ADAPTRICITY
Planning Smarter Grids

Grid Impact Assesment of E-Mobility

SCCER Mobility Annual Conference 2019

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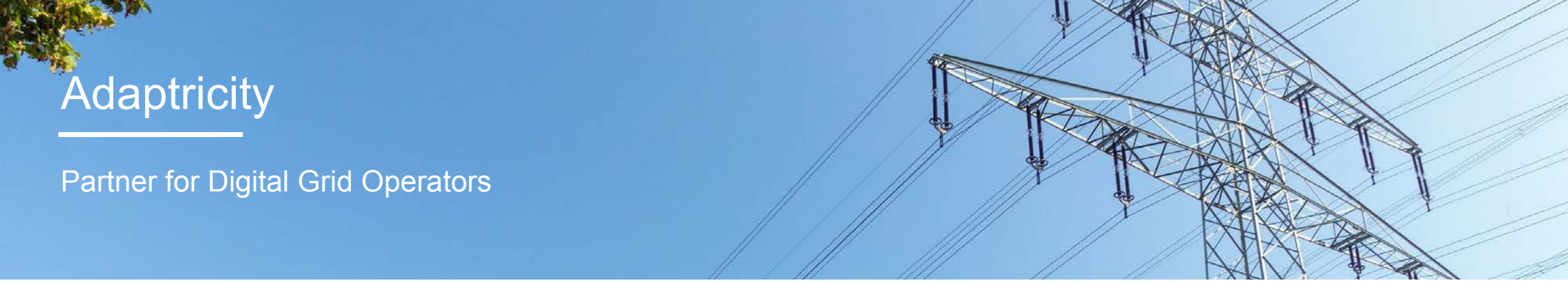
Spinoff ETH zürich



Adaptricity

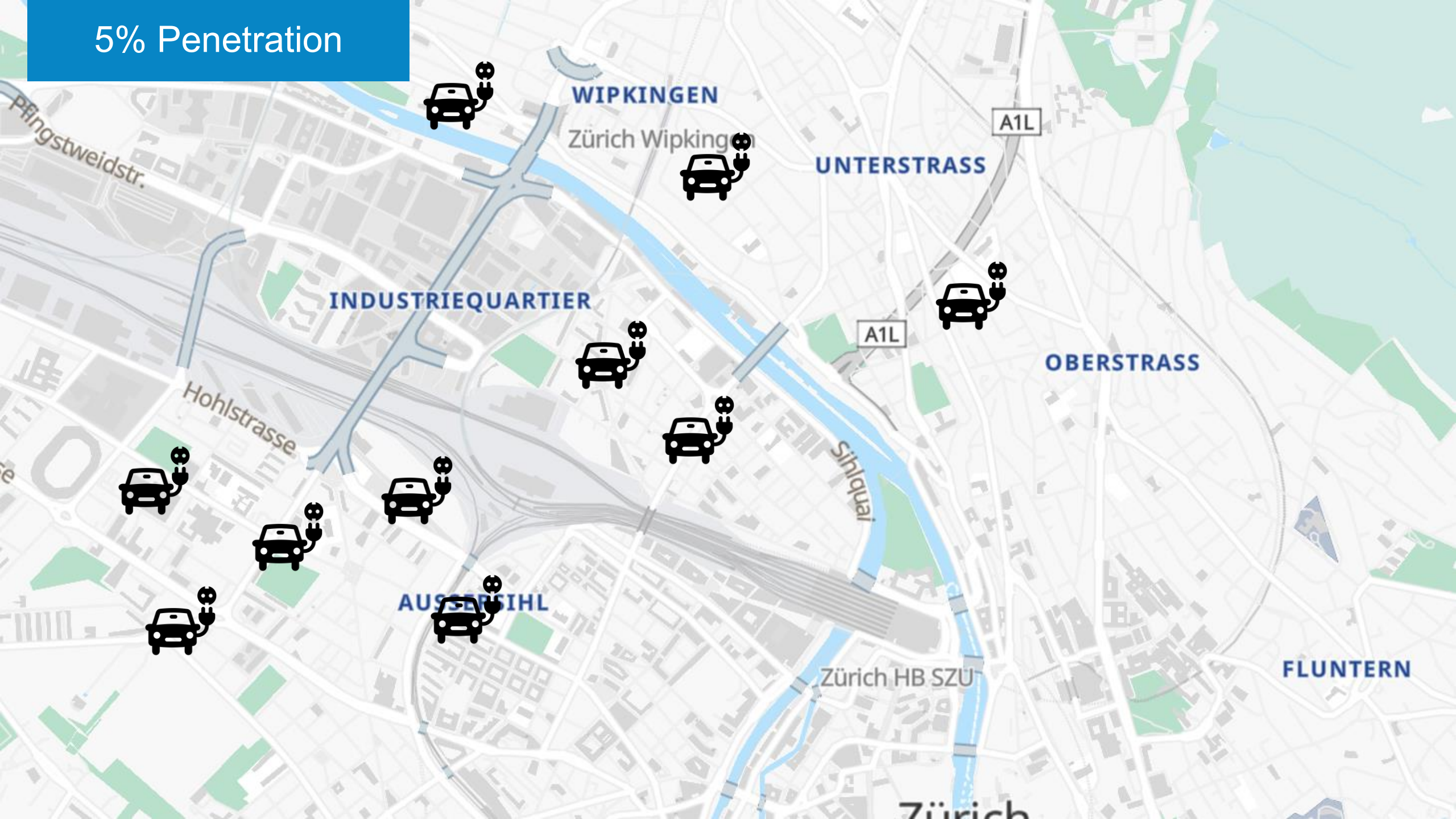
Partner for Digital Grid Operators

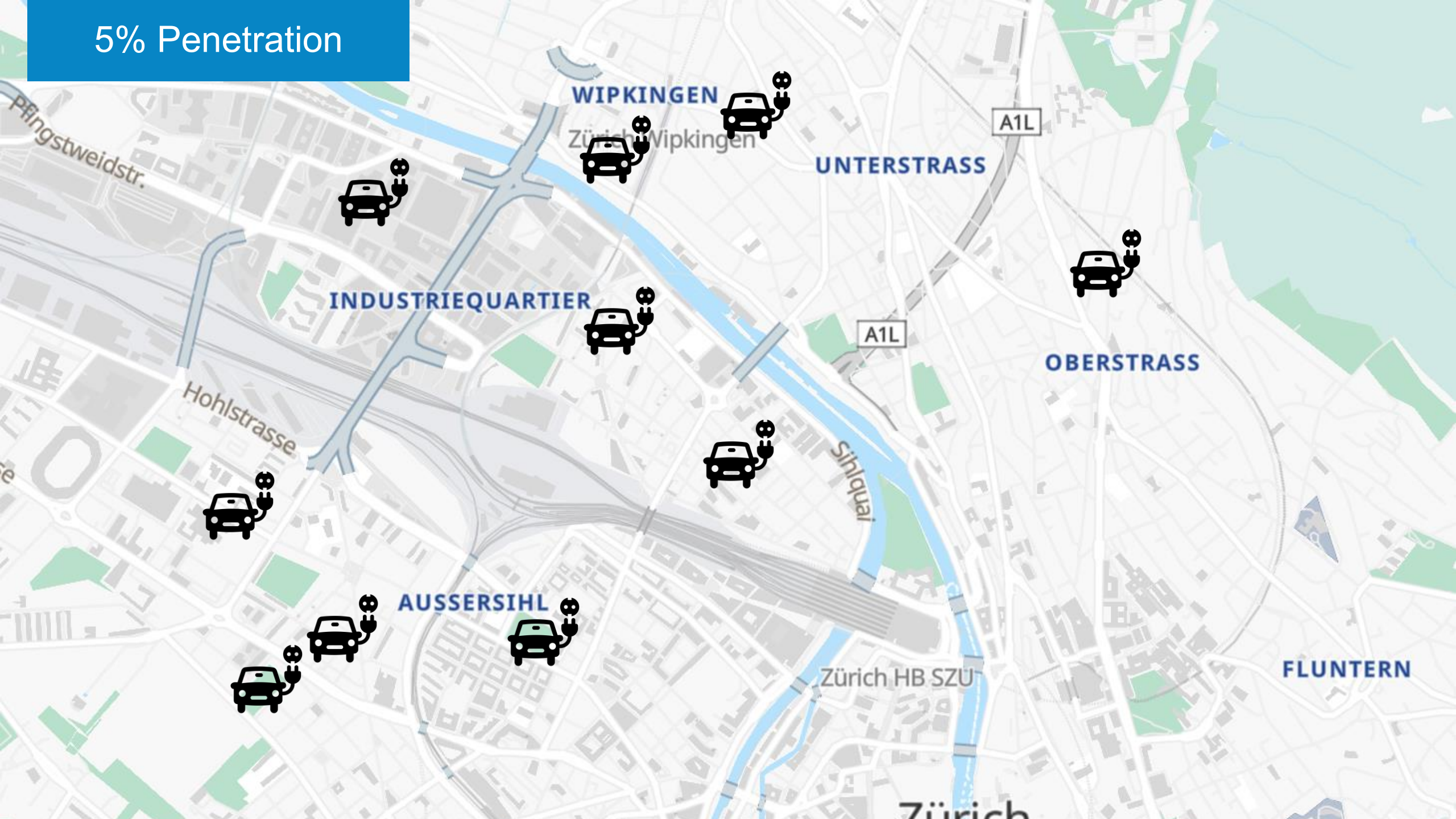
Spinoff ETH zürich

March 2014	**Founding Vision** – Digital & Efficient Power Grids
Since 2014	**Strong Growth** in DACH Area with 50+ customers
Feb. 2017	**Majority Acquisition** by LEONI Group (85'000 employees)
Nov. 2017	**Swiss Technology Award** – Finalist (Top 3)
Since 2018	**Market Expansion:** Europe, Asia & Australia
	dena Startup Award 2018 & 2019 – Top 100
	Free Electrons – Global Energy Accelerator (Top 15 of 500+)
	CIRED 2019 Startup Award | Asian Utility Week 2019 Innovate Award
Today	**Reliable Partner** for Grid Planning, Asset Management and Digitization

bayernwerk NETZOÖ Ein Unternehmen der Energie AG Schleswig-Holstein Netz Netze Mittelbaden AusNet services CLP 中電 STADTWERK WINTERTHUR

5% Penetration




5% Penetration
WIPKINGEN
Zürich-Wipkingen
UNTERSTRASS
A1L
Pfingstweidstr.
INDUSTRIEQUARTIER
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OBERSTRASS
Hohlstrasse
Sihlquai
AUSSERSIHL
Zürich HB SZU
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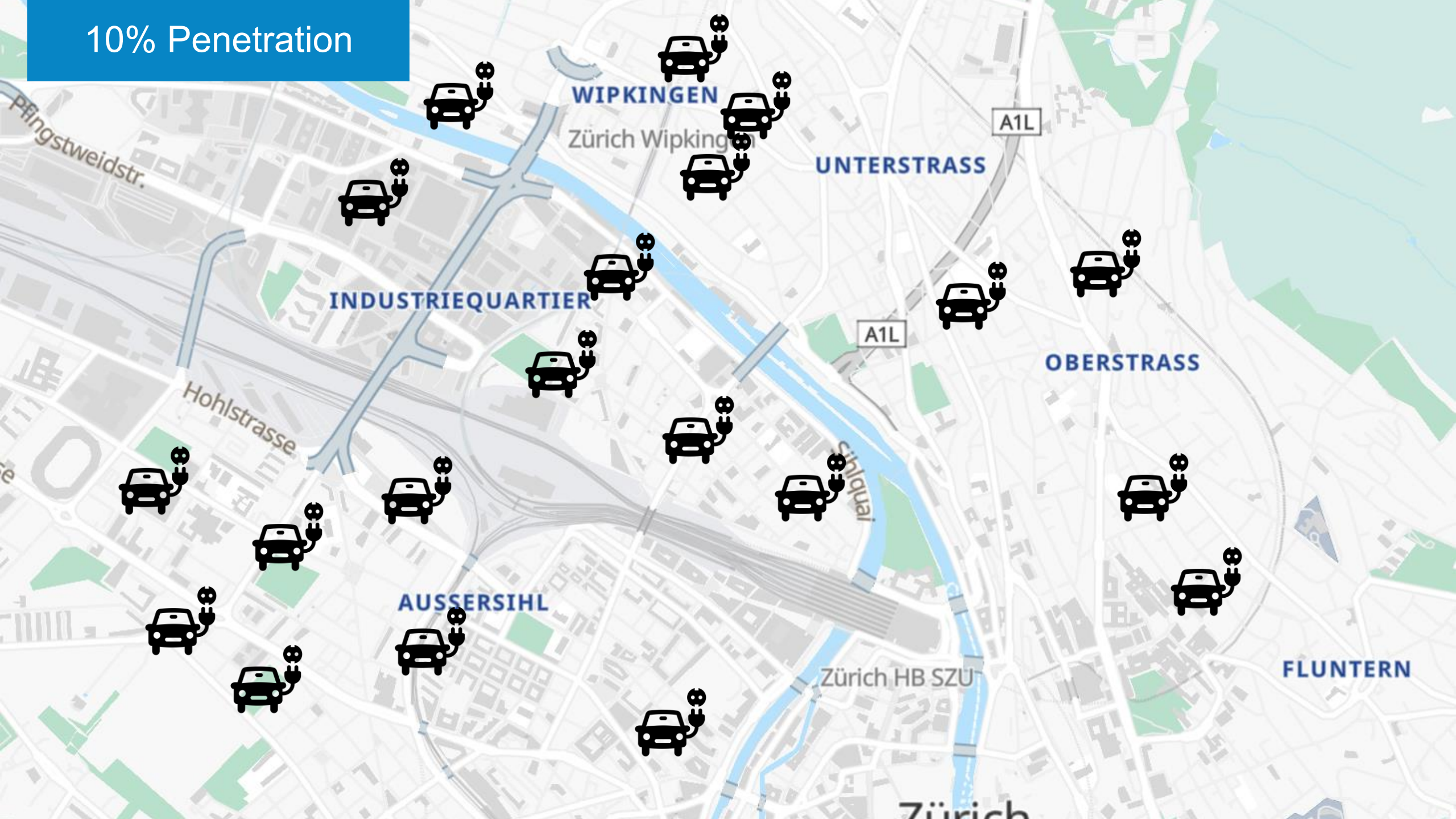
10% Penetration
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Zürich Wipkingen
UNTERSTRASS
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Sihlquai
AUSSERSIHL
Zürich HB SZU
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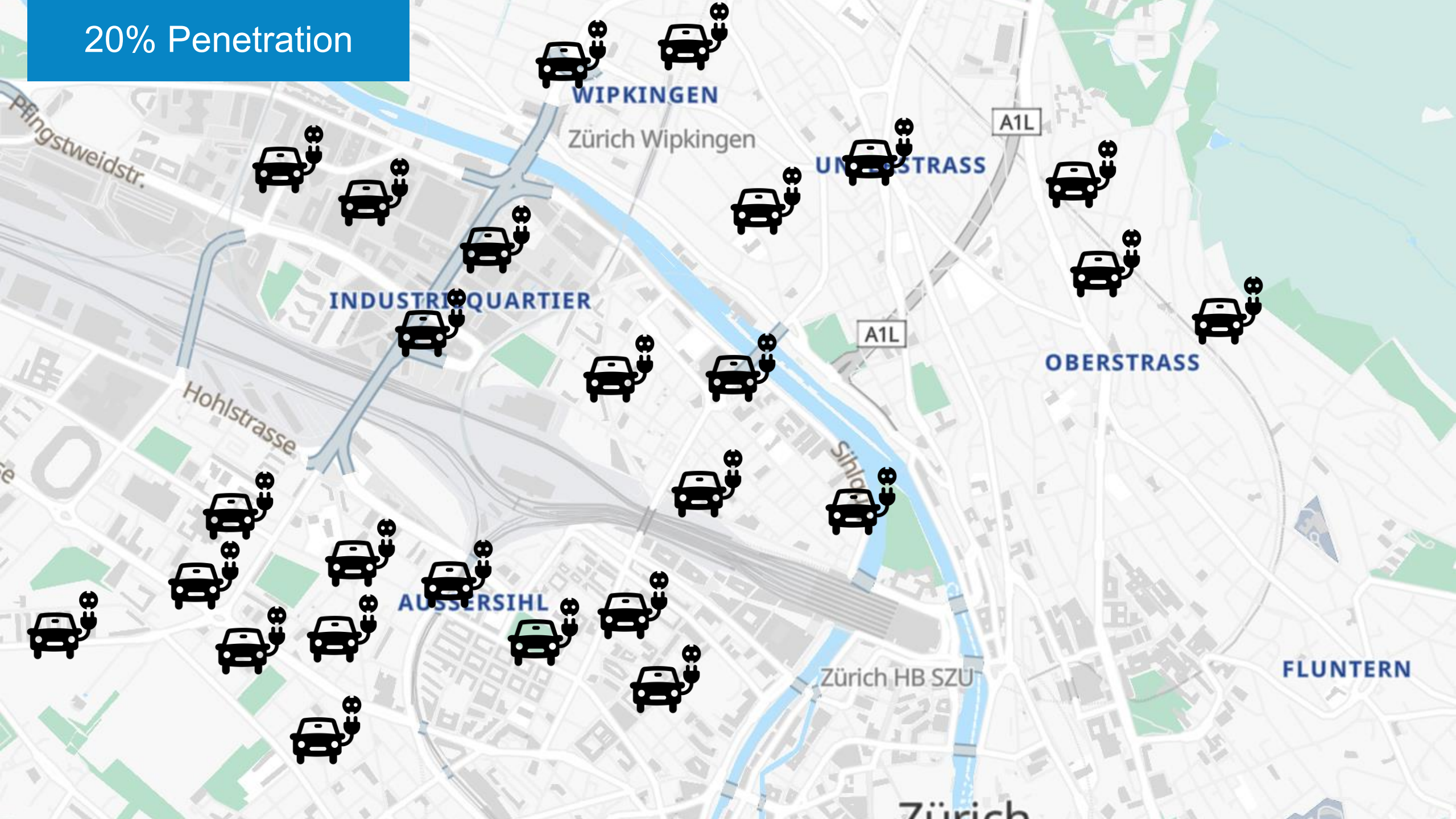
20% Penetration
WIPKINGEN
Zürich Wipkingen
Pfingstweidstr.
INDUSTRIEQUARTIER
Hohlstrasse
A1L
A1L
OBERSTRASS
AUSSERSIHL
Zürich HB SZU
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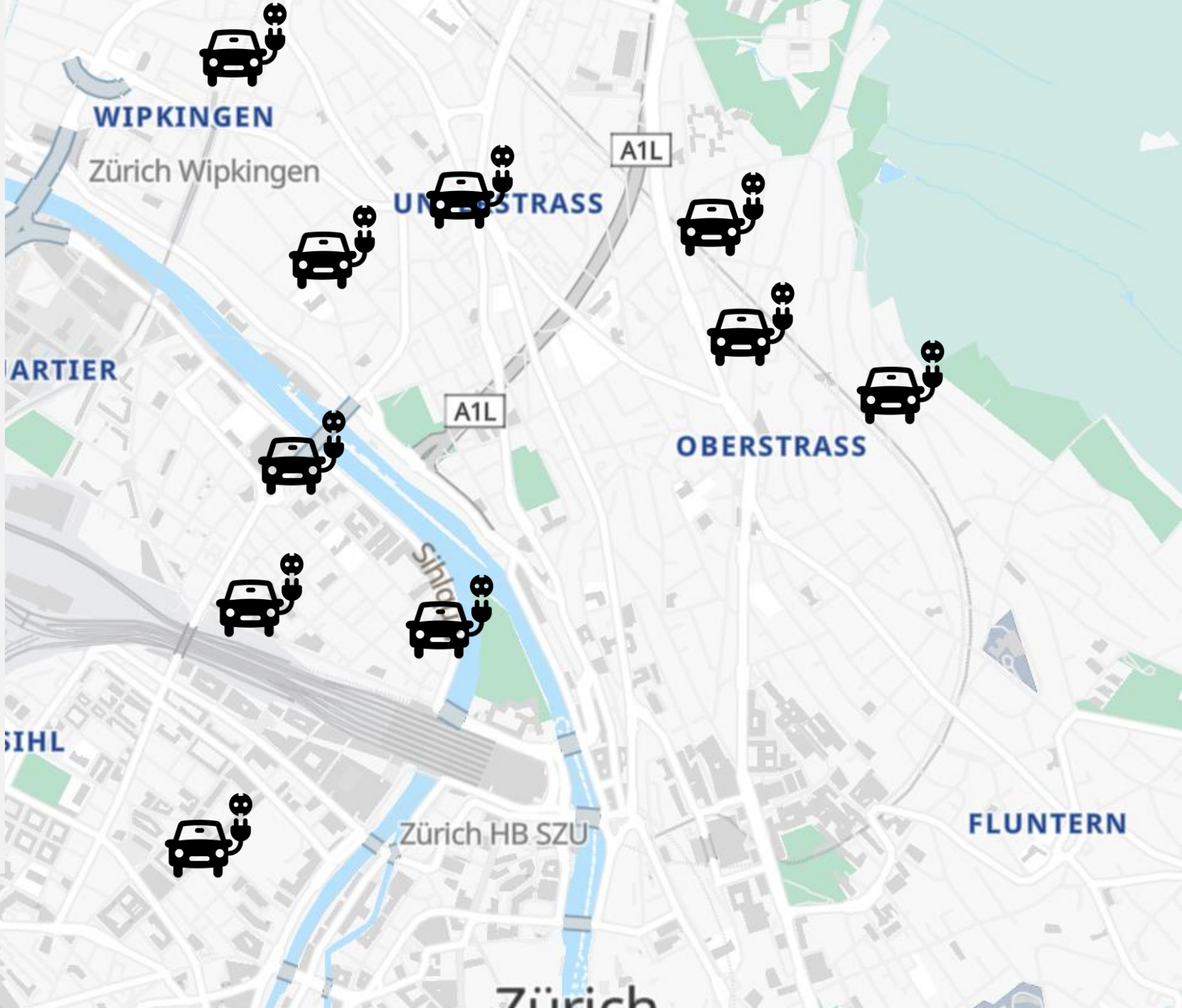
Robust Grid Impact Assessment of E-Mobility

Analysis

- At which EV penetration rate do grid overloadings occur?
- Which grid regions and components are most vulnerable to EV charging?
- What can be done today about (likely) future grid problems?

Goal: Useful Grid Upgrade Strategies

- Targeted investments into grid sensors and grid reenforcement
- Integration into existing long-term grid upgrade strategy



Use-Case: E-Mobility

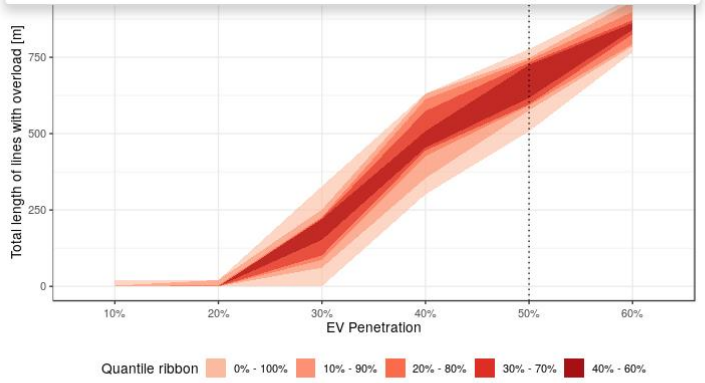
Robust Grid-Impact Assessment – Monte-Carlo-based Grid Analytics

- Single Scenarios
- Montecarlo Heat-pumps
- Montecarlo Electric Vehicles

EV behaviour

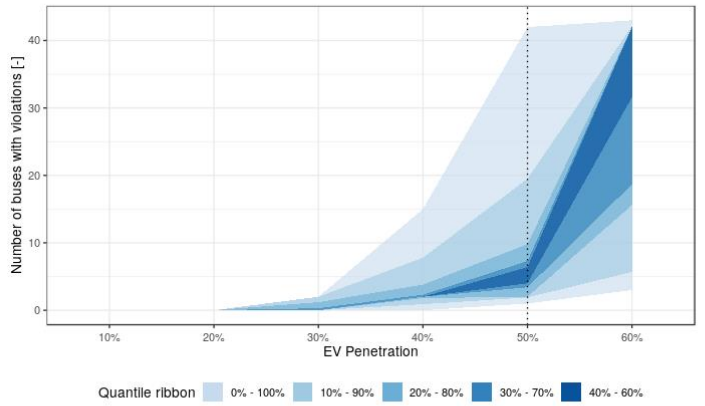
Model02: 11kW - High Coincidence

- Model01: 11kW - Low Coincidence
- Model02: 11kW - High Coincidence
- Model03: 3.7kW - High Coincidence

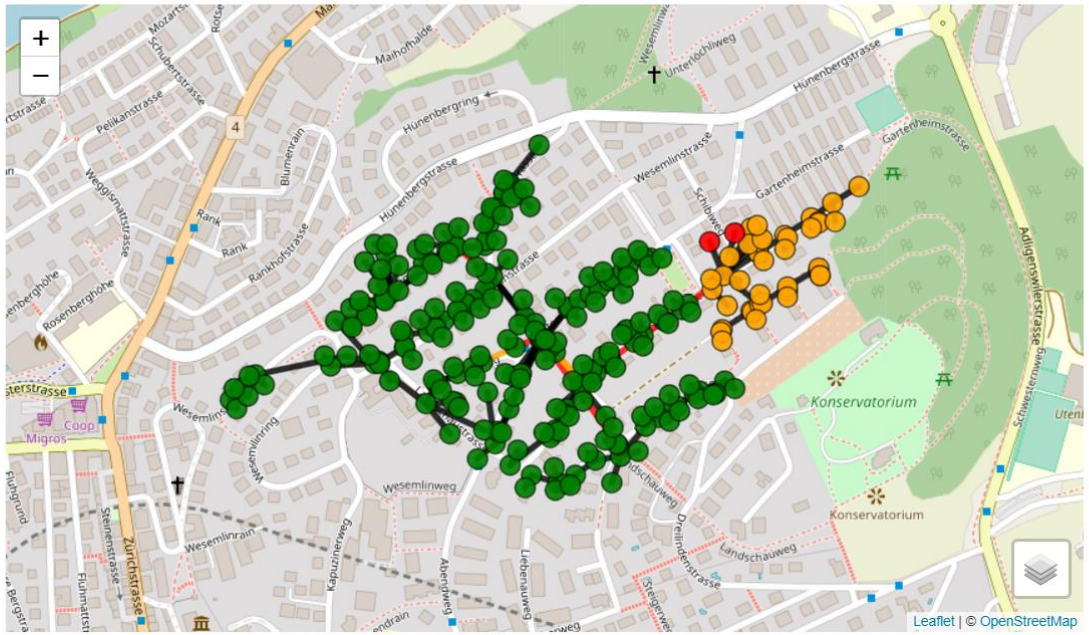


Bus violations

Total number of simulations: 60. Total number of buses: 298

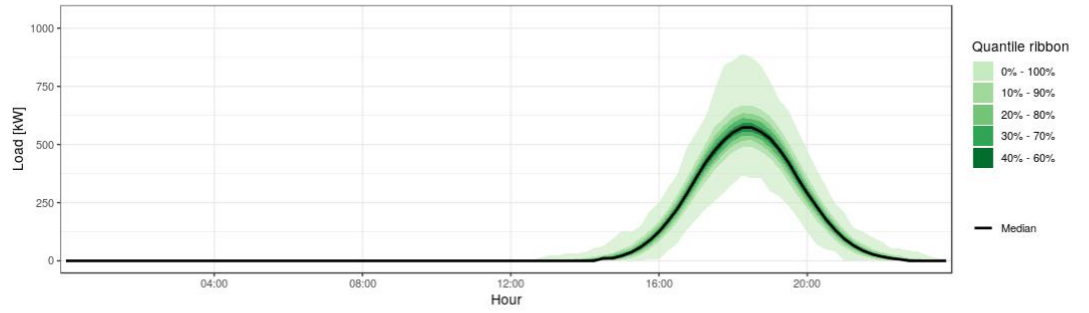


Map | Data Buses | Data Lines



EV load

Time window: 2016-11-01 to 2017-03-31



Scenarios | Legend

Legend

OK
0% scenarios have violations

Warning
1%-80% scenarios have violations

Problems
+80% scenarios have violations

Violation Line
Loading 100%+, 1+ timesteps

Violation Bus
Voltage outside 0.9-1.1 pu, 1+ timesteps

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Monte-Carlo-based Grid Analytics (Electric Mobility)

Sensitivity Analysis 1 (Lucerne) – Fragility to modelling choices across all components of a low-voltage grid (60 simulations)

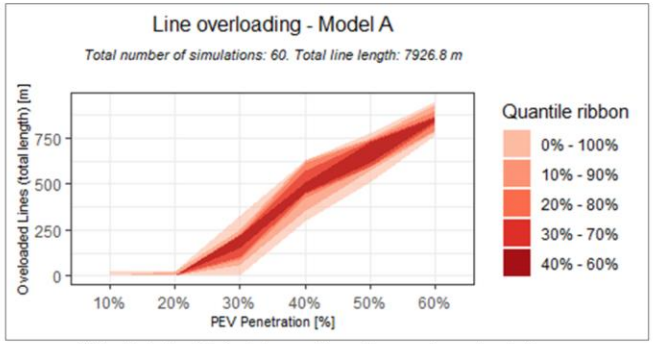
Modelling choices

EV modelling	Key Features
Model A (harsh)	11 kW, high charging coincidence
Model B (medium)	11 kW, low charging coincidence
Model C (mild)	3.7 kW, low charging coincidence

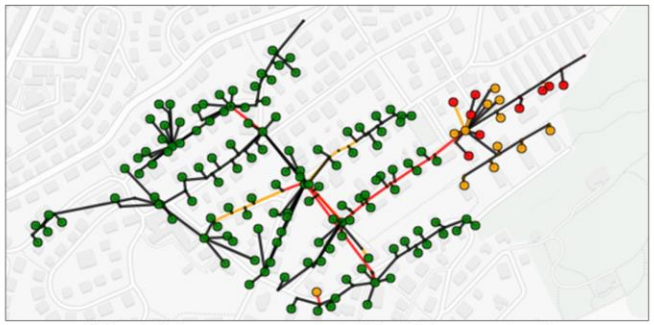
Legend

Color	Cases with violations
GREEN	0%
ORANGE	1% - 99%
RED	100%

Model A (harsh) – Heavy overload

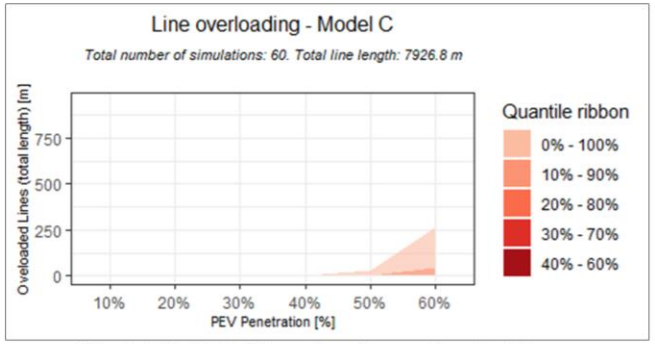


Model A: Total length of overloaded lines

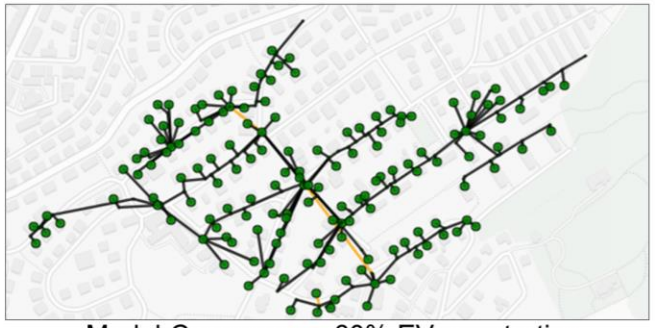


Model A: summary, 60% EV penetration

Model C (mild) – No problem

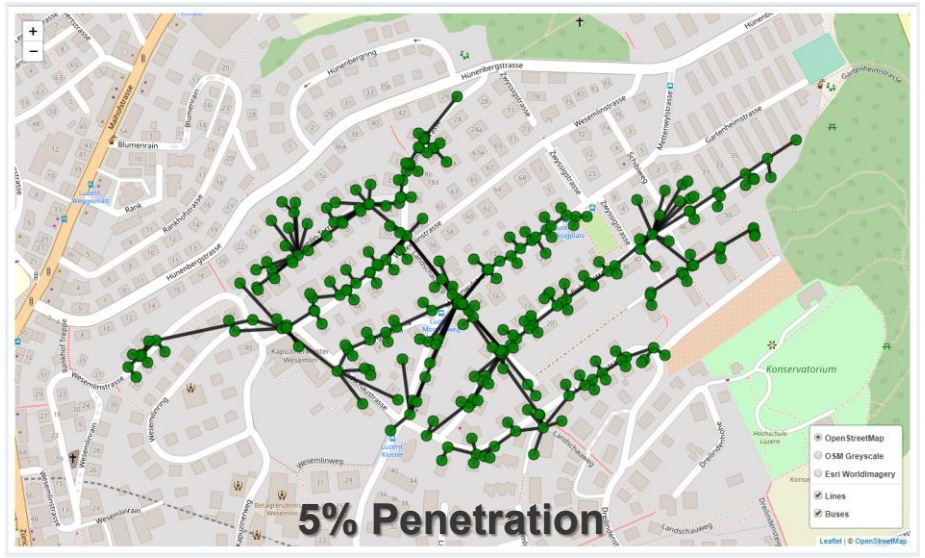


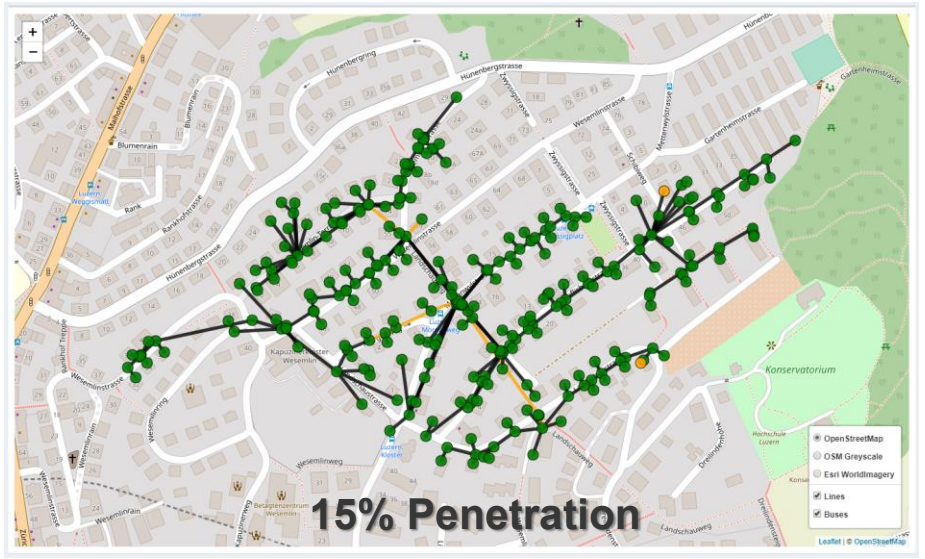
Model C: Total length of overloaded lines

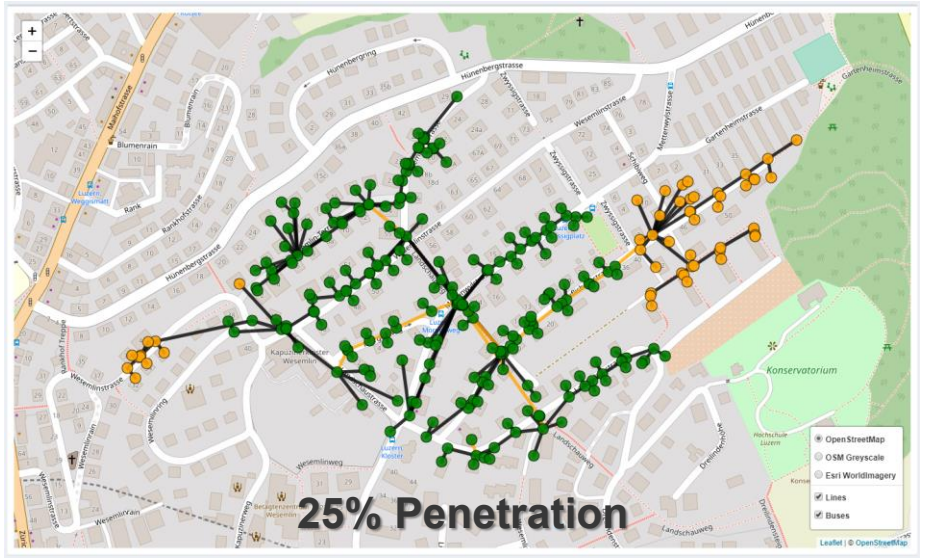


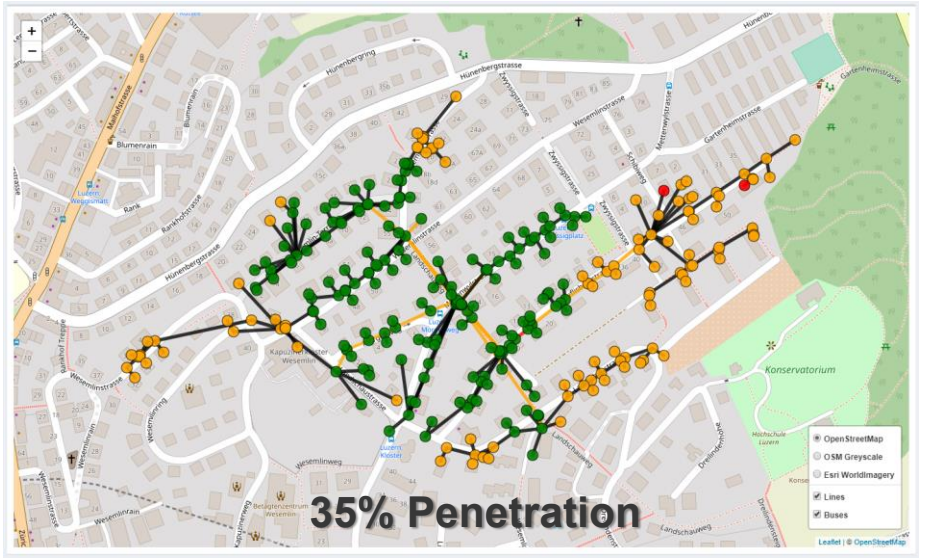
Model C: summary, 60% EV penetration

Monte-Carlo-based Grid Analytics (Heat Pumps)

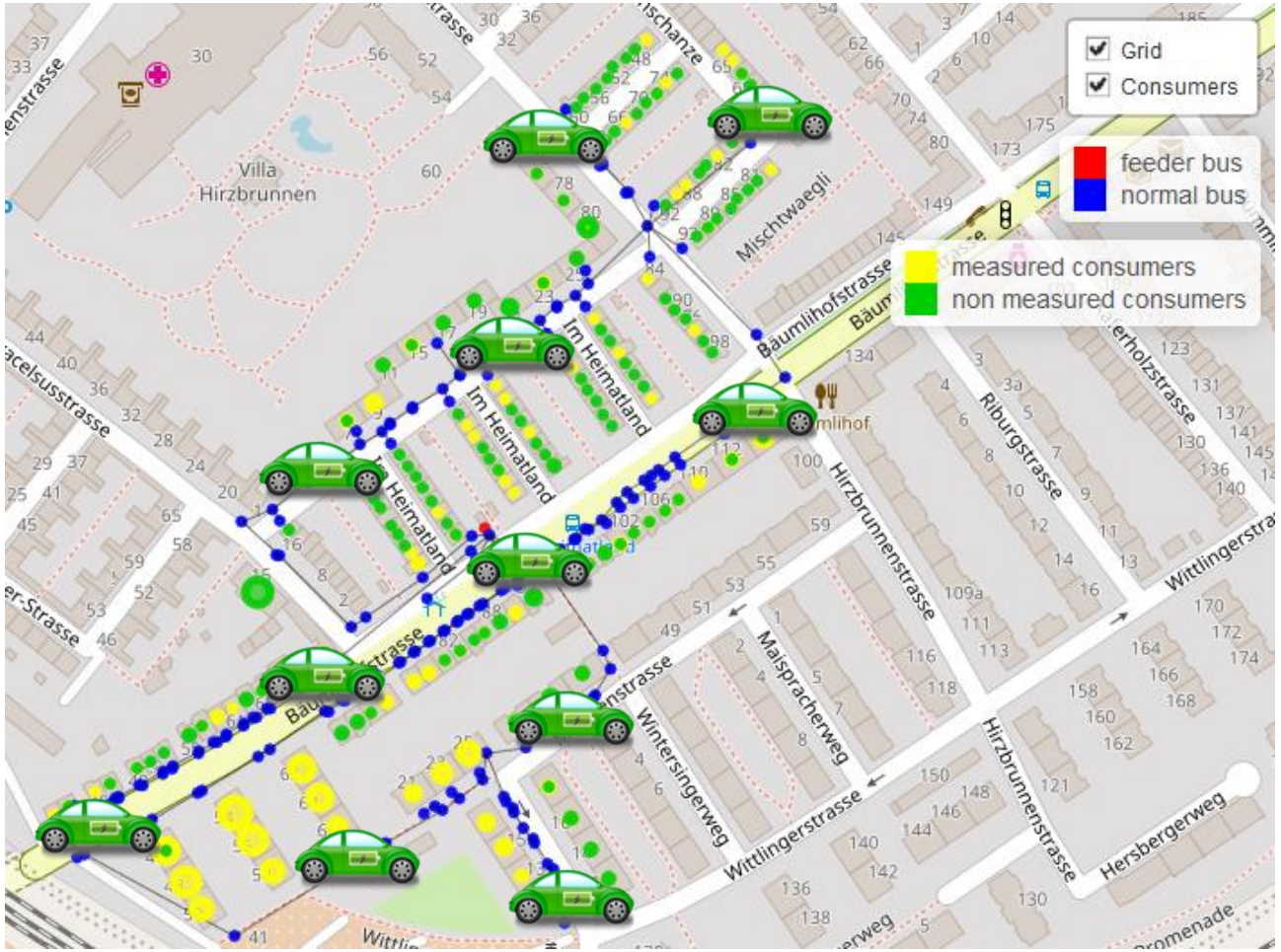








City of Basel – Modelling of Low-Voltage Grid + Electromobility



Case Study – Urban low-voltage grid in City of Basel

Sensitivity analysis of EV penetration to evaluate impact on low-voltage grid

- ➔ Level of penetration ?
- ➔ Location of EVs ?
- ➔ Modelling of charging behaviour (time series)?

Mobility Data

OR

Charging Measurements

From Mobility Behavior to EV Charging Profiles

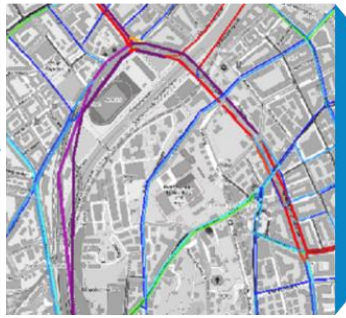
Sozio-ökonomische Daten

Infrastruktur

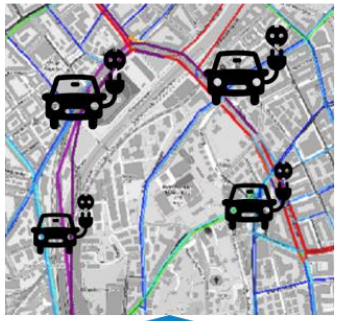
Mobilitätsmodus

Bewegungsmuster

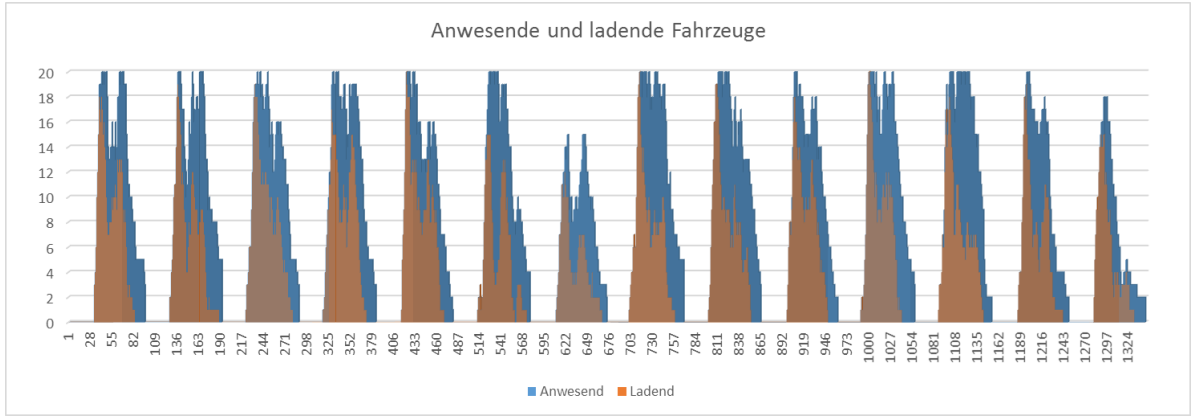
Mobilitätsmodell

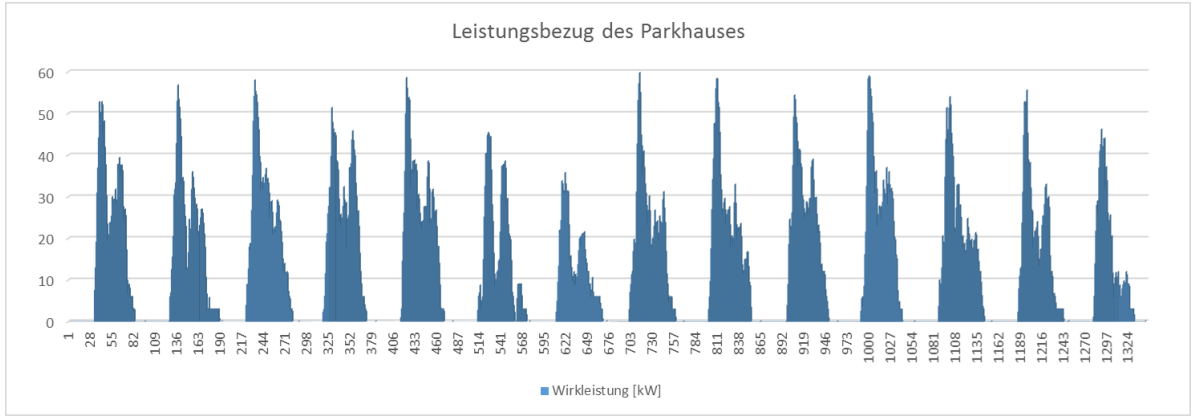


Szenarien E-Mobilität



Verschiedene Anteile und Verteilungen von E-Autos



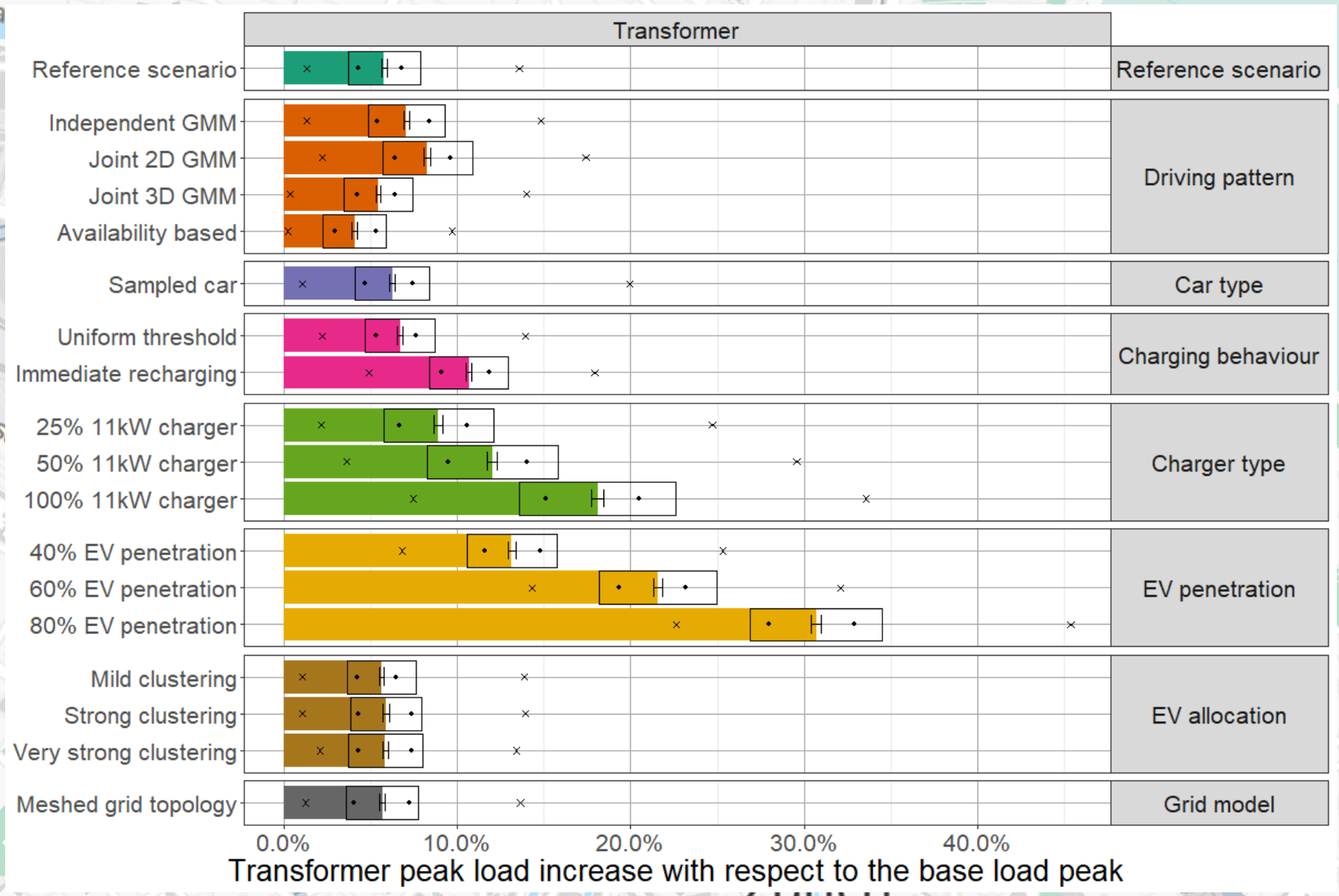


Anteil E-Autos:	Szenarien:					
5%	A-5	B-5	C-5	D-5	E-5	...
10%	A-10	B-10	C-10	D-10	E-10	...
20%	A-20	B-20	C-20	D-20	E-20	...
30%	A-30	B-30	C-30	D-30	E-30	...

EV Grid-Impact Assessment

Key Results

- EV penetration rate and assumed charging power (3.7 or 11 kW) show highest sensitivity to grid impacts
- Monte-Carlo scenario-based analysis allows to assess probability of grid problems to occur and where they are most likely
- Imminent uncertainty of future developments can be significantly reduced
  - ► tangible, practical grid upgrade strategies

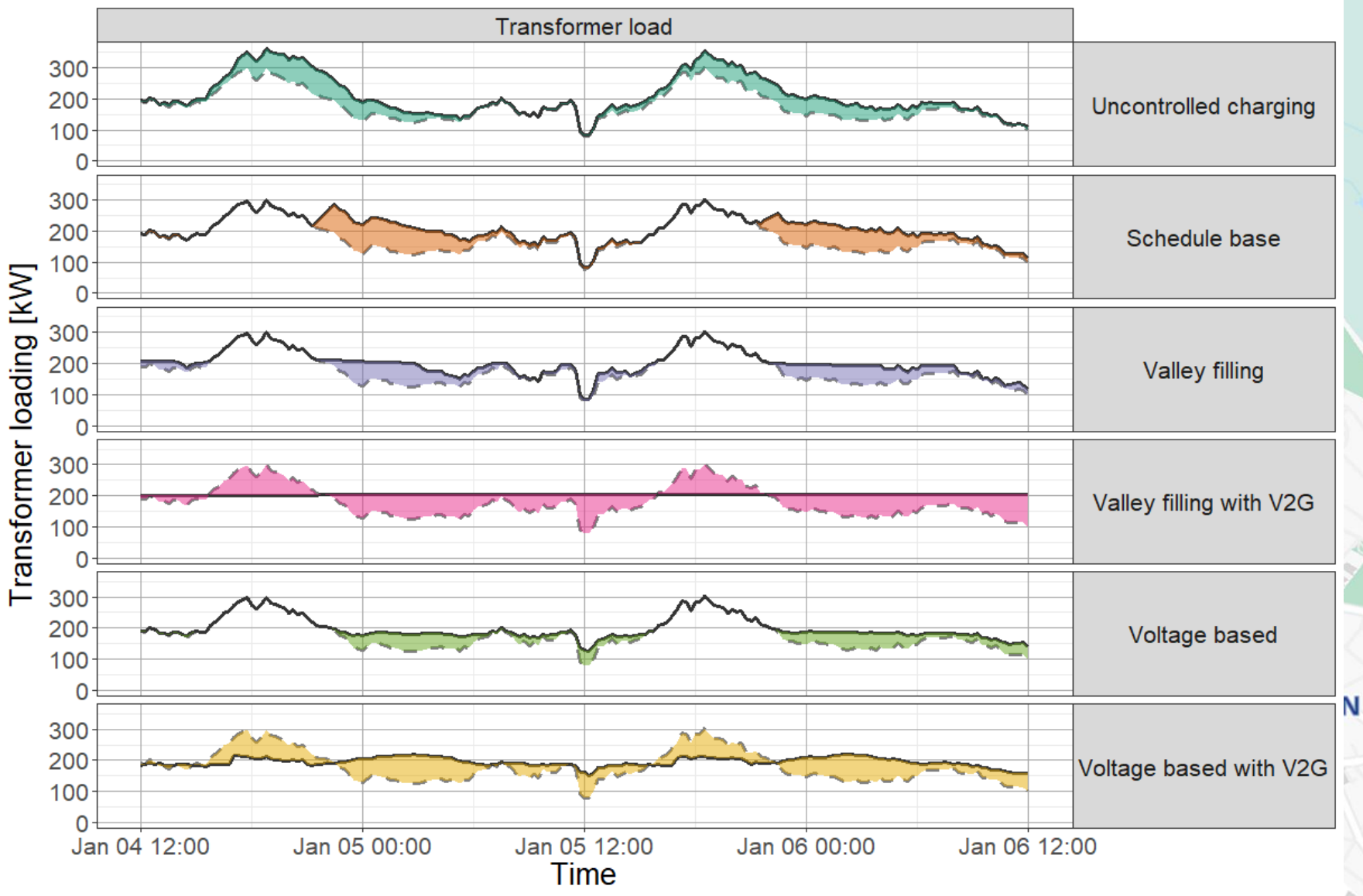


Reference scenario: MZMV, average car, gaussian threshold, 3.7 kW charger, 20% EV penetration, uniform EV allocation, radial grid

EV Charging Control Performance

Key Results

- Uncontrolled EV charging increases peak loading
- EV Charging control schemes reduce peaks
- Central EV charging (schedule, valley filling) performs best but requires extensive coordination and communication
- Simple, decentral EV charging (voltage-based) is similarly effective in reducing peak loading

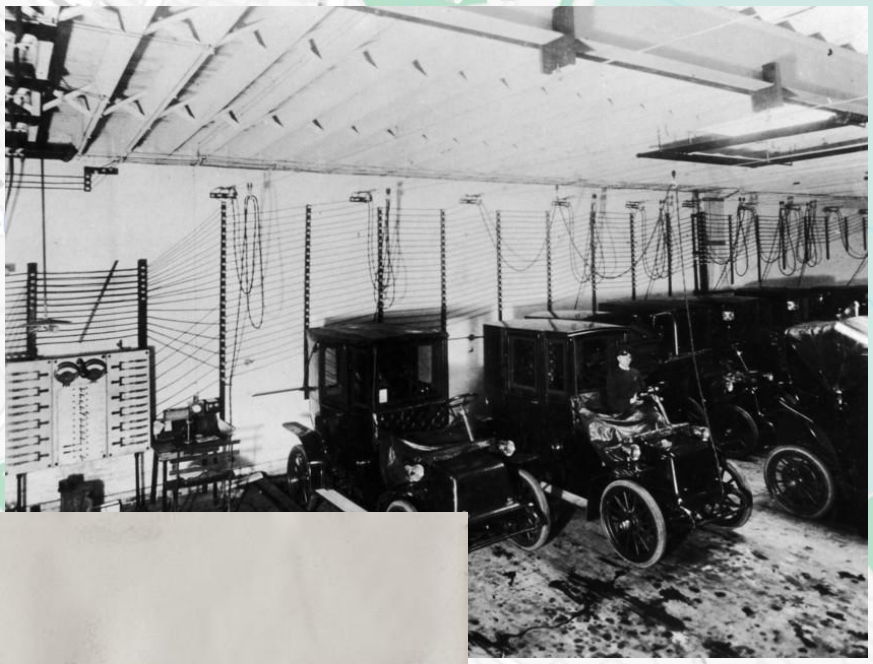


Common scenario parameters: MZMV, average car, gaussian threshold, 3.7kW charger, 20% EV penetration, uniform EV allocation, radial grid

Electric Mobility – Back to the Past?

Some final thoughts

- Electric mobility is not an entirely new concept
- Also introduced for environmental reasons in 1900s (horse manure!)
- Semi-public transport (taxis) was the first large-scale use-case



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Source: DER SPIEGEL (11.6.2012): Taxi Drivers with electric cars from Edison Company in New York (1906).

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