Modelling the plug-in availability and calculation of energy storage potential of electric vehicles in Germany

Niklas Hartmann

Özdemir, E. D., Goyns, P. H., Eltrop, L.

Institute of Energy Economics and the Rational Use of Energy ,

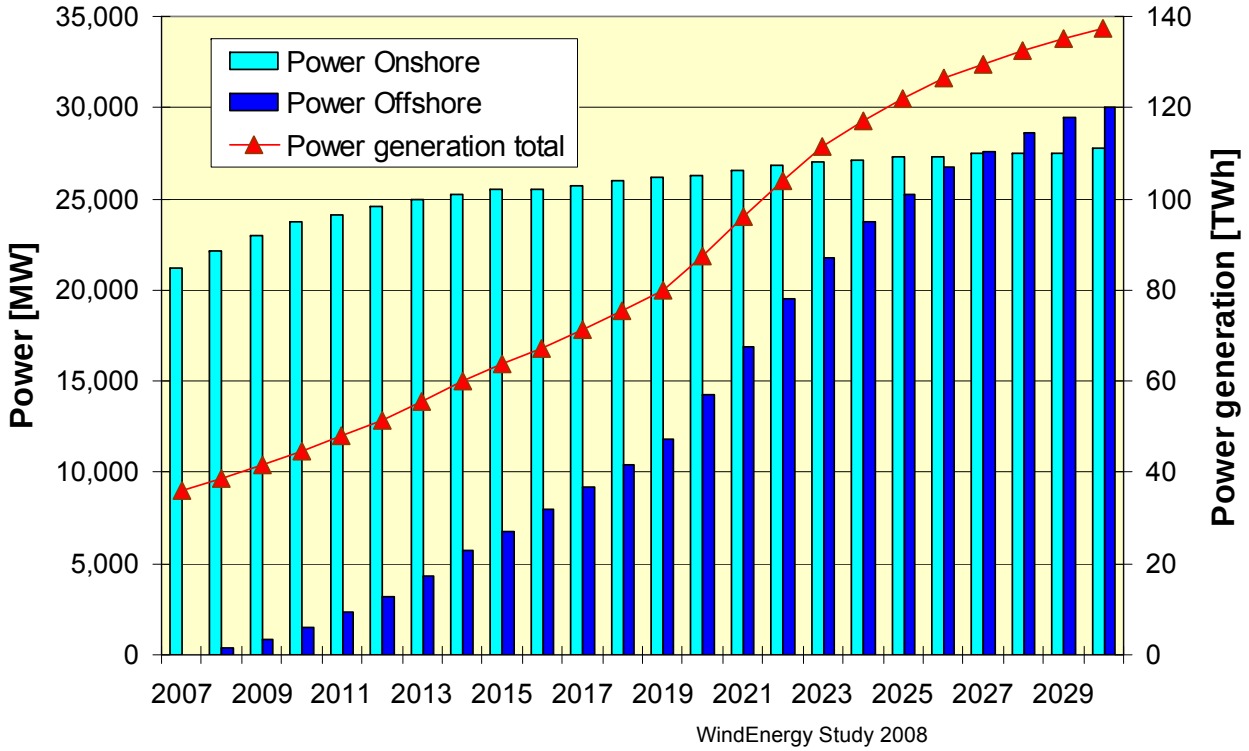
University of Stuttgart

17.06.2009

- Introduction
- Approach
- Simulation results
- Summary and conclusion

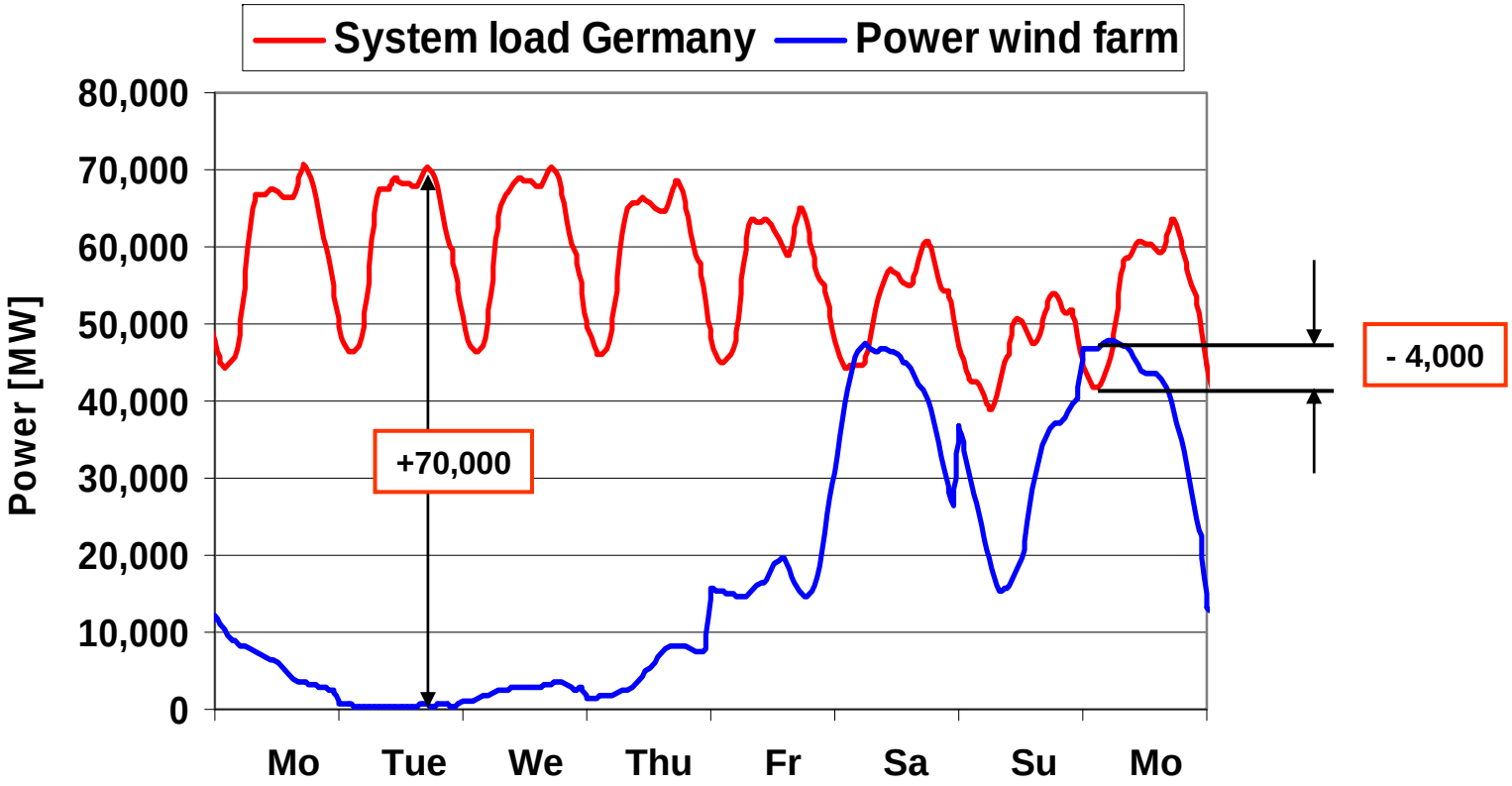
- **Introduction**
- Approach
- Simulation results
- Summary and conclusion

- Aim in Germany to produce 20-30% of the electrical generation capacity with renewable energies in the year 2030.
- A massive offshore development of wind farms is unavoidable to reach the goal.
- In the year 2030 the installed wind power (onshore and offshore) will rise to about 65 GW in Germany



The main challenge is to integrate the fluctuating wind power into the grid.

Fluctuations of 65 GW Wind energy compared to the system load in Germany in 2030.



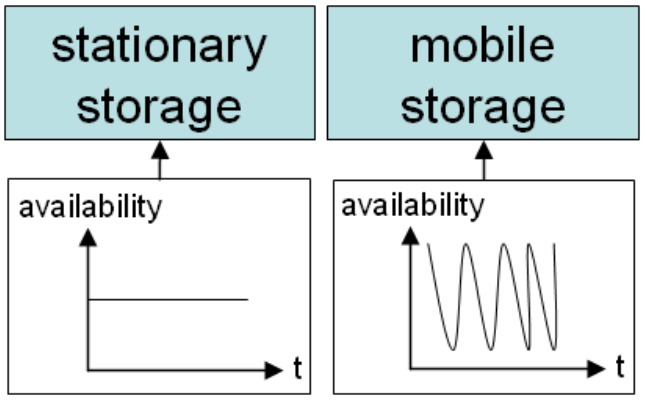
The main challenge is to integrate the fluctuating wind power into the grid.

- Storage facilities can balance the fluctuating character of renewable electricity generation.
- Stationary storage is available basically throughout the day

  e.g. pumped hydro, compressed air, stationary battery
- Mobile storage systems are only available when they are connected to the grid

→ When is the mobile storage available to the grid?

→ How big is the storage potential?



- Introduction
- **Approach**
- Simulation results
- Summary and conclusion

Basic assumptions for the calculation

- A vehicle which is standing is plug-in available
- Calculations are preformed in hourly time steps
- Data from the survey “Mobilität in Deutschland”
- Vehicles can be charged within one hour

Assumptions for the scenario:

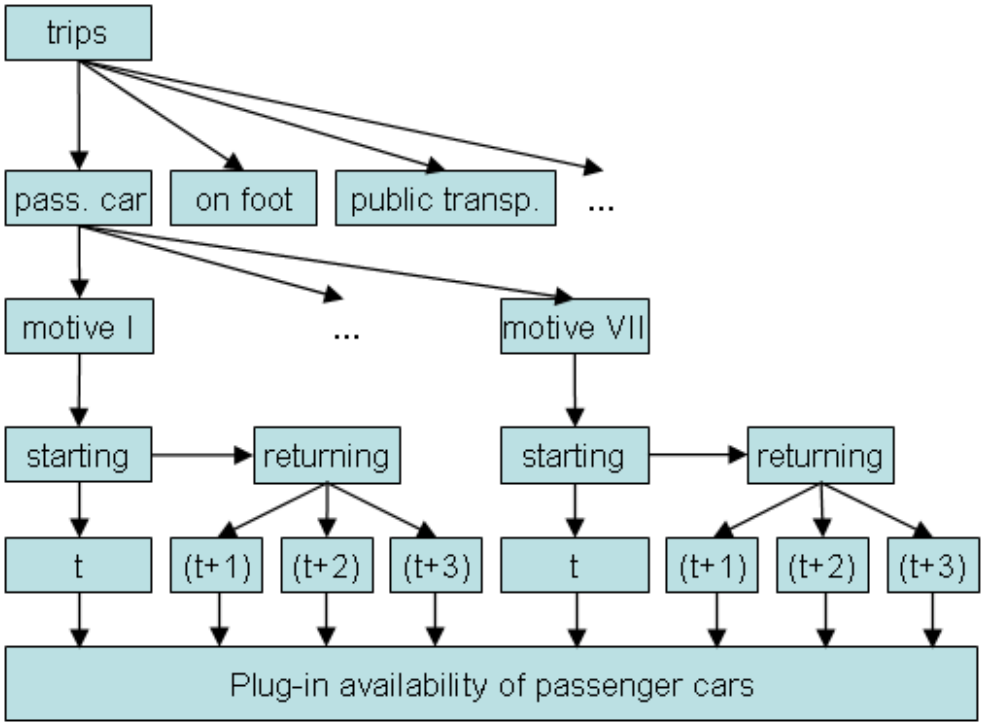
- Maximum trip distance a vehicle drives per day is equivalent to 123 km
- DoD and aging of battery is included
- Electricity consumption of an electric vehicle is set to 0.51 MJ/vkm

Plug-in availability of passenger vehicles in Germany

- Division into different modes of transport

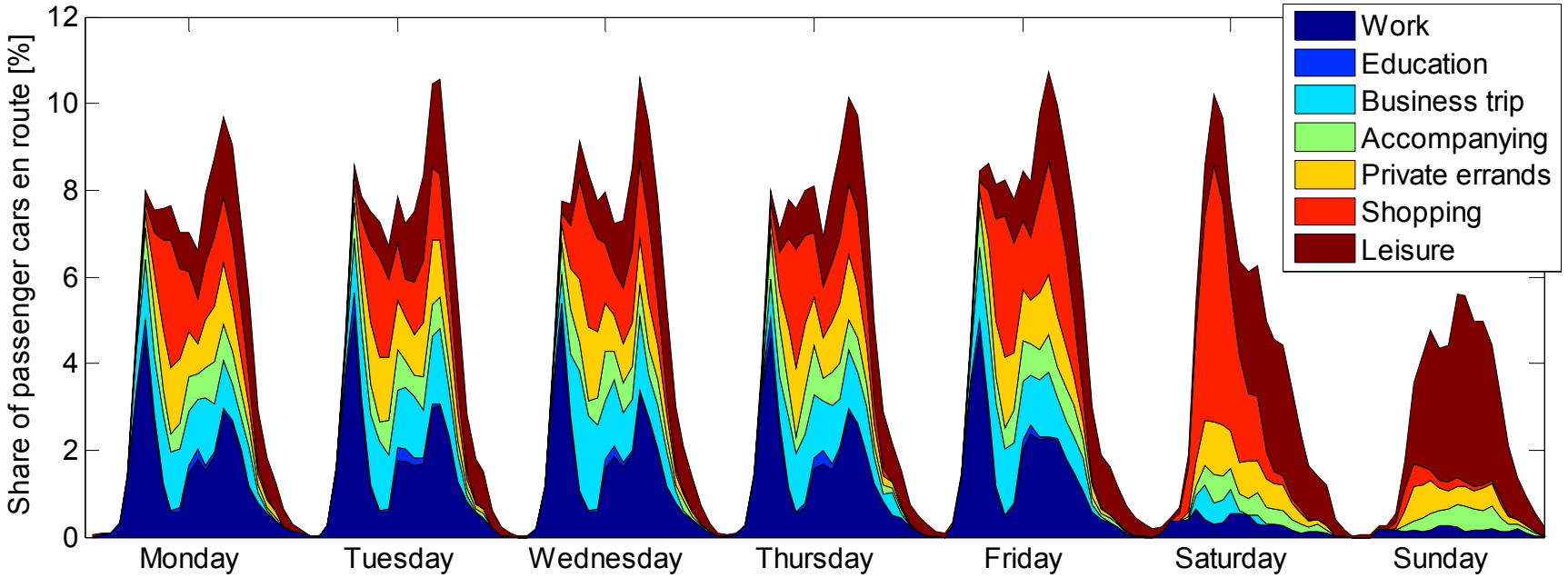
In Germany:

- About 80 Mio people and
- about 46 Mio passenger vehicles



- Introduction
- Approach
- **Simulation results**
- Summary and conclusion

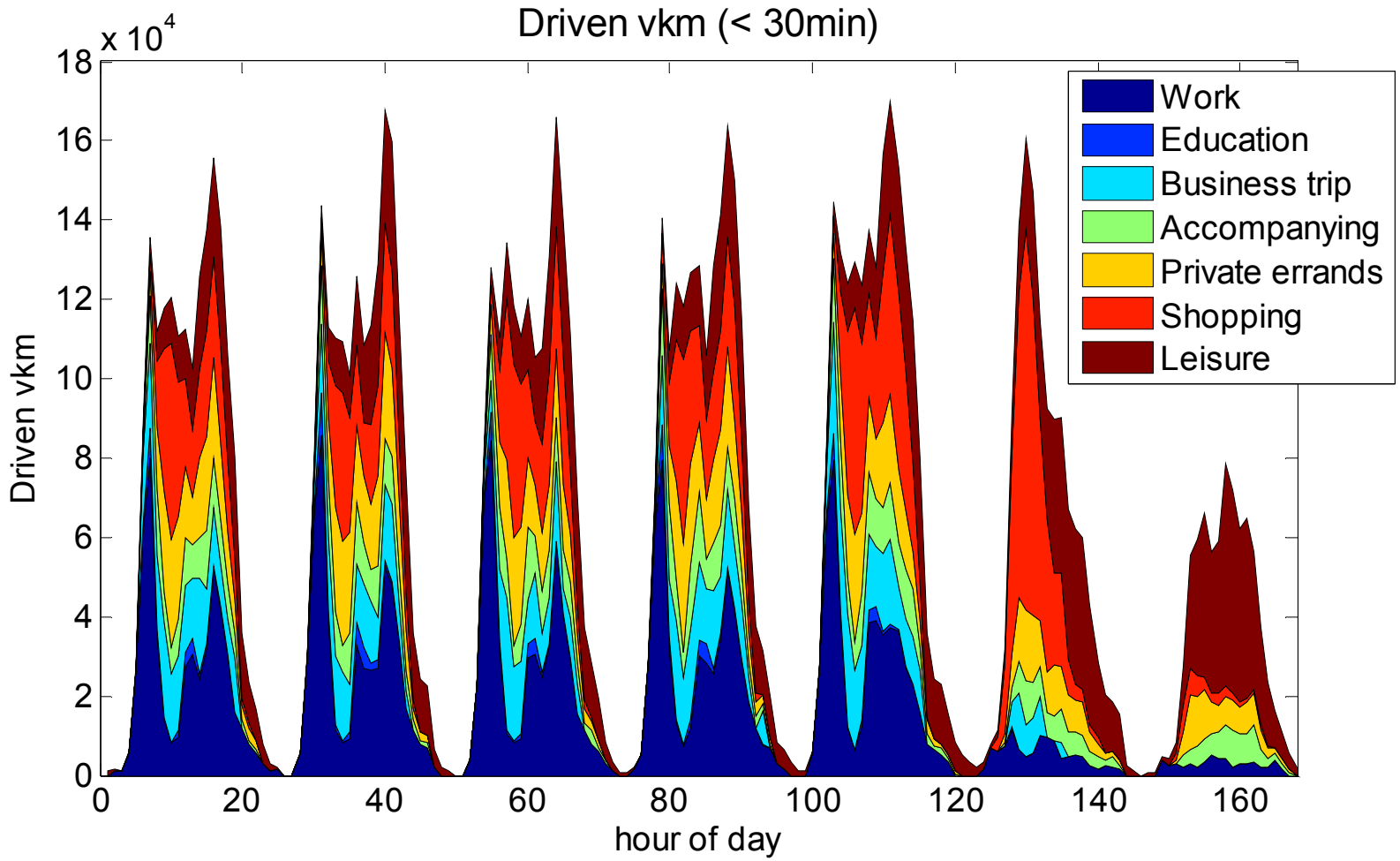
Share of passenger cars en route of an average week



- Maximal 11% of passenger cars en route at the same time.
  Peak in the afternoon at around 4 pm.
- Saturdays the peak shifts to the morning (10 am), due to shopping trips
- On Sundays most trips are performed with the motive „leisure“

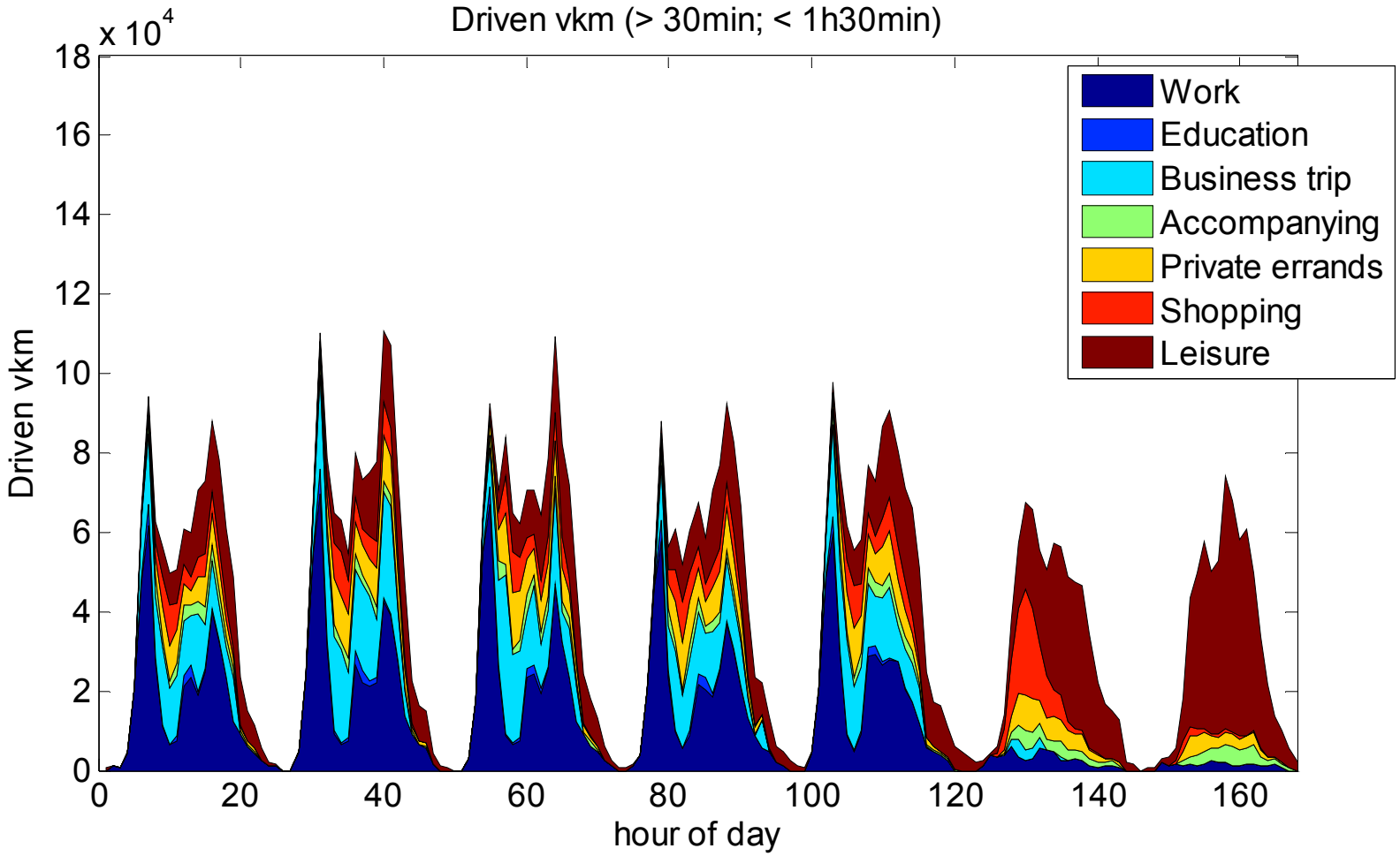
plug-in availability in Germany is high at any time over the day (> 89 %)

Driven vkm of 100,000 passenger cars for an average week



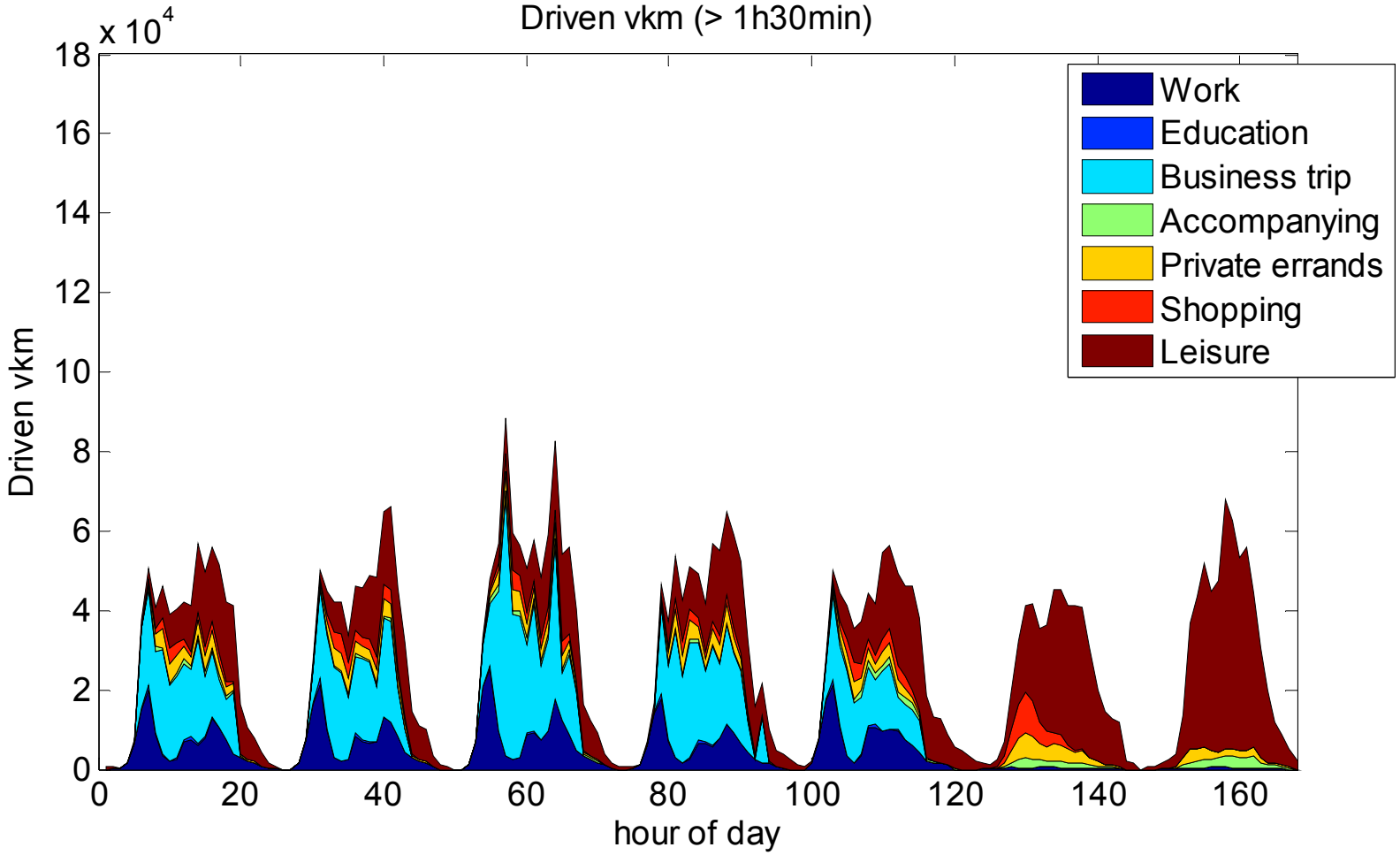
High amount of vkm with the motive “Work” and “Shopping”

Driven vkm of 100,000 passenger cars for an average week



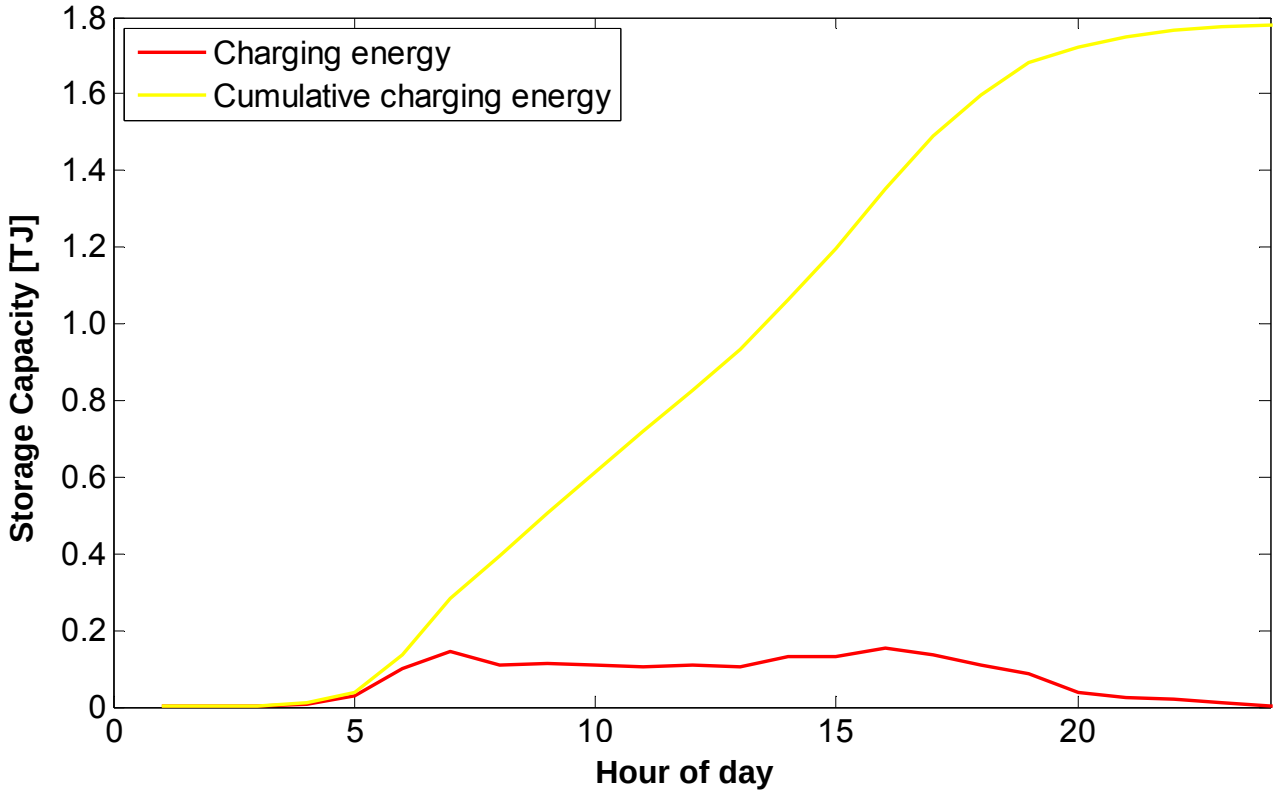
High amount of vkm with the motive “Work” and “Leisure”

Driven vkm of 100,000 passenger cars for an average week



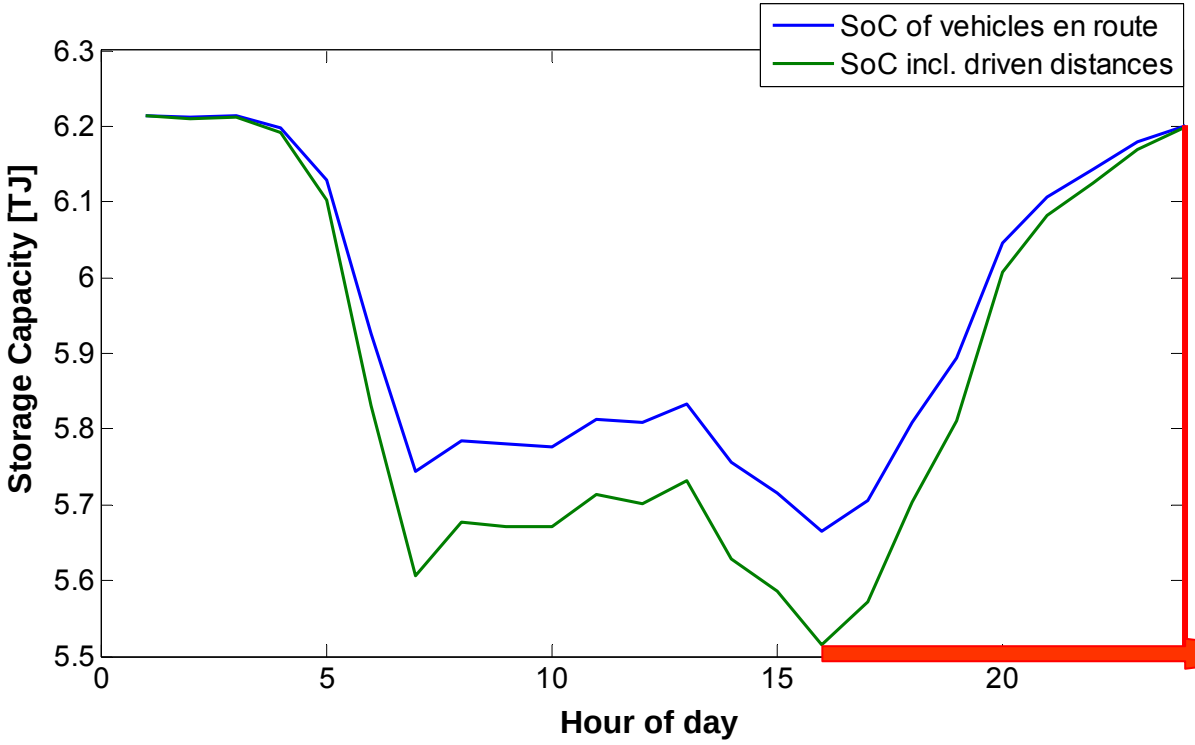
High amount of vkm with the motive “Business trip” and “Leisure”

Charging energy of 100,000 EVs for an average weekday



About 1.8 TJ charging energy is needed over an average day

Storage capacity of 100,000 EV in Germany during the day (average weekday)



- 100.000 EVs account for a storage potential of about 6.2 TJ, with a variation of about 10 %
- Incl. the driven distances, a variation of 12 % over the day

The potential for delaying the charging of the vehicles into the night and therefore providing grid service in the afternoon and night will is large

↳ Maximum trip distance equivalent to 123 km

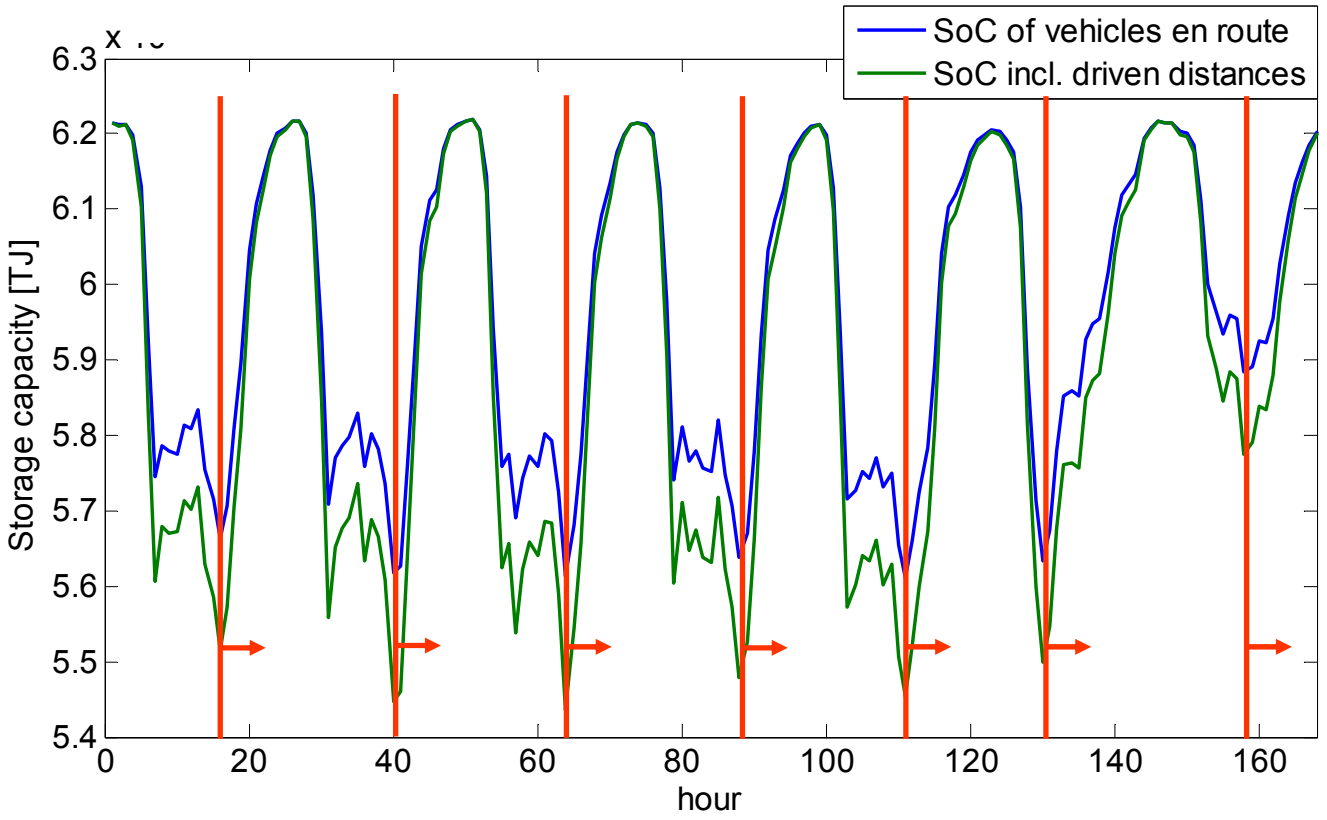
↳ Electricity consumption is set to 0.51 MJ/vkm

↳ Storage capacity of 62 MJ per electric vehicle

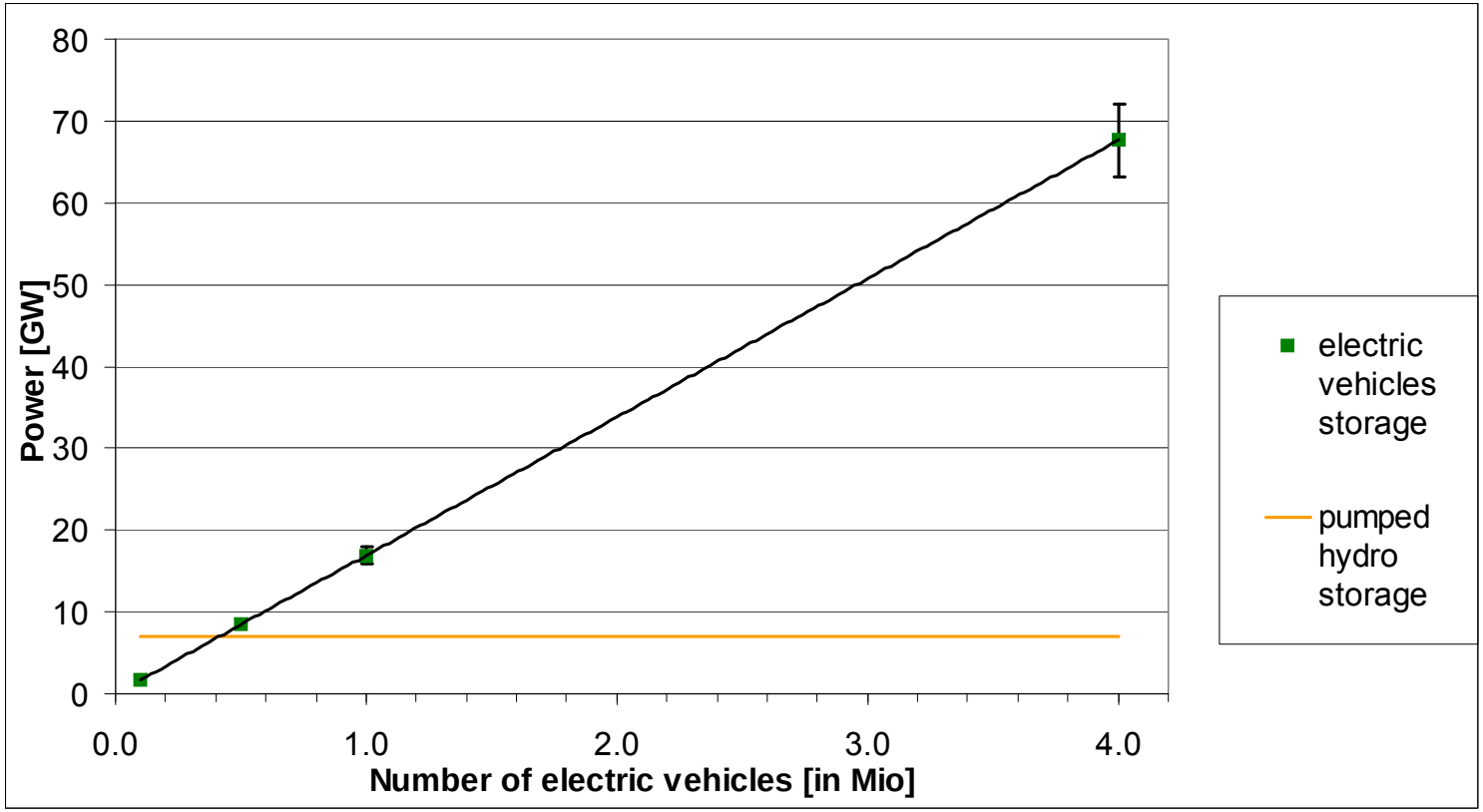
Energy consumption of 100,000 EV in Germany during the day (average week)

Large potential due to time

Large potential due to charging energy



Storage power of electric vehicles in Germany



- About 400,000 electric vehicles would have the same storage power than the installed pumped hydro storage power of Germany
- 4 Million EVs have a storage power 10 times the installed pumped hydro storage power

- Introduction
- Approach
- Simulation results
- **Summary and conclusion**

Low daily variation of passenger cars en route (< 11%) but difference between weekdays Saturdays and Sundays.

- On weekdays a maximum of 11 % of passenger cars are en route (at 4 pm)
- On Saturdays the peak shifts to the morning (at 10 am)
- On Sundays about only about 6 % of passenger cars are en route

Large potential for grid service

- Large storage capacity which is plug-in available
- Potential for delaying the charging of the vehicles into the night

High potential for a big storage power

- About 400.000 EVs in Germany would have a storage power of about the installed pumped hydro storage power of today.


Thanks to the Reiner Lemoine Foundation in Germany for supporting the work
Thanks for your attention!