Probabilistic Modeling of Charging Profiles in Low Voltage Networks

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Agenda

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1. **Introduction**

2. **Individual Driving Profiles**
   - Derivation of Probabilities
   - Individual Trips
   - Driving Profiles

3. **Charging Impact**

4. **Conclusion**

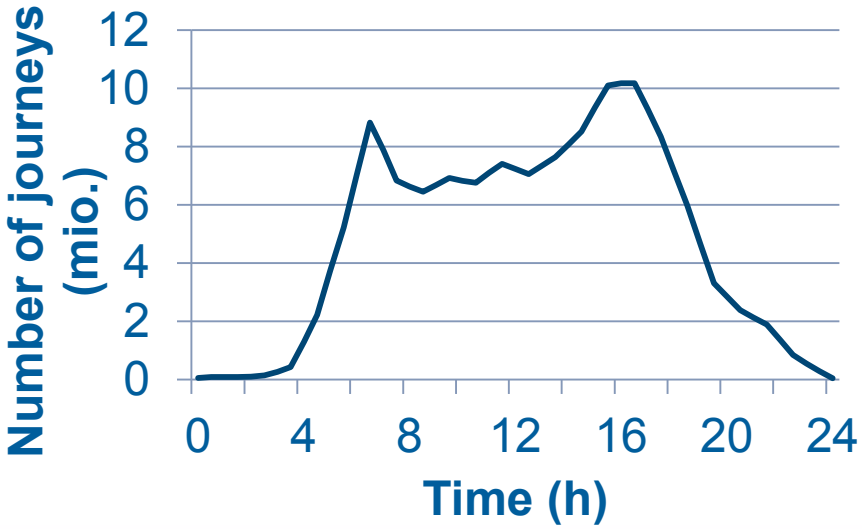
1. Introduction

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

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Probabilities for trips to and from activity needed for driving profiles

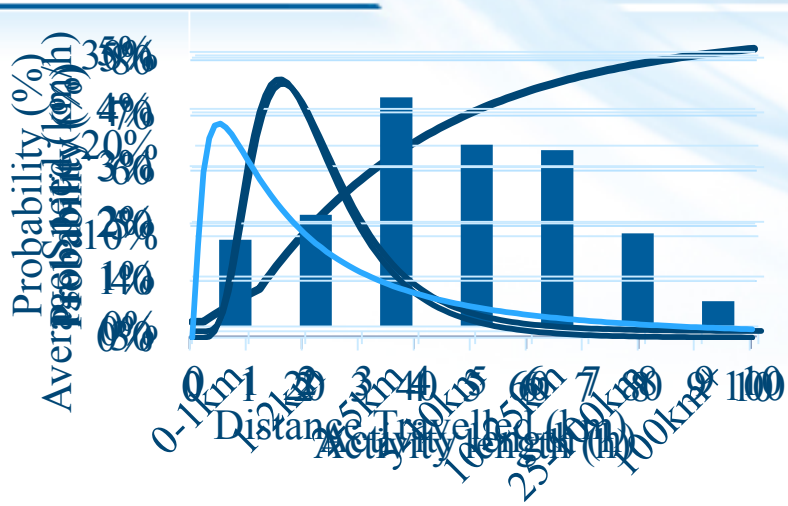
Activity depended derivation:

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



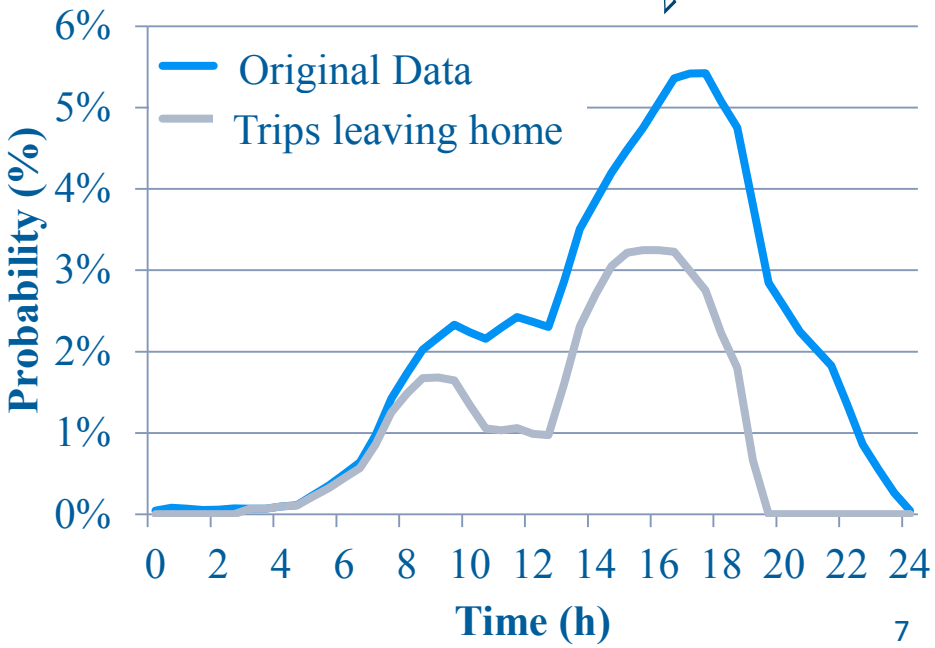
Method:

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

All departing vehicles –

Returning vehicles =

Vehicles departing from home



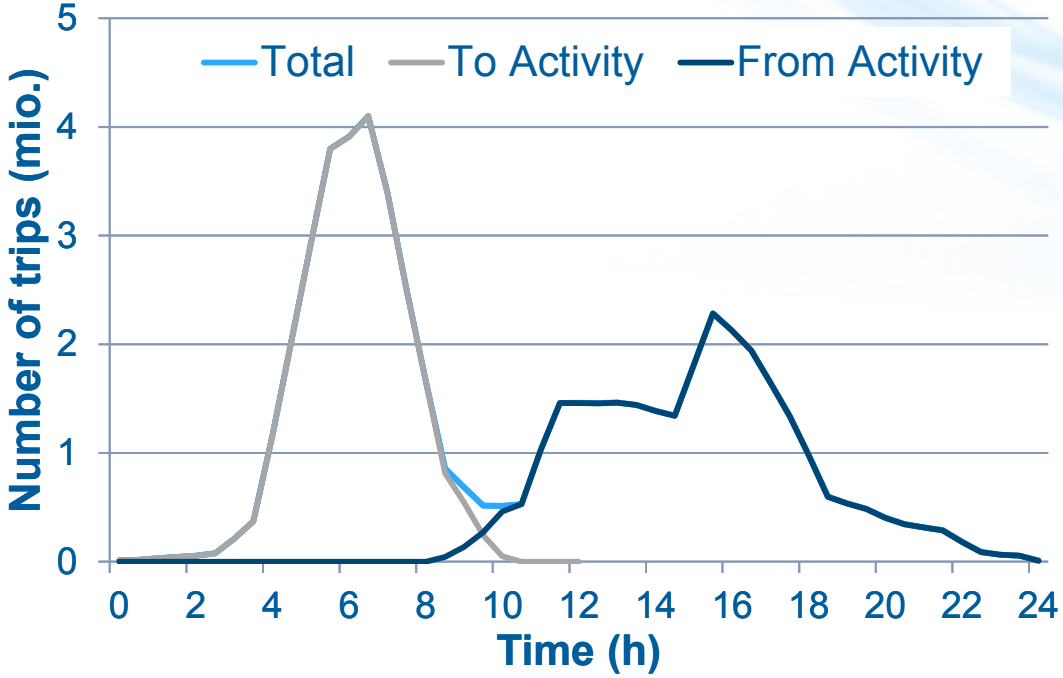
2. Derivation of Probabilities

Long activity length:

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

Recursive trip match:

- Ø 4h min. activity time
- Ø 12h max. activity time



3. Individual Trips

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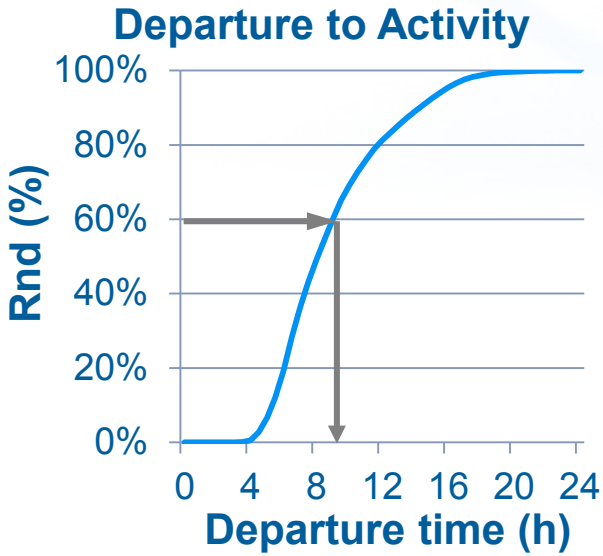
Individual trip generation:

1. **Departure to Activity**



3. Individual Trips

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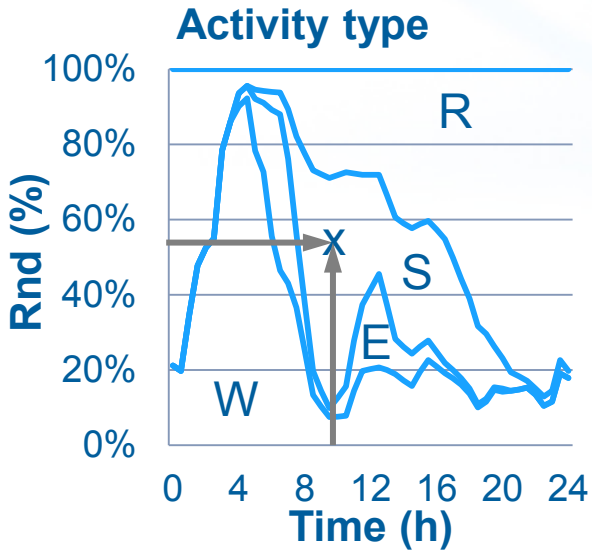
Individual trip generation:

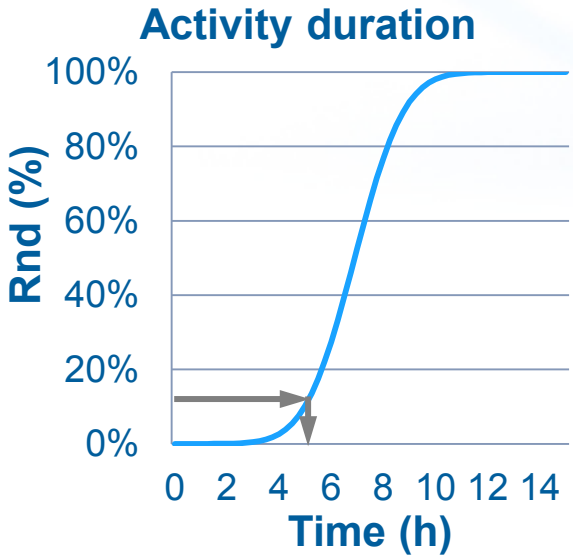
1. **Departure to Activity**
2. **Activity type**



3. Individual Trips

Individual trip generation:

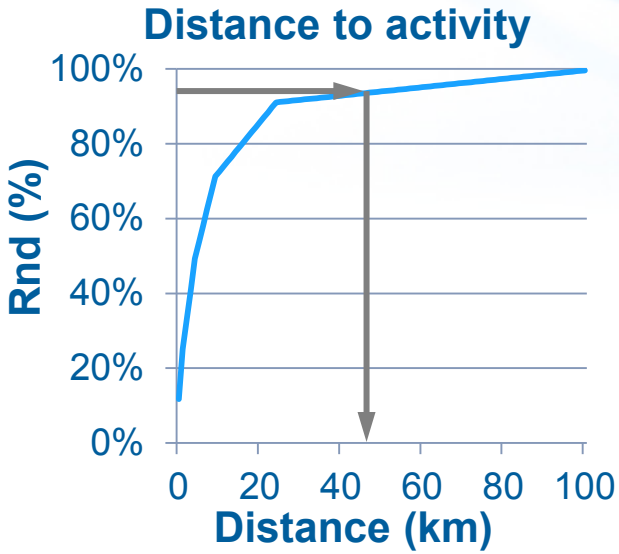
1. **Departure to Activity**
2. **Activity type**
3. **Short Activities:**
   a) **Activity duration**



3. Individual Trips

Individual trip generation:

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

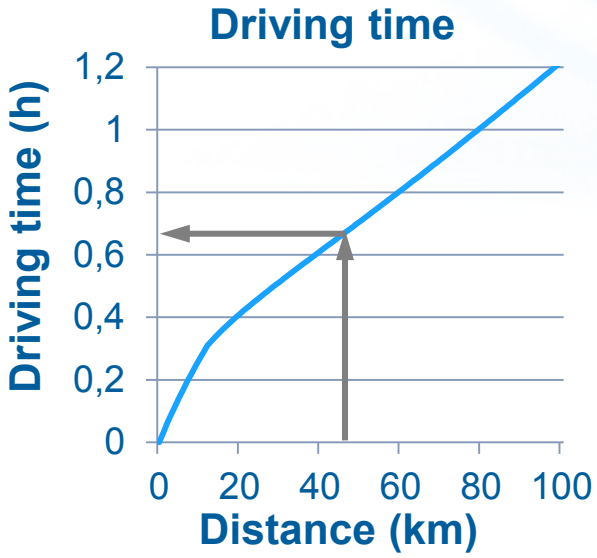


3. Individual Trips

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

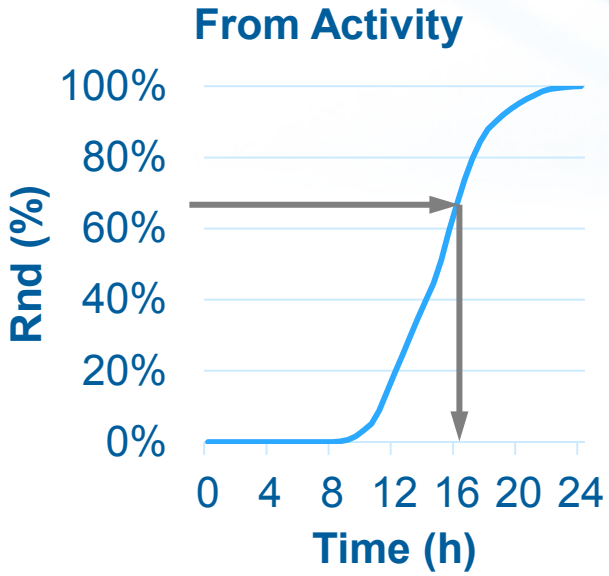


3. Individual Trips

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**

   } **2x**
4. **Long Activities:**
   a) **Probability from activity**



3. Individual Trips

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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**
4. **Long Activities:**
   a) **Probability from activity**
   b) **Distance to activity**
   c) **Driving time to activity**

   } **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

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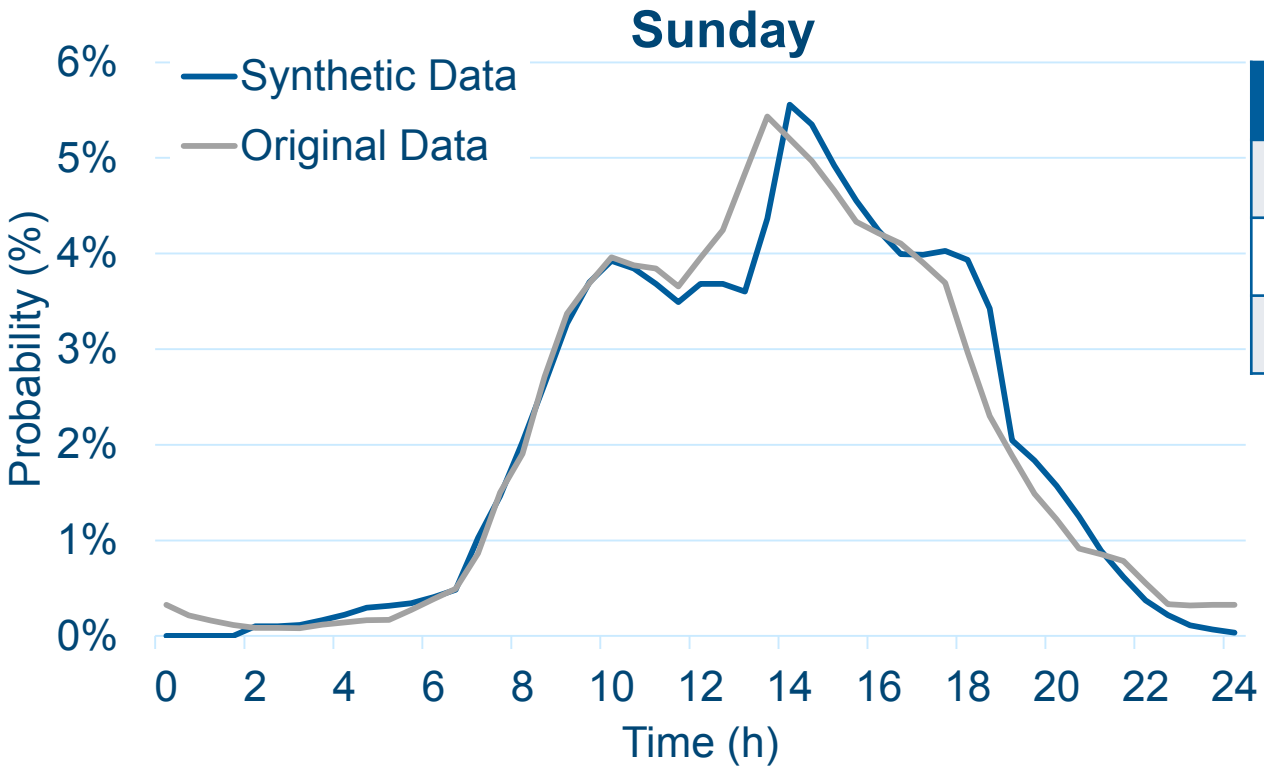
Validation via average over 100.000 profiles

- **Original vs Synthetic Data**



DAY	ST-D
Workday	0.14%
Saturday	0.25%
Sunday	0.38%

4. Driving Profiles

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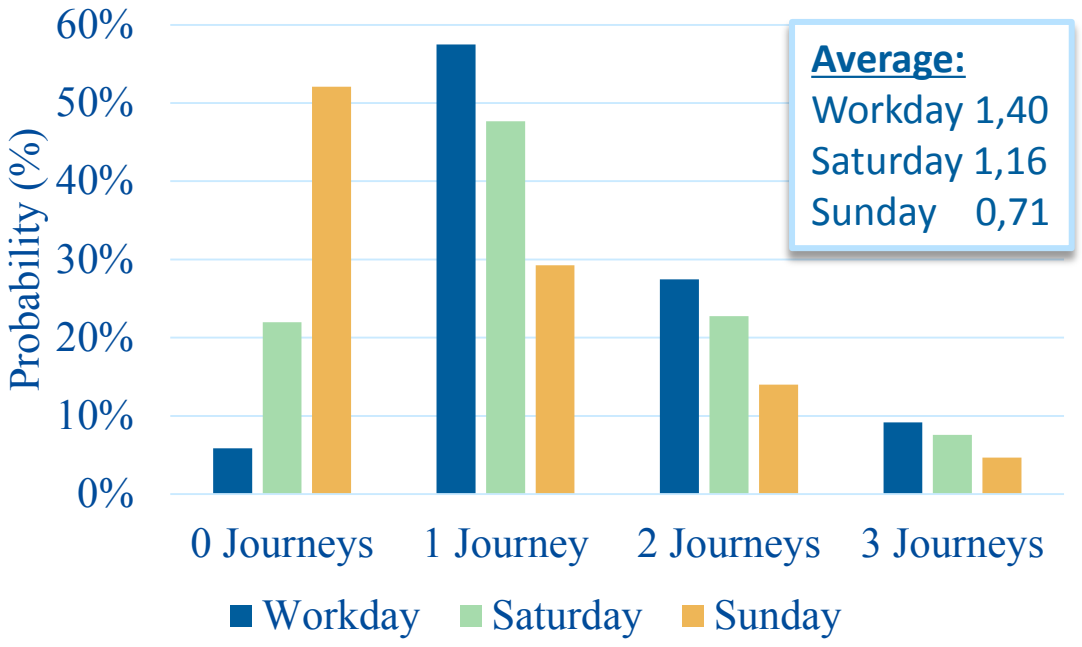
Vehicle usage varies

- **Daily driving match according to probabilities**
  - Minimal time between trips Ø 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

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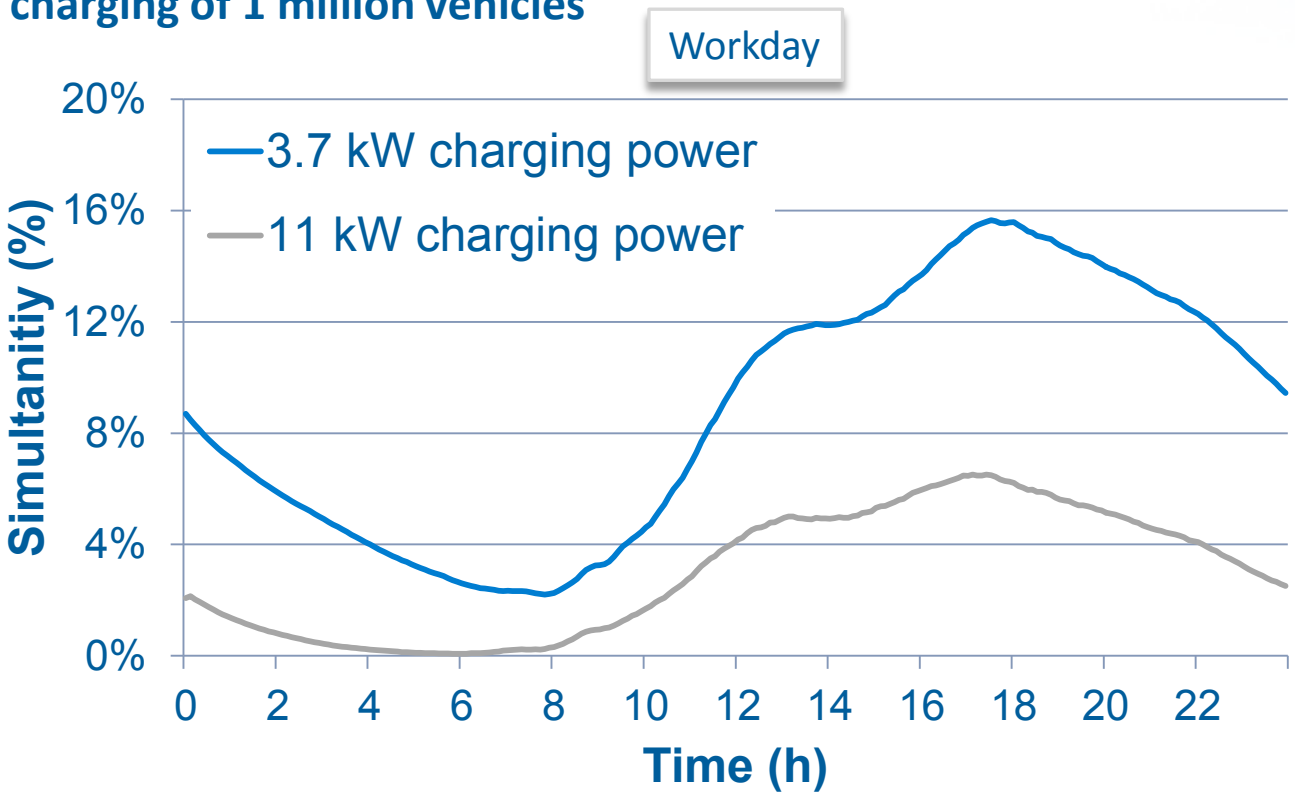
Simultaneity factor:

- **Percentage of vehicles charging at the same time**

Direct charging of 1 million vehicles



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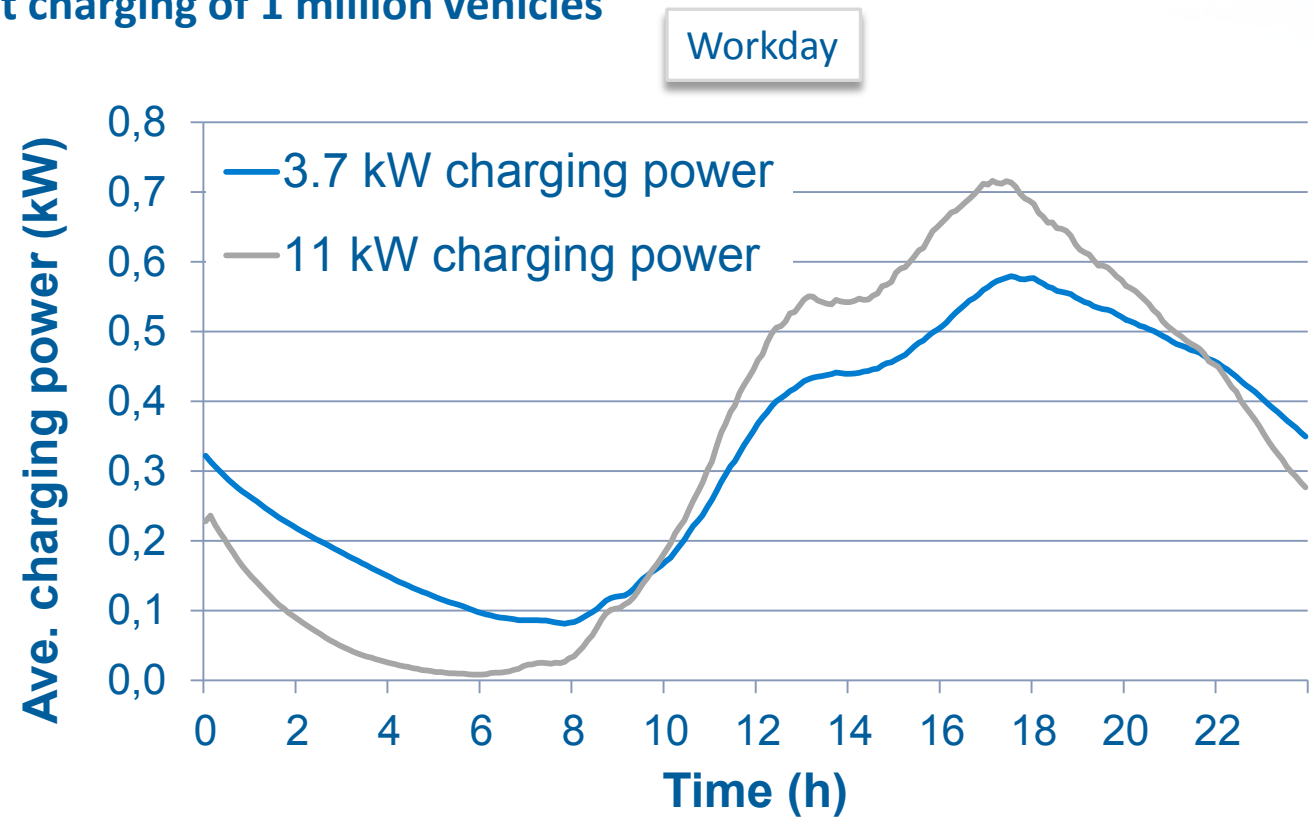

5. Charging Impact

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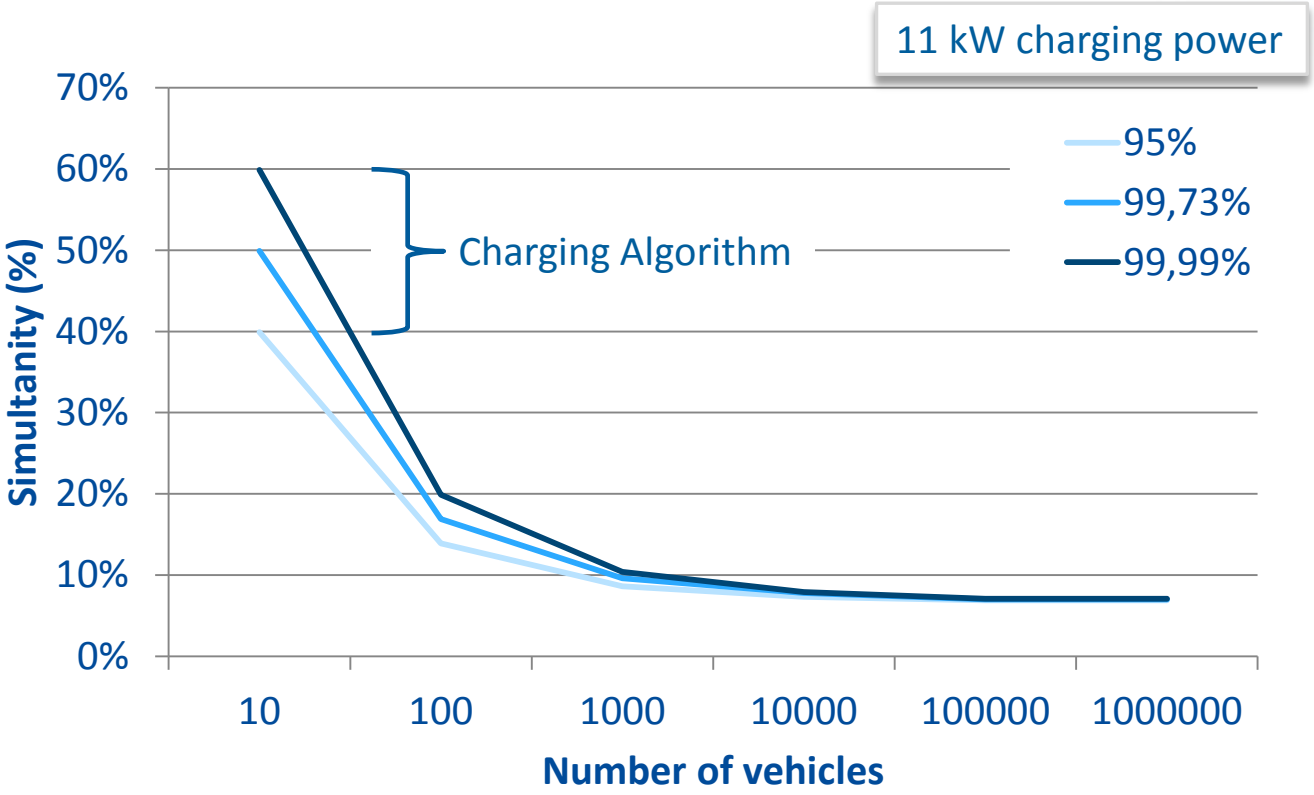
Grid size dependencies

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



6. Conclusion

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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

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Thank you for your attention!