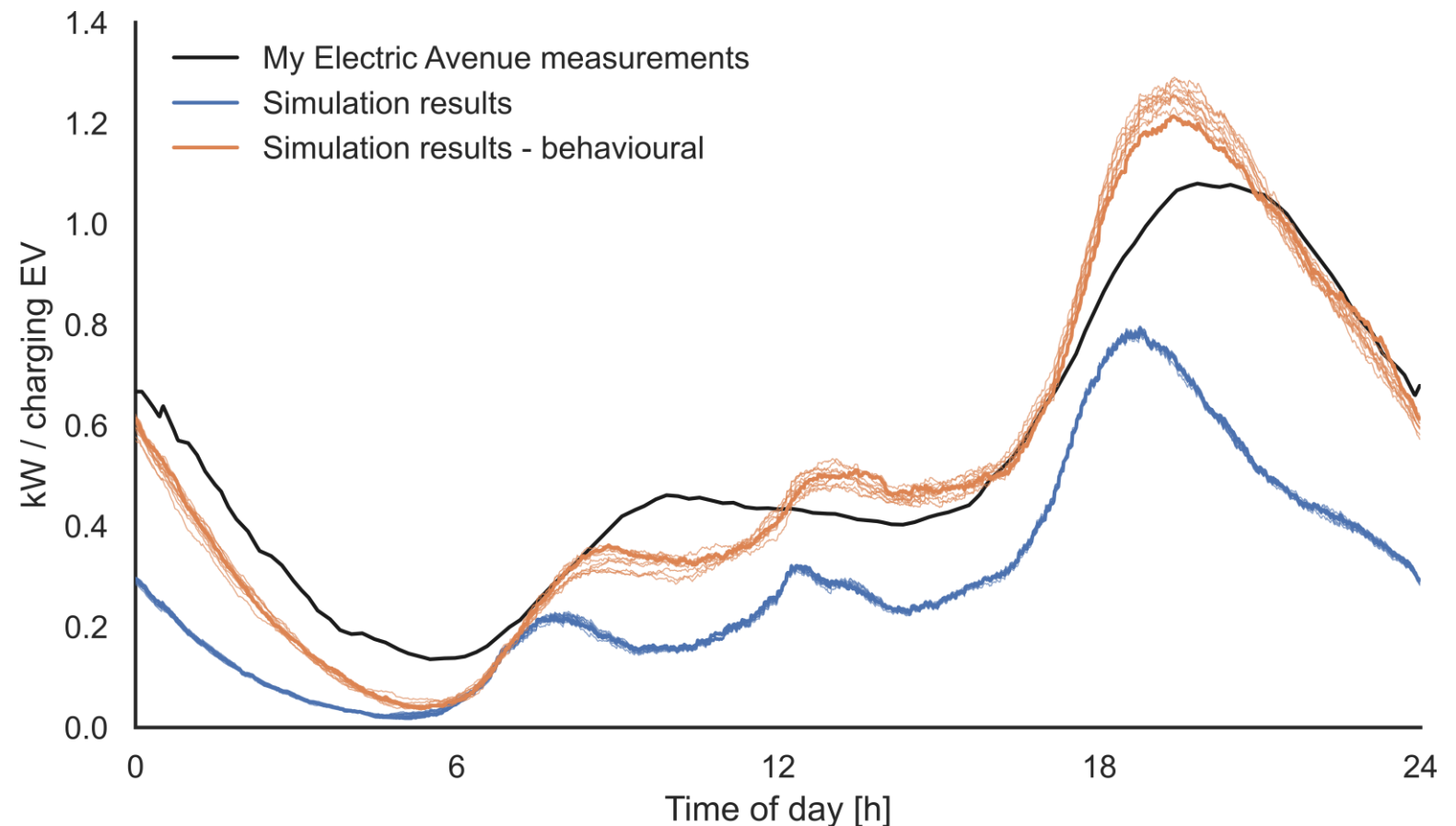


# Empirical charging behavior:



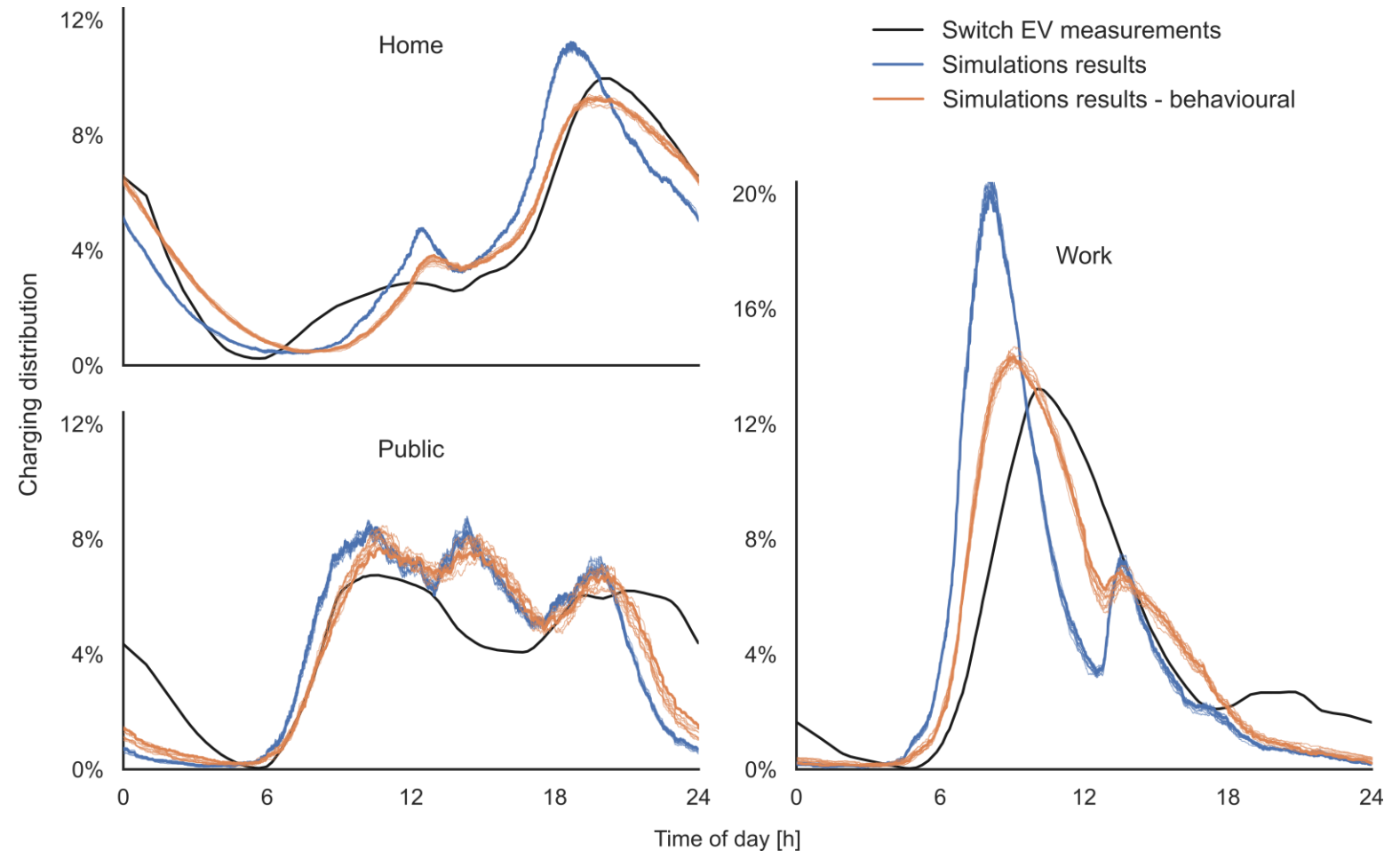
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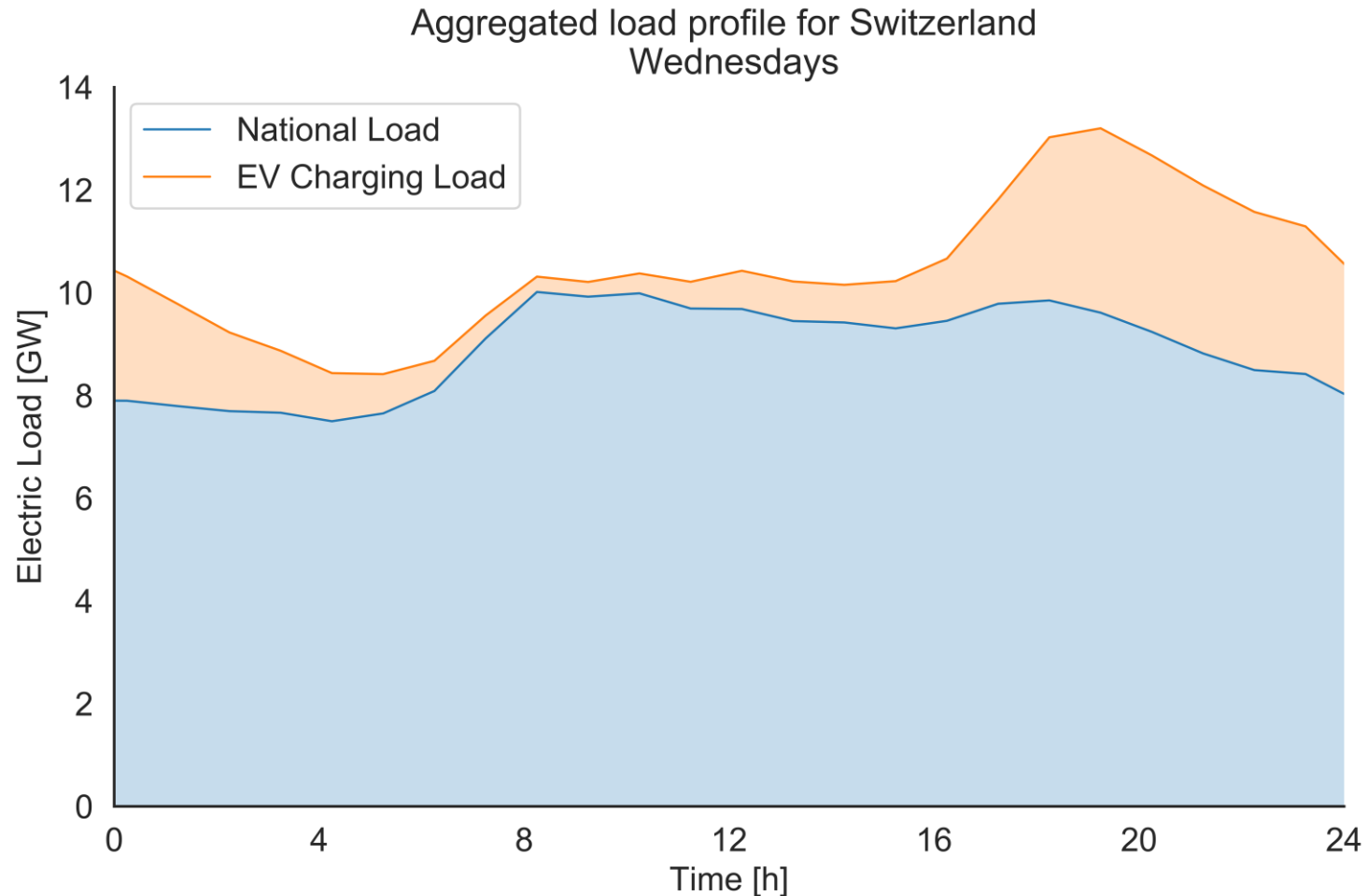
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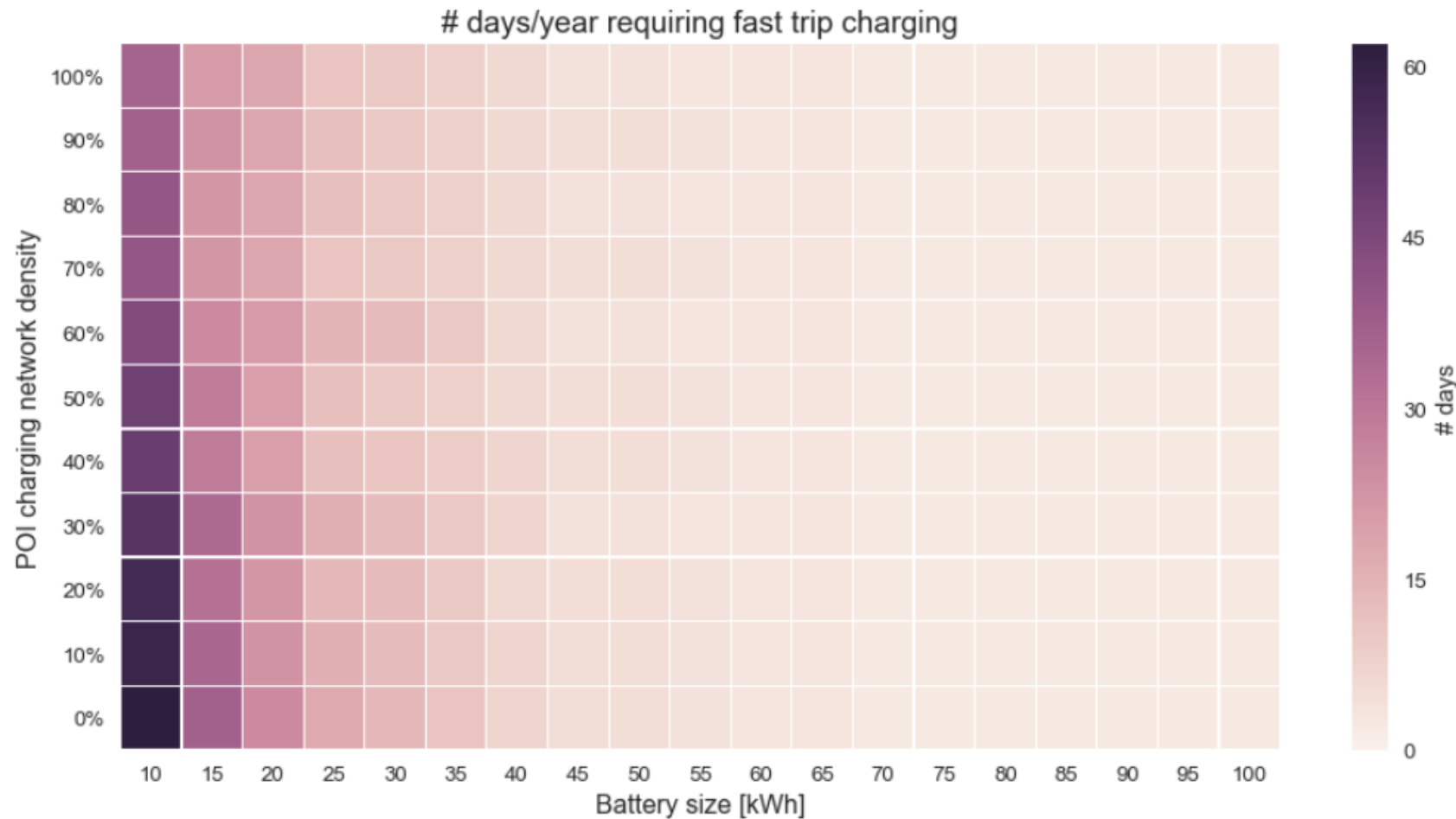
# A glimpse of the applications

- 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

