DTE+ Workshop, September 10th 2021: Electric Vehicle Charging Infrastructure: Planning, Allocation and Challenges

Allocation scenarios:
Homecharging, public charging and an outlook for truck charging

Speakers: Philip Gauglitz [a,b], Daniel Speth [c]

[a] Fraunhofer IEE, [b] University Kassel, [c] Fraunhofer ISI

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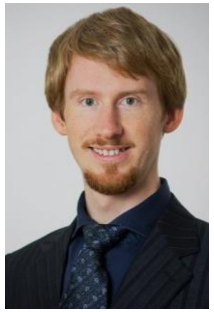
Philip Gauglitz, Fraunhofer IEE



- RWTH Aachen University, 2016 Master in Mechanical engineering, focus renewable energies
- Adaption Energiesysteme AG, 2012 – 2014, Municipal climate action projects
- Fraunhofer IEE (Institute for Energy Economics and Energy System Technology), since 2016
  - Focus: scenarios for the spatial allocation of energy producers (e.g. wind turbines) and energy consumers (e.g. electric vehicles)
- University of Kassel, section Integrated Energy Systems, since 2020

Daniel Speth, Fraunhofer ISI

- Karlsruhe Institute of Technology (KIT) Industrial Engineering and Management, focus energy economics and logistics
  - 2018: Master-Thesis at Fraunhofer ICT (Institute for Chemical Technology)
- Fraunhofer ISI (Institute for Systems and Innovation Research), since 2019
  - Focus: Electrification options for heavy duty vehicles

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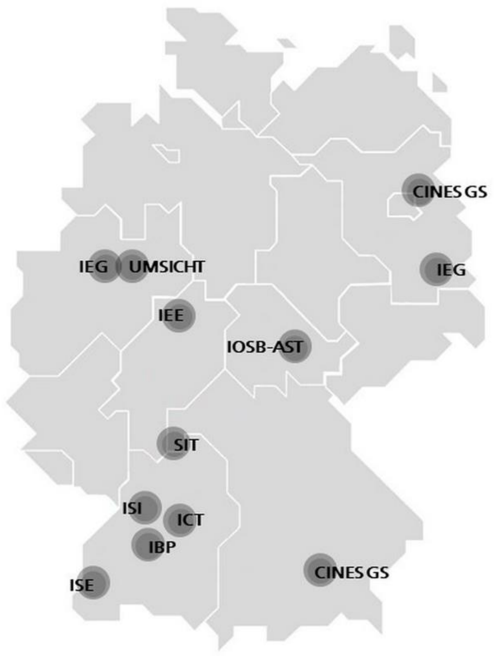
Fraunhofer Cluster of Excellence Integrated Energy Systems CINES

The "Integrated Energy Systems" research cluster is carried by the joint vision of transforming Fraunhofer into the lead research institution for applied energy research. As such, the cluster addresses the central technical and economic challenges of the next phase of the global energy transition: the system and market integration of high shares of variable renewable energy sources into the energy system. To achieve this, a high level of flexibility is imperative. Furthermore, demand and supply must be integrated across all sectors – electricity, heating, cooling and transportation. [2]



CINES: Participating core institutes (Fraunhofer IEE, IEG, ISE and ISI)
and associated institutes (Fraunhofer IBP, ICT, IOSB-AST, SIT and UMSICHT

[1] https://www.fraunhofer.de/en/about-fraunhofer/profile-structure.html
[2] https://www.fraunhofer.de/en/institutes/institutes-and-research-establishments-in-germany/cluster-of-excellence/integrated-energy-systems.html

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- Socio-economic data and demographic change
- Utility analysis and precise local distribution

Public charging:

- Demands
  - Compensation for missing home charging stations
  - POI / Destinations
- Parking potentials
- Precise local distribution

Truck charging:

- Data and Methodology
- Results and Outlook

Contact us: @

philip.gauglitz@iee.fraunhofer.de

daniel.speth@isi.fraunhofer.de

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Starting Point:

Dynamic expansion of electric vehicles requires equally dynamic expansion of charging infrastructure.

Challenge:

As a new consumer with sometimes significant outputs, the charging infrastructure has an impact on the entire electric power system, in particular on the power grids.

Goal:

To be able to spatially represent which electrical services can be added where. So: Scenario creation with high GIS reference.

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State-of-the-art literature:

Numerous studies on this topic with different methods and application areas. For example, in a review, Pagani et al. [6] analyzes 119 publications in which the spatial distribution of charging infrastructure is modeled.

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Features of our research:

- Consideration of groups, such as charging...
  - at home
  - at company
  - in public (and semi-public) area
- Usability for every Municipality in Germany (analog with corresponding data probably also international)
- Consideration of socio-economic parameters and mapping of demographic change
- Inclusion of grid calculations and the experience of distribution grid operators

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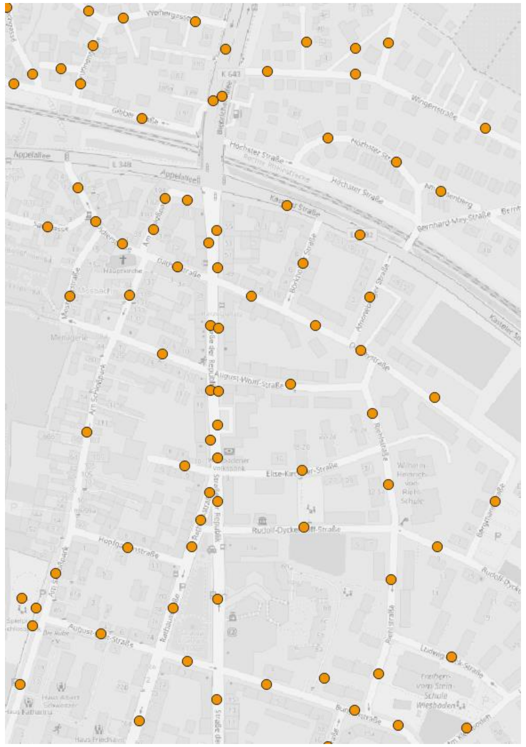
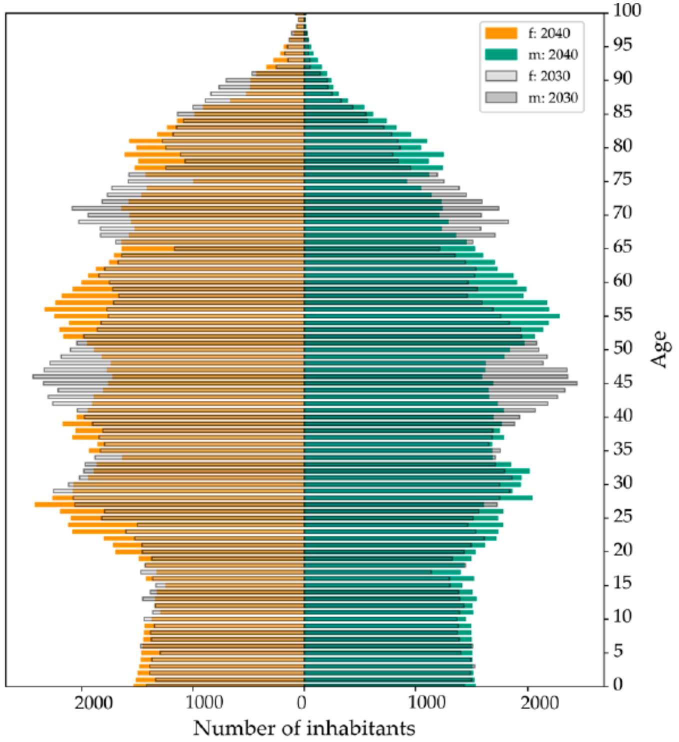


Wiesbaden; Data: Bevölkerungsstrukturdaten, socio-economic data for Germany of GfK Geomarketing; Map data: OpenStreetMap

- Socia economic data
- On level of street sections
- Contains e.g. income, household-type, etc.

- Demografic change
- Used source for 2030 [7]
- Own model for 2040:
  - Births
  - Deaths
  - Migration

(each: Location and age specific)



Population pyramid for Wiesbaden. [4] with use of [7]

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[7] Statistische Daten, Bevölkerungsvorausberechnung-Bevölkerungsstruktur https://www.wegweiser-kommune.de/statistik/bevoelkerungsstruktur

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a) Mean household score per building.
b) Number of vehicles per building in 1 of 50 variants.
c) Number of charging points per building in 1 of 50 variants.that do not have a home charging option

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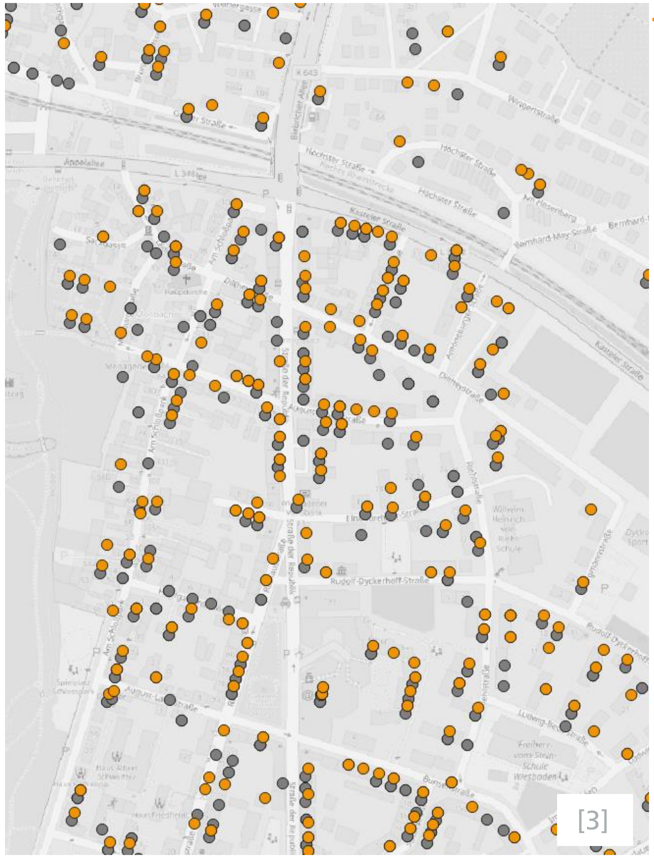
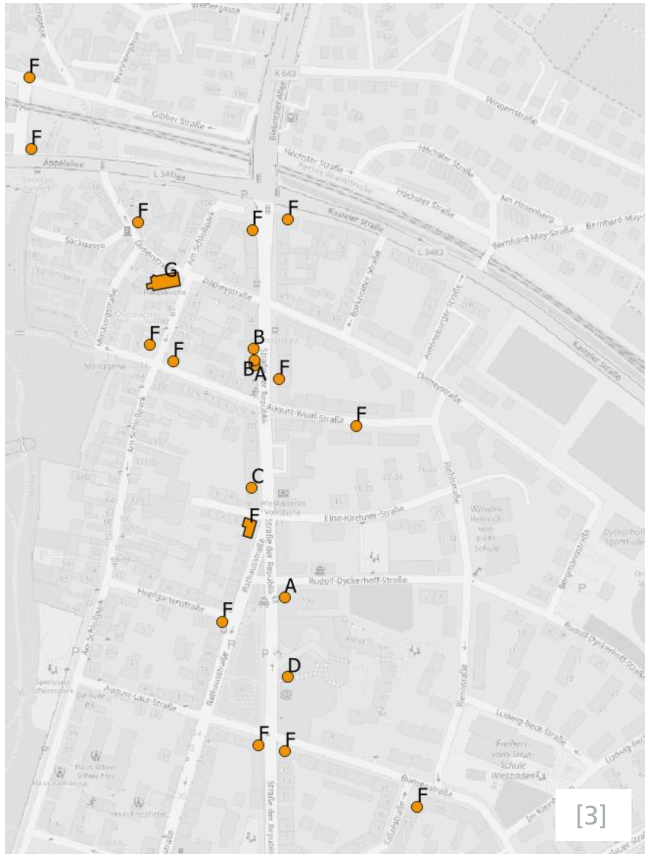


- Possible locations of electric vehicles that do not have a home charging option
- The "opposite" of the previous mentioned dataset

- POI from OpenStreetMap
- Assignment to "Mobilität in Deutschland" (Mobility in Germany)
- Selection of the most important categories
- Weighting of the categories based on the number of routes per category



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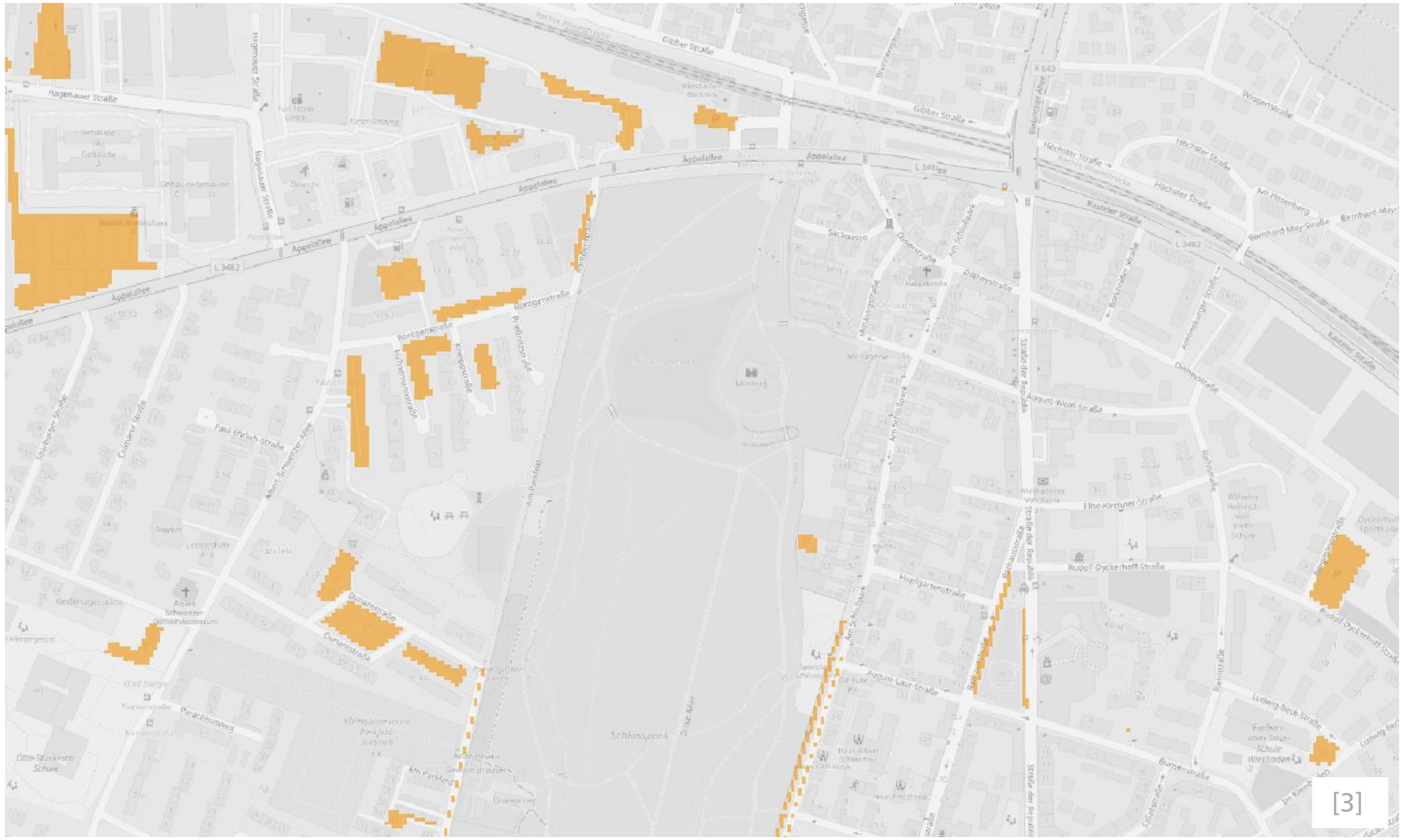

- Consideration:
  - Parking areas and parking buildings
  - Point-based information on parking lot numbers
  - Streets with parking spaces

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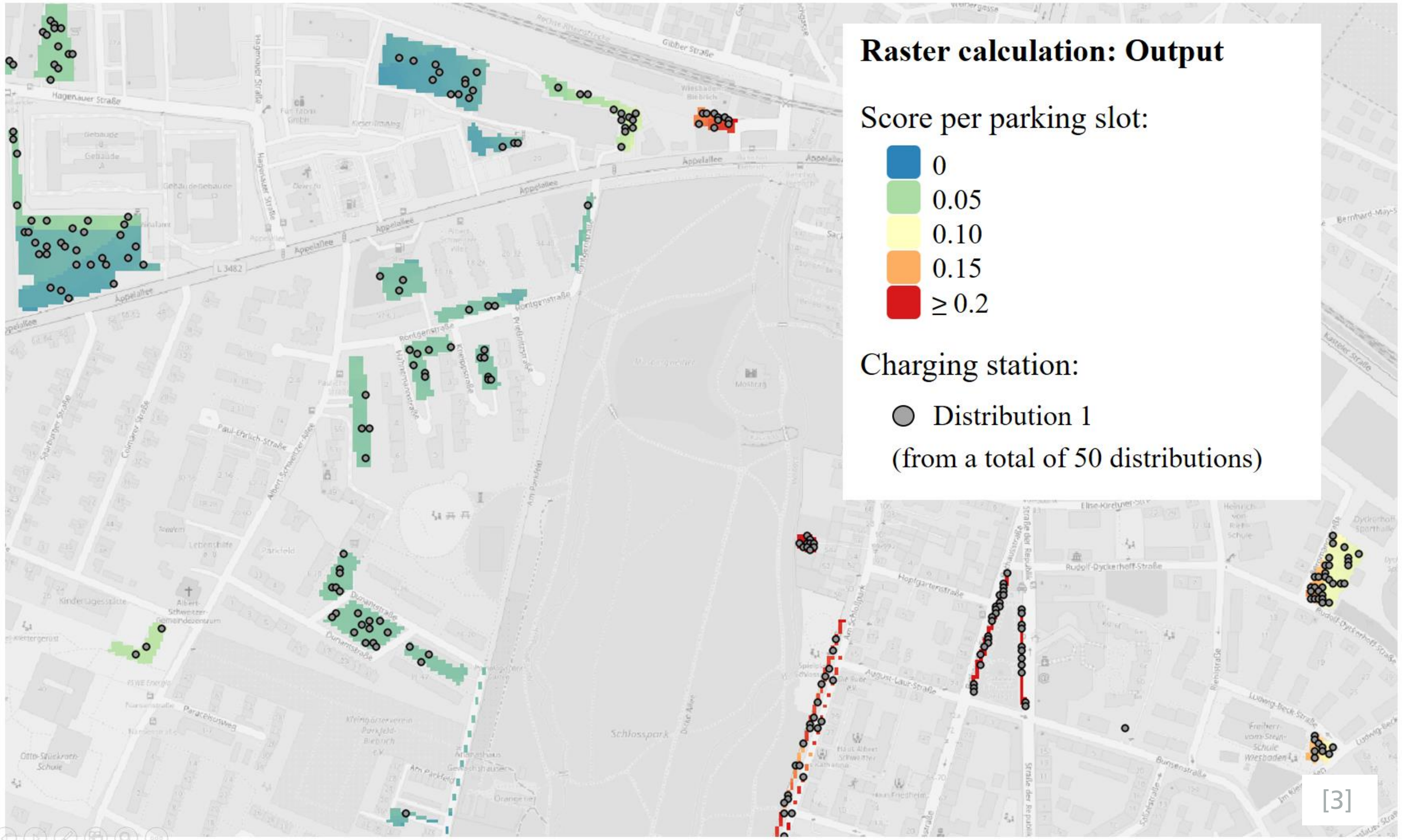

- Results:
  - The demands and potentials leads to a scoring per parking slot
  - The scoring is used for a weighted random draw
  - And results in a distribution of possible charging stations
- Consider:
  - Not a Prediction!
  - But a method and tool, to represent plausible distributions depending on assumptions
  - More analysis and model comparisions see [8]

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https://adgeo.copernicus.org/articles/56/1/2021/

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Allocation scenarios:
Homecharging, public charging and an outlook for truck charging

Speakers: Philip Gauglitz [a,b], Daniel Speth [c]

[a] Fraunhofer IEE, [b] University Kassel, [c] Fraunhofer ISI

Data Input (examples)

- Socio economic data
- POI from OpenStreetMap
- Routes from MiD
- Heat demand
- Roof areas
- Building volume

Modeling:

- Homecharging:
  - Utility analysis
  - Weighted random Draw
- Public charging:
  - Evaluation of travel routes
  - Demand Map
- Other models for detailed locations, especially:
  - Company charging
  - Heatpumps
  - Photovoltaic

Application:

- Various research aspects
- In particular: distribution grid calculations

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Truck charging:

- Data and Methodology
- Results and Outlook

Contact us: @

philip.gauglitz@iee.fraunhofer.de

daniel.speth@isi.fraunhofer.de

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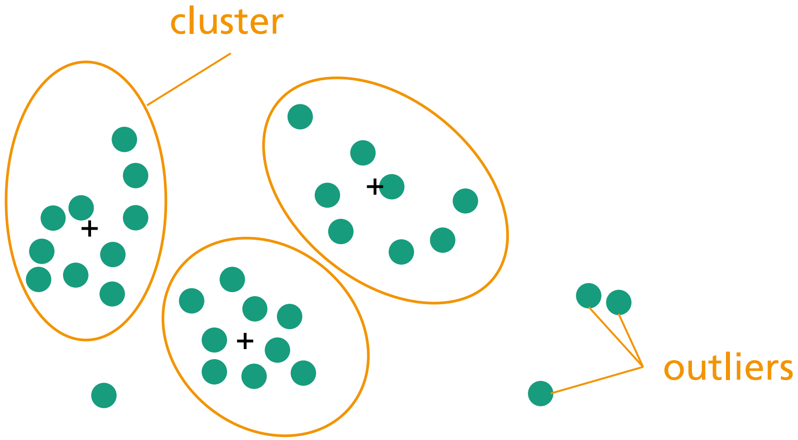
Data Collection:

- 7 truck OEM provided GPS coordinates of truck stop locations from trucks GCW >= 7.5 t
  - "regional" : 90 % of coordinates within 200 km from the vehicle's home-base.
  - "long haul" = not regional

Aggregation:

- Clustering of individual locations into larger groups (DB scan algorithm with 200 m radius)
- Kept stop location clusters with
  - at least 100 stops per year
  - at least 3 OEMs present



Validation:

- Comparison of long-haul stops with trip ends in synthetic EU trip dataset (ETISplus)
- Identify „type" of stops using OpenStreetMap API and HERE API

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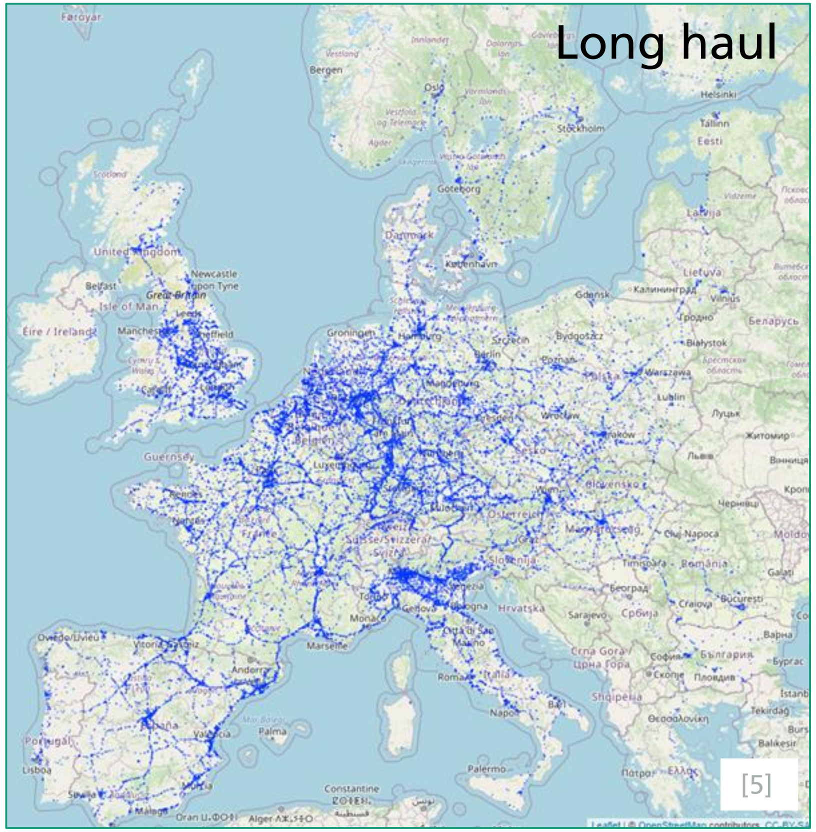
Results:

	Long haul	Regional
Trucks	230.000	170.000
Locations before aggregation	550.000	194.000
Locations after aggregation	31.145	4.023
Countries covered	35	23
Average stops / year	1.678	1.271
Deviation stops / year	3.615	3.044
Median stops/year	596	455

long-haul: rest areas (30-50 %), companies (25-45 %), ports (1-5 %)

Outlook:

- Improve typing of locations (additional API, idle time)
- Design possible infrastructure ramp-up
- Accompany the diffusion of electric trucks practically (HoLA) and theoretically (STORM)



https://www.acea.auto/downloads/FraunhoferStudy/export_longhaul_percountry.html

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Thank you!

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Sources:

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