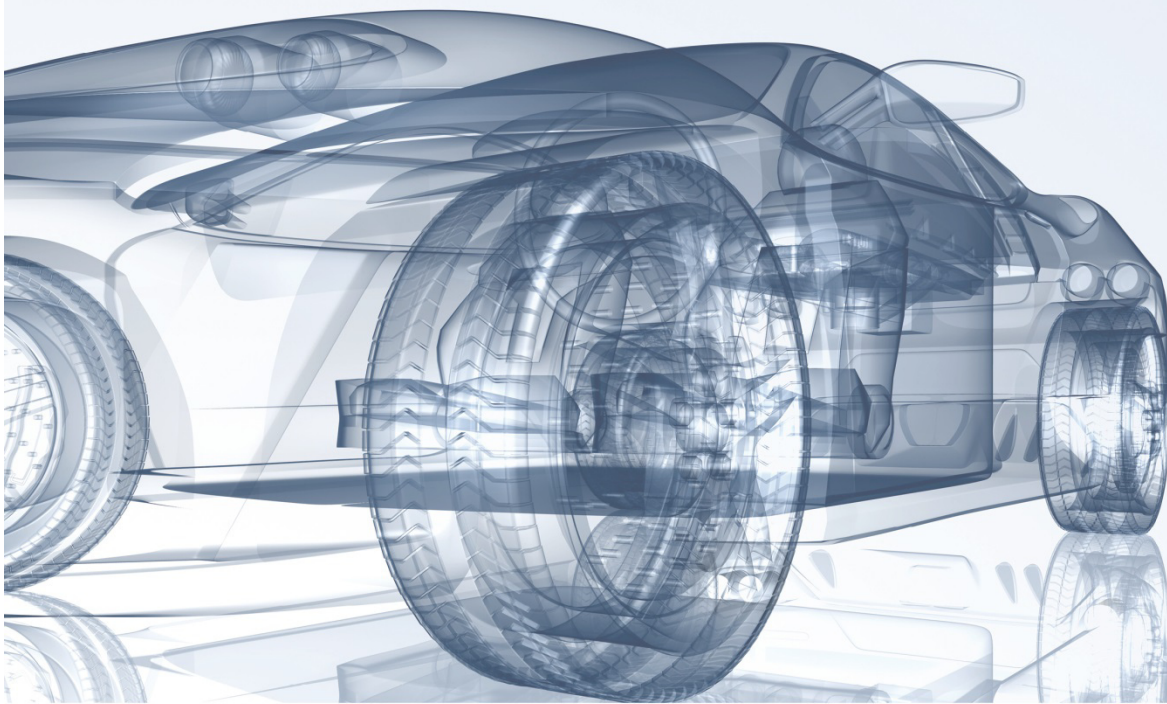


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Electrification of Transport by Renewables

Acknowledgements/Authors

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- Dr.-Ing. Frank Mayer, Head of Department Storage and Energy Management, Wobben Research and Development GmbH

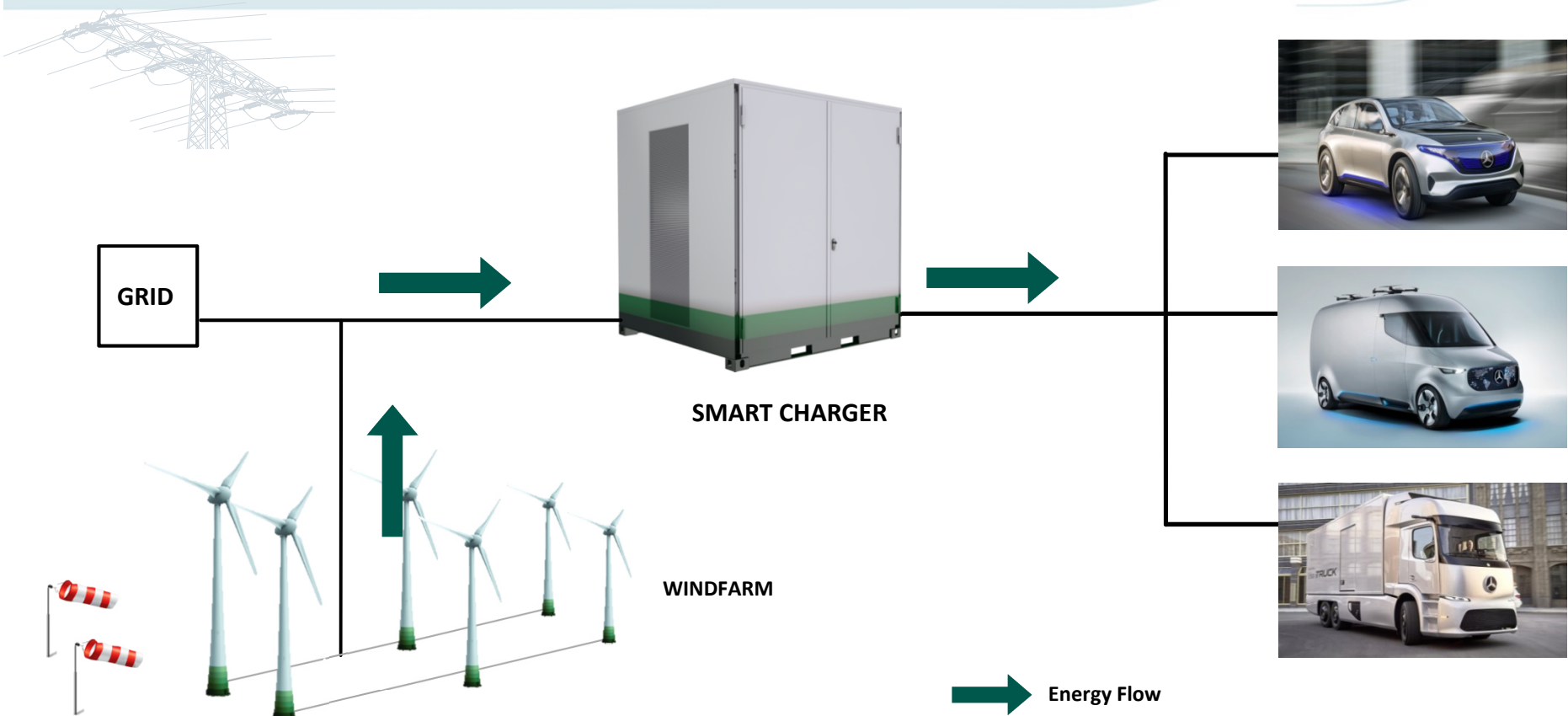
Electrification of Transport by Renewables

Agenda

- Motivation / Vision
- Availability of Renewable Sources
- Typical use patterns of Car Drivers
- Charging options today and in the future
- Grid voltage support by Charging Station
- Different strategies of a Charging Station with FACTS
- Power Management in the Charging Station
- Additional use of Buffer Storage
- Investment aspects for Charging Infrastructure
- Conclusions and Outlook

Electrification of Transport by Renewables

Motivation – Wind Power into the Transport Sector



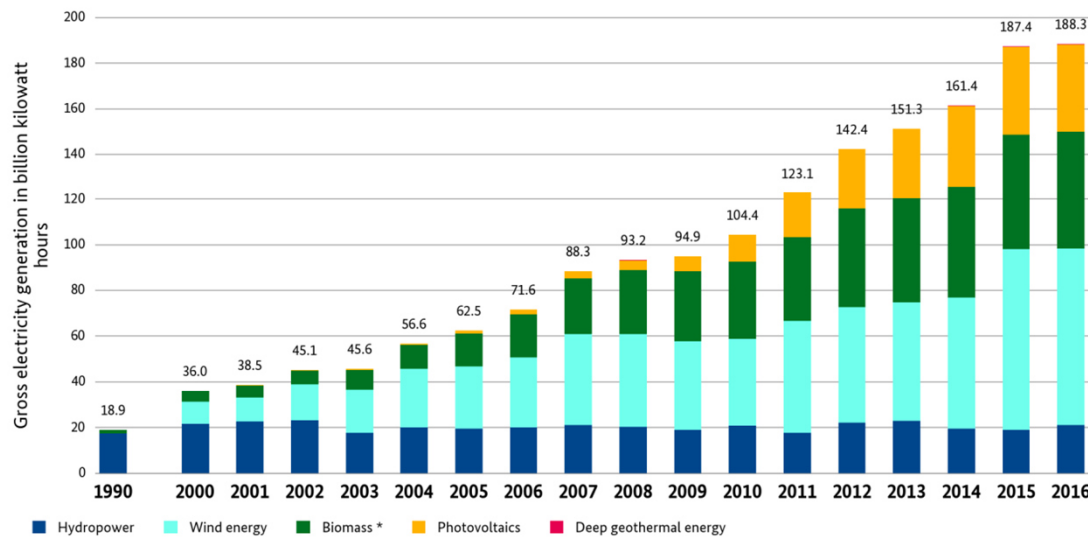
Presenter: Dr.-Ing. Frank Mayer, WRD GmbH

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Availability of Renewable Sources



Development of renewables-based electricity generation in Germany



* incl. solid and liquid biomass, biogas incl. biomethane, sewage gas and landfill gas as well as the biogenic fraction of waste, from 2010 incl. sewage sludge; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2017; all figures provisional

wind energy contributes 12% to Germany's electricity production

13 % of the area of Germany is suited for wind energy (equals 2.900 kWh/a)

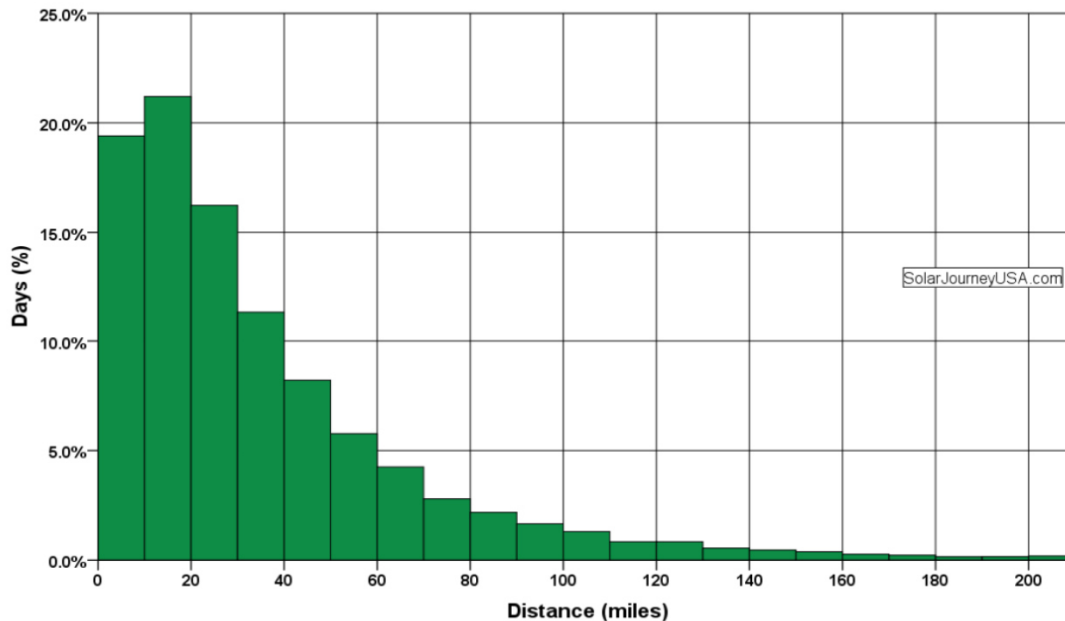
app. 550 TWh/a electricity today
transport sector add. 650 TWh/a
=> switch is possible!

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Typical use patterns of Car Drivers



U.S. Daily Driven Distance Distribution for Cars (n = 179,484)



93 % of driven distances
< 100 miles / 160 km

BUT

purchasing decision also dependant
on usability for long distance drives

=> **obvious demand for
real fast charging opportunities**

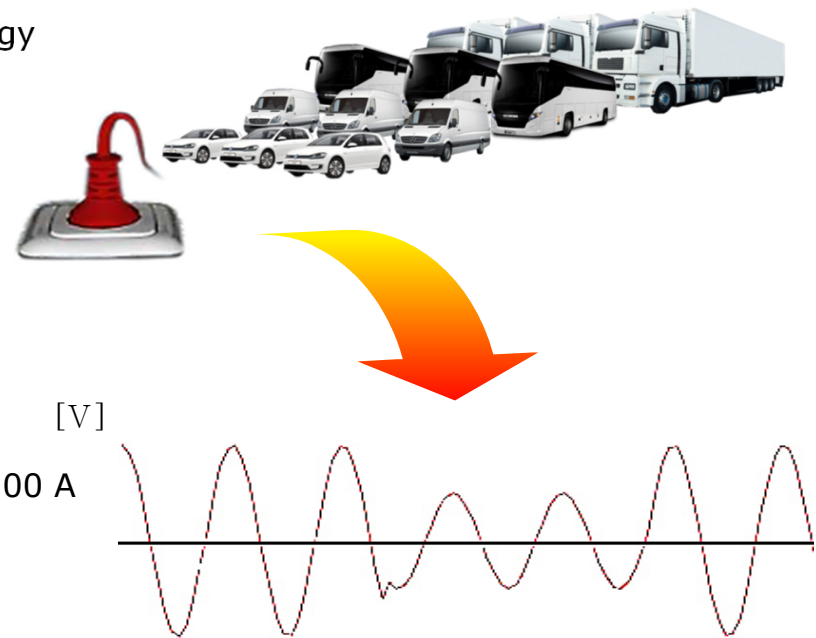
This is mostly analysed for private sector – especially for company / shared and rental cars
and for the industrial sector, additional use patterns will have to be fulfilled

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Charging options today and in the future



- proprietary network of Californian OEM „Super Charger“; 120 kW
 - => app. 10.000 end of 2017
 - => key component for a successful sales strategy
- public charging posts AC, max. 43 kW
 - => charging times typically > 1h
 - => on-board „Charger“ required
- public charging posts DC; 22 kW, 50 kW
 - => charging times typically > 1h
 - => CHAdeMO limited to 60 kW
 - => CCS possible with up to 1.000 V and up to 500 A
- charging posts of up to 350 kW are announced (HPC2)
 - => challenge for grid operators

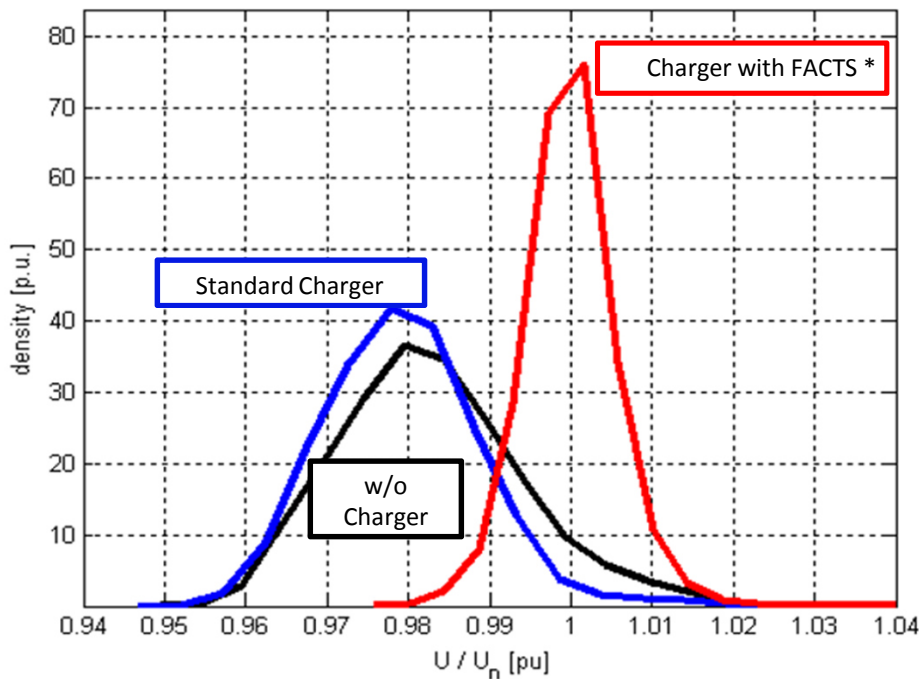


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Grid voltage support by Charging Station



Voltage behaviour on a medium voltage grid in different scenarios



Source: "GridSurfer" joint research project supported by German Government (BMW)

typical shift of nominal voltage in rural areas due to inductive behaviour of cables and loads

implementation of a standard charger would even worsen the scenario (especially high number of HPC2 Chargers)

Charger with FACTS* functionality can improve nominal voltage behaviour e.g. by feeding reactive power to the grid

* FACTS = Flexible AC Transmission System

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Different strategies of Charging Station with FACTS



The applied inverter technology – used in WEC (Wind Energy Converters) for > 30 years – **offers the following advantages**

- „smooth“ and balanced drawing of power from the grid (full converter with active front-end)
- current flow from supply grid is nearly sinusoidal, to minimize harmonic effects
- reactive power can be fed into the grid in parallel
- power reduction of the charger on demand of the grid operator (controlled load)
- avoid additional challenge of uncontrolled loads (add. to decentralized power generation)
- dimensioning of grid according to worst case maximum power demand not required
- optimum use of available power in the relevant grid area
- grid expansion can be avoided

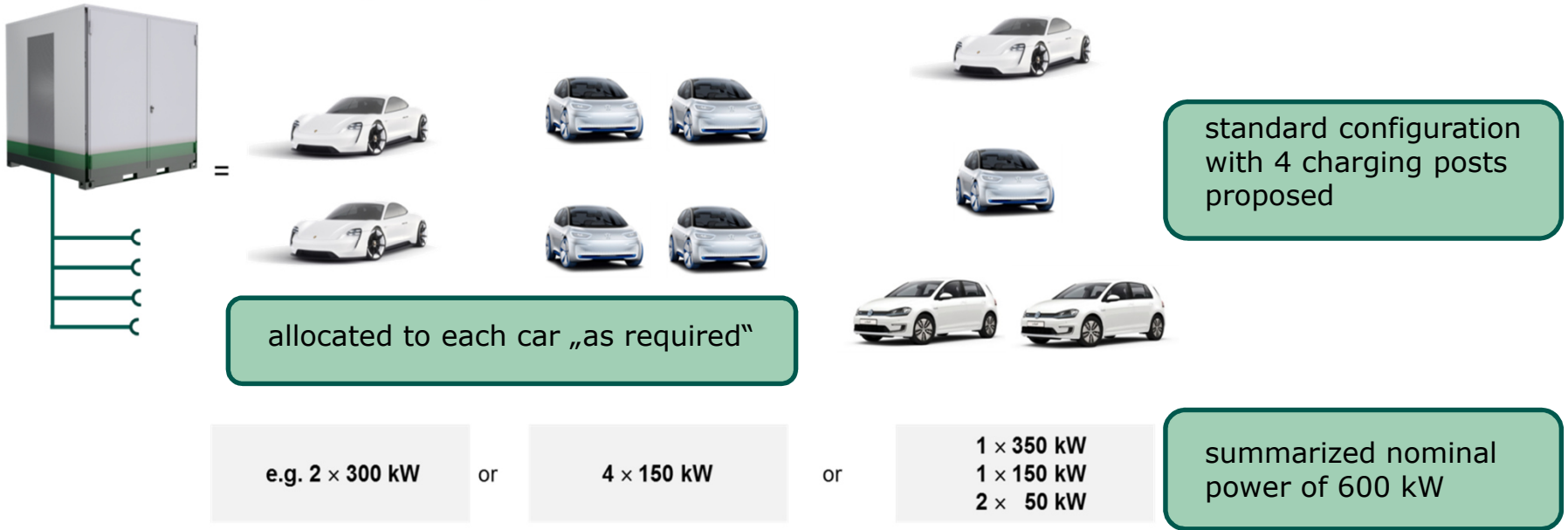
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Power Management in the Charging Station



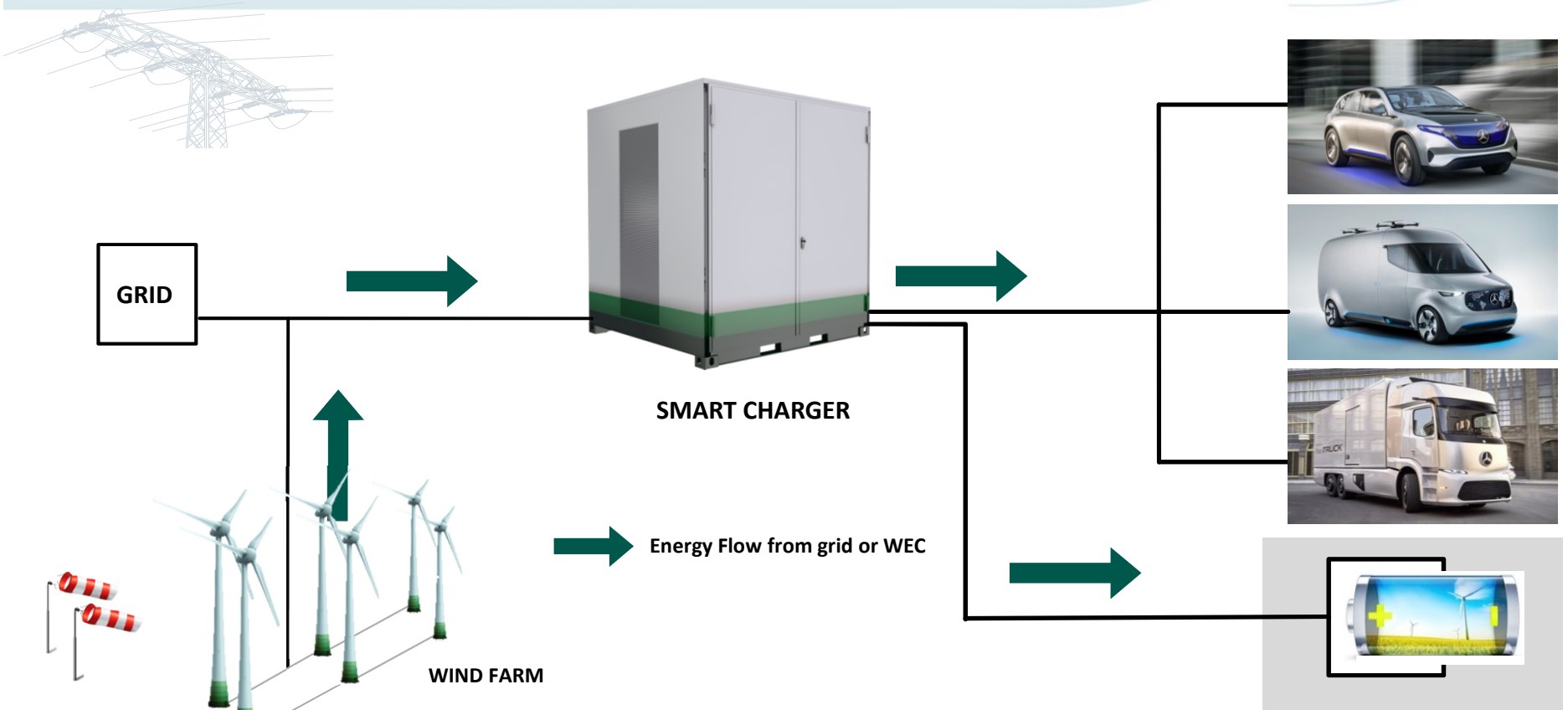
Intelligent power distribution from the Charging Station to the cars „on demand“

Fully flexible power distribution



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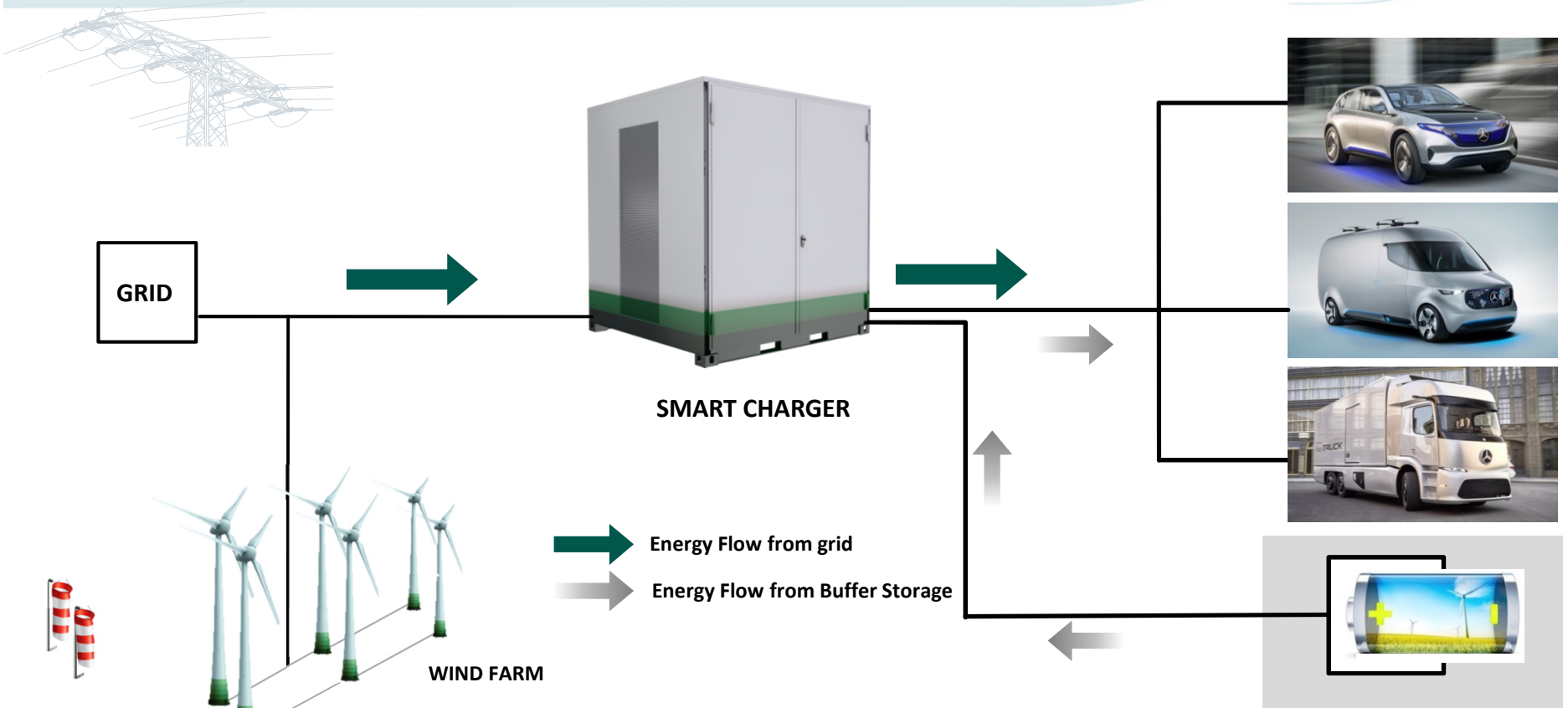
Additional use of Buffer Storage



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Additional use of Buffer Storage



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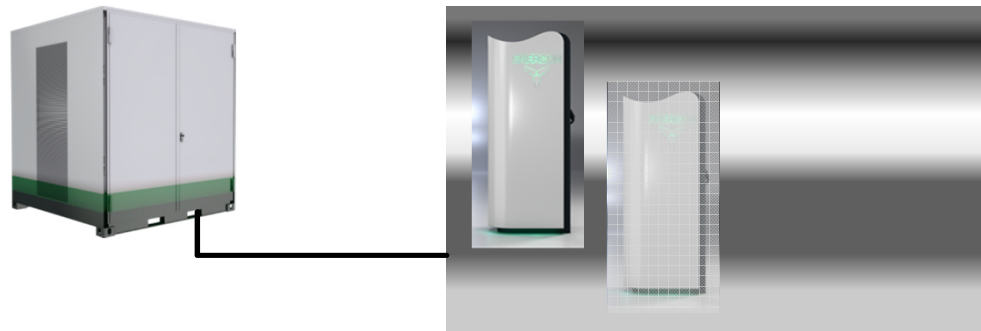
Investment aspects for Charging Infrastructure



The proposed technology presents an optimized modular concept

- start with minimum configuration

e.g. 300 kW system power
and 1 or 2 charging posts



- manageable base investment for current business case scenarios

Electrification of Transport by Renewables

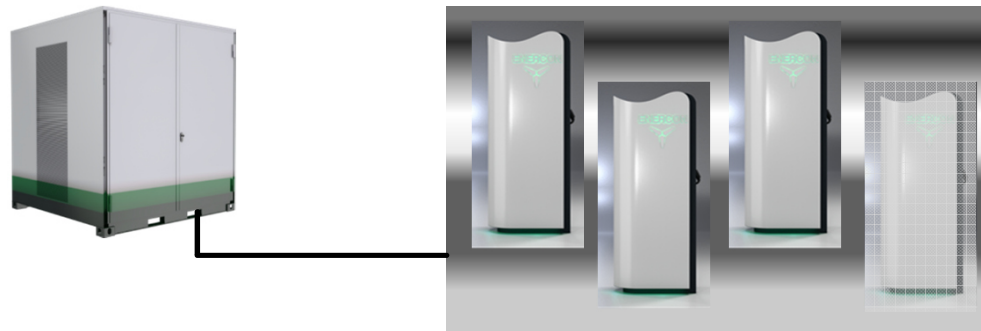
Investment aspects for Charging Infrastructure



The proposed technology presents an optimized modular concept

- start with minimum configuration

e.g. 600 kW system power
and 3 or 4 charging posts



- manageable base investment for current business case scenarios
- successive enhancement possible as more BEV with HPC2 capability enter the market
- sustainable investment, replacement of outdated Charging Stations can be avoided

Electrification of Transport by Renewables

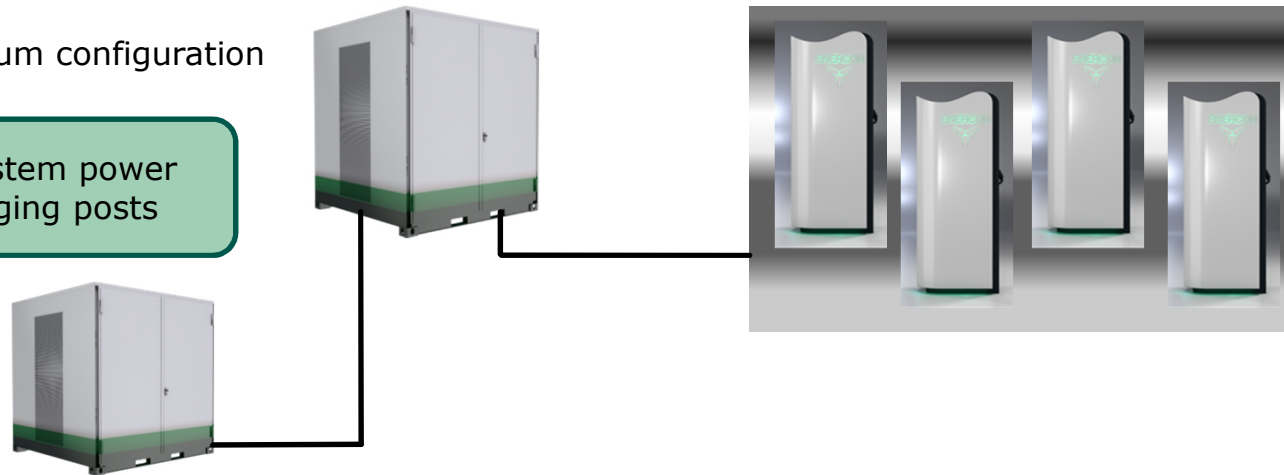
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- manageable base investment for current business case scenarios
- successive enhancement possible as more BEV with HPC2 capability enter the market
- sustainable investment, replacement of outdated Charging Stations can be avoided
- integration of buffer storage possible based on experience with grid operators

Electrification of Transport by Renewables

Conclusions and Outlook



Crucial aspects to make electrification of transport a success story

- min. realistic range of BEV of about 200 – 400 km
- increase of the electricity generation by renewable sources
- availability of “real fast charging” stations along main traffic routes
- increase of BEV types that are ready to be DC (ultra fast) charged



- increase of the willingness to invest in charging infrastructure (support for business models)

Electrification of Transport by Renewables

Conclusions and Outlook



THANK YOU FOR YOUR INTEREST

