

Probabilistic Modeling of Charging Profiles in Low Voltage Networks



energy nautics
solutions for sustainable development

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Agenda

1. Introduction

2. Individual Driving Profiles

- Derivation of Probabilities
- Individual Trips
- Driving Profiles

3. Charging Impact

4. Conclusion



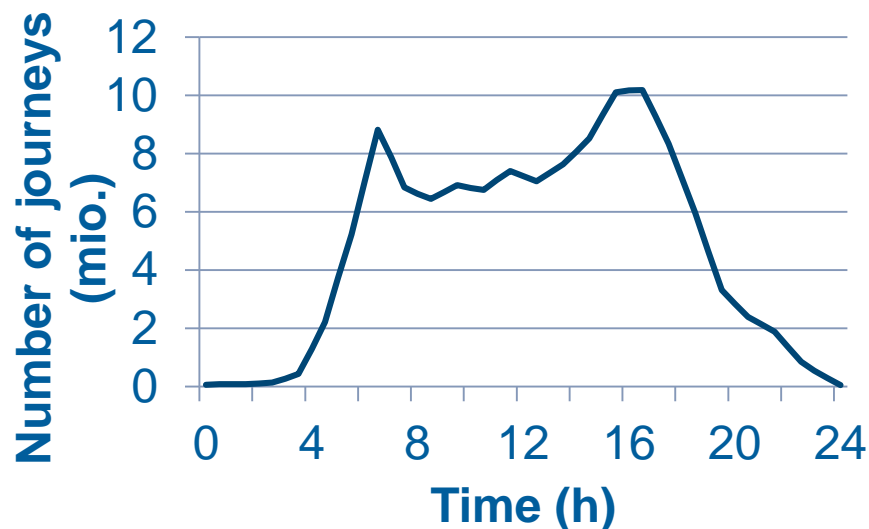
1. Introduction



1. Introduction

- **Individual driving profiles vary immensely**
 - Based on probabilistic distributions
 - More realistic charging behavior
- **Report “Mobility in Germany”**
 - Day dependent (Workday, Saturday, Sunday)
 - Departure times combined (to and from activity)

Workday





2. Individual Driving Profiles



2. Derivation of Probabilities

Probabilities for trips to and from activity needed for driving profiles

Activity depended derivation:

- 1. Short activity length (shopping and recreation)**
- 2. Long activity length (work and education)**



2. Derivation of Probabilities

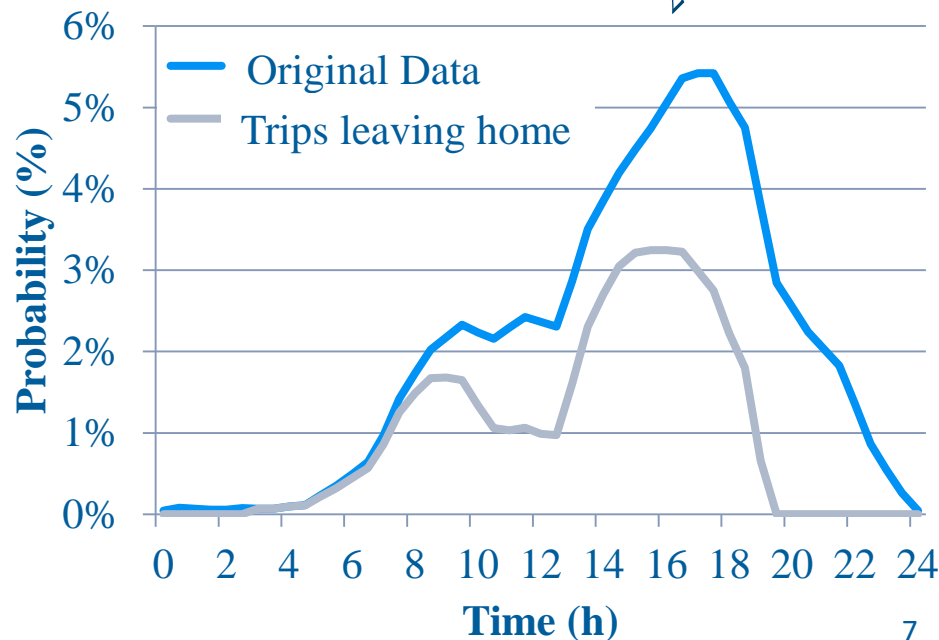
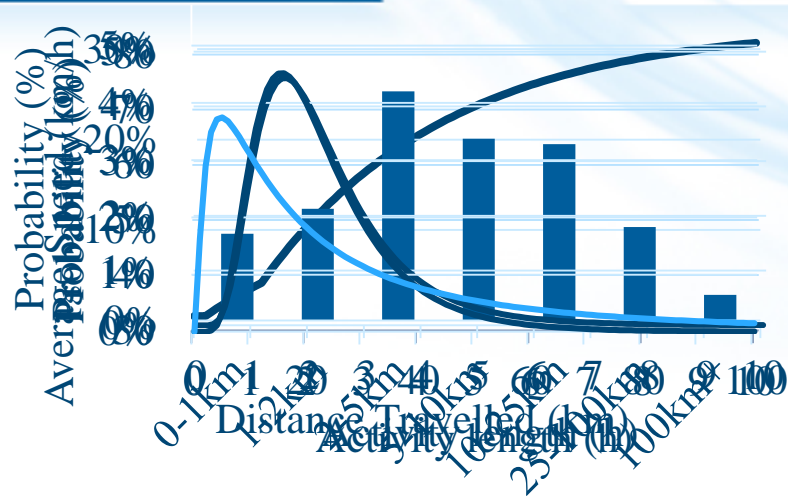
Short activity length:

- All vehicles are home at 3 am
- Probability for travel distance
- Function for travel time
- Logarithmic distributed activity length

Method:

- Iterative (activity length unknown)
 1. Probability of journey length
 2. Time dependent departures

All departing vehicles –
 Returning vehicles =
 Vehicles departing from home





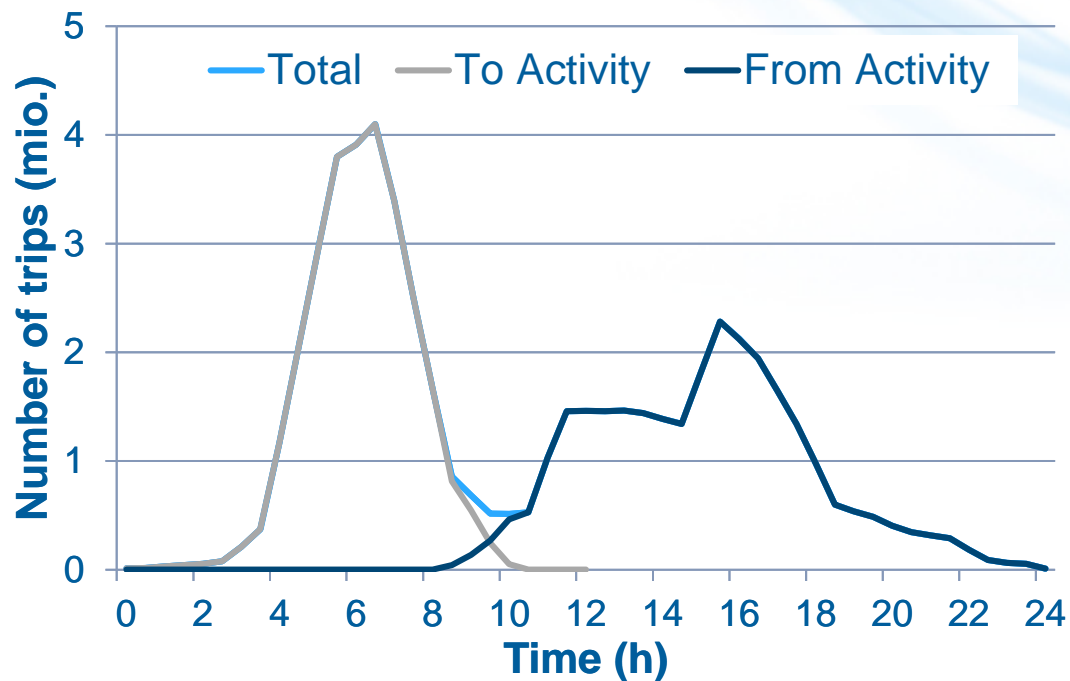
2. Derivation of Probabilities

Long activity length:

- To activity in the morning
- From activity in the evening
- Overlap midday

Recursive trip match:

- \emptyset 4h min. activity time
- \emptyset 12h max. activity time





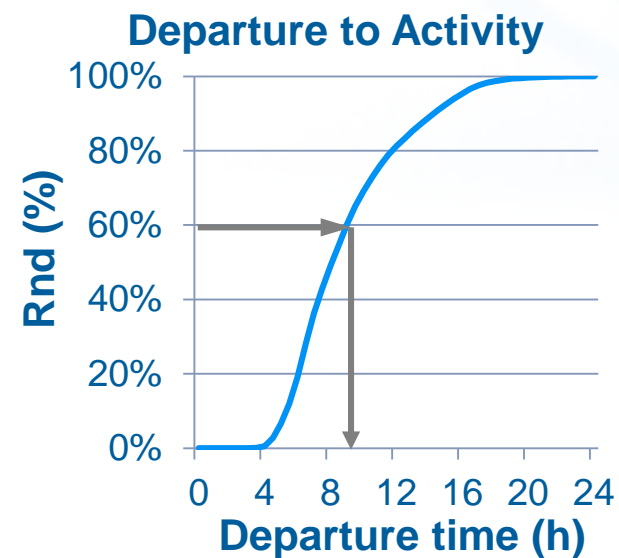
3. Individual Trips



3. Individual Trips

Individual trip generation:

1. Departure to Activity

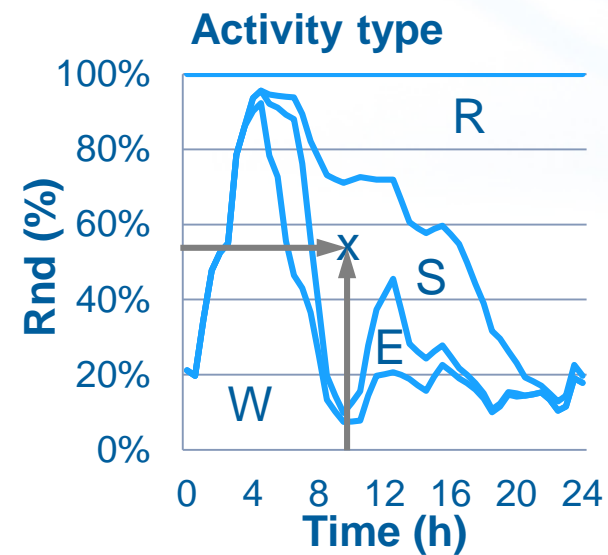




3. Individual Trips

Individual trip generation:

1. Departure to Activity
2. Activity type

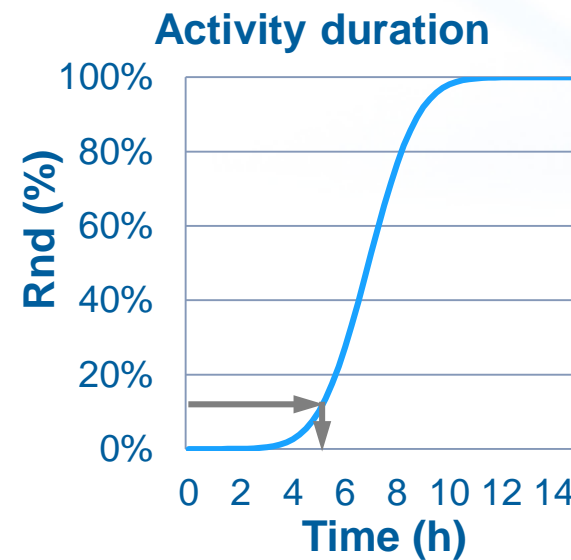




3. Individual Trips

Individual trip generation:

1. Departure to Activity
2. Activity type
3. Short Activities:
 - a) Activity duration

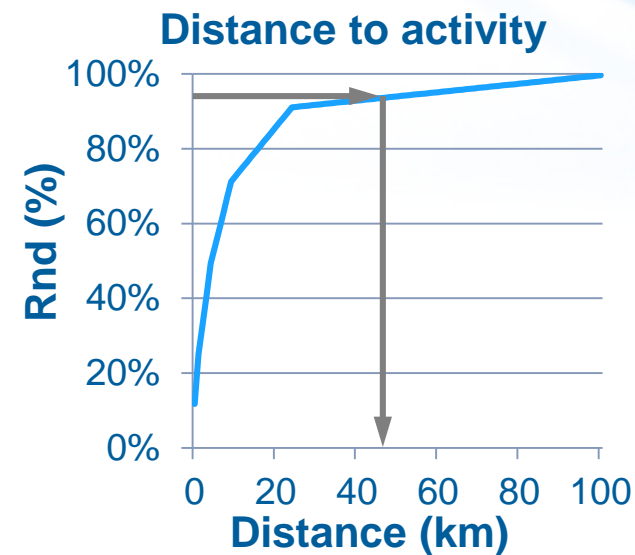




3. Individual Trips

Individual trip generation:

1. Departure to Activity
2. Activity type
3. Short Activities:
 - a) Activity duration
 - b) Distance to activity

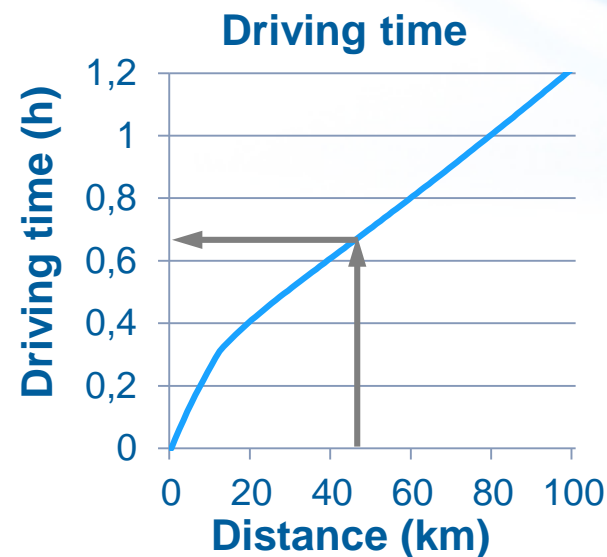




3. Individual Trips

Individual trip generation:

1. Departure to Activity
 2. Activity type
 3. Short Activities:
 - a) Activity duration
 - b) Distance to activity
 - c) Driving time to activity
- } **2x**

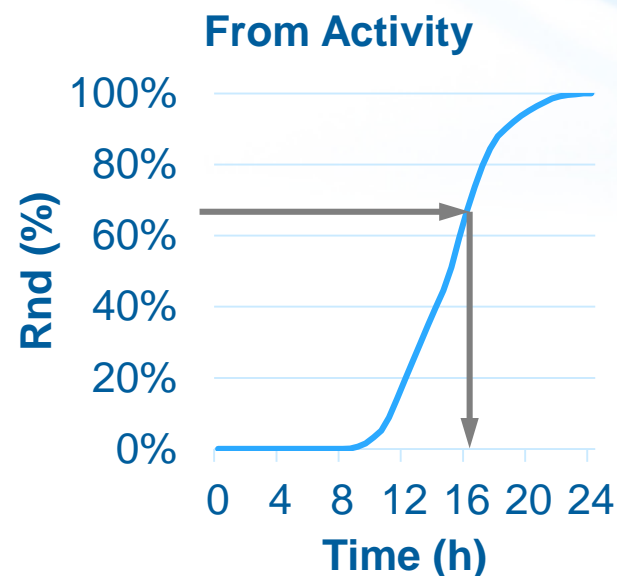




3. Individual Trips

Individual trip generation:

1. Departure to Activity
 2. Activity type
 3. Short Activities:
 - a) Activity duration
 - b) Distance to activity
 - c) Driving time to activity
 4. Long Activities:
 - a) Probability from activity
- } **2x**





3. Individual Trips

Individual trip generation:

1. Departure to Activity
 2. Activity type
 3. Short Activities:
 - a) Activity duration
 - b) Distance to activity
 - c) Driving time to activity
 4. Long Activities:
 - a) Probability from activity
 - b) Distance to activity
 - c) Driving time to activity
- Diagrammatic annotations: A bracket groups items b) and c) of the 'Short Activities' list with the label '2x'. Another bracket groups items b) and c) of the 'Long Activities' list with the label '1x'.

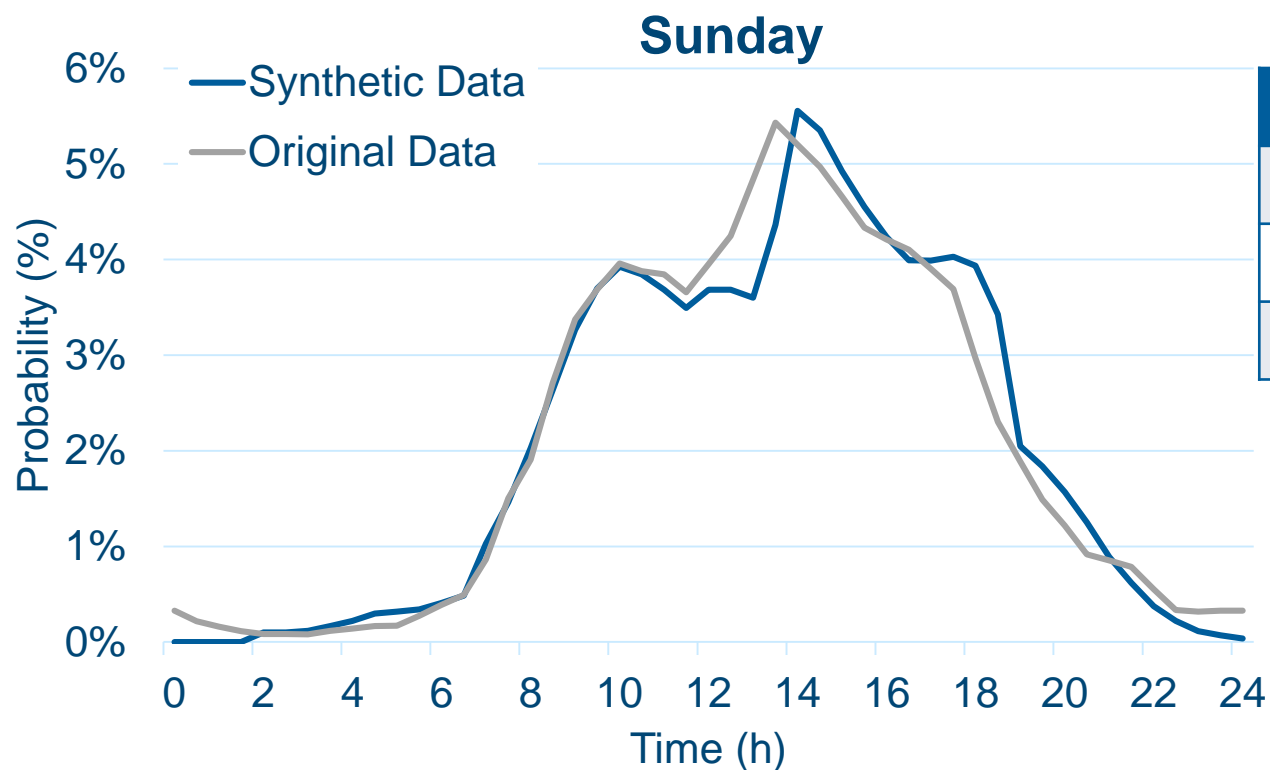
Activity-Type:	Departure from home:	Arrival back home:	Traveled Distance:
Recreation	13.8 h	16.4 h	3.2 km
Recreation	15.6 h	19.5 h	6.5 km
Work	6.8 h	17.3 h	57.2 km
Recreation	8.3 h	11.3 h	11.5 km
Shopping	7.3 h	9.4 h	0.8 km
Work	6.9 h	16.5 h	40.8 km



3. Individual Trips

Validation via average over 100.000 profiles

- Original vs Synthetic Data





4. Driving Profiles



4. Driving Profiles

Vehicle usage varies

- **Daily driving match according to probabilities**
 - Minimal time between trips \emptyset 30 min



Type:	Ave. Dist.
Workday	42.8 km
Saturday	32.8 km
Sunday	23.3 km

Data:	Yearly Dist.
Synthetic	14089 km
Original	14357 km

1.9% Difference



5. Charging Impact

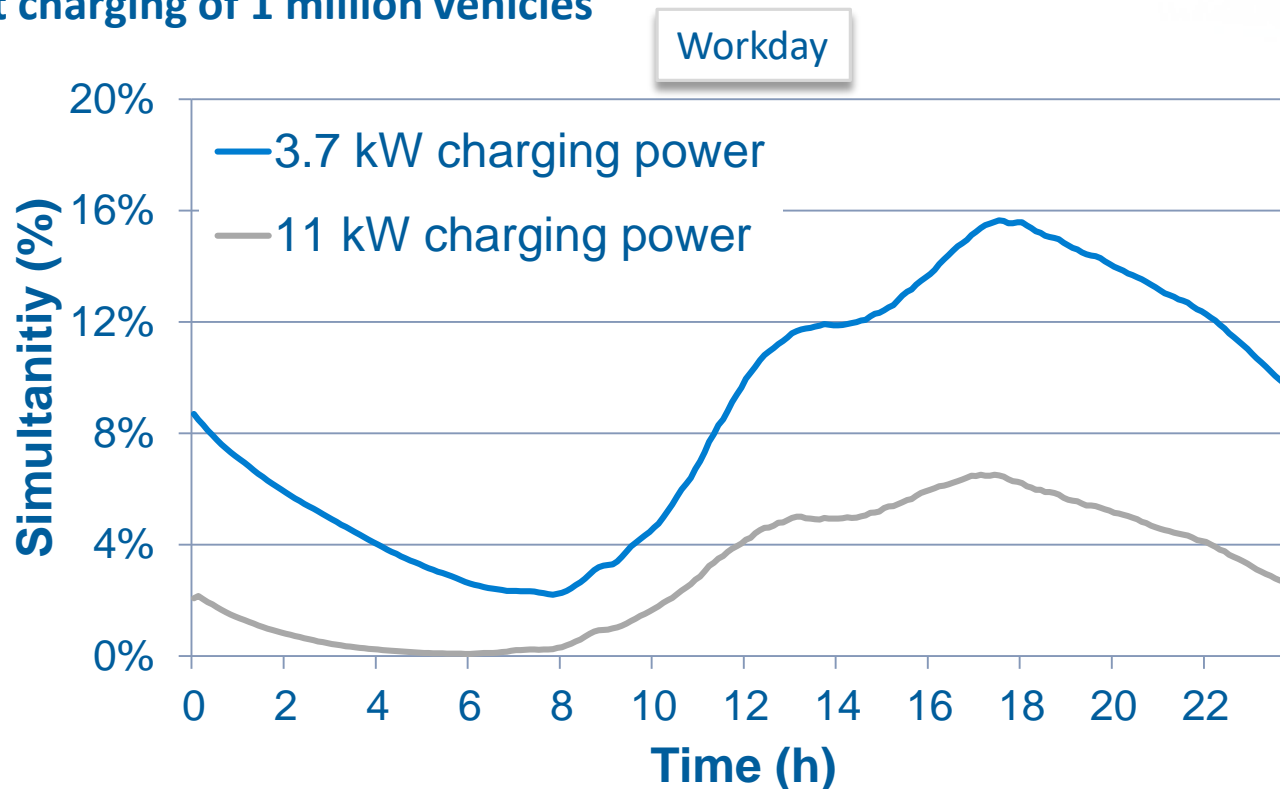


5. Charging Impact

Simultaneity factor:

- Percentage of vehicles charging at the same time

Direct charging of 1 million vehicles



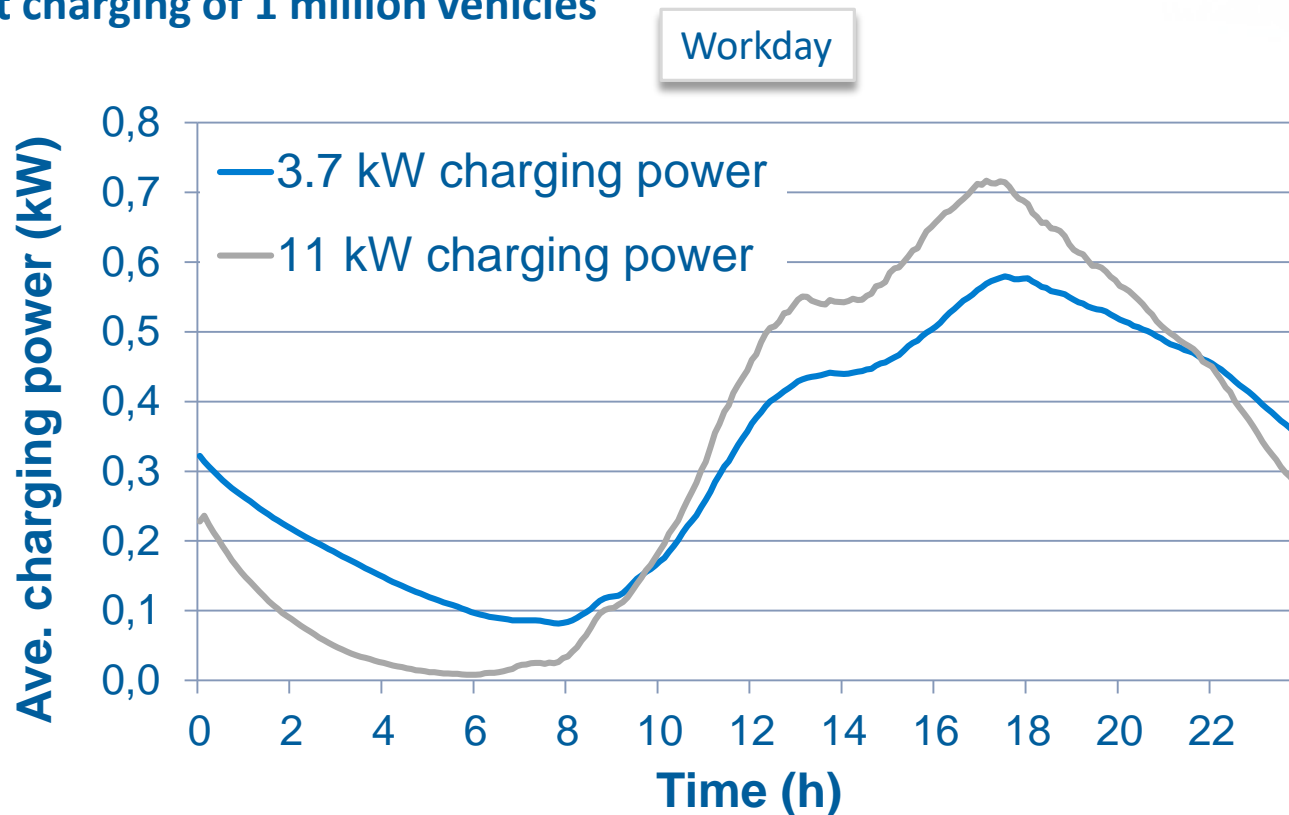


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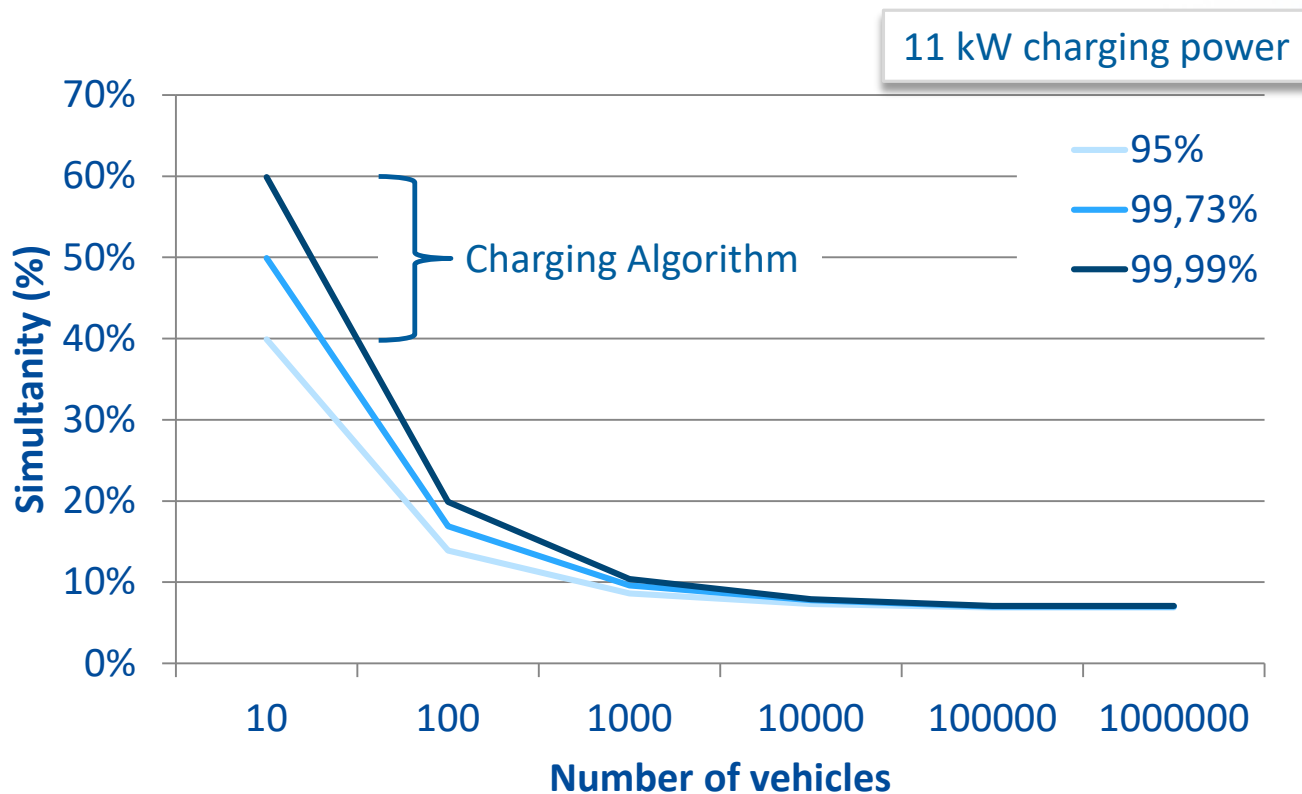




5. Charging Impact

Grid size dependencies

- Simultaneity increase in smaller grids
- Confidence interval necessary below 1000 vehicles





6. Conclusion



6. Conclusion

Design of deterministic driving profiles out of report data

Probabilistic evaluation of driving profiles show a reduced grid impact of EV's

Especially in smaller low voltage grids EV integration could lead to high expansion costs (Confidence Interval)

Intelligent charging algorithms could EV grid impact



Thank you for your attention!