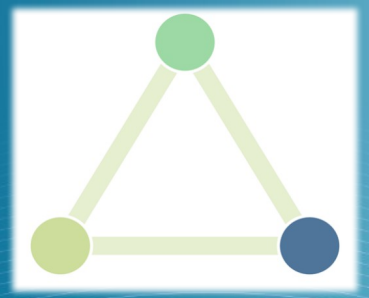
Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages



Fraunhofer ISI
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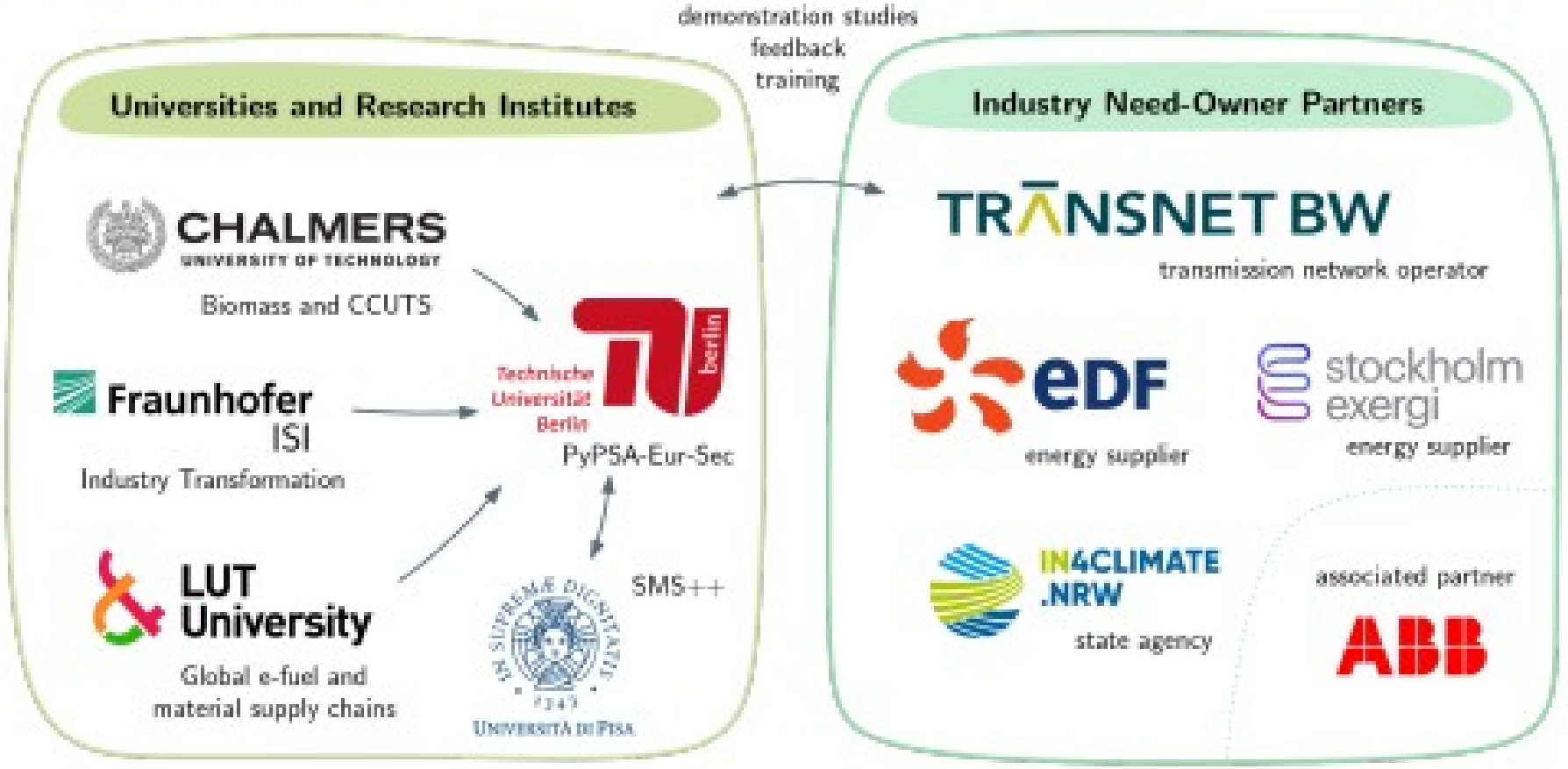
06.11.2024 - TRI1/6 Flexibility in industry event

Input from Resilient project:

Energy flexibility from industrial process heating - Relevance, system impacts and ways forward

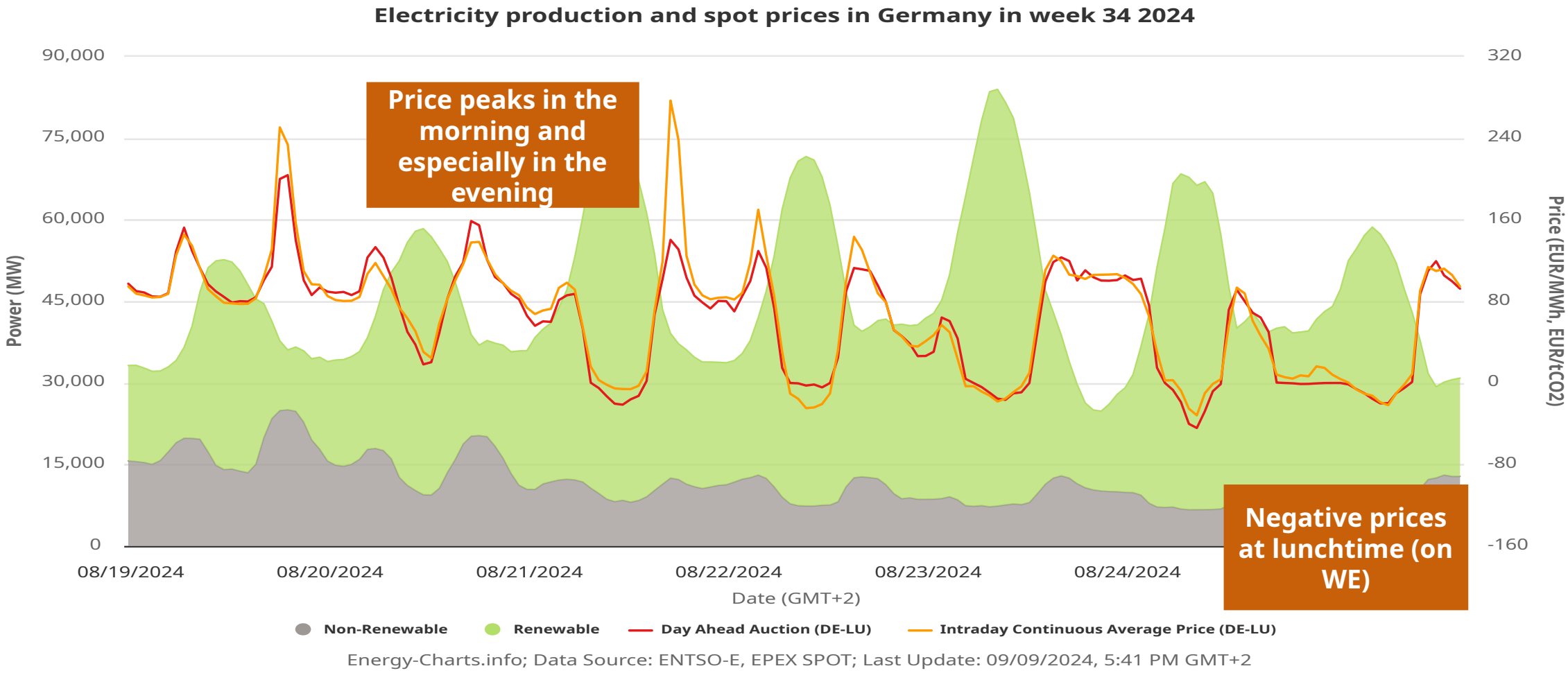
Tobias Fleiter, Khaled Al Dabbas, Benjamin Lux, Wolfgang Männer
(Fraunhofer Institute for Systems and Innovation Research)

Partners in the Resilient project



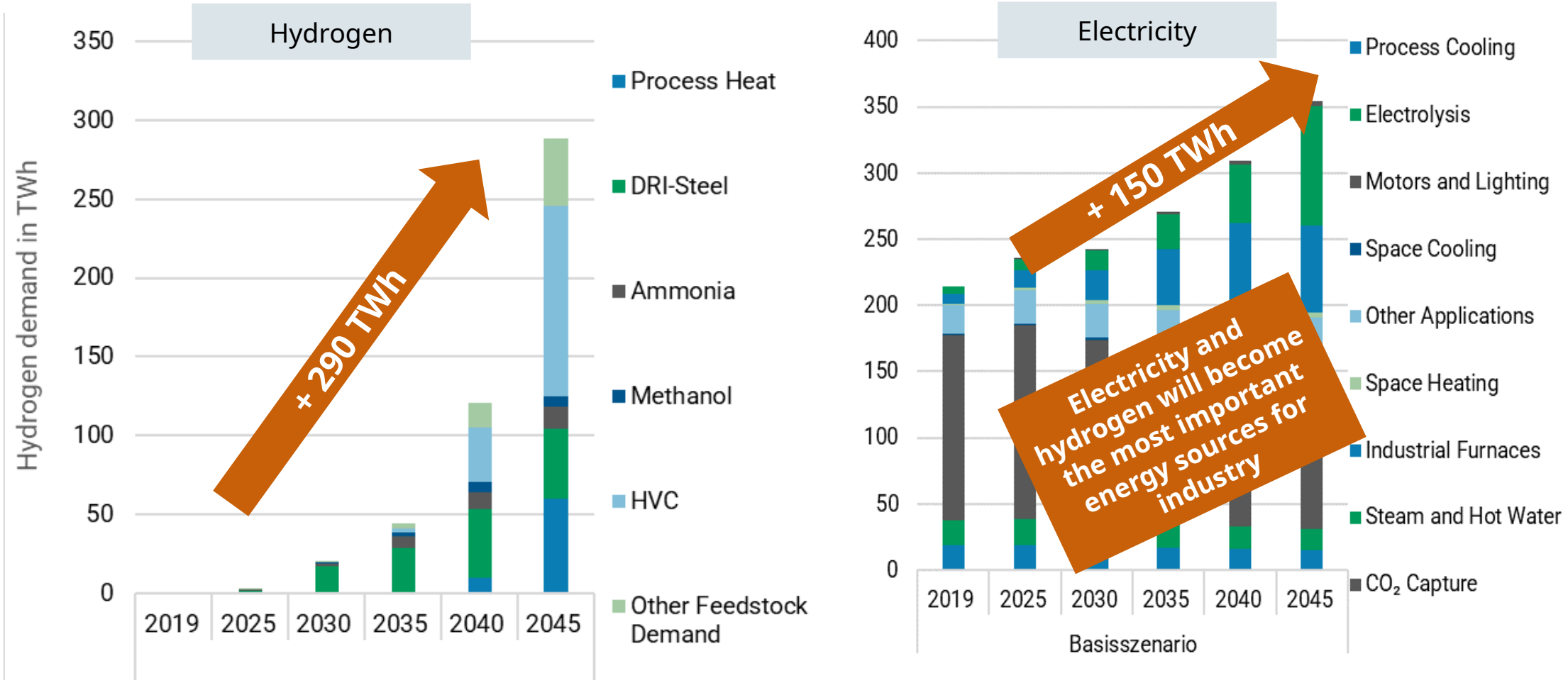
Motivation: First a look back

Source: Fraunhofer ISE
Energy Charts



Strong increase in hydrogen and electricity demand from industry expected

Hydrogen and electricity demand in industry by application



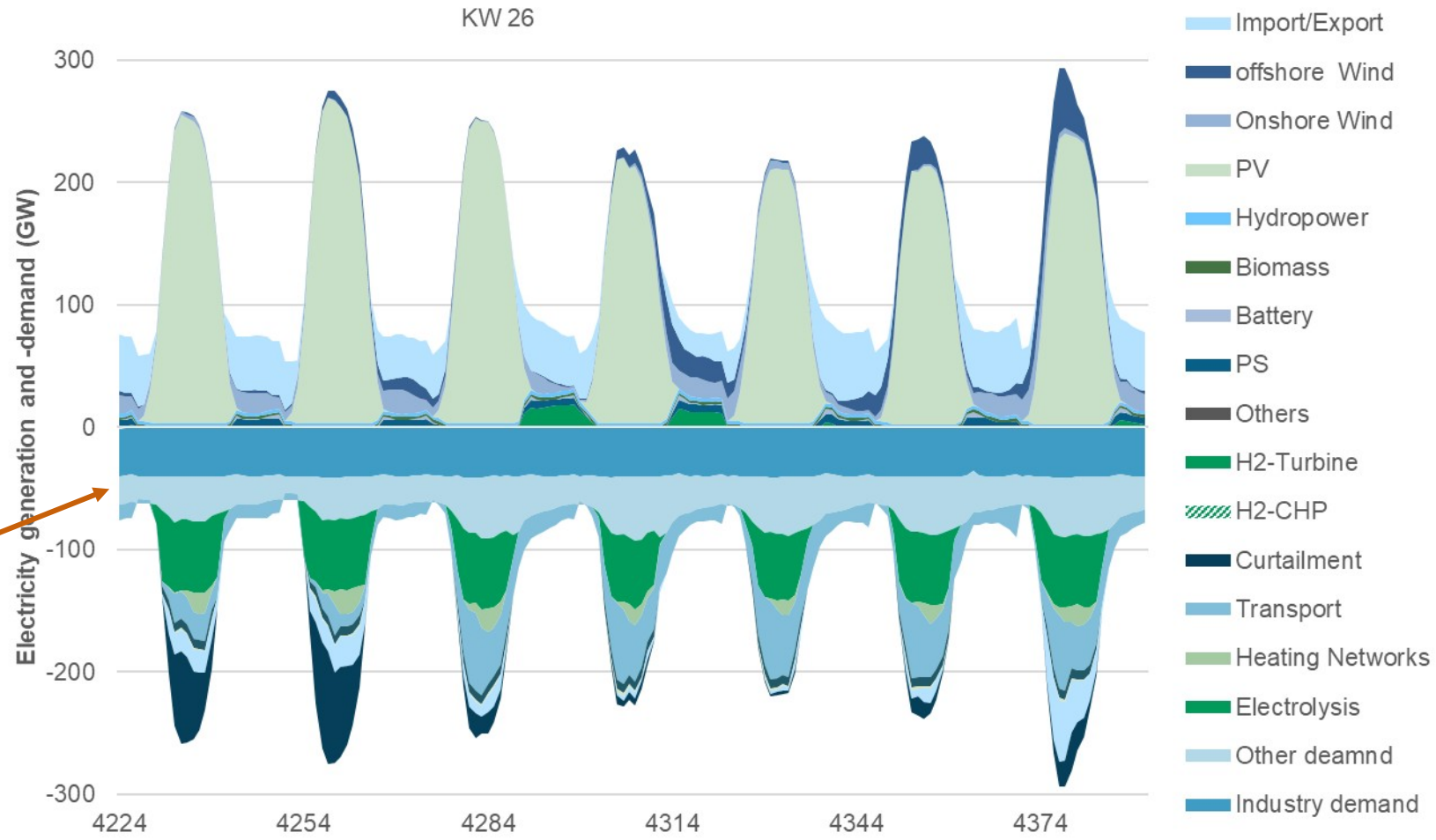
The electricity system needs seasonal balancing and short-term flexibility

Electricity generation and load - summer week (week 26) in 2045

Electricity system 2045 compared to today:

1. **Electricity demand: +140%** to 1200 TWh (about 510 TWh in 2023)
2. **Inst. capacity from wind and PV +300%** to 570 GW (150 in 2023)
3. **Load + 300%** to around 50-300 GW (today about 40-80)

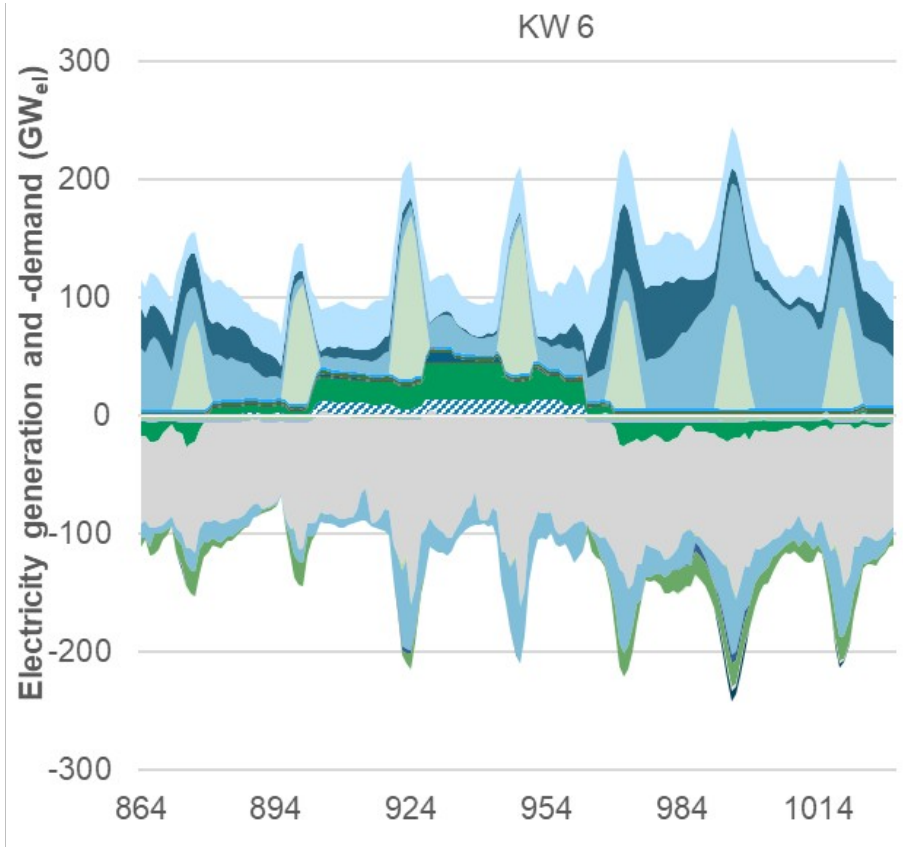
Literature analysis Flex potential of already electrified processes: ~5 GW load reduction for 4h



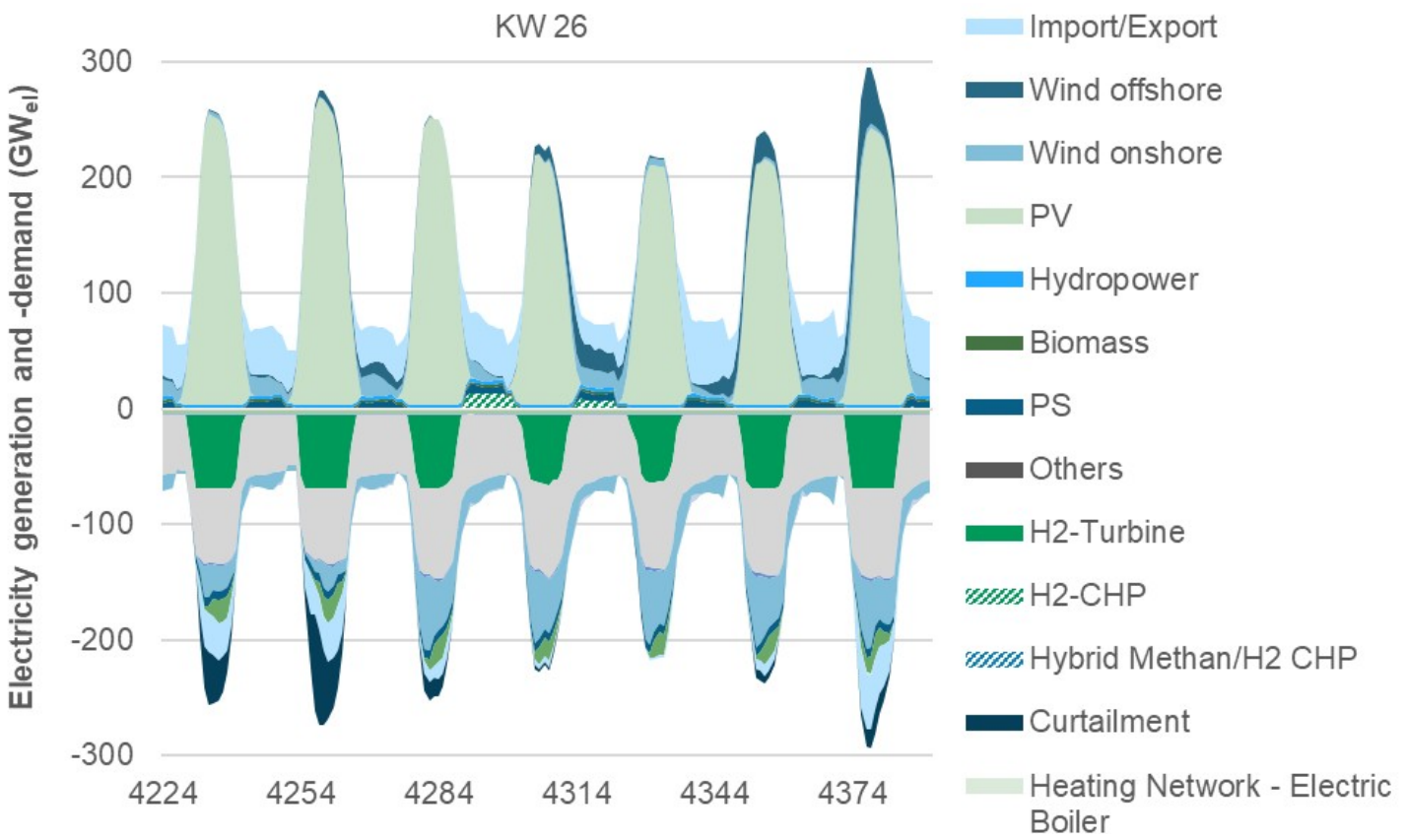
The electricity system requires seasonal balancing and short-term flexibility

Electricity dispatch 2045 in winter and summer in comparison

Winter week in the year 2045

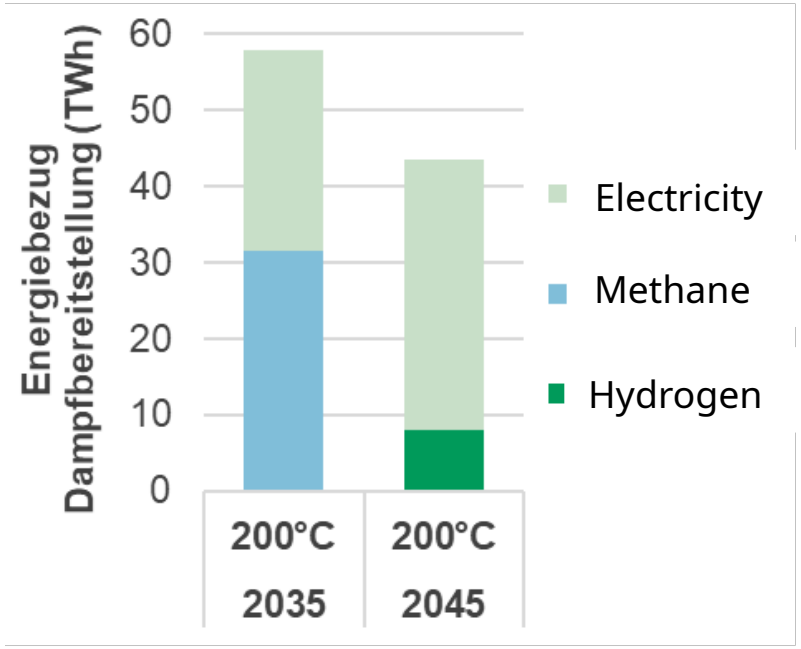


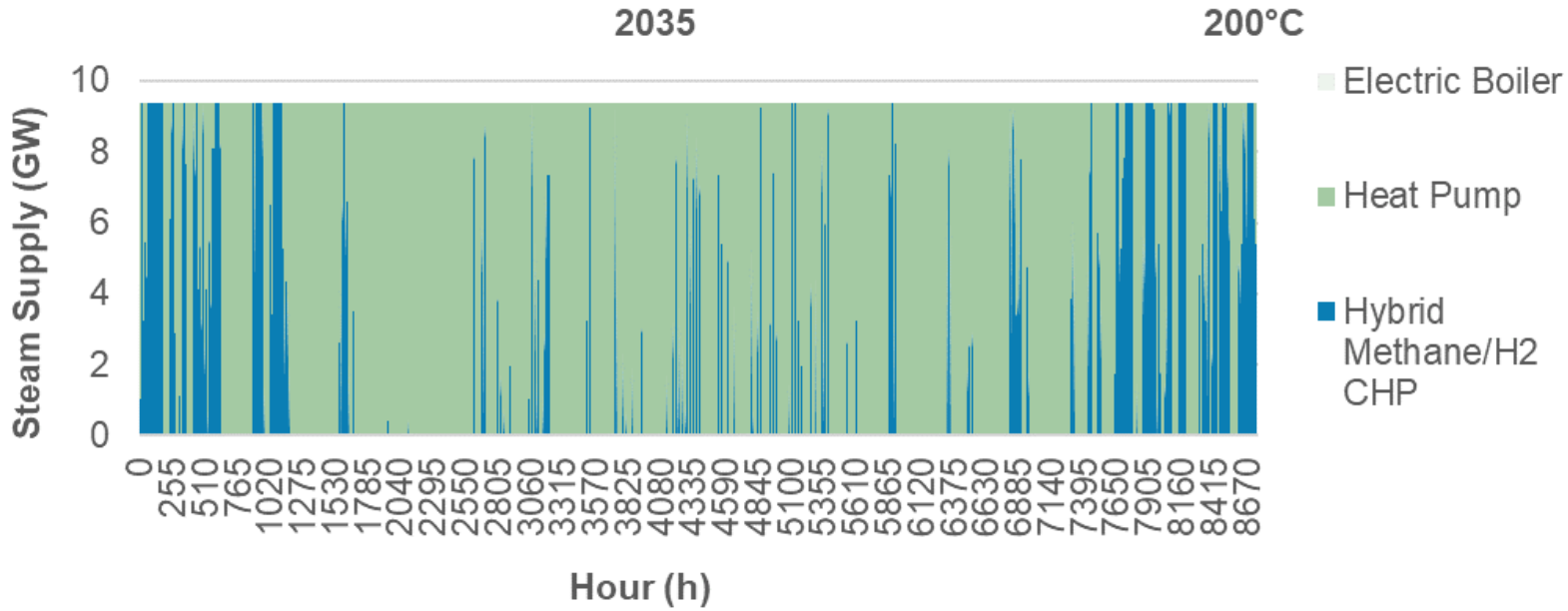
Summer week in the year 2045



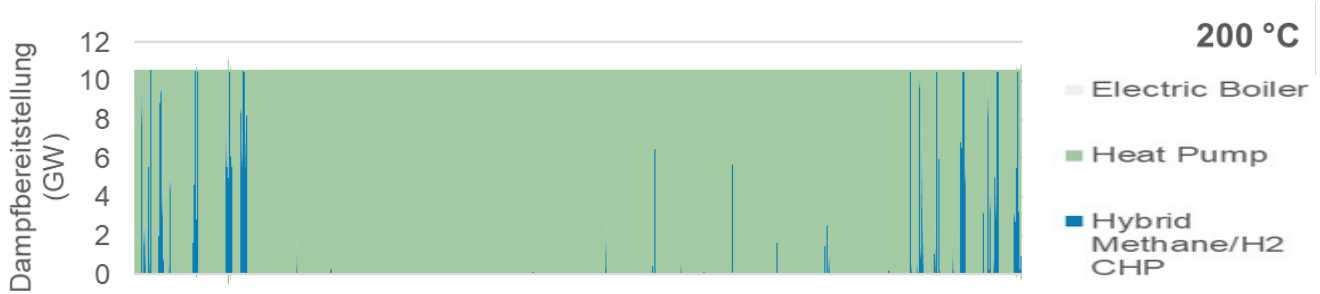
Process steam: operation of hybrid systems is clearly seasonal

Combined use of electric heating and CHP is cost-efficient





The flexible hybrid supply of process heat with natural gas/H2 and electricity is cost-efficient from a system perspective.

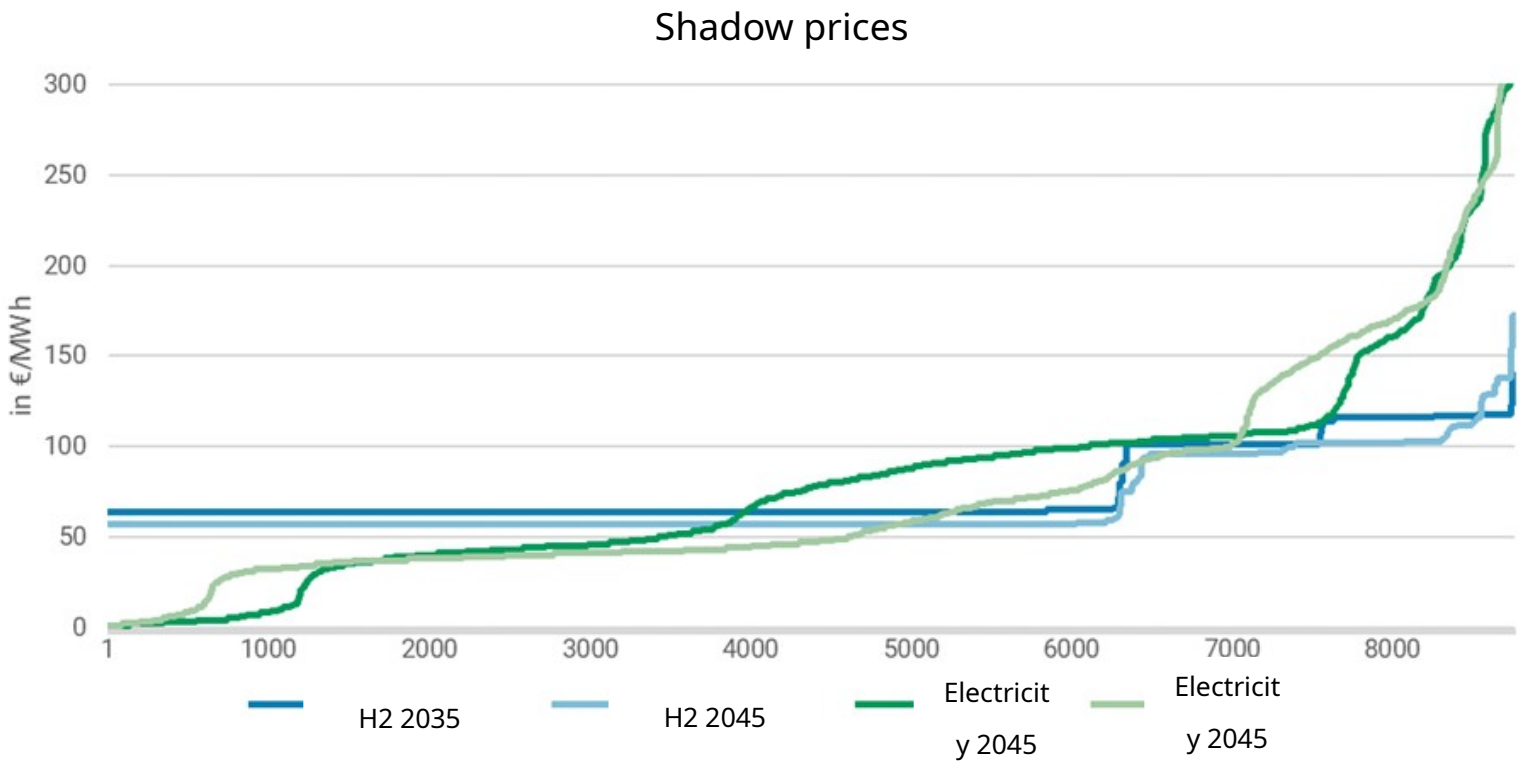


Framework conditions for economic evaluation

Price trends for gas, electricity and hydrogen

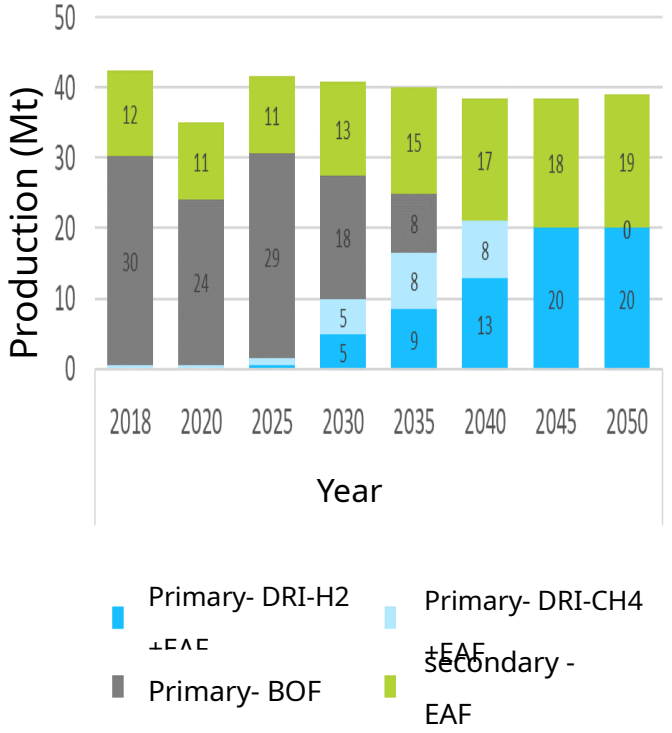
Price trends and price variability:

- **Energy price expectations** in the model:
  - Electricity prices with greater variability compared to hydrogen
  - Hydrogen storage systems dampen price variability
  - **Additional revenues in the** balancing power market and congestion management **possibl**
- **price developments** in the energy market in th short term:
  - Gas cheaper than electricity
  - Hydrogen more expensive than electricity
- long-term **price trends** in the energy market:
  - Gas prices rise with ETS prices
  - Hydrogen prices fall with low electrolyser and storage costs, rapid wind/PV expansion



Overview of the Iron and Steel Scenario Assumptions for Germany

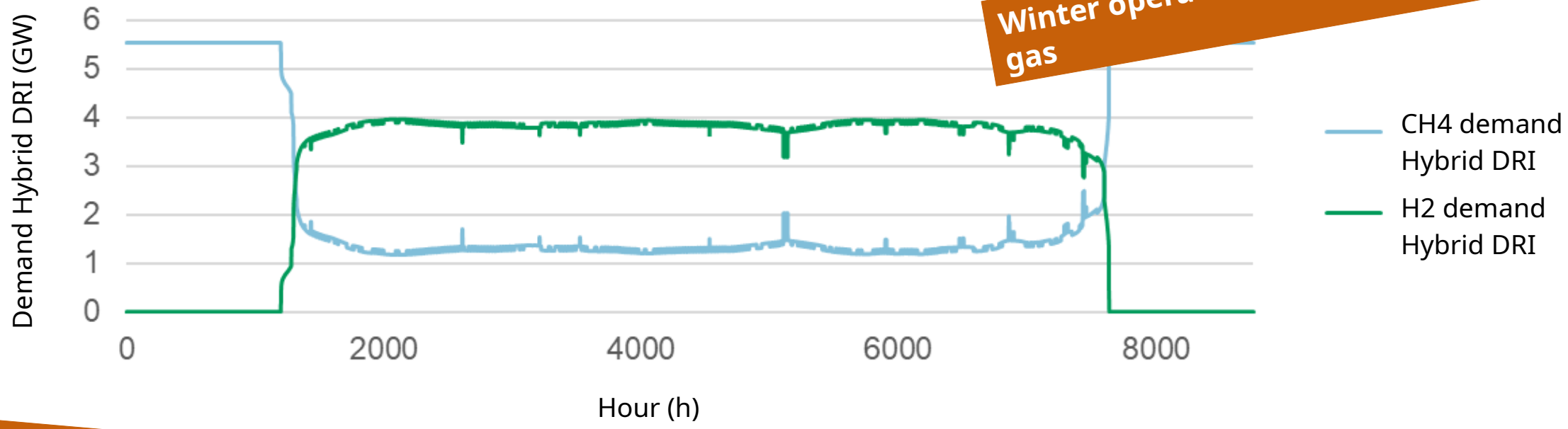
- **Recycling:** Increase in secondary steel share from 30% (2018) to 50% (+8 Mt) by 2050
- **Process switch:** Replacing 17 Mt blast furnace production by direct reduced iron (DRI) by 2035
- **Flexibility in DRI operation** blending CH4 and H2.



Hybridisation of steel production creates seasonal flexibility

Use of H2 and natural gas in DRI production as an annual profile for 2035

Winter operation relying solely on **natural gas**



A clearly **seasonal profile** of the use of H2 and natural gas in DRI systems is cost-efficient from a system perspective – during the **transition phase**.

Core results of the system analysis

1. The climate-neutral energy system will be strongly characterised by wind and PV as well as a high degree of sector coupling. There will be a high demand for hourly and seasonal flexibility.
2. In the coupled energy system, flexible loads follow the supply of renewable electricity. At the same time, the potential for industrial flexibilisation should be realistically assessed.
3. Hybrid systems as combinations of electric heating and CHP are cost-efficient and beneficial to the system.
4. **Initially, heat pumps or electric boilers should supplement gas-fired CHP systems, which can be converted to hydrogen in the long term.**
5. **If possible, natural gas and hydrogen should be used in a flexible mix during the transition period. The operation of future direct reduction plants in steel production in particular has great potential.**

Outlook: Related work streams for the resilient project

Endogenisation of the industry sector in the energy system model Pypsa-EurSec

- **Endogenous invest decisions in new plants** according to modernisation cycles for major energy-intensive industries
- **Operational flexibility** e.g. by using hydrogen and natural gas in the transition period
- Endogenous investment decisions for **hybrid systems in steam generation**
- Realistic technology potentials, e.g. for **high-temperature heat pumps**

Thank you for your attention!

Contact:

Dr. Tobias Fleiter, Khaled Al-dabbas M. Sc.

Tobias.fleiter@isi.fraunhofer.de
Khaled-al-dabbas@isi.fraunhofer.de

Fraunhofer Institute for Systems and Innovation Research ISI
Breslauer Straße 48
76139 Karlsruhe
www.isi.fraunhofer.de