Building Up Demand-Oriented Charging Infrastructure for Electric Vehicles in Germany

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Tamer Soylu, John Anderson, et al.

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LADEN2020

Objective:

- Development of a systematically comprehensible and consistent strategy to build a charging infrastructure for E-Vehicles in Germany.
- Main assumption: **1 Million** registered E-Vehicles by 2020.

Projekt Partners:

- DLR
  - Insitut für Fahrzeugkonzepte (FK)
  - Institut für Verkehrsforschung (VF)
- KIT
  - Institute for Transport Studies (IfV)

Funding Institution:

- Federal Ministry for Economic Affairs and Energy

Long-distance travel – Charging infrastructure

Long Distance Travel – Charging Infrastructure: Methodology

- Usage patterns of conventional vehicles
- Trip length distributions of long distance trips by car
- Calculation of different travel demand levels with respect to temporal effects (different days of the week, holidays etc.)

Car use model of conventional vehicles in LD-travel

- Spatial as well as temporal resolution and distribution of travel demand
- Network characteristics
- Assignment of the total demand for charging on the LD-network (no commuting)

Traffic Assigment on a network model

- Scenarios for the future fleet of electric vehicles (shares of BEVs / PHEVs, etc…)
- Vehicle and charging infrastructure characteristics (ranges, capacities of batteries, charging durations, charging currents, …)

Characteristics of future Electromobility

Estimation of the charging demand and spatial assignment of charging infrastructure

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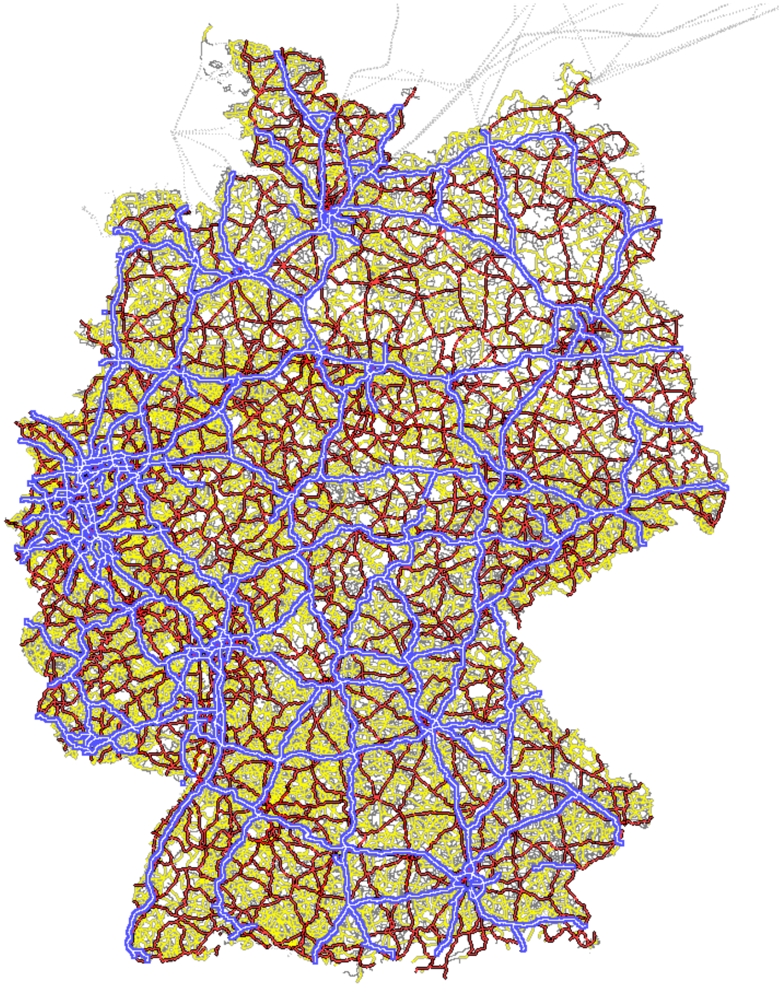
Car Usage Patterns and Long Distance Travel Demand

Network and Traffic Model

Data:

- VALIDATE (PTV Group) fine-scaled zone and network-model
  - about 10.000 traffic zones
  - about 2 Mio. nodes

- Demand on **workdays (Tuesday – Thursday)**
  - ca. 120 Mio. car-trips
  - ca. 8 Mio. O-D-relations



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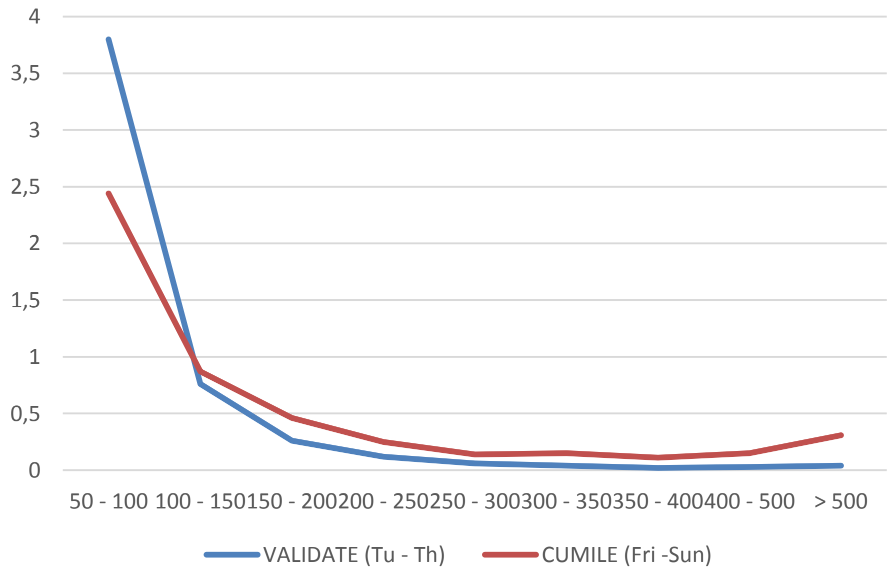
Car Usage Patterns and Long Distance Travel Demand

- Effects of seasonality on travel demand (Weekday vs. Weekend):

Trip Length Distribution on Weekdays and Weekends – Results of two different data sources



Input data for Travel Demand Modelling:

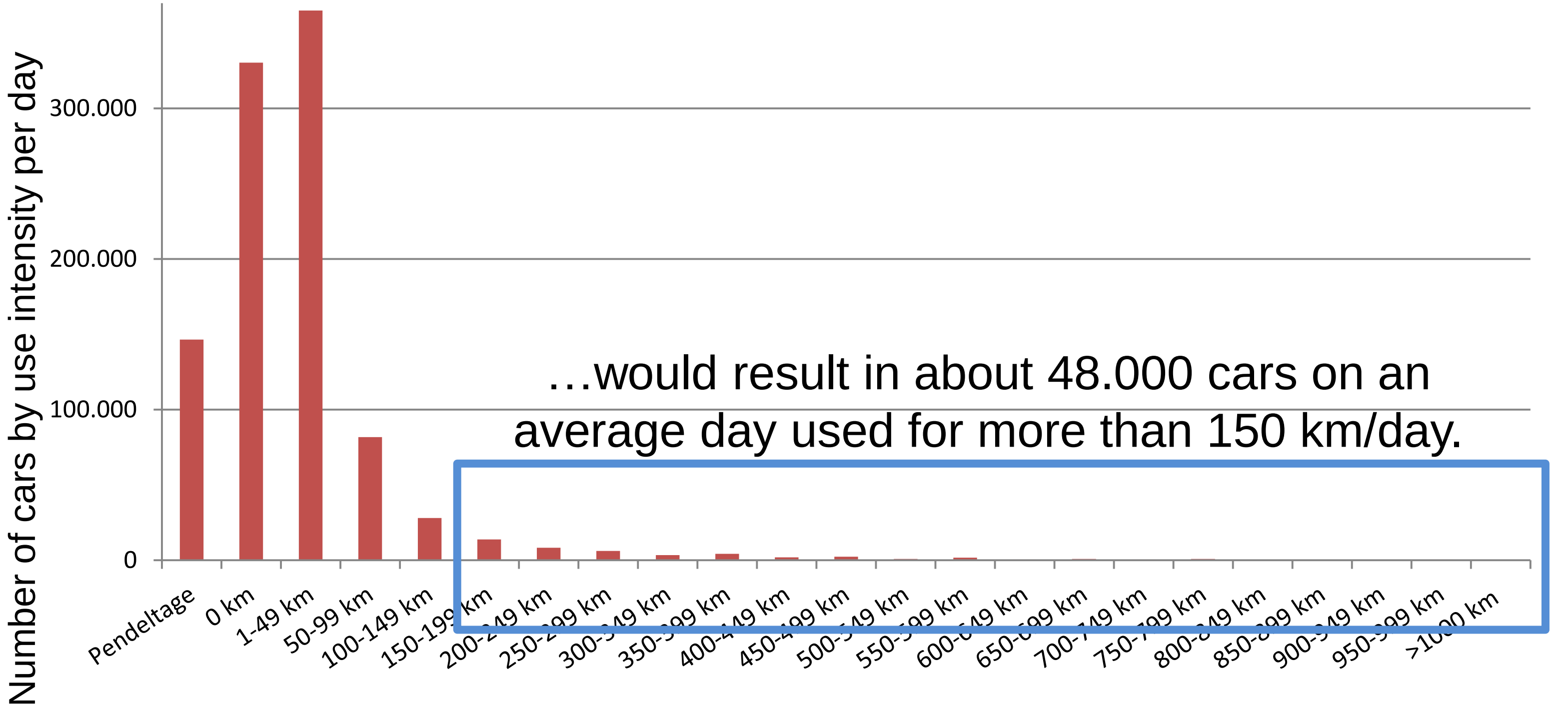
- Trip Length distributions from:
  - VALIDATE, MOP and CUMILE
- Different temporal resolution

Solution:

- Scaling factors for the demand on weekends and holiday seasons are calculated

Car Usage Patterns and Long Distance Travel Demand

- 1 Million EV within German car fleet - assuming a usage behaviour like „conventional cars“*.



*** Based on the CUMILE- Model (Car Usage Model Integrating Long Distance Events) developed in KIT – IfV.**

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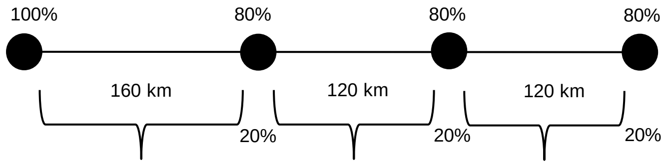
Determining Charging Demand and Allocation of Infrastructure

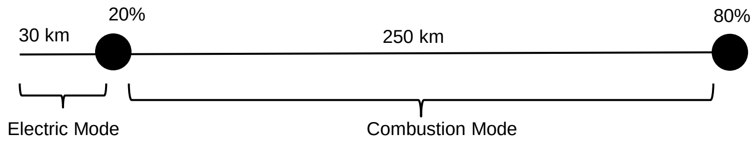
- **Input data:**
  - Assumption: 1 Mio. E-vehicles (1/3 BEV, 2/3 PHEV)

- **Assumptions:**
  - BEV: 200 km range
  - PHEV: 40 km electric range
  - State of Charge (SOC): 100 % at start
  - Recharging required at 20 % SOC
  - Fast charging up to 80 % of capacity within 30 minutes

  - **BEV:**

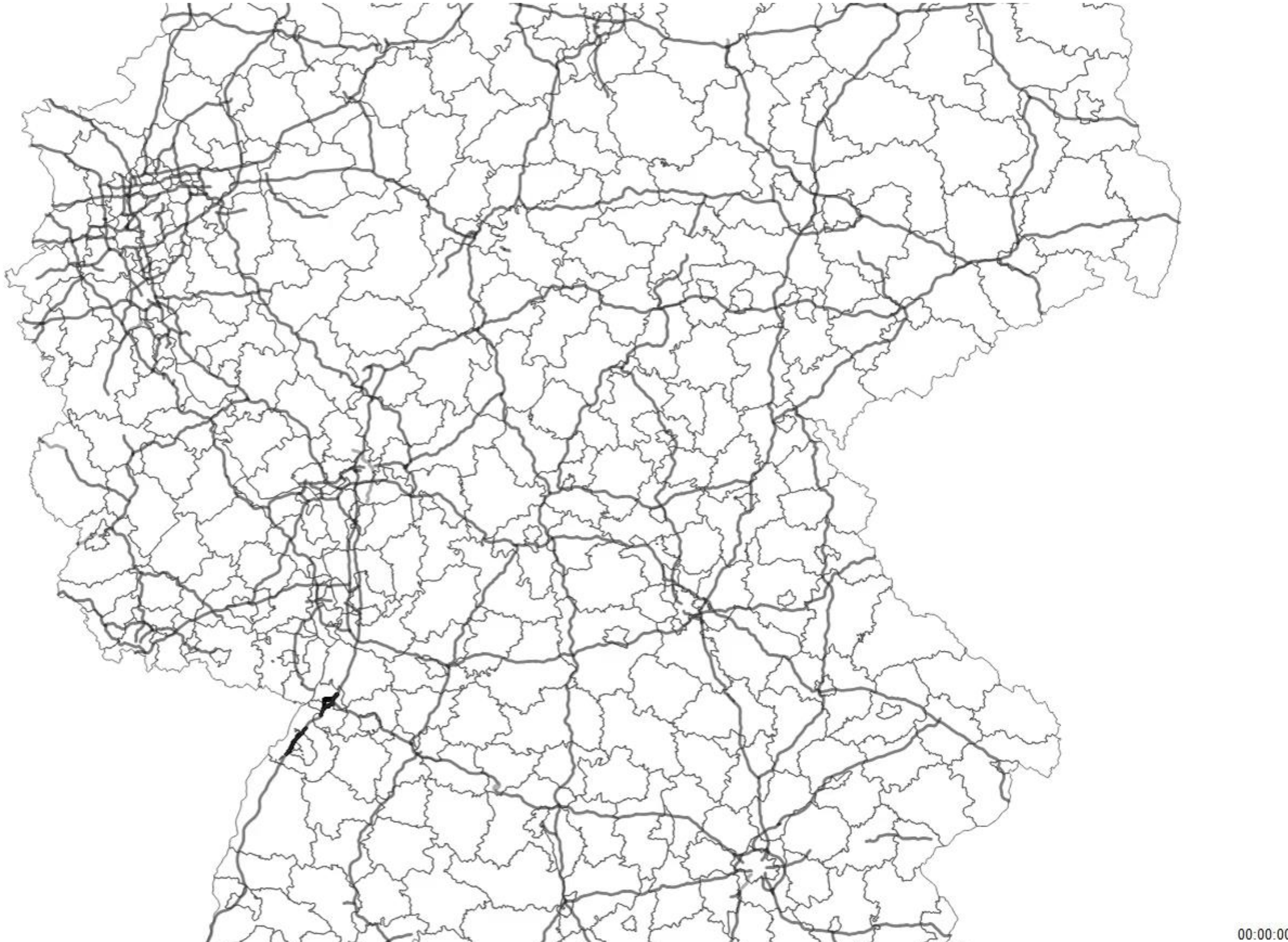


  - **PHEV:**



Determining Charging Demand and Allocation of Infrastructure

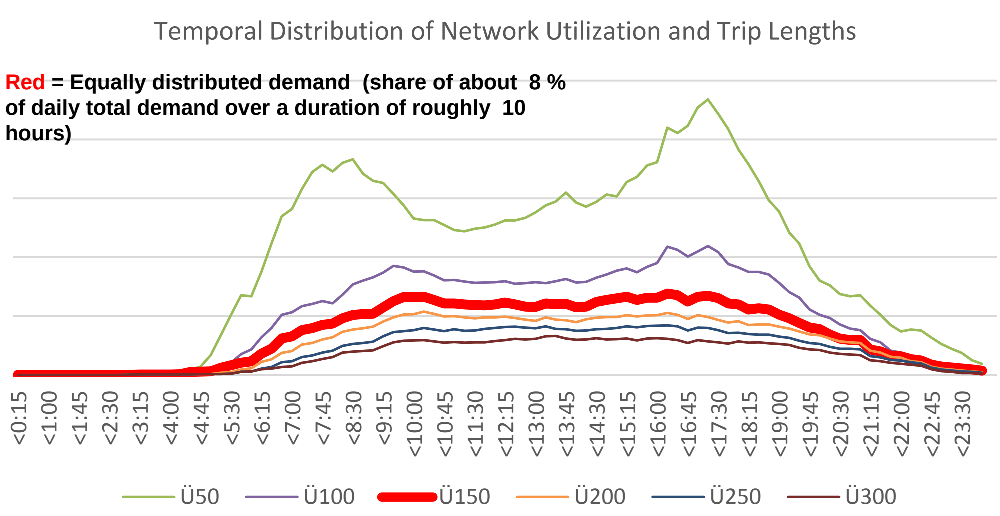
- Simulation

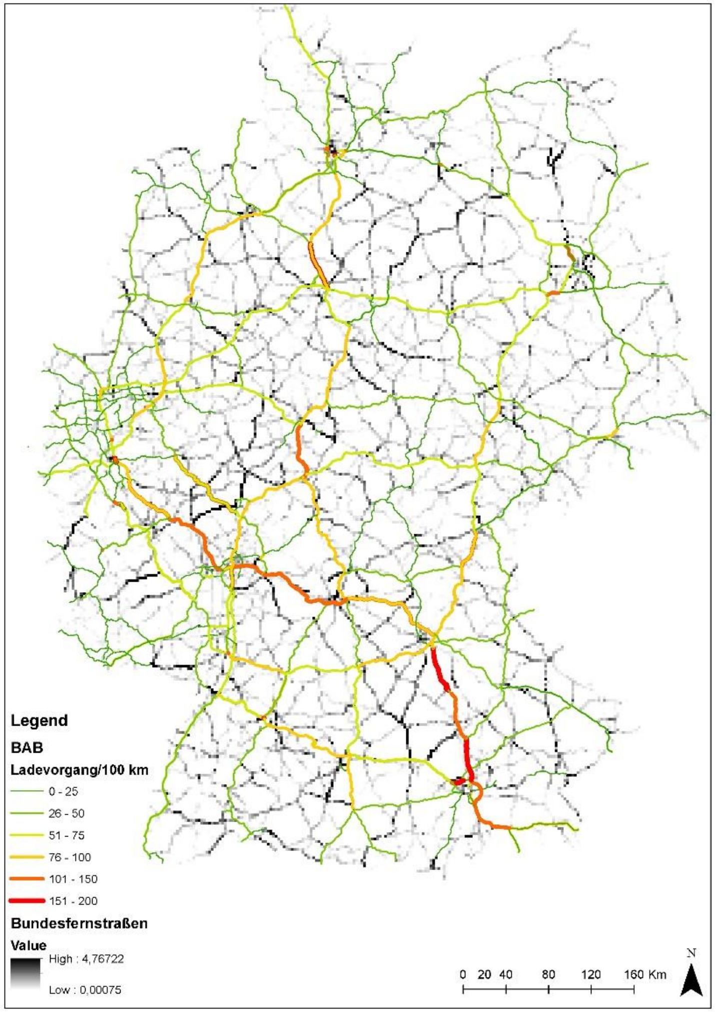


Determining Charging Demand and Allocation of Infrastructure

- Translation of Charging Demand into Infrastructure Demand:

- Illustration of Charging Events as Charging Density:
  - $CD = \frac{\#\ Charging\ Events}{100\ km}$





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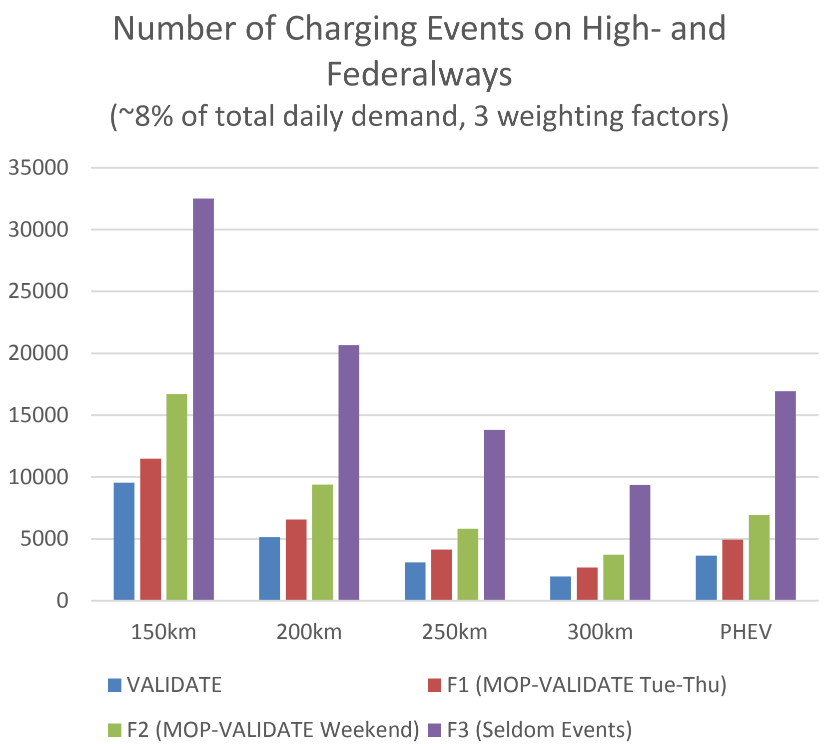
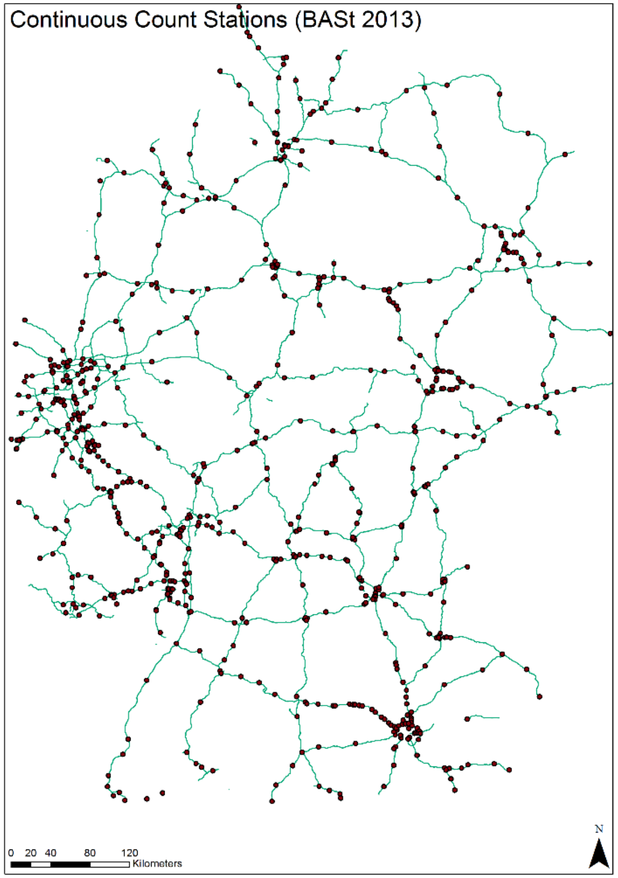
Determining Charging Demand and Allocation of Infrastructure

- Effect of various BEV Ranges on infrastructure demand:



- Continuous Count Stations and Annual Profiles



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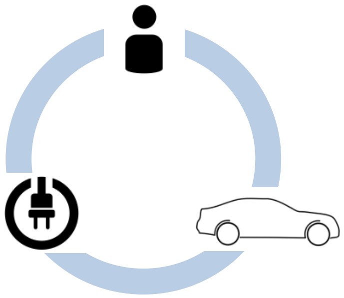
Daily travel – Charging infrastructure

Daily travel – Charging infrastructure: Methodology

Assumptions

- Mass market by 2020
- Charging occurs when cars park
- No change in activity and travel patterns



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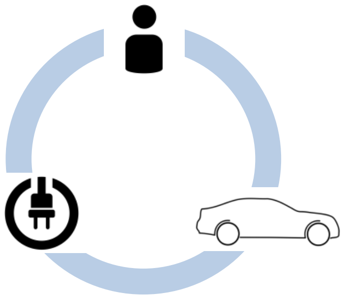

16,000 x ICE (MiD 2008, KiD 2010) → 16,000 x PHEV / 16,000 x BEV → **Vehicle trip diary** → **Charging algorithm** → **1 million EVs** → **Charging demand**

Charging algorithm: Preference, location, accessibility, speed, daily travel

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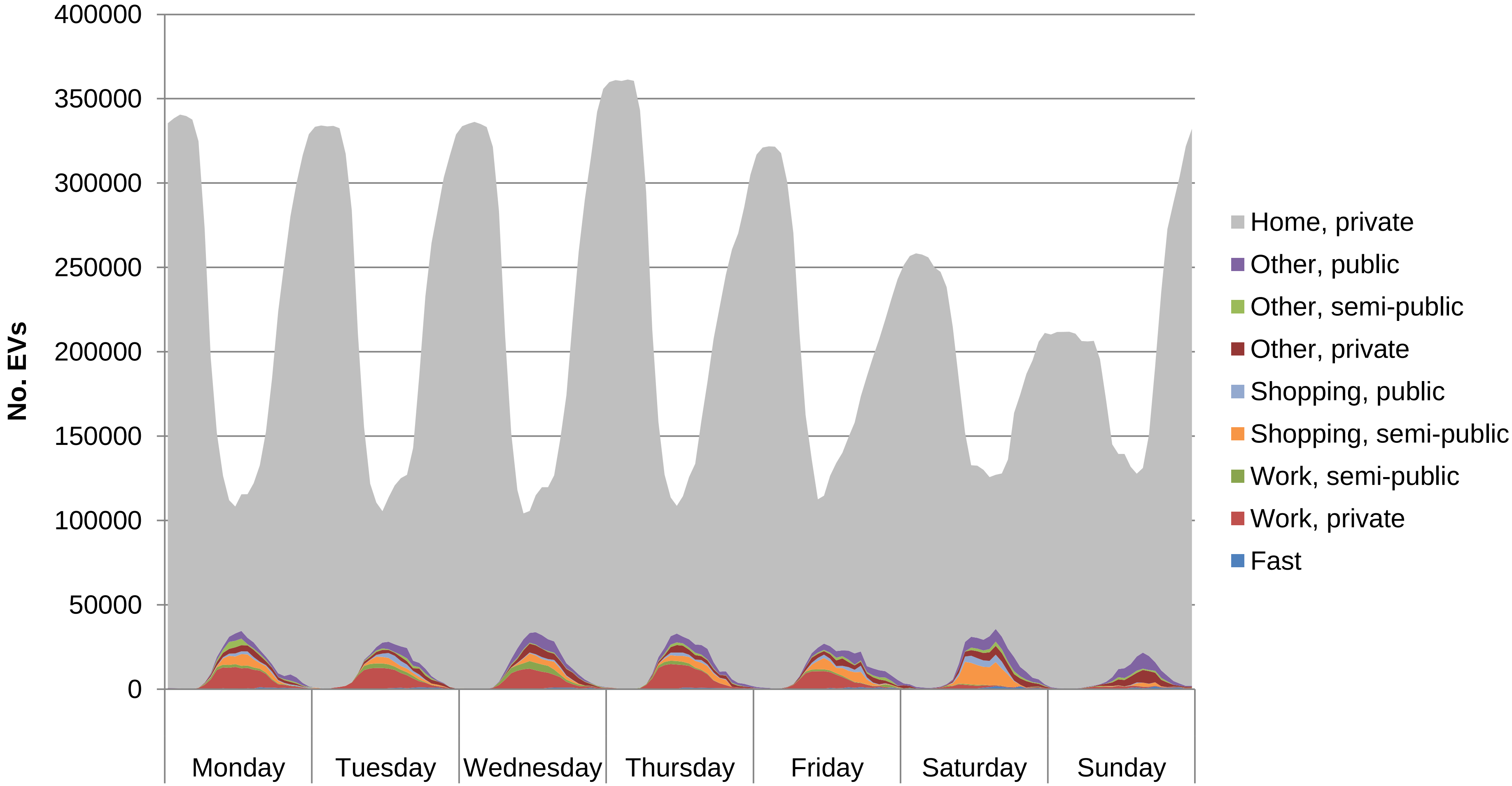
Results: Occupancy of charging infrastructure by EVs throughout the week



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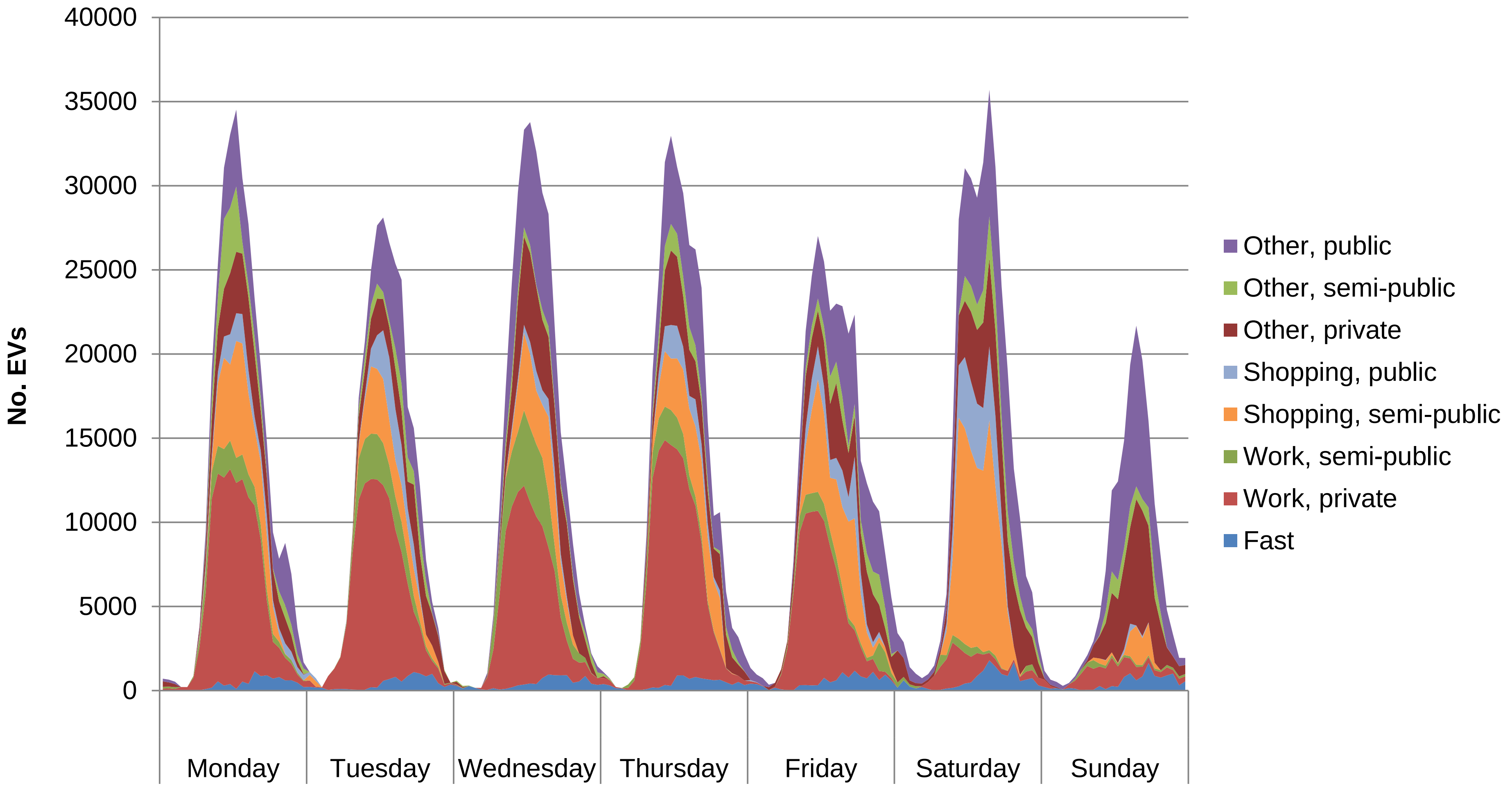
Results: Occupancy of charging infrastructure by EVs throughout the week – absent home charging



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Scenario comparison:
Reference scenario and sensitivity analysis

Number of charging points (values in 1,000)

Speed	Location	Reference Scenario	667,000 BEVs 333,000 PHEVs	Charging at home & work	Range +50%: BEV 300 km PHEV 60 km
Normal	Semi-public	22	14	13	17
Normal	Public	14	9	69	12
Fast	Daily travel	2	4	1	1
Fast	Long-distance travel	3	5	3	2

Karlsruhe Institute of Technology
Institute for Transport Studies
Tamer.Soylu@kit.de

German Aerospace Center
Institute of Transport Research
John.Anderson@dlr.de