

Prof. Dr. Christof Wittwer
EM-Power Europe 2024
Munich, 18.6.2024

System Integration in Energy Transition

Fraunhofer-Institut für Solare Energiesysteme ISE

Our Business Areas

Photovoltaics –
Materials, Cells,
Modules

Solar Power Plants and
Integrated Photovoltaics

Electrical
Energy Storage

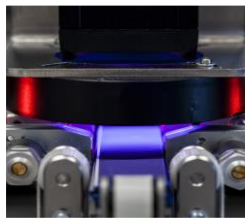
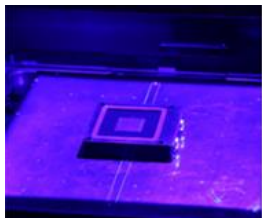
Power Electronics
and Grids

Photovoltaics –
Production Technology
and Transfer

Climate-Neutral Heat
and Buildings

Hydrogen
Technologies

System Integration



Systemintegration

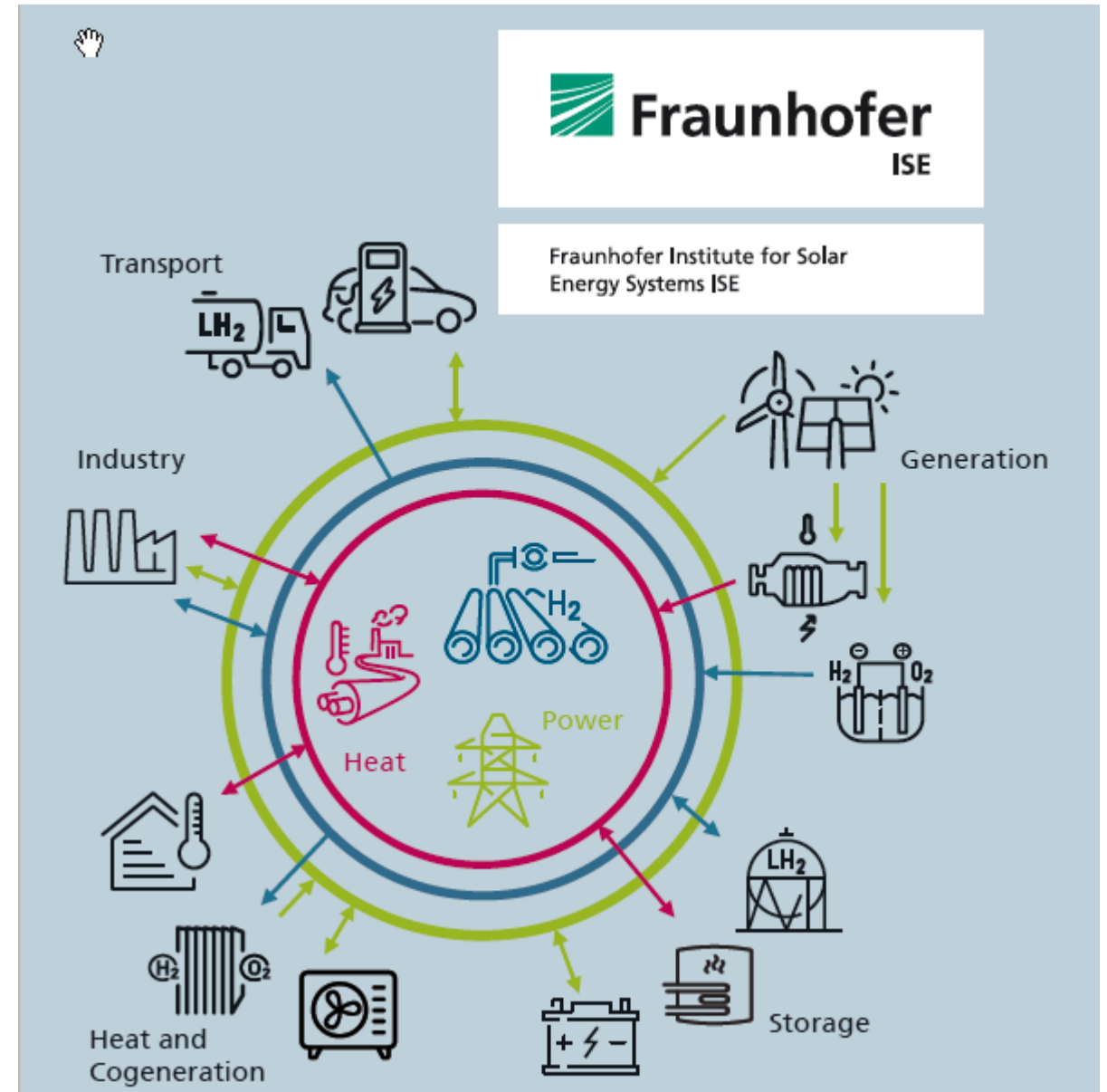
Research Activities Fraunhofer ISE

System Integration

Our System Integration services offer comprehensive solutions for a resilient and sustainable energy future:

- energy system analysis
- system simulations covering power-heat coupling, thermal and electrical storage, and hydrogen-based energy systems
- data management and data analytics
- development and implementation of inter-sectoral energy supply systems
- conception of decarbonization of industries
- transformation management for urban districts
- conception and coordination of living labs

3



Introduction

Key drivers for the transformation of the energy system

Greenhouse gases and climate change



oben links: National Geographic, October 10th 2020 | oben rechts: BBC, May, 22nd 2020
unten links: Time, May 22nd 2020 | unten rechts: The Guardian, March 11th 2020

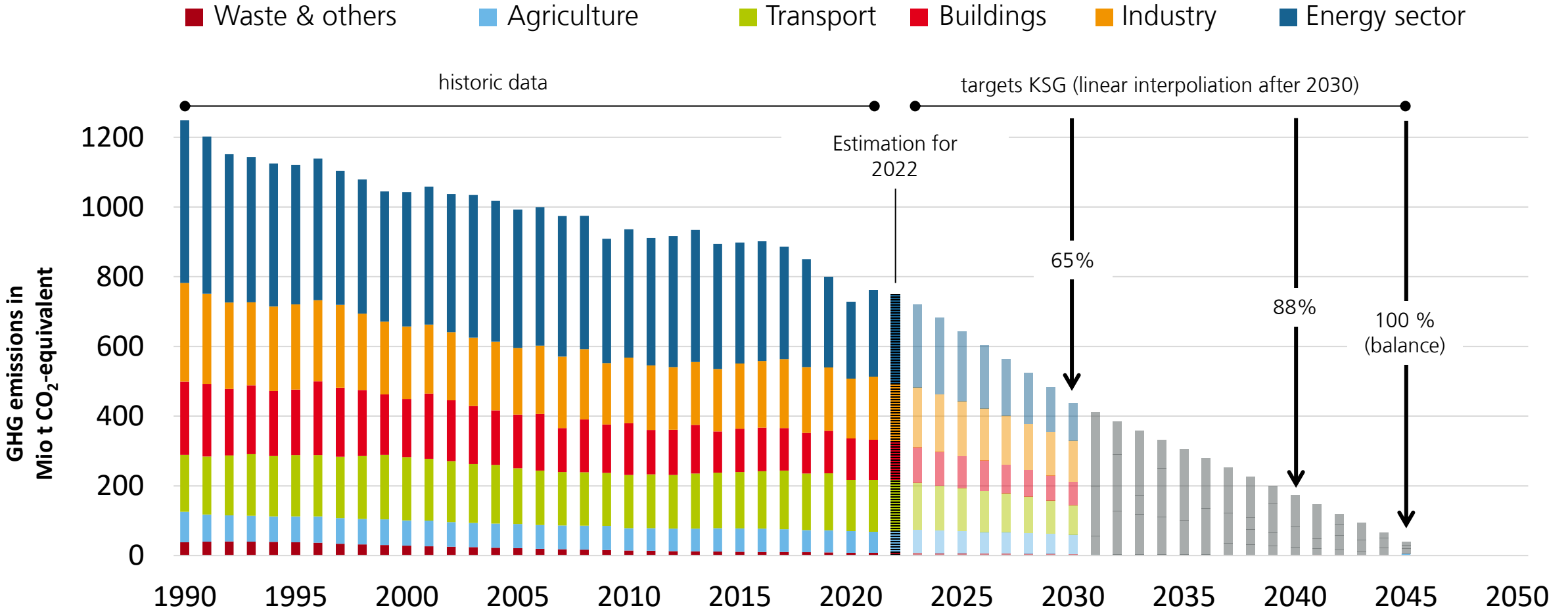
Energy imports and security of supply



oben: [de.wikipedia.org/wiki/Europipe_\(Pipeline\)#/media/Datei:Europipell.jpg](https://de.wikipedia.org/wiki/Europipe_(Pipeline)#/media/Datei:Europipell.jpg)
unten: www.wikidata.org/wiki/Q52353566

Germany's Federal Climate Change Act (KSG)

Germany's GHG Emissions – Historic Data and Targets

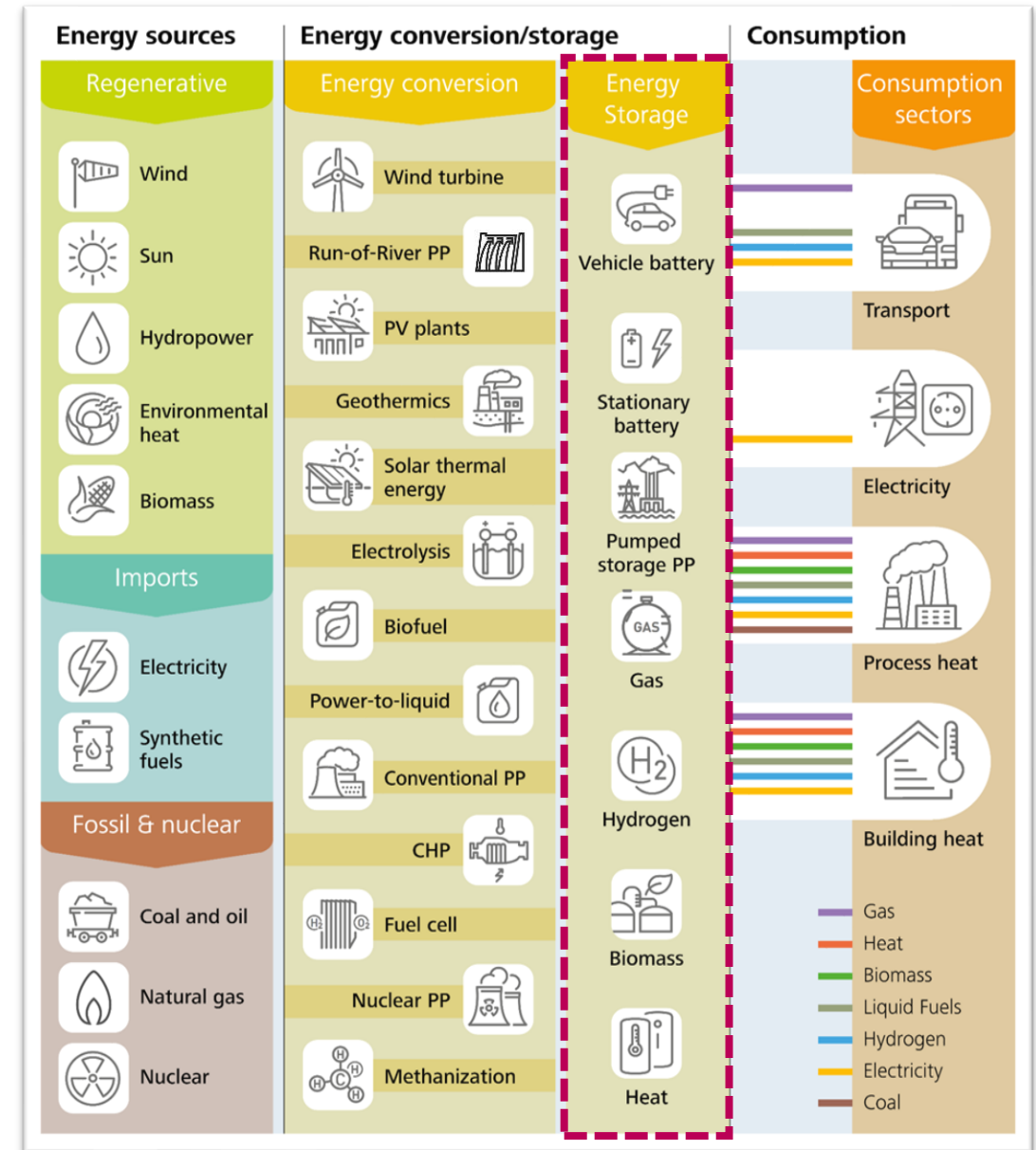


Energy System Analysis – Methodology

Renewable Energy Model »REMod«

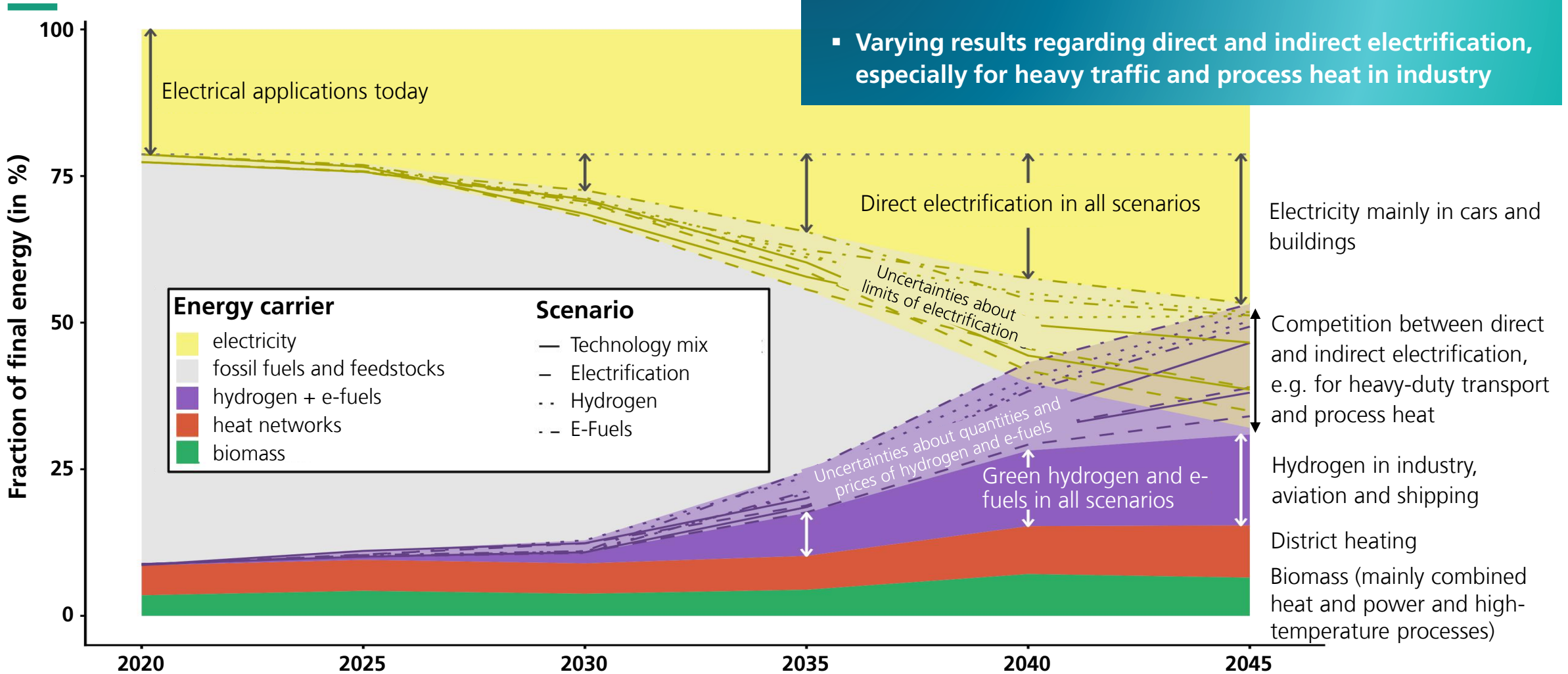
Strictly model-based techno-economic optimization of transformation pathways

- Consideration of all end-use sectors and energy sources
- Comprehensive simulation of energy systems (hourly time scale)
- Mathematical optimization: Minimize total transformation cost in strict compliance with climate protection targets (year by year; climate neutrality in 2045)



Energy System Analysis Transition

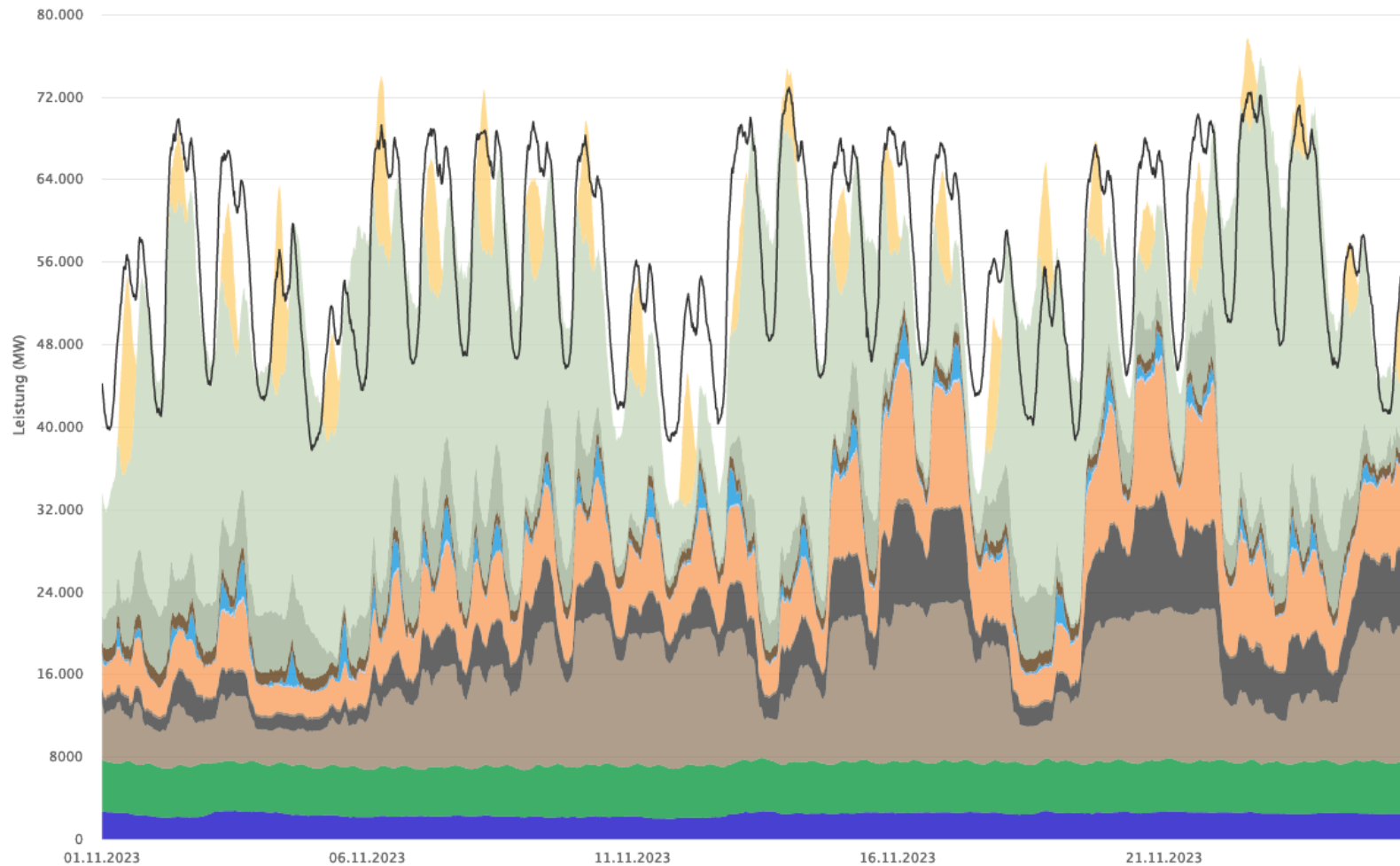
Final energy: direct vs. indirect electrification



- Strong increase in electricity as final energy is a consistent result of all scenarios and system studies
- Varying results regarding direct and indirect electrification, especially for heavy traffic and process heat in industry

System Analysis Transparency

Monitoring for National and European Grid: Energy-Charts



- Generation
- Data from EEX/ENTSO-E

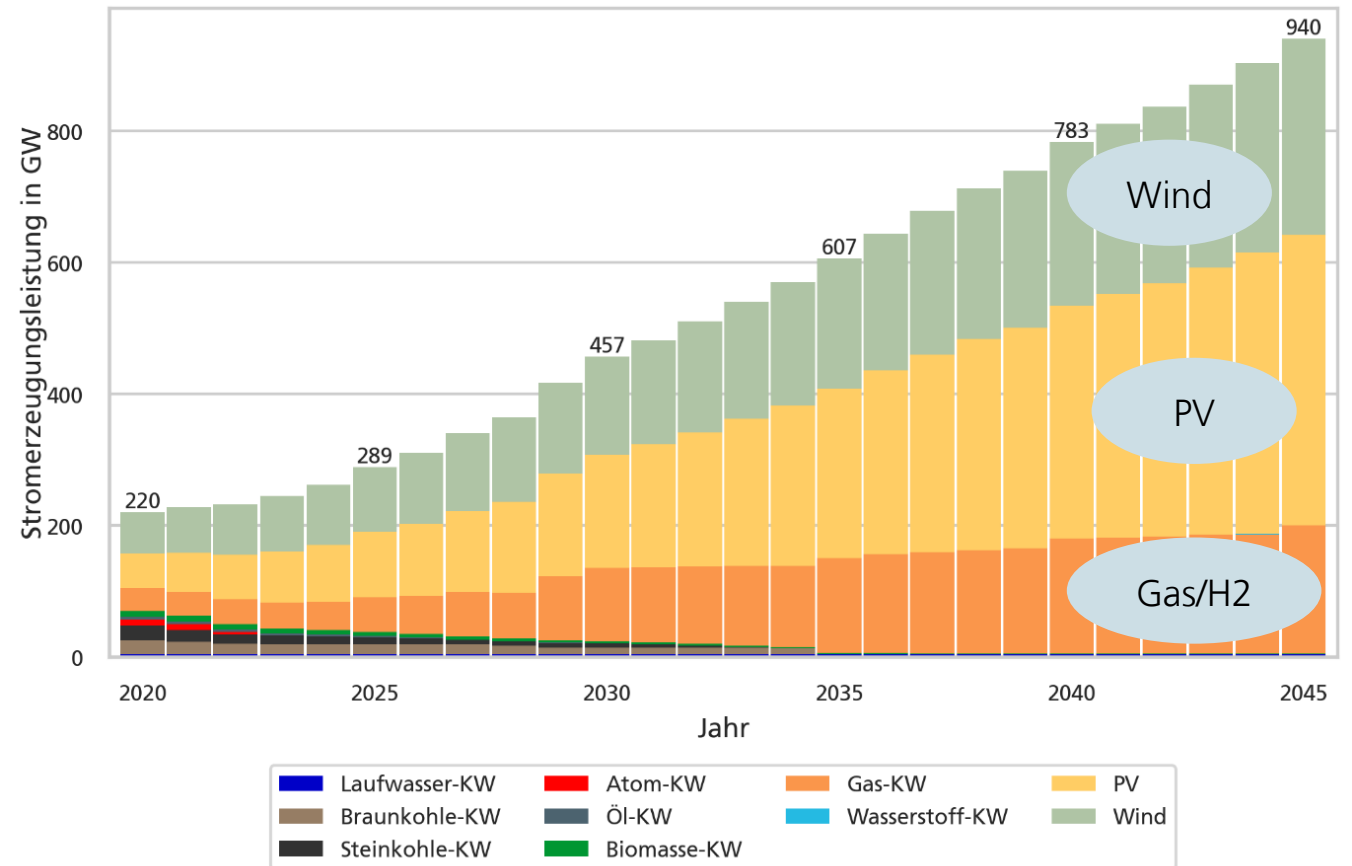
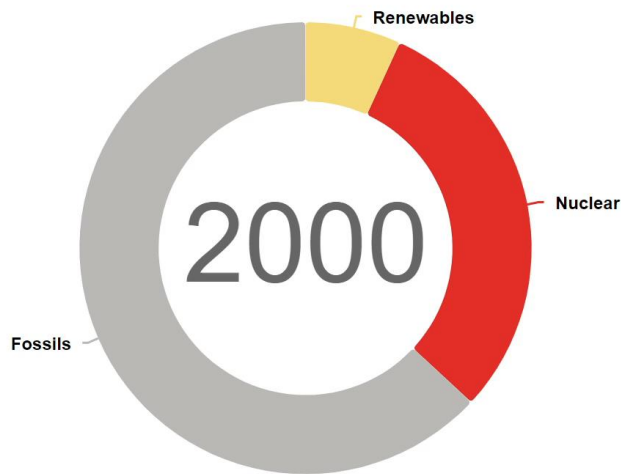


Transition Path

Extension of Wind, PV, Power Plants by 2045 for the Net Zero System

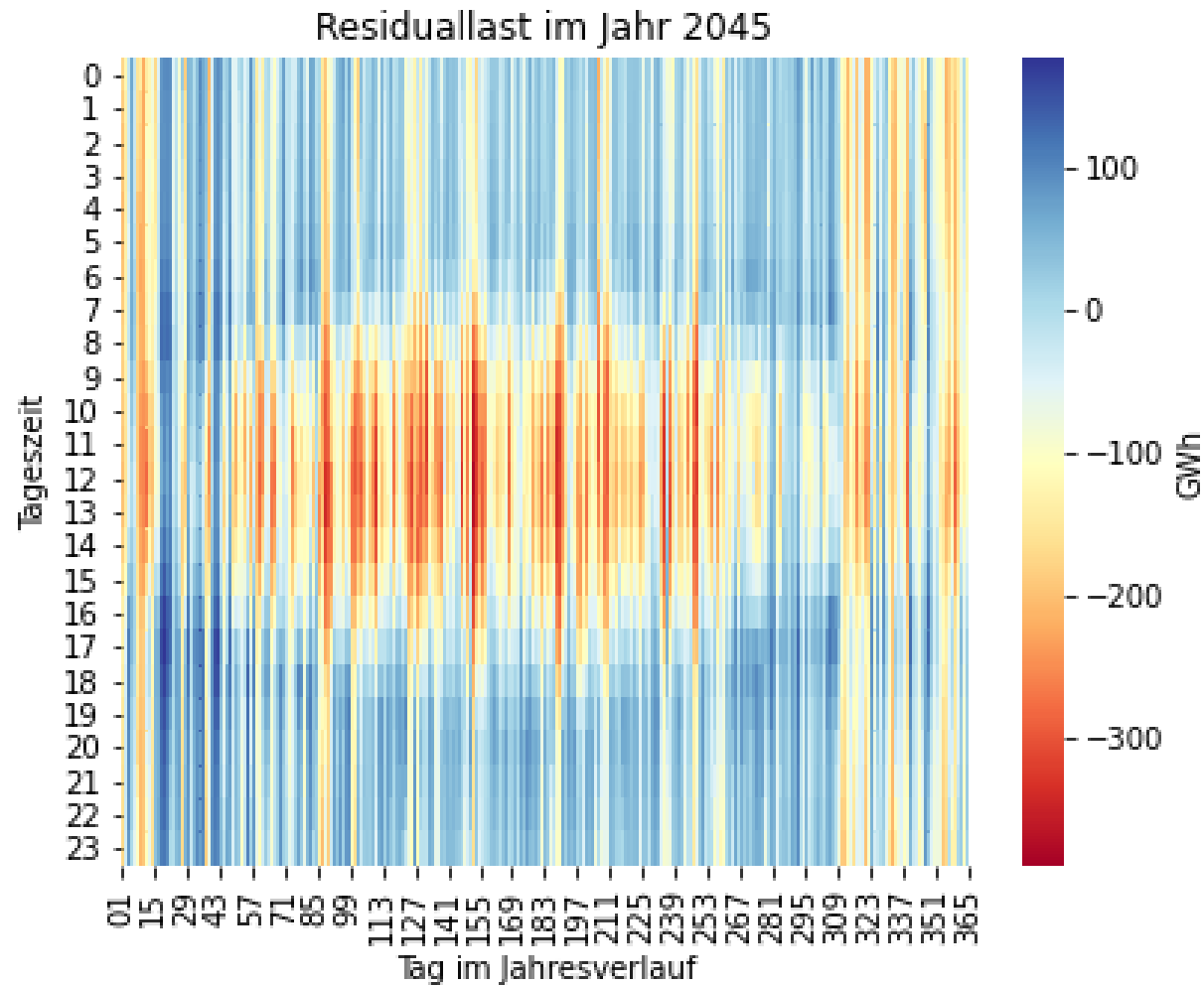
- Wind, PV, Backup-Power Plants, starting with Gas, converted to H2
- Strong growth -> grid extension essential -> flex management

Total net electricity generation in Germany



Residual Load , Year 2045

:High Demand

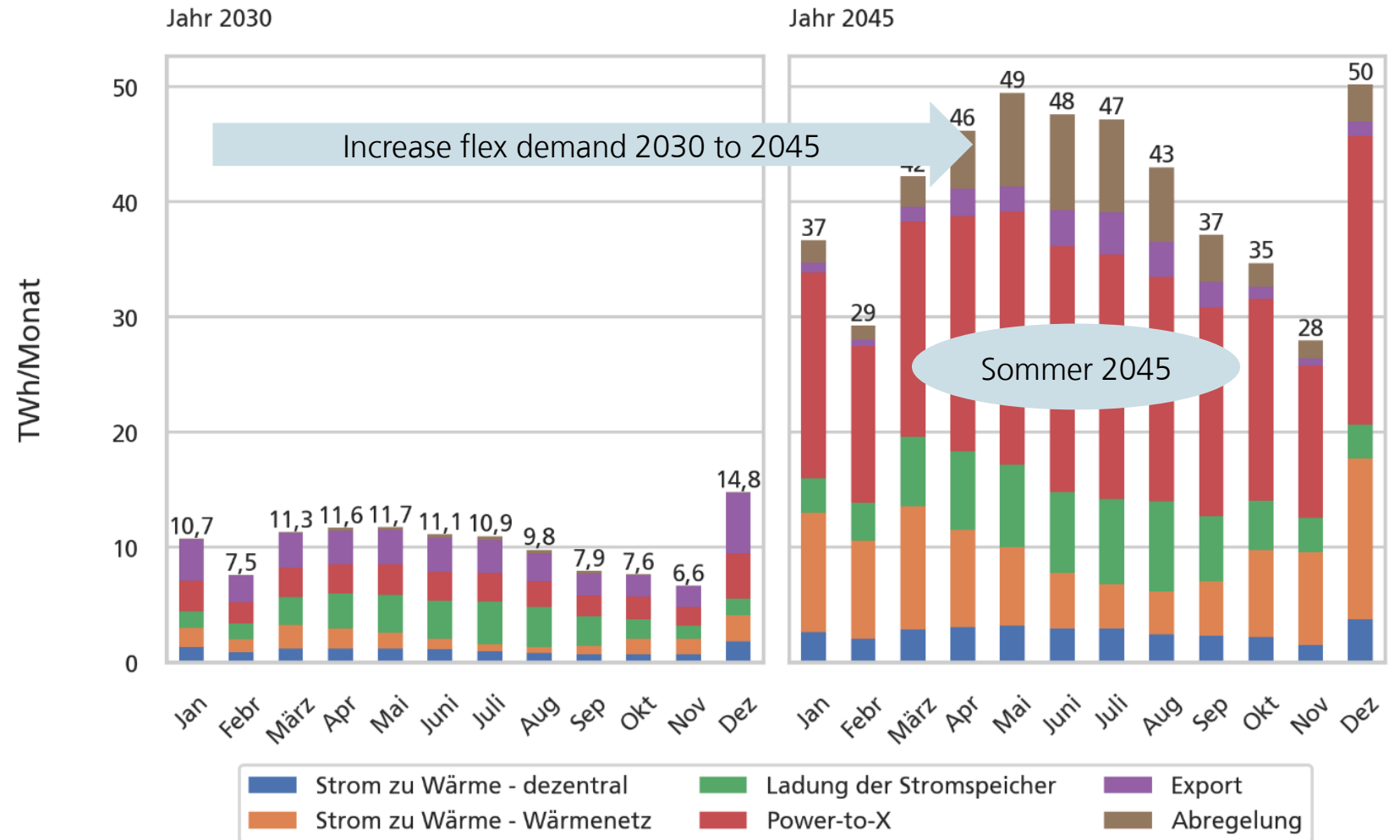


- High negative residual loads
- Storage needed
- flex management
- Integration of all sectors: transport/heat

System Integration

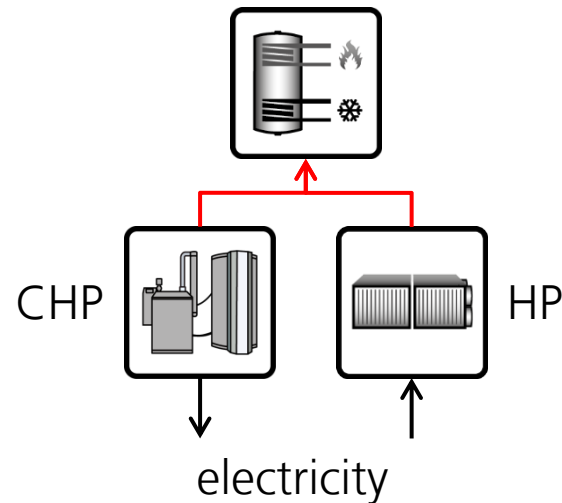
Flexibility Demand for Electricity 2030 vs. 2045

- Battery storage at sommer
 - Heat storage
 - Elektrolysis P2X
- ➔ **Smart Grids** allows flex management to balance the system



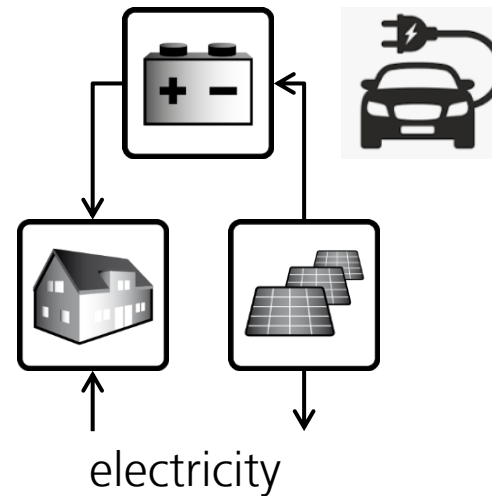
System Integration using Smart Grids Technology

Storage and BiFlex Car



Thermal Storage: CoGen (CHP) and Heatpump

- Thermal storages offer the possibility to decouple thermal and electric consumption
- Highest Efficiency for primary energy use
- Low Cost Storage as a water tank (1 kWh/Km³)
- From heat driven CHP to electricity demand driven operation
- Flexible production: demand side management and flex tarif;



PV-Battery Systems

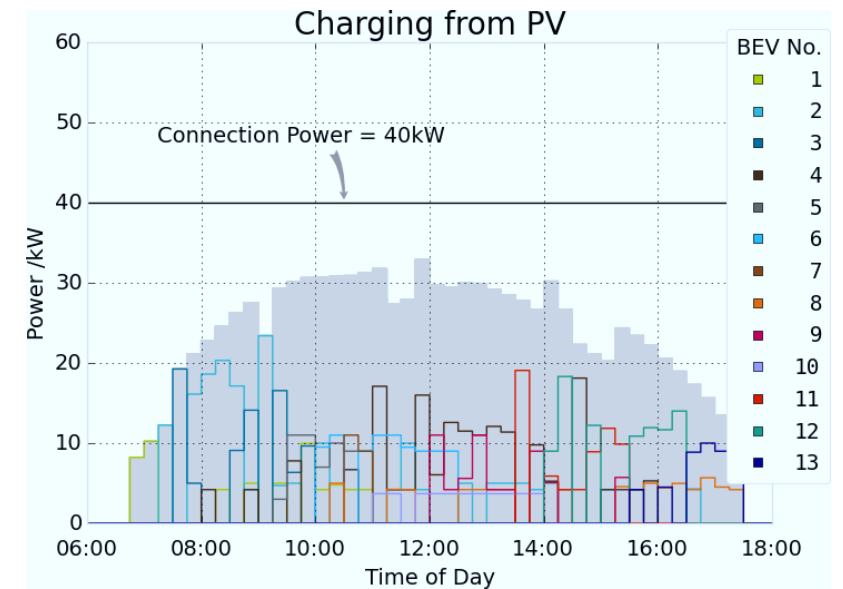
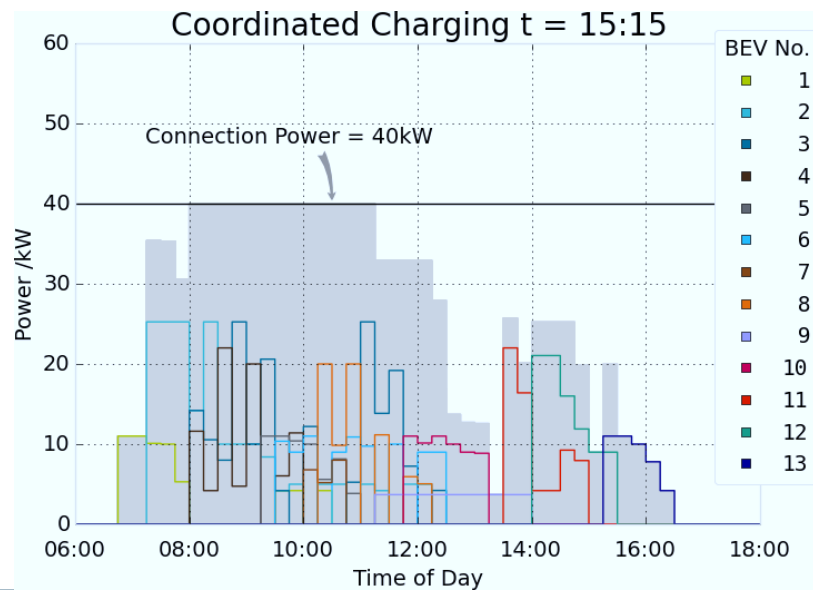
- Highest Efficiency for electric storage
- Self consumption operation strategy already a business model
- LCOE for PV-Bat Systems: 7-14 Cent/kWh in 2021, strong decrease
- Grid services, ancillary services for grid support (voltage control)
- V2G Vehicle to Grid allows bidirectional integration of huge storage capacity

Smart Grids, EV fleet Management

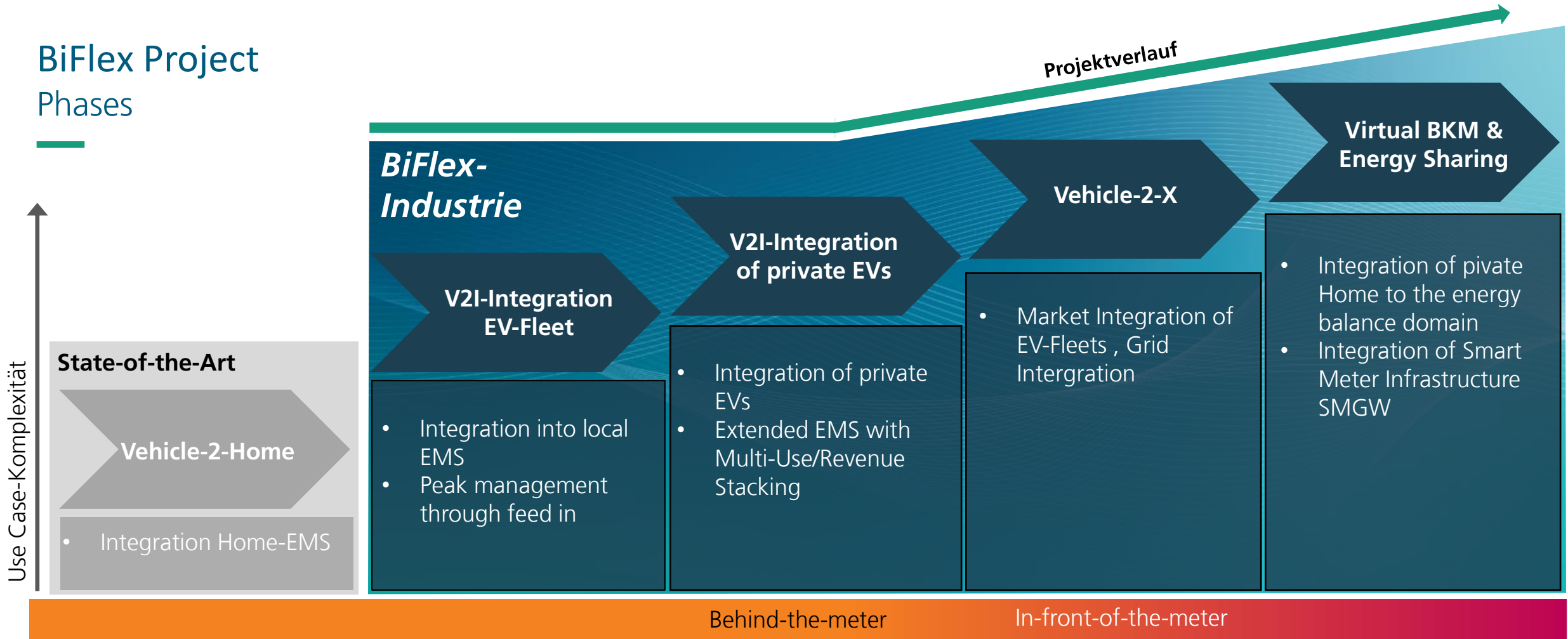
EMS Energy Management: Flexibilization to PV of dynamic Prices

Different use cases of Energy management

- ✓ Reduction of CO₂ emissions
 - EV Charge management
 - Increasing PV - self consumption
 - Increasing efficiency



BiFlex Project Phases



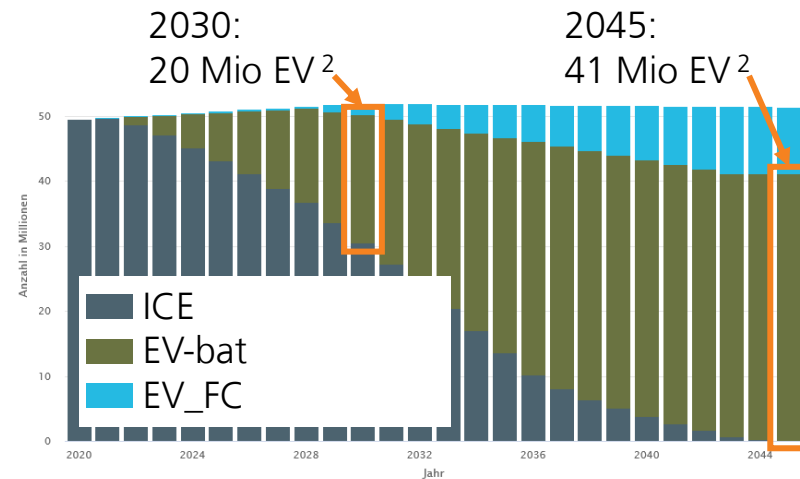
- Integration of EV-Fleets into enterprises → Flex-Ressource for the energy System

WBInspektion, Integration of EV to the Grid Project

Ramp-Up Emobility

pv-magazine published Market Overview with 200 Wallboxen (19 bidirektional)¹

Flex Operation, Integration



Spec of wallboxes today without efficiency parameters



Testing

New Methods to evaluate uni- and biflex wallbox
Establish test procedure as industrial standard

Comparability & Transparency

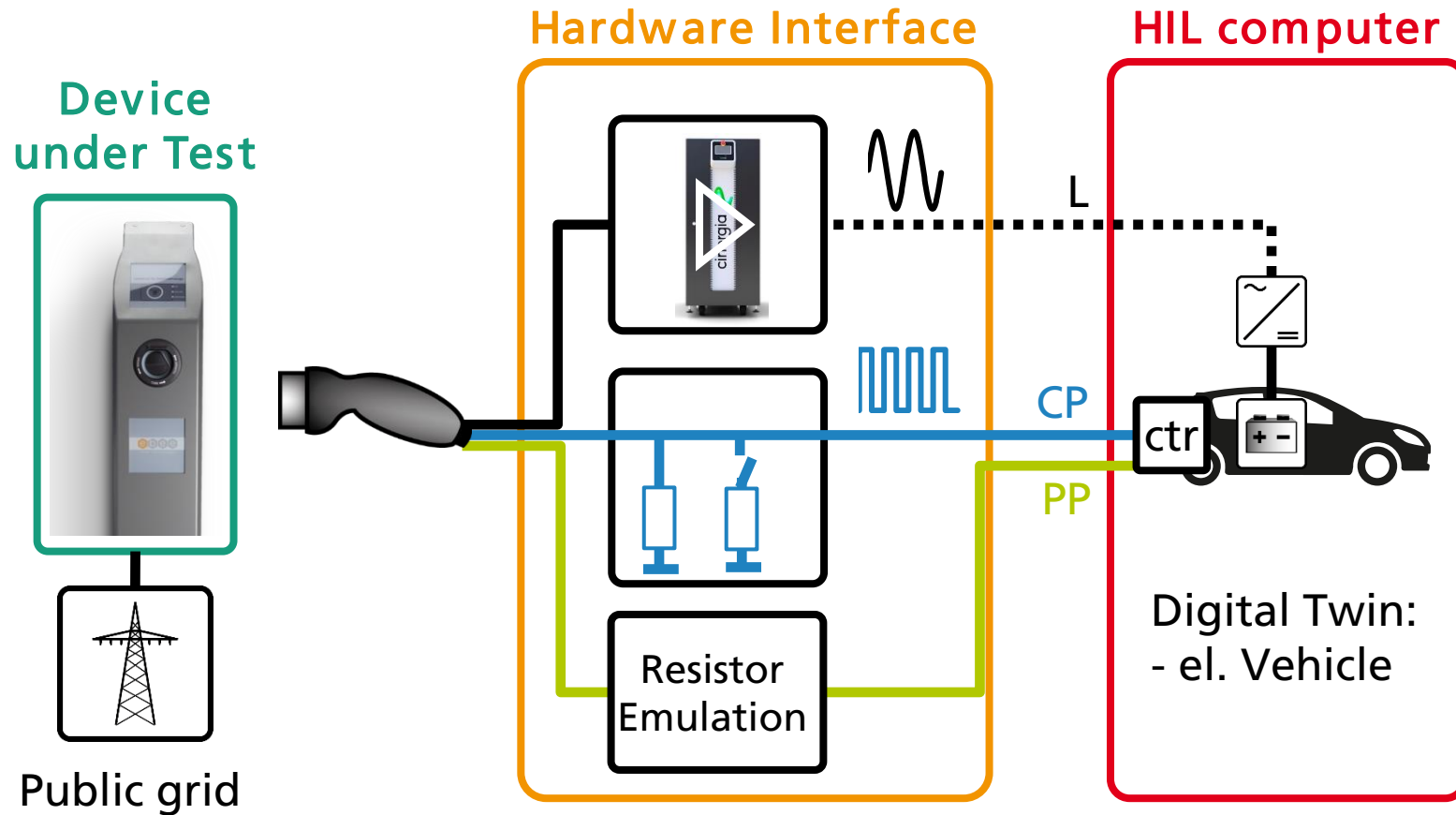
Eval of commercial WB
Eval of Solar optimized Charging
Publication of Benchmarks

Development Potential

Identification of optimization potential

Power HIL Setup

Digital Twin Electric Vehicle – AC Charging

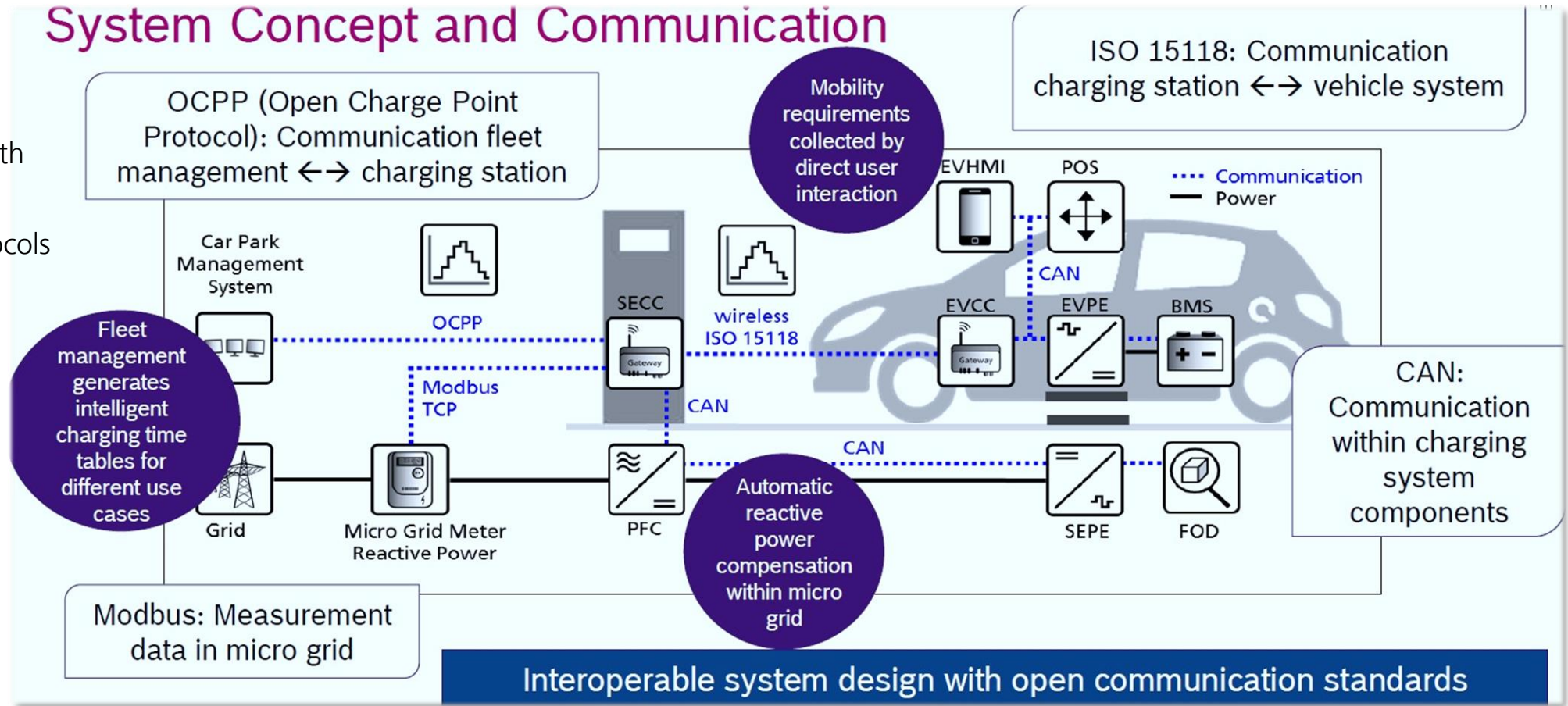


System Integration with Smart Grids

Communication Protocols: OCPP and Co

Electric Mobility

- System integration with ICT: Standards for Communication Protocols essential



System Integration in Energy Transition

Conclusion

- 1 The demand for electricity increases significantly – electricity becomes the most important primary energy
- 2 Flexibility management is essential, Smart Grids are used to integrate all sectors to the energy system.
- 3 Stationary and mobile Storage V2G will help to shift solar production to the evening
- 4 Grid management and dynamic pricing for energy will help to balance the system, storage is needed for the next phase of the energy system transition

Industry Workshop 19.6. at the Intersolar trade fair in Munich

Electrification of the heating sector? PV heat pump systems with battery storage

19.6.24 von 14:30-16:00 Uhr

Three components - heat pump, battery and PV or PVT - as a complete system

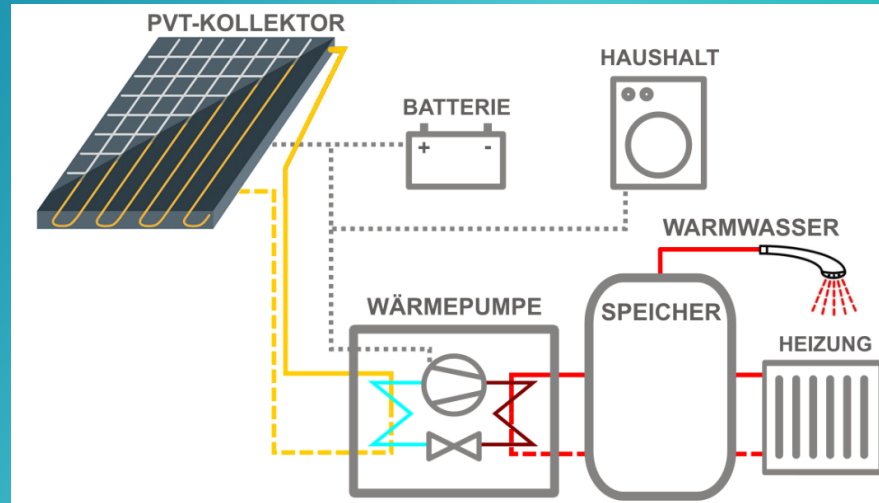
Workshop

- Costs / efficiency / potential
- Challenges
- Ecological footprint / systemic considerations
- Technical insights, how does the hybrid inverter work?
- Project results of the 'Integrate' project

A workshop for exchange, discussion and networking!

Language: German

Registration here:
[Industrieworkshop »Systemintegration«
- Fraunhofer ISE](#)



Many thanks for your attendance...

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