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The electricity sector in Germany: energy flexibility, energy storage and trends

Der Stromsektor in Deutschland: Energieflexibilität, Energiespeicherung und Trends

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Personal Introduction

Lucas Eduardo Marra de Lima

Background:

- Mechatronics and Mechanical Engineering, focus on Robotics and Control Systems

Expertise:

- Control Systems, Automation, DC Microgrids and Bidirectional Charging.

Association:

- Fraunhofer IPA
- EEP at University of Stuttgart

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1 EEP – A Research Hub for Industrial Energy Efficiency

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3 Energy flexibility – Rethinking energy consumption

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5 Trends – Future solutions

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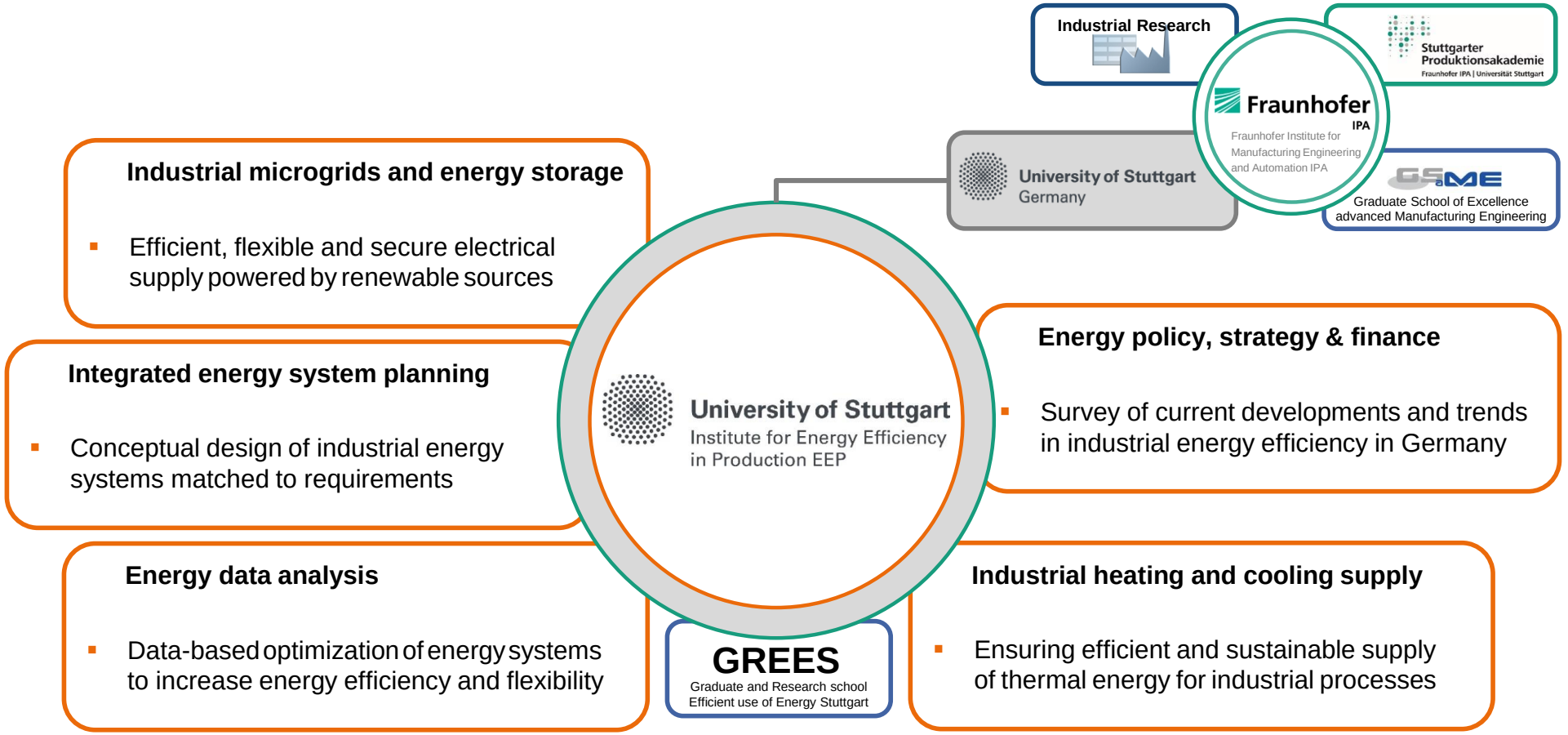
EEP – A Research Hub for Industrial Energy Efficiency



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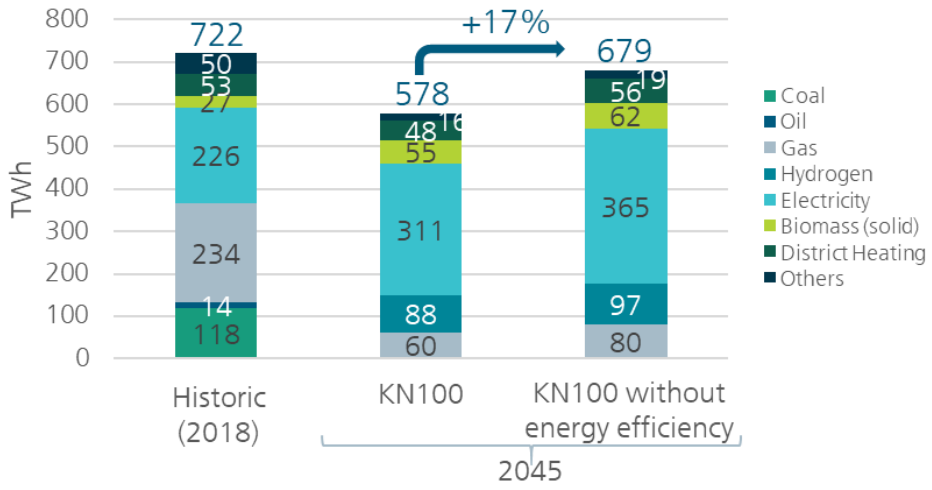
Electricity sector in Germany – Energy supply and challenges

Levers for sustainable energy supply: Efficiency & Flexibility

Development of industrial energy supply

Source: dena-Leitstudie Aufbruch Klimaneutralität, dena (2021);

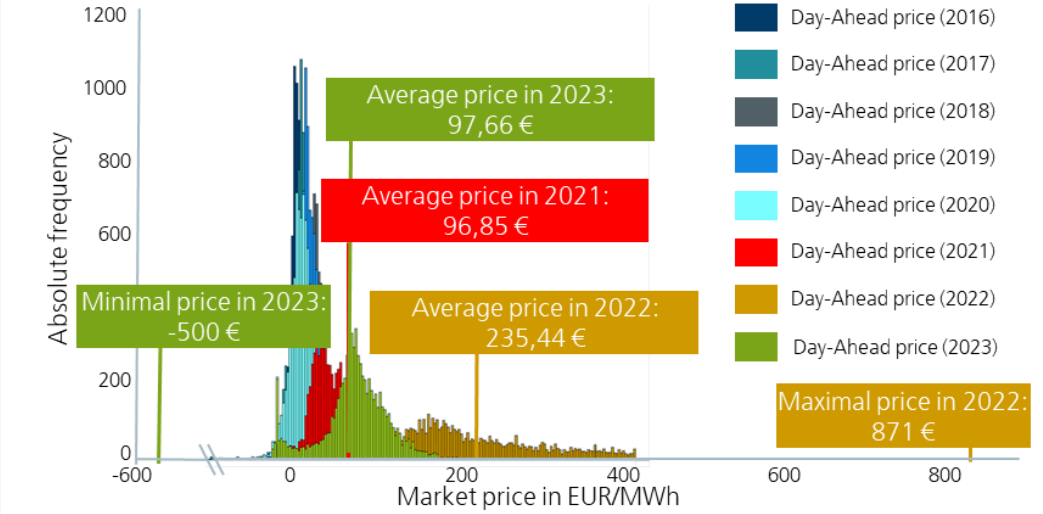


Massive switch to electricity, hydrogen and biomass as energy sources

Electrification requires additional efforts in efficiency and local or regional energy generation.

Electricity price distribution in Germany between 2016 and 2023

Source: Kopernikus-Projekt Synergie (FIM/FIT)



Electricity prices are rising and the range of fluctuation is increasing significantly

Economic and ecologic energy systems must become more flexible.

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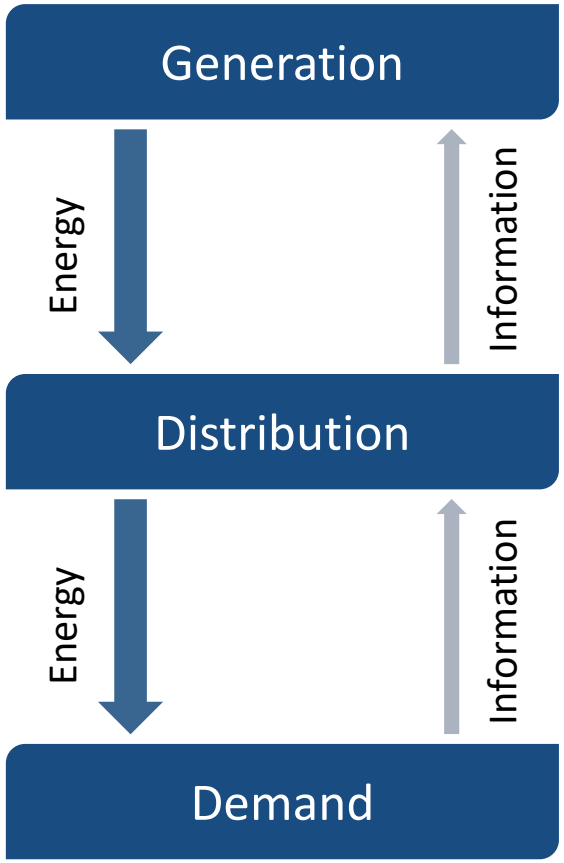
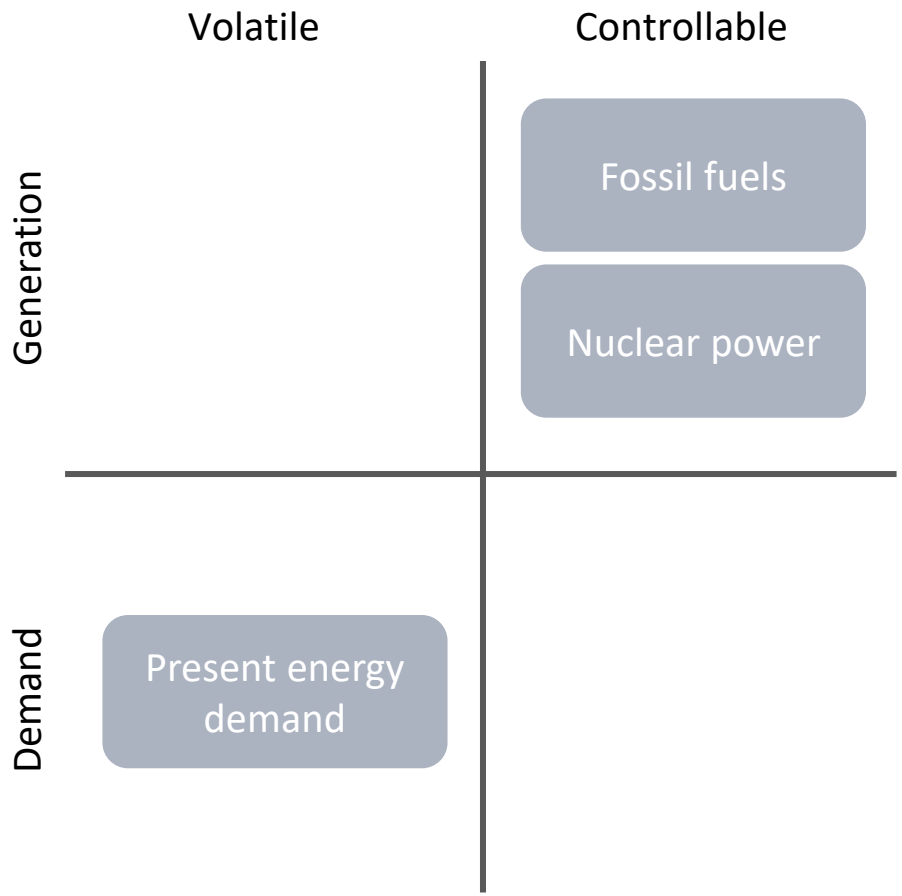
Electricity sector in Germany – Energy supply and challenges

Challenges posed by changing energy generation composition





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Electricity sector in Germany – Energy supply and challenges

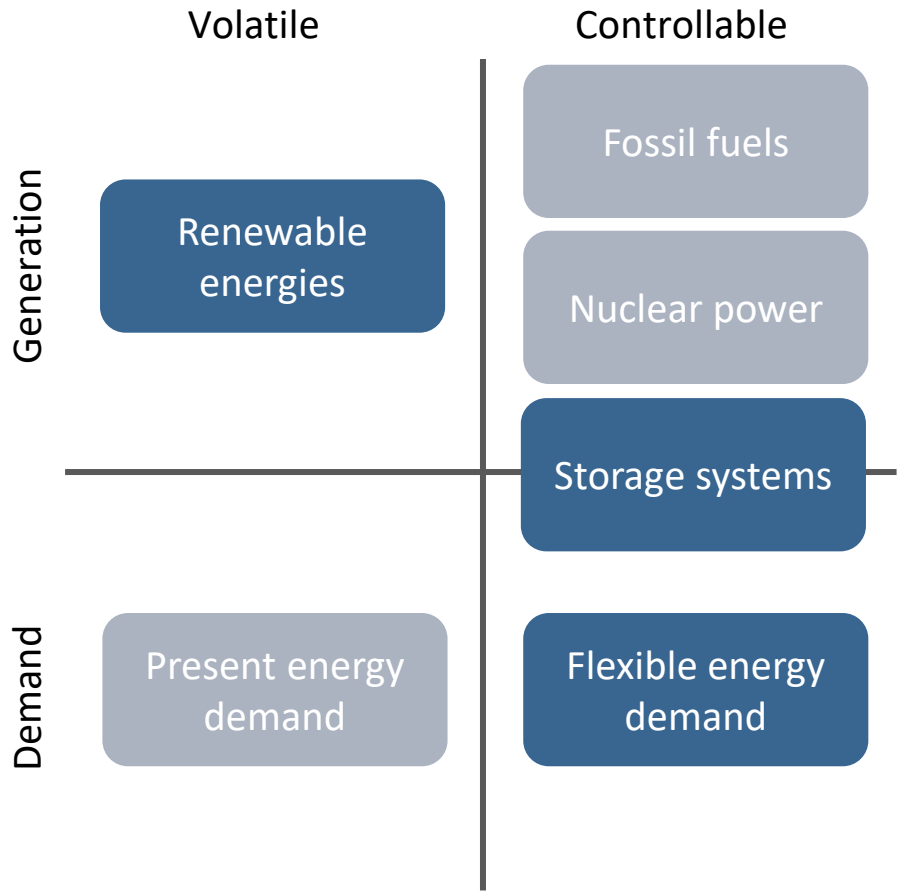
Challenges posed by changing energy generation composition

There is a need for controllable energy consumption and storage capacities:

Industry 4.0 – Balancing demand and generation by increasing information exchange

Energy storages allow to decouple energy demand and generation

Everybody must play a more active role in future energy systems



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Electricity sector in Germany – Energy supply and challenges

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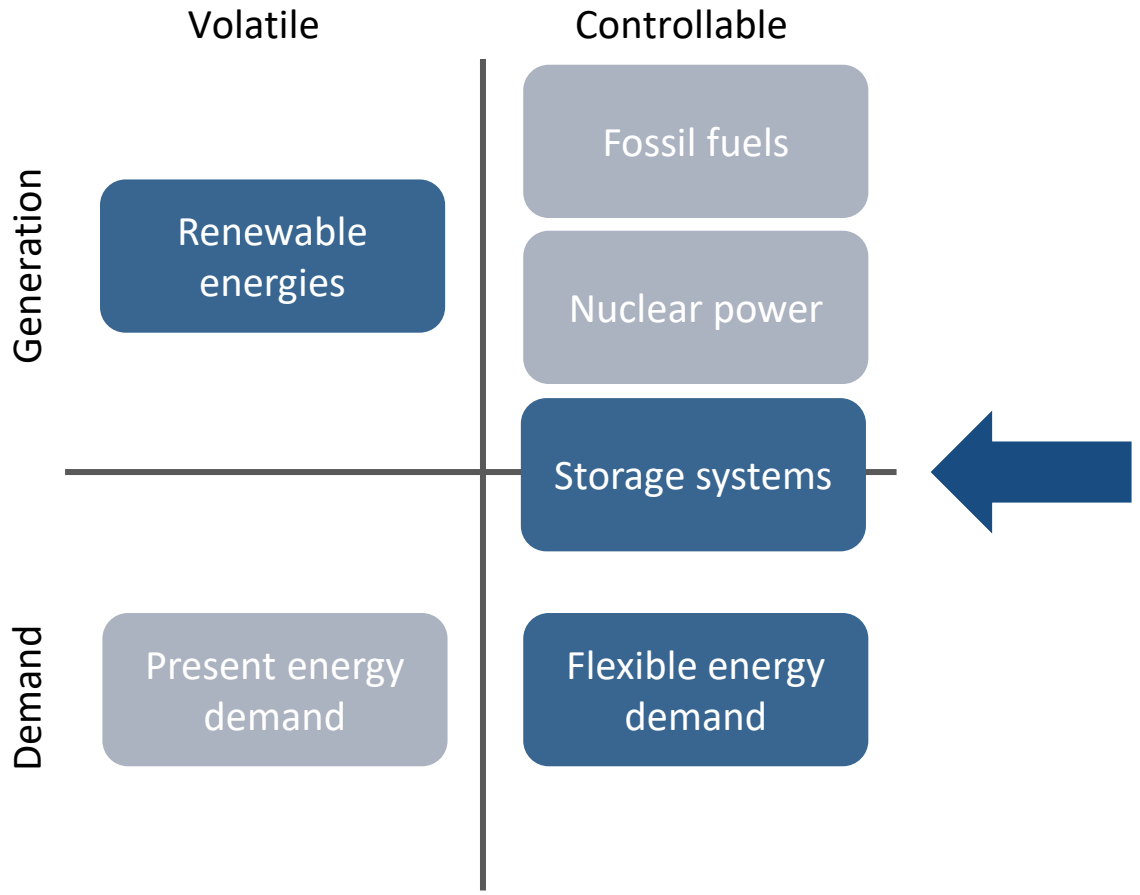

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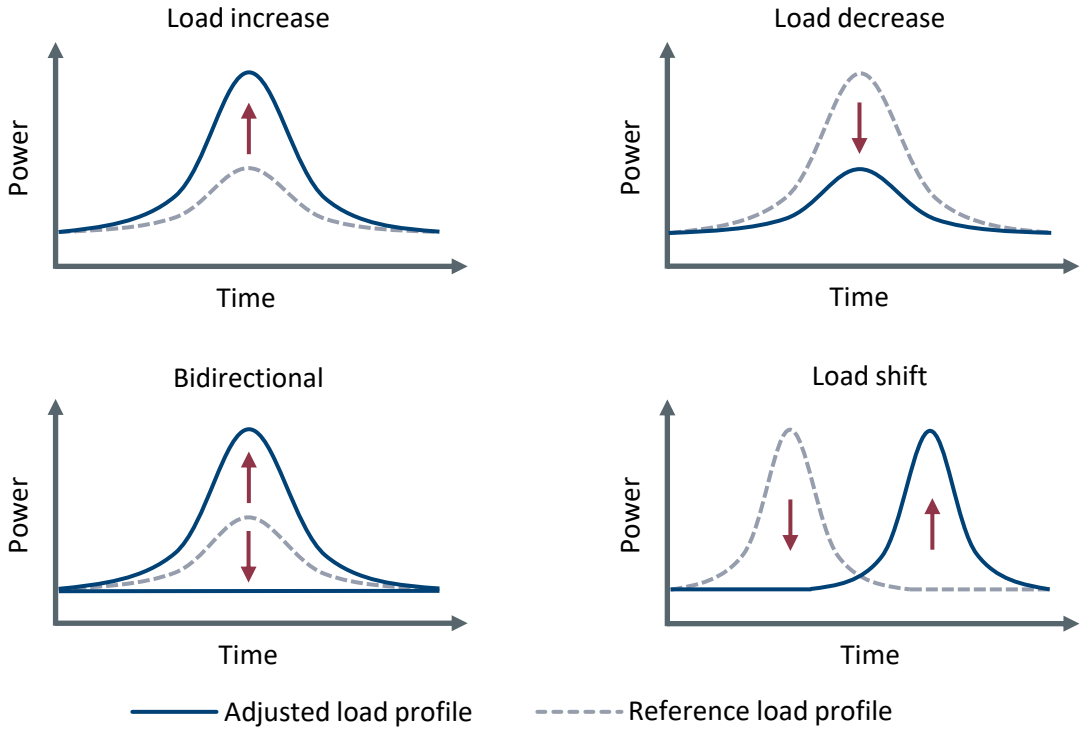
Energy Flexibility – Rethinking energy consumption

An enabler to increase energy utilization rate and sustainable energy

Different flexibility types of energy flexibility measures



- **Energy flexibility:** the ability of a production system to adapt quickly and with minimal financial effort to changes in the energy market

- **Energy flexibility measures:** concrete and conscious actions ending up in consumption variation at the grid connection point

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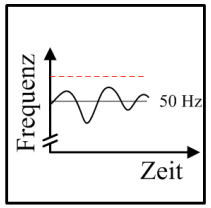
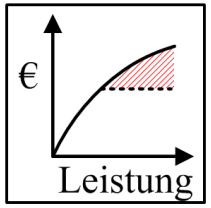
Energy Flexibility – Rethinking energy consumption

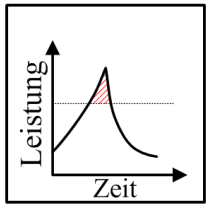
Benefits from utilization of energy storage and flexible loads



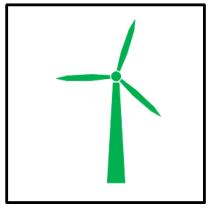
Stabilization of internal electric supply system



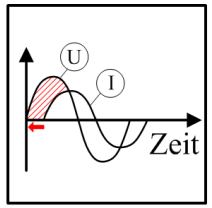
Reduction of costs by dynamic load management



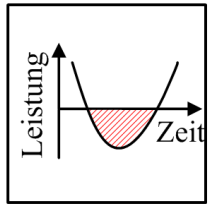
Minimization of installed load capacities



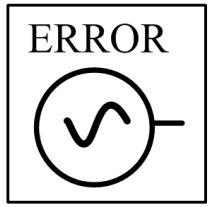
Integration of volatile renewable generation



Compensation of reactive power by storage systems



Utilization of recuperated energy



Increase of reliability in case of failure

These factors provide a cost benefit to the electrical grid and the consumer

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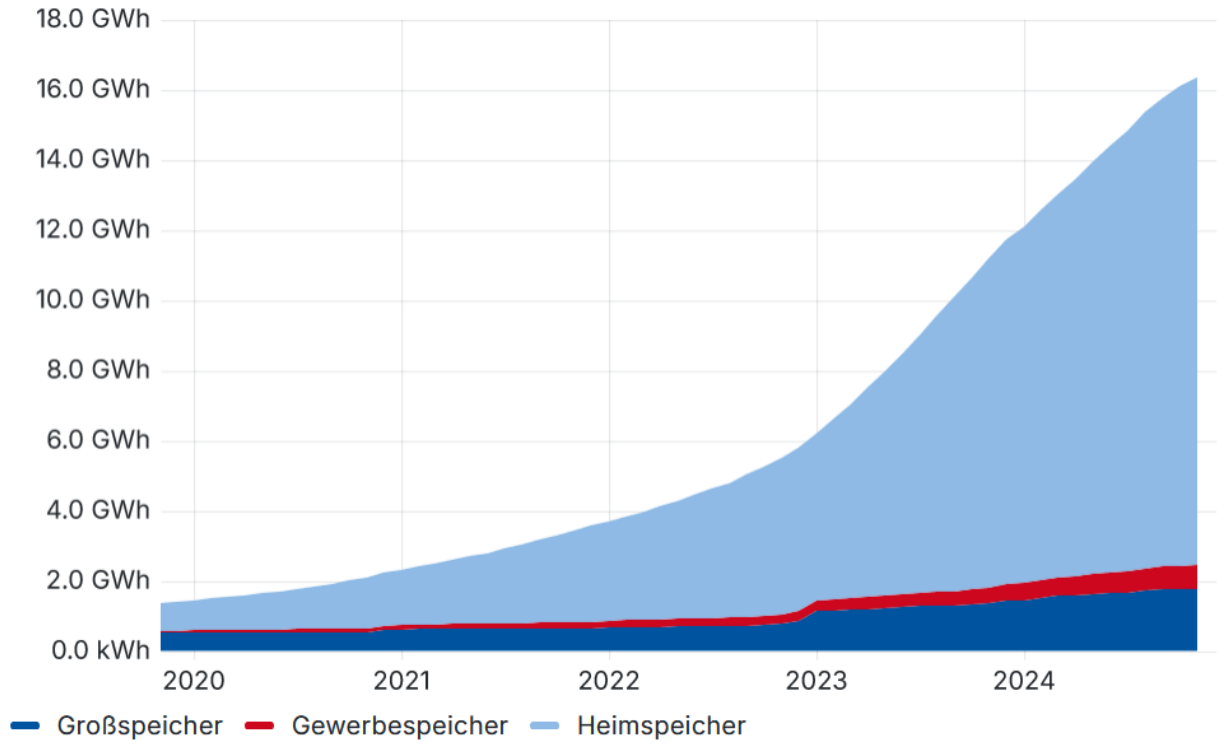
Energy storage – Residential and large energy storage systems

Storage as a key element in the expansion of renewable energy

- Residential energy storage systems (ESS) are currently mainly used to increase self-consumption of solar energy.
- Large ESSs have been built almost exclusively to supply primary control power.
- The expansion of large ESSs will support the integration of the rapid increase in solar and wind energy capacity into the electricity sector.

Battery storage capacity in Germany



Source: Battery Charts, (2024) https://battery-charts.de/

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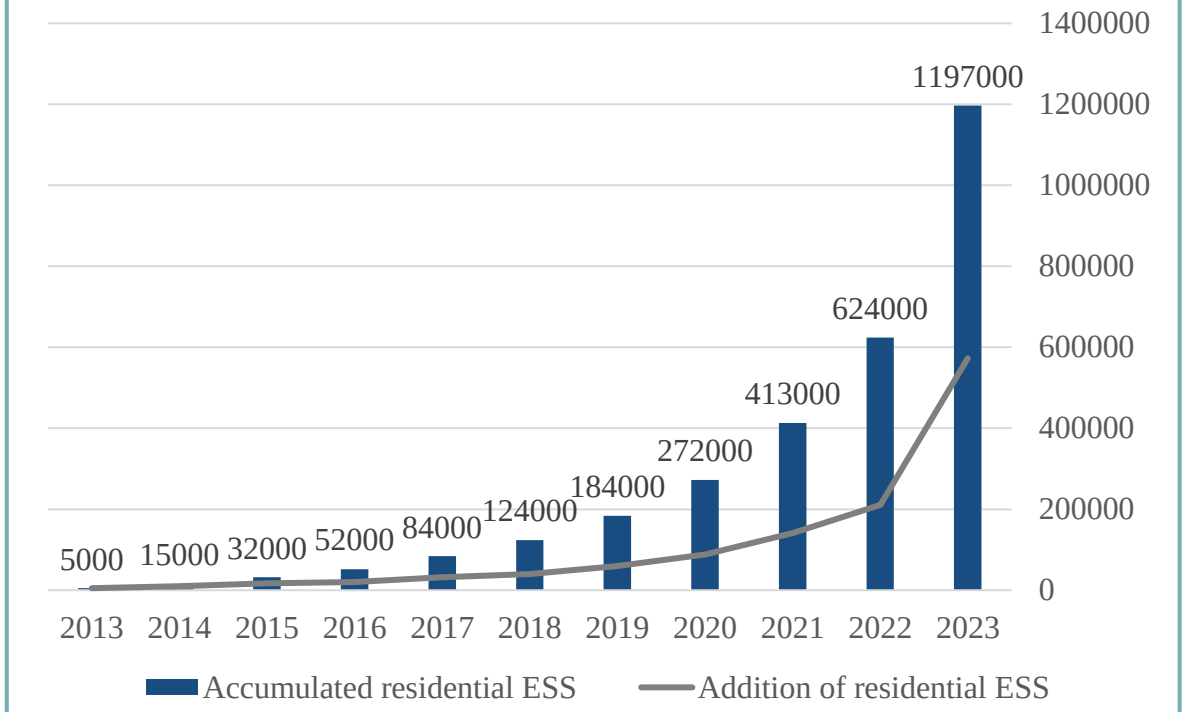
Energy storage – Residential and large energy storage systems

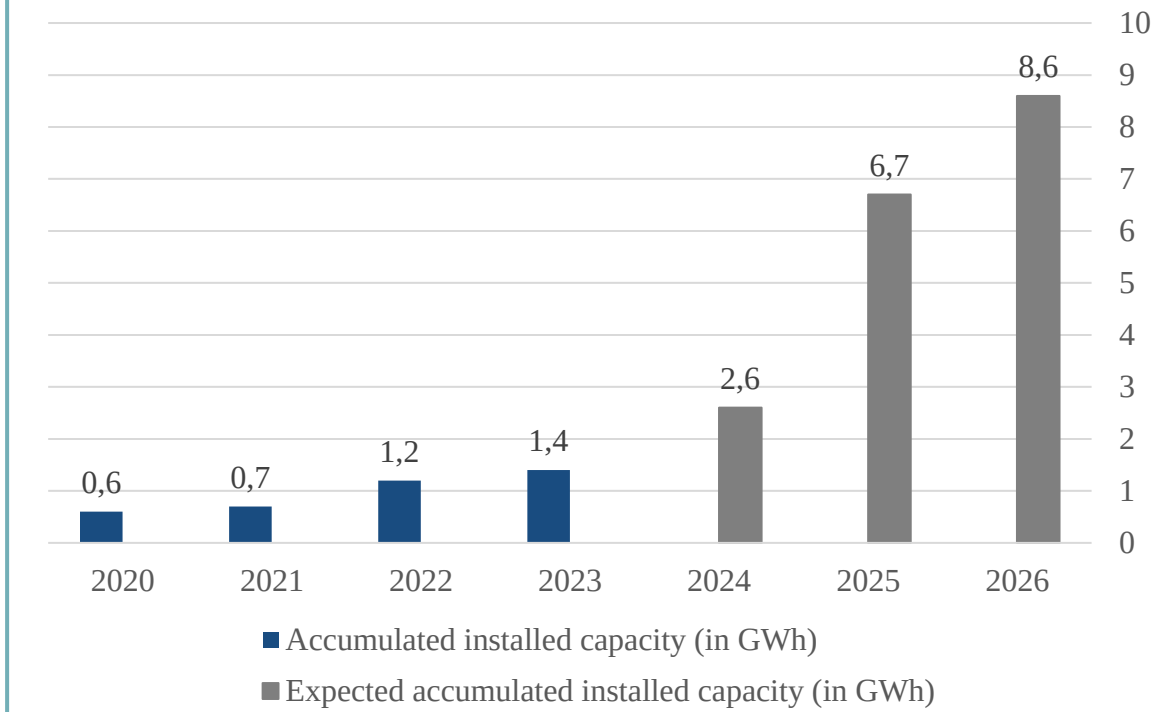
Residential or large: both prevail in their respective roles

The exponential growth of energy storage systems installed in private households in Germany



Source: BSW-Solar , Stand - 05.01.2024

Five-fold capacity expected in two years for large energy storage systems in Germany



Source: Enervis-Analyse im Auftrag des BSW-Solar, Stand - September 2024

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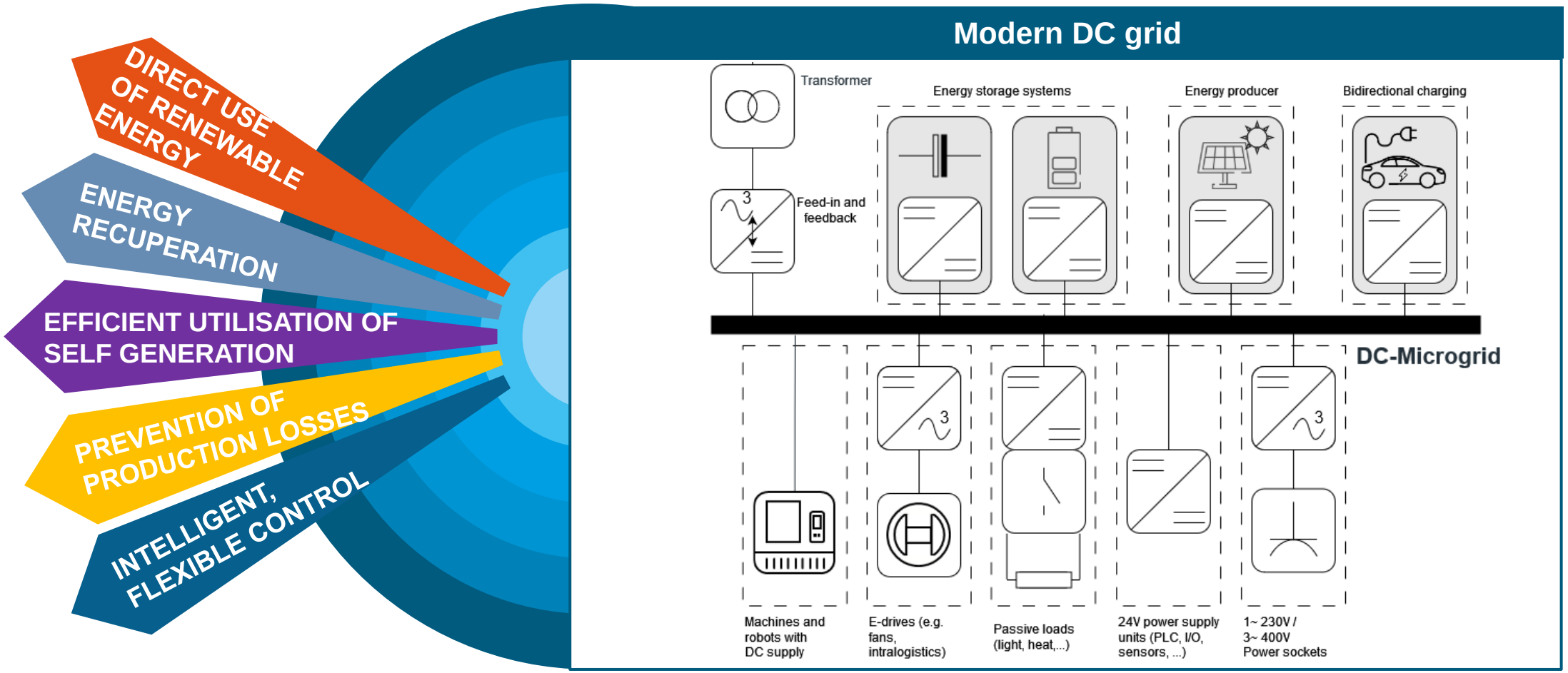
Trends – Future solutions

Rethinking the energy supply to direct current (DC)



Source: Alexander Sauer (Hrsg.). Die Gleichstromfabrik. Carl Hanser Verlag GmbH & Co. KG. ISBN 978-3446465817.

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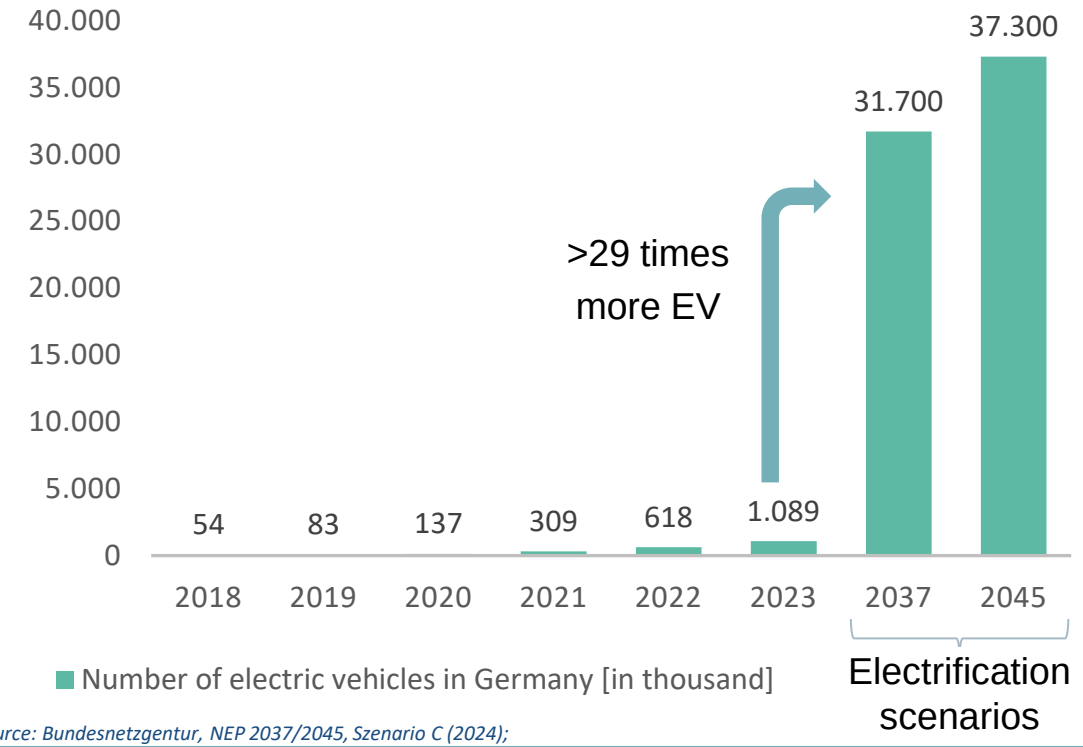
Trends – Future solutions

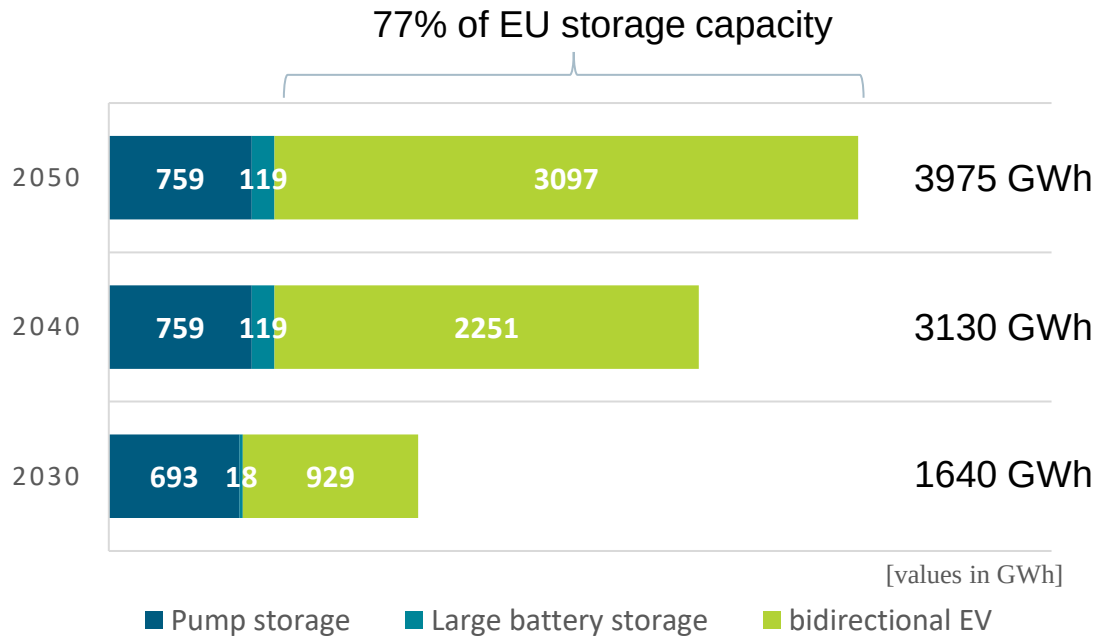
Electromobility can shape the future of power systems

Constant increase of EV will massively increase in the next years



Source: Bundesnetzgentur, NEP 2037/2045, Szenario C (2024);

Bidirectional EV storage capacity can support the volatile renewable generation in the EU



Source: Nationale Leitstelle Ladeinfrastruktur, NOW GmbH, Szenarien Bidirektionales Lademanagement – BDL (2024)

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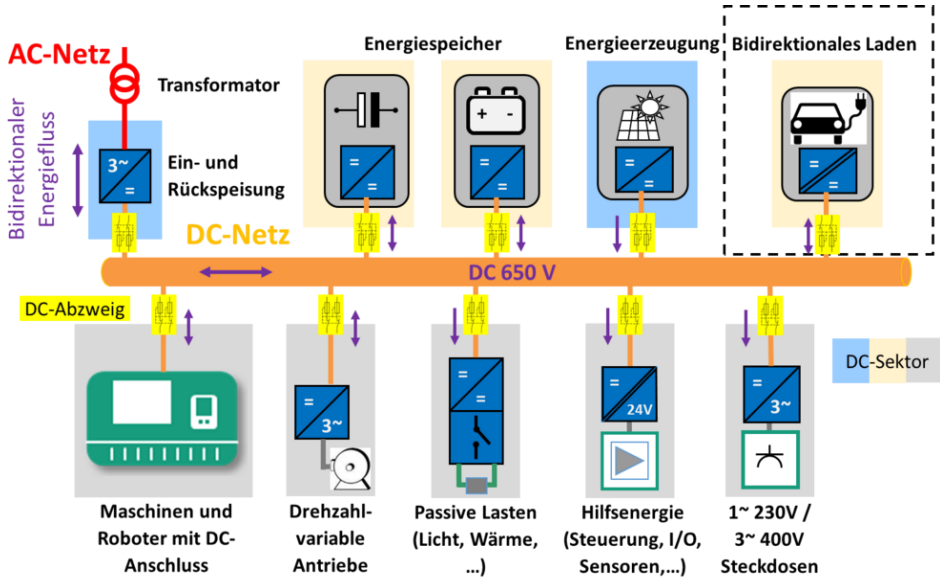
Trends – Future solutions

Integration of charging stations into the DC grid - DCI4CHARGE

DCI4CHARGE



Research project founded by the German Federal Ministry for Economy and Climate Protection

Bundesministerium für Wirtschaft und Klimaschutz

DCI 4CHARGE

Background

The DC-INDUSTRIE research project has developed a system description for industrial DC grids. The basic concepts are openly accessible in the system concept, but individual aspects, such as integrating electric charging stations, are still missing.

Benefit

The potential of DC grids is expanded by enabling electric vehicles to be charged more efficiently. This allows the industry to save energy when charging each vehicle. Furthermore, electric vehicles will act as virtual batteries, which enable flexible use of stored energy.

Project duration: 08.2023 - 01.2026

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Thank you!

Lucas Eduardo Marra de Lima
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„Industrial microgrids and energy storage systems“

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