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Charging infrastructure for electric vehicles: demand, cost and impact on the energy supply in Austria by 2030

Institut für Fahrzeugantriebe & Automobiltechnik

Institut für Energiesysteme und Elektrische Antriebe

DI Thomas Bruckmüller
DI Dr. Werner Tober
DI Dominik Fasthuber

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- ☐ Motivation and aim
- ☐ Methodology
- ☐ Input data and assumptions
- ☐ Results
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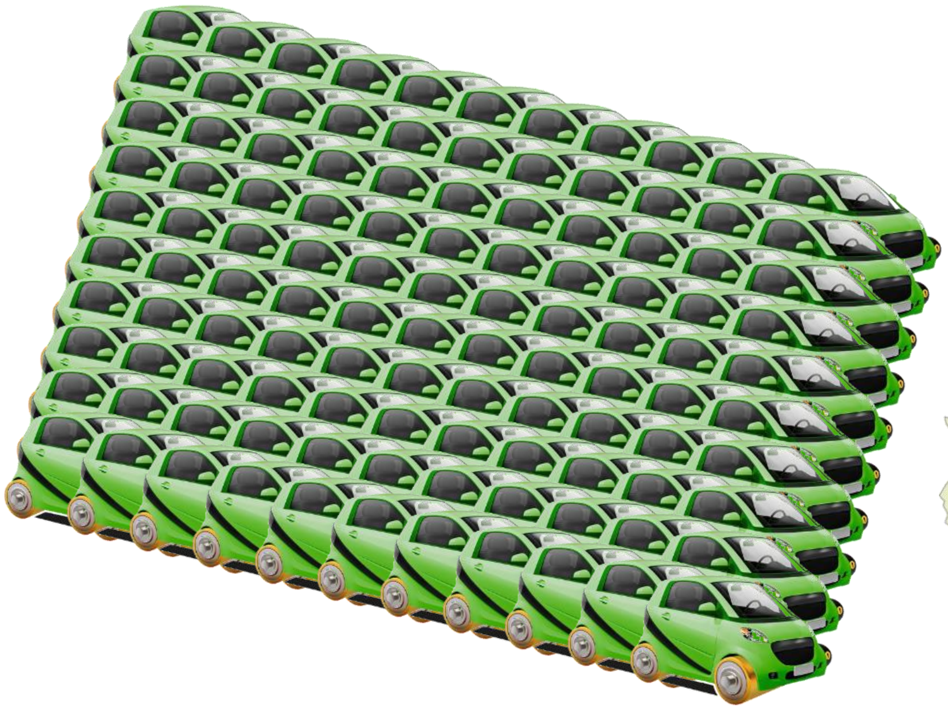
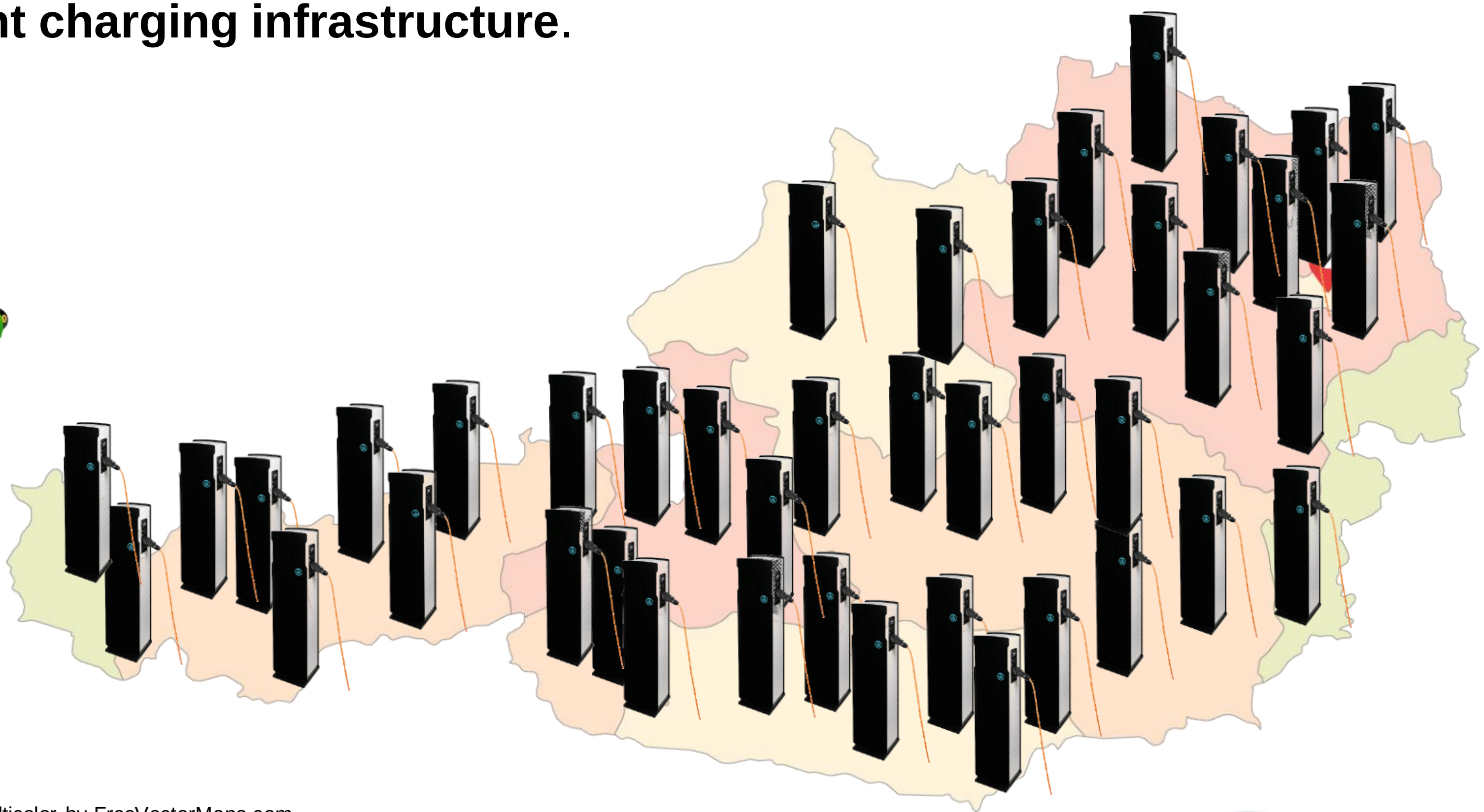
Motivation

- ☐ The improvement of **air quality** and **climate protection** is the motivation for **legal regulations** to reduce pollutant (**Euro classes**) and greenhouse gas emissions (**CO_2 fleet consumption**).
- ☐ **Electromobility** is understood as **one of the solutions** and **requires appropriate market penetration**.
- ☐ However, this also requires a **sufficient charging infrastructure**.



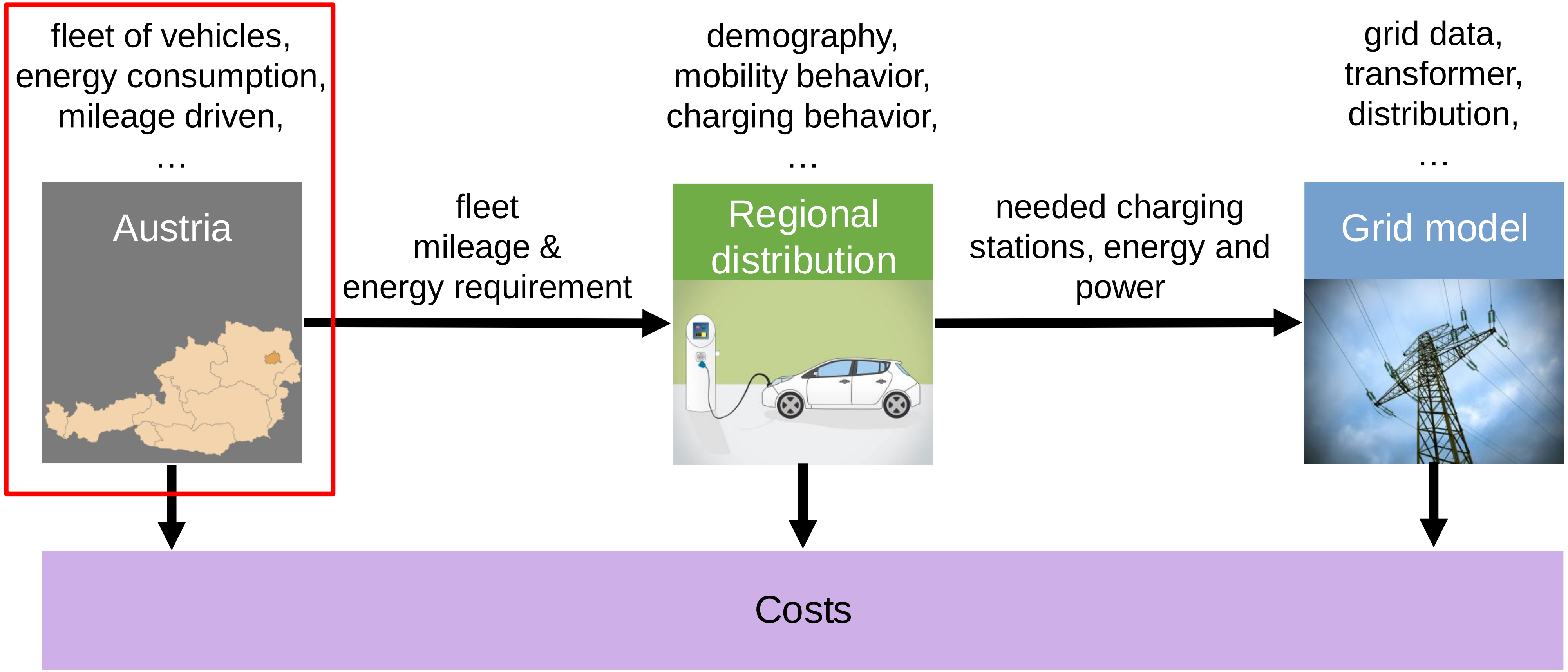


Ref.: www.huk.de, www.walther-werke.de, Austria with States - Multicolor by FreeVectorMaps.com

Aim

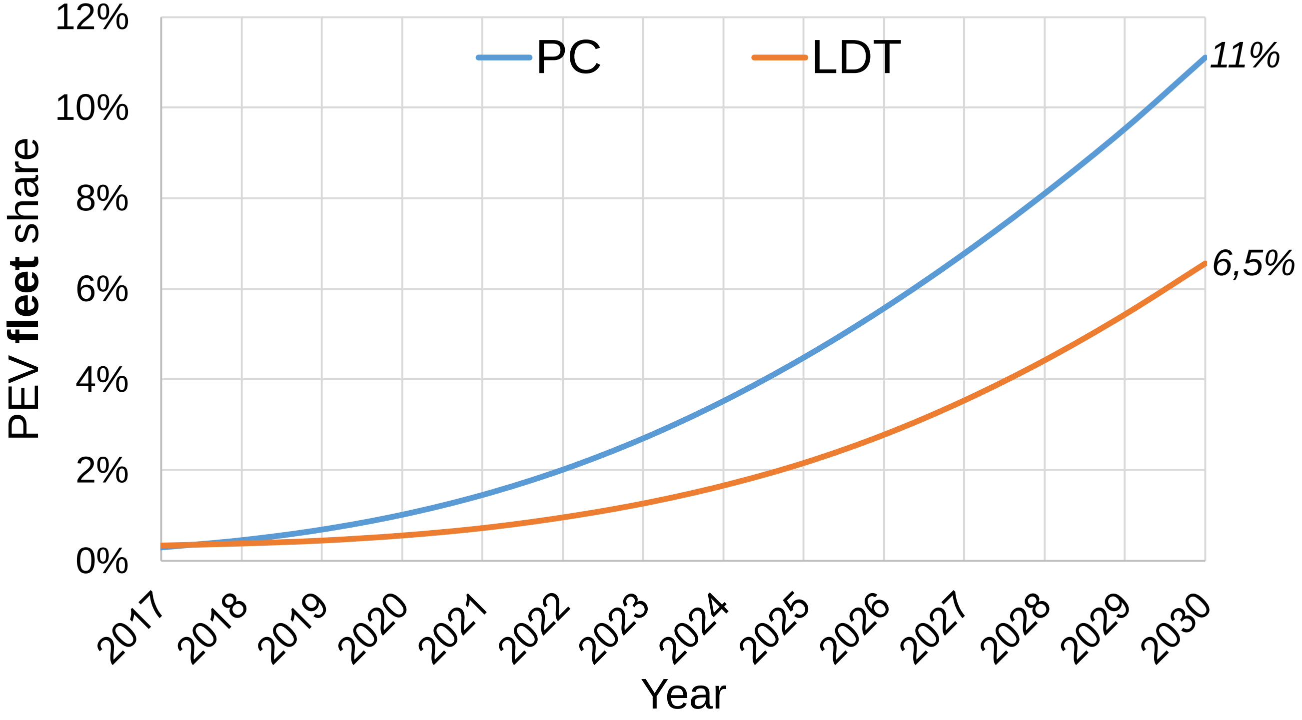
- **Tool-based identification of the required charging infrastructure and its impact on energy supply by 2030 in Austria.**
- Key questions:
  - **How many** charging points are needed?
  - **When** are these required?
  - **Where** are they needed?
  - **Which** charging power should be installed?
  - **What** costs can be expected for the construction of the infrastructure?
  - **What** effects are there on the grid?
- This results in the main topics:
  - Forecast of **new registrations and fleet** of pure battery electric vehicles
  - Analysis of **mobility behavior**
  - Derivation of the **number of charging points** per **charging power** and their **distribution** (city/country-side)
  - Determination of the **additional electrical power and energy requirements** for e-mobility
  - **Costs** for the construction of charging infrastructure
  - **Impact on local grids**

Methodology



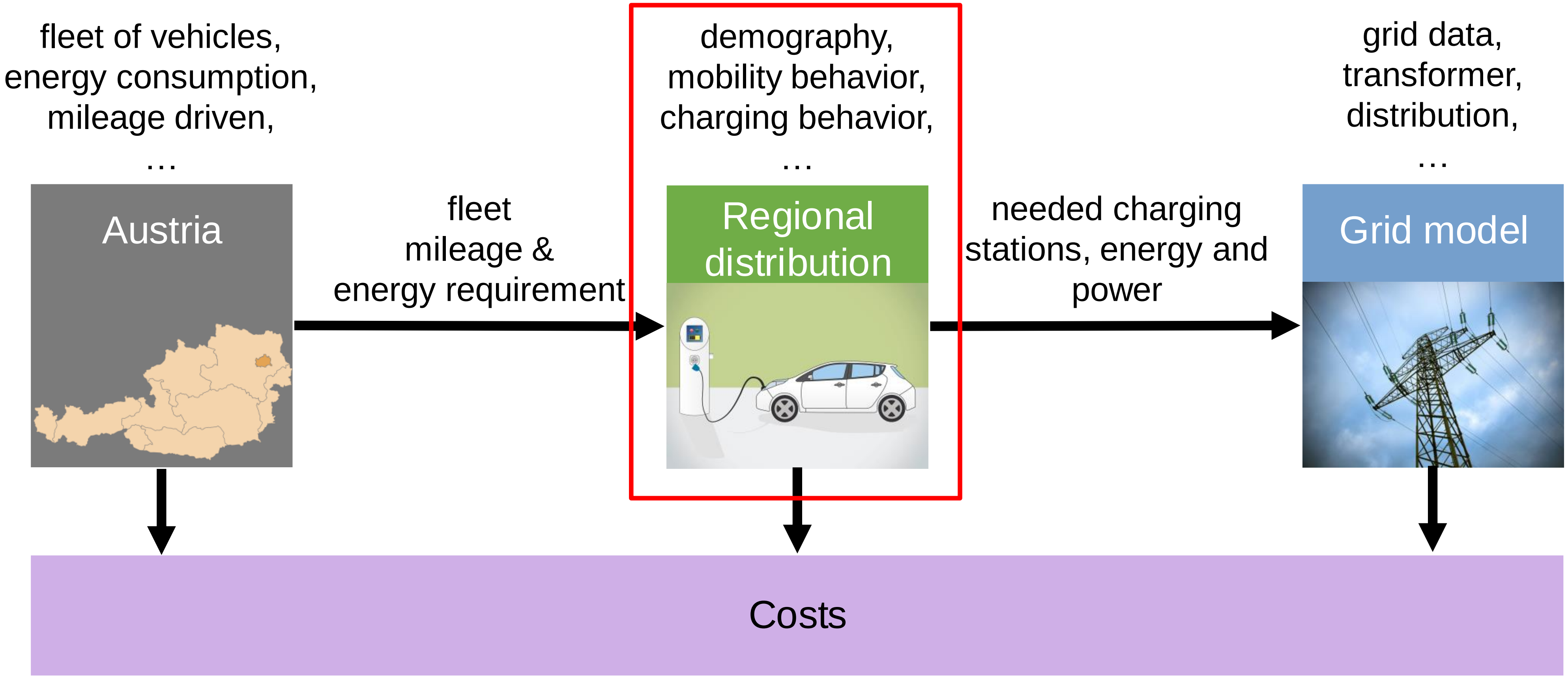
New registrations and fleet development

- Based on an expert assessment regarding the development of new registrations of pure electric vehicles up to 2030, **26 % new passenger cars (PC) and 16 % new light duty truck (LDT) registrations** are expected **in 2030 in Austria**.
- This leads to a **stock of 11 % passenger cars (PC) and 6,5 % light duty truck (LDT)** of pure electric vehicles **in 2030**.



Ref.: Geringer, B., Eichlseder, H.: ÖAMTC Expertenbericht Mobilität und Klimaschutz 2030, Wien: ÖAMTC, 2018 (for PC)

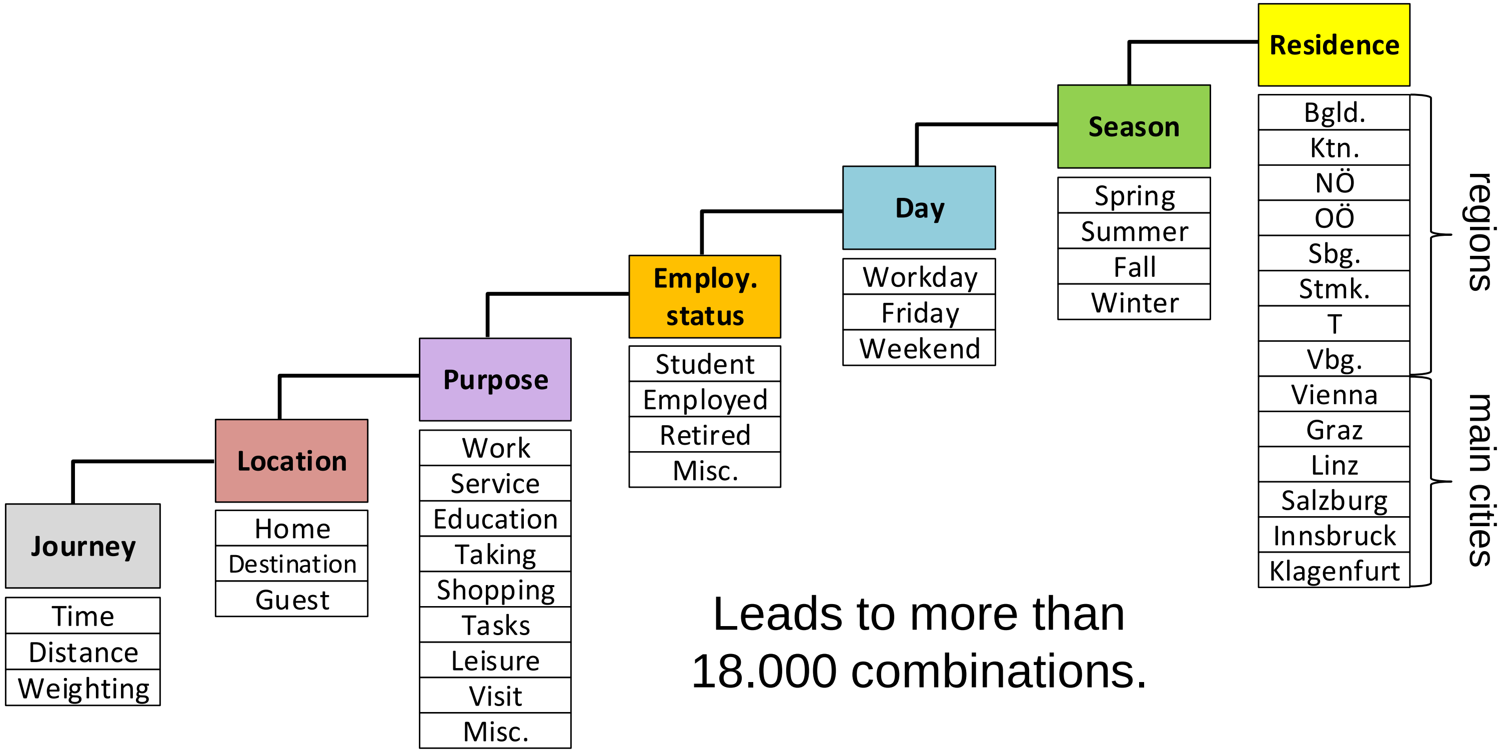
Methodology



Mobility behavior

to define the charging behavior by time and duration

- ☐ A highly detailed austrian-wide **survey on individual mobility behavior** was used.
- ☐ Main data of a single trip
  - – arrival time
  - – trip length
  - – weighting factor
- ☐ Differentiated according →
- ☐ Assumption:
  - – charging after every trip



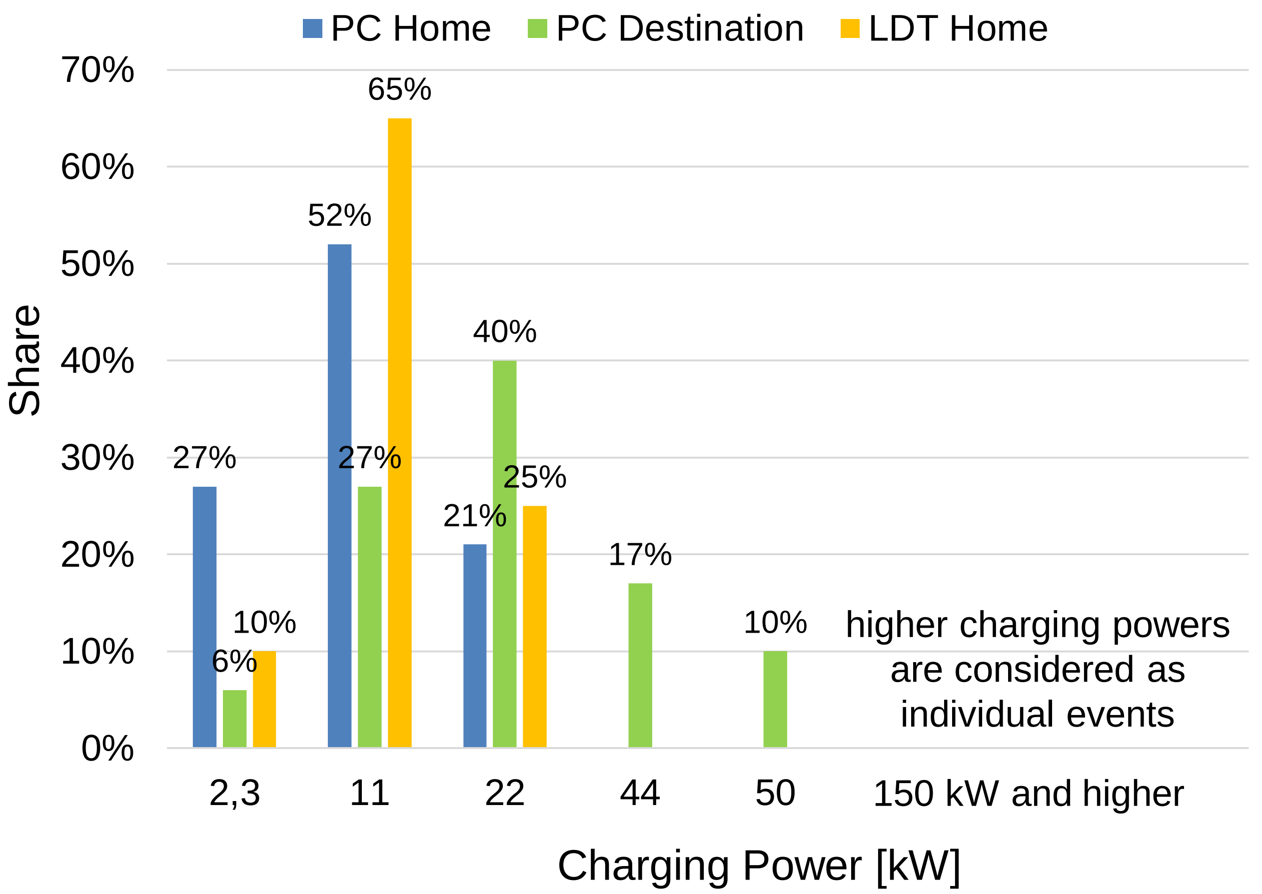
Leads to more than 18.000 combinations.

Ref.: Tomschy, R., Herry, M. et al: Ergebnisbericht zur österreichweiten Mobilitätserhebung "Österreich unterwegs 2013/2014", Wien: Bundesministerium für Verkehr, Innovation und Technologie (Hrsg.), Juni 2016

Charging behavior

Assumption for the distribution of charging power according to place of charging

☐ <u>Expected charging power</u> for PC Home, PC Destination and LDT Home



<u>PC Home:</u>
PC charging at home or their home charging place (own parking spaces or roadside)

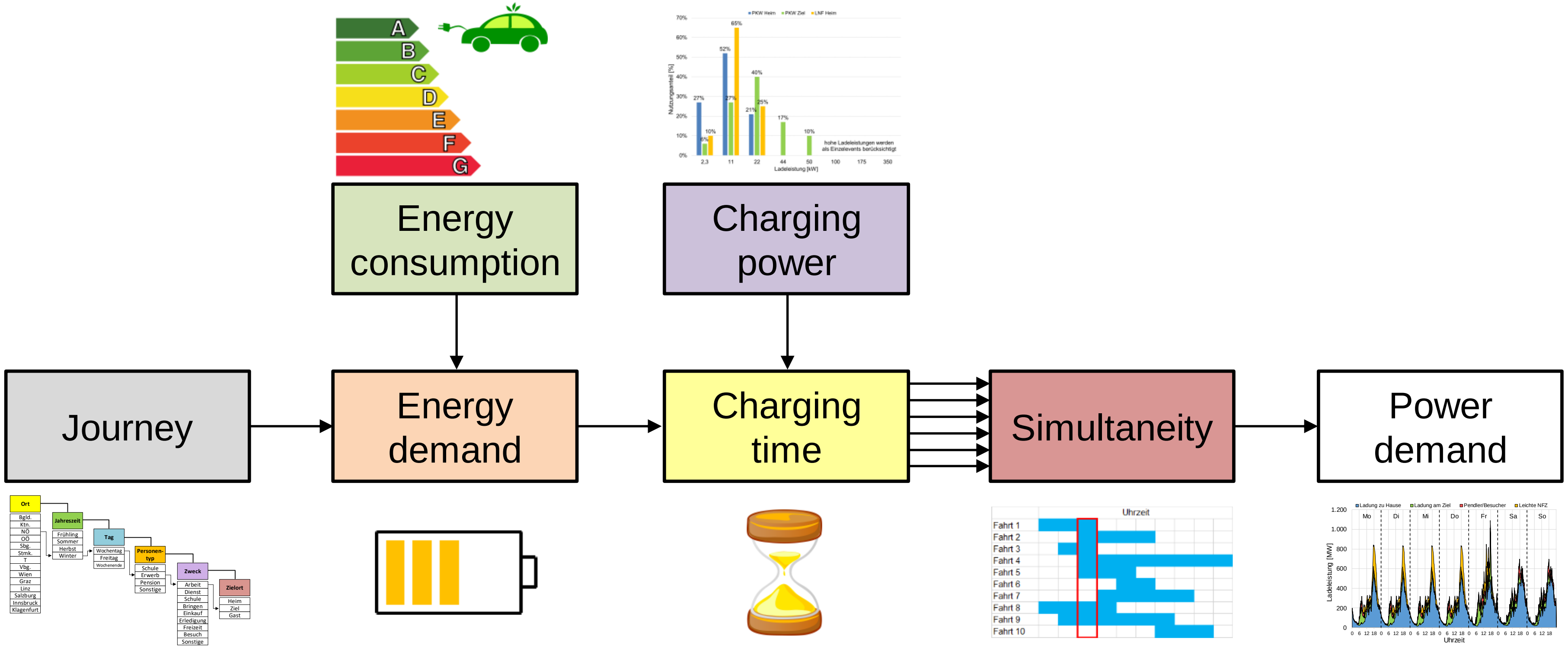
<u>PC Destination</u>
PC charging at their destination (public)

<u>LDT Home:</u>
LDT charging at home at their own parking spaces

Calculation scheme

to determine the simultaneity and load profile

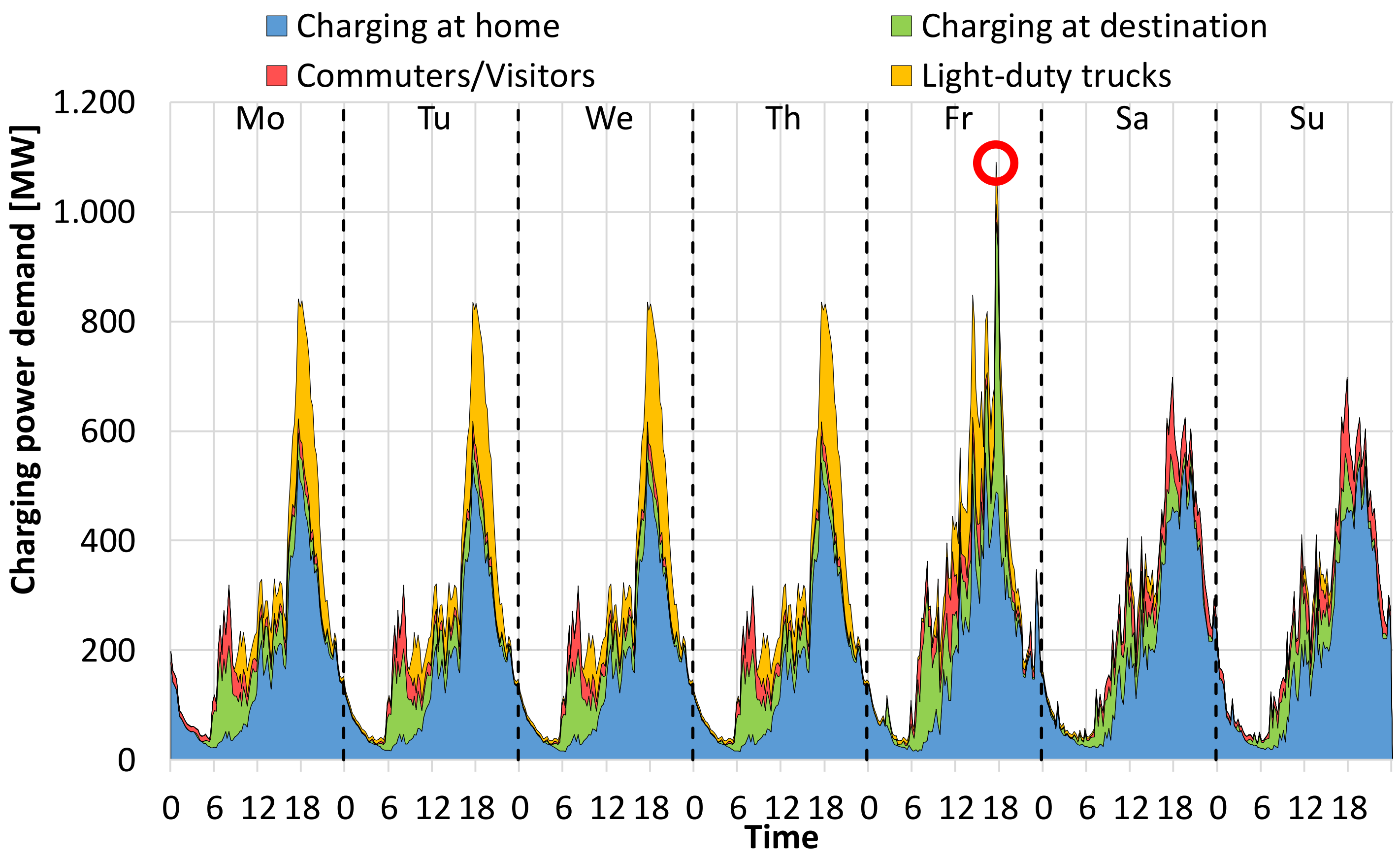
- Based on the input data and assumptions shown above, the simultaneity and load profile were calculated, respecting
  - 93.000 different single trips; statistically recorded
  - an average yearly mileage of 12.900 km (PC) and 18.600 km (LDT)
  - an average energy consumption of 25,6 kWh/100km (PC) and 55 kWh/100km (LDT)



Charging power demand for pure electric vehicles (PC and LDT) in 2030

Maximum power in calendar week 3

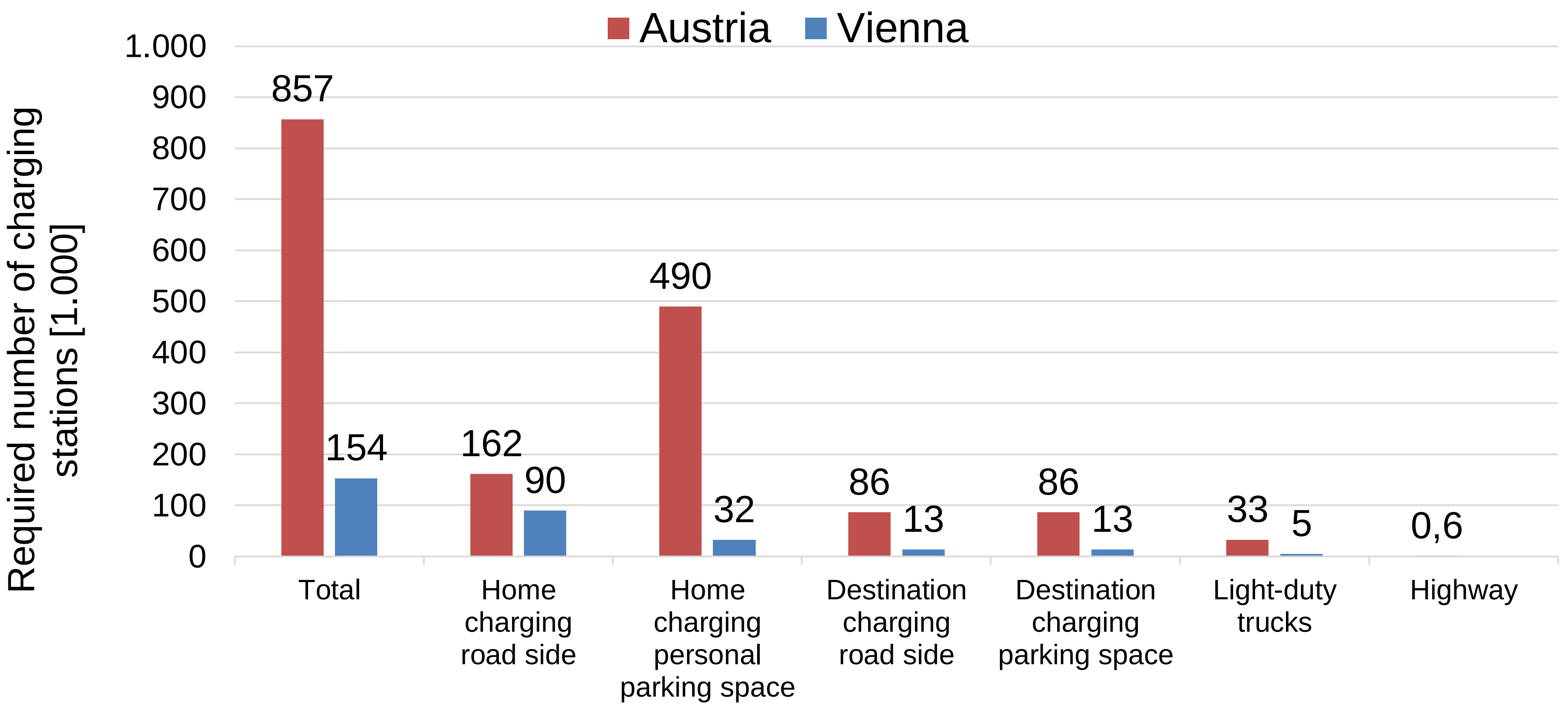
- Energy demand: **2,23 TWh** (equals **3,2 %** of the energy demand in 2018)
- Maximum power demand: **1,1 GW** (equals **10,8 %** of power demand in 2018)



Required number of charging stations until 2030

Distribution according to place of loading

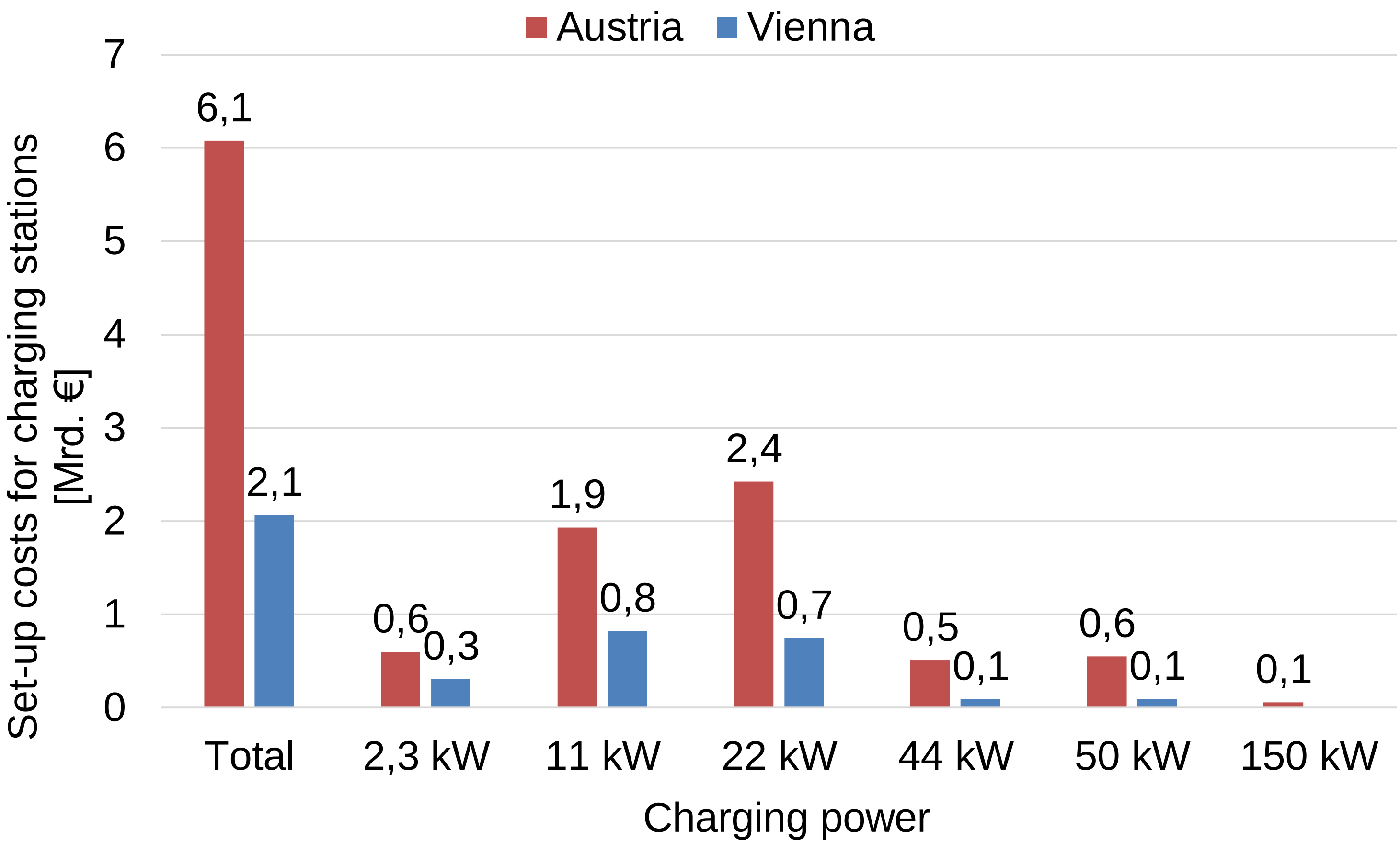
- By **2030**, Austria will require **857.000 charging points for 623.000 PC and LDT**.
- This corresponds to **1,38 charging points per vehicle**.
- **39 % of them in public space**.



Costs for the construction of charging stations until 2030

Distribution according to charging power

- Cost estimate of various energy provider and operators.
- Consideration of the costs of:
  - Hardware
  - Grid fees
  - Building measures
- Distinction according to:
  - Charging power (2,3 - 50 kW)
  - Loading location (urban / rural)
  - Loading type (roadside/parking space)
- In total **6,1 Mrd. € until 2030**.
- This corresponds to **9.800 €/vehicle** in the scenario described.



Methodology

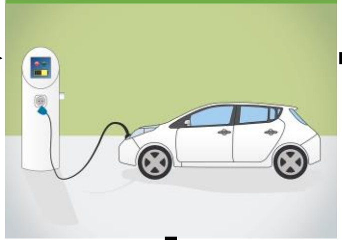
fleet of vehicles,
energy consumption,
mileage driven,
…

Austria

fleet
mileage &
energy requirement

demography,
mobility behavior,
charging behavior,
…

Regional distribution



needed charging
stations, energy and
power

grid data,
transformer,
distribution,
…

Grid model

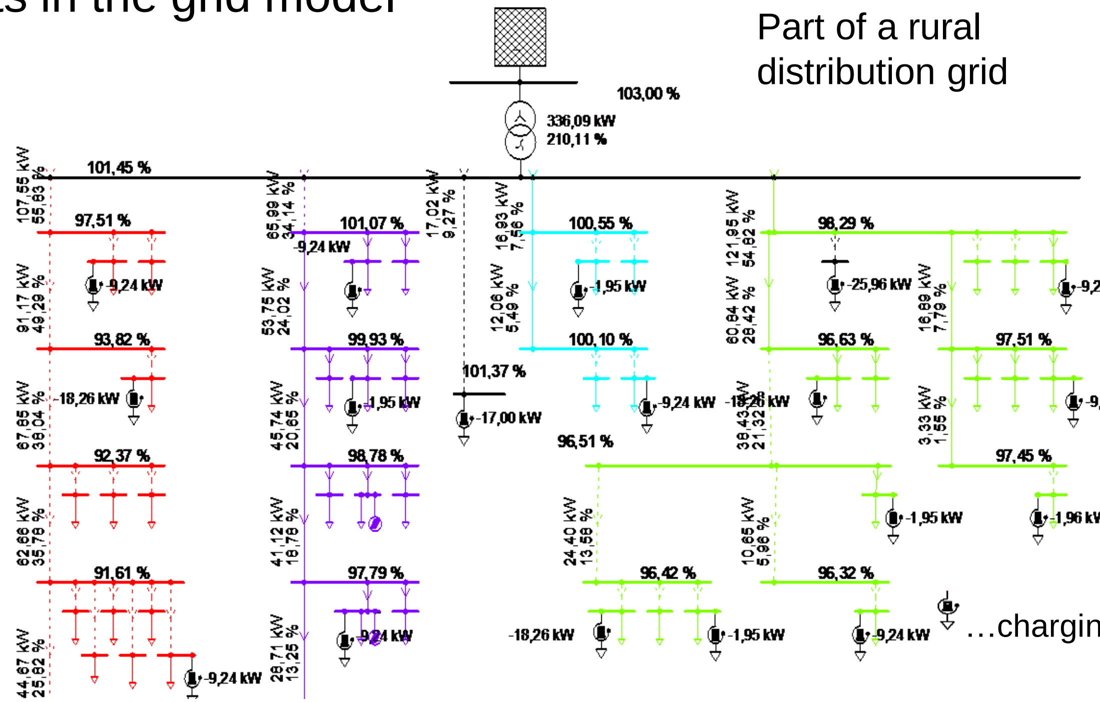
Costs

Impact on the grid

Consideration of various local grid models

- Considering a model for a
  - Rural grid (59 households)
  - Small town grid (87 households)
  - Metropolitan grid (168 households)
- Random distribution of the required charging points in the grid model
- Using the calculated load profile
- Determining the impact on the local grid
- Derivation of possible corrective measures

Part of a rural distribution grid



…charging spot

Impact on the grid
Results by 2030

- ☐ In the analyzed rural, small town and metropolitan grids, there has been **no inadmissible resource utilization and voltage range deviations occurred**.
- ☐ The grid models considered in the study **reach their limits** at a fleet share of
  - Rural grid: 30 % PC and 18 % LDT pure electric vehicles
  - Small town grid: 56 % PC and 33 % LDT pure electric vehicles
  - Metropolitan grid: 48 % PC and 28 % LDT pure electric vehicles
- ☐ **The limits of the considered grids are achieved by the maximum utilization of the transformers** and not by voltage band violations or line overloads.
- ☐ In unfavorable cases (e.g. old or higher loaded grids) an inadmissible operation can not be excluded even before 2030.
- ☐ **Due to the long planning phases** in grid expansion, the start of **extensions** for higher fleet shares of pure electric vehicles may already be **appropriate before 2030**.
- ☐ To **protect the grid** in a first step, **intelligent charging management** (e.g. smart meter) controls the charging power (e.g. P_{max}, $P_{(U)}$) and/or the charging time (start, end, duration).

Summary

- ☐ With the methodology developed, a **tool** was created **to assess** the **requirements and consequences of electromobility** with regard to the **charging infrastructure and energy supply** of a country under **free selectable boundary conditions**.

Based on the parameters shown, for Austria in 2030:

- ☐ Pure electric vehicle **stock of 11 % passenger cars (PC) and 6,5 % light duty truck (LDT)**.
- ☐ For most journeys, **low charging power is sufficient**.
- ☐ The **additional annual energy demand** amounts to **3,2 %** of the energy demand in 2018.
- ☐ The **additional power requirement** amounts to **10,8 %** of the maximum power level in 2018.
- ☐ **857.000 charging points** for 623.000 PC and LDT **needed**.
- ☐ The construction of **charging infrastructure** will incur cumulated **costs** of **6,1 Mrd. €** or 9.800 €/vehicle
- ☐ The analyzed grids show **no problems with inadmissible resource utilization and voltage range deviations**.

Thank you for your attention!

Institut für Fahrzeugantriebe
& Automobiltechnik

Institut für Energiesysteme
und Elektrische Antriebe

DI Thomas Bruckmüller
thomas.bruckmueller@ifa.tuwien.ac.at