PATHWAYS TO A CLIMATE-NEUTRAL ENERGY SYSTEM

The German Energy Transition and the Need for Energy Storage

Prof. Dr. Hans-Martin Henning,

IRES2021, March 16th 2021

Fraunhofer Institute for Solar Energy Systems ISE

www.ise.fraunhofer.de

Fraunhofer ISE

Background

Climate Change – Forest fires, extreme wether events, melting glaciers,…

National Geographic, October 10th 2020:
“Climate change is contributing to California's fires”

CNN, November 16th 2019:
„Venice sees worst floods in 50 years“

CBS News, January 3rd 2020:
„How climate change has intensified the deadly fires in Australia”

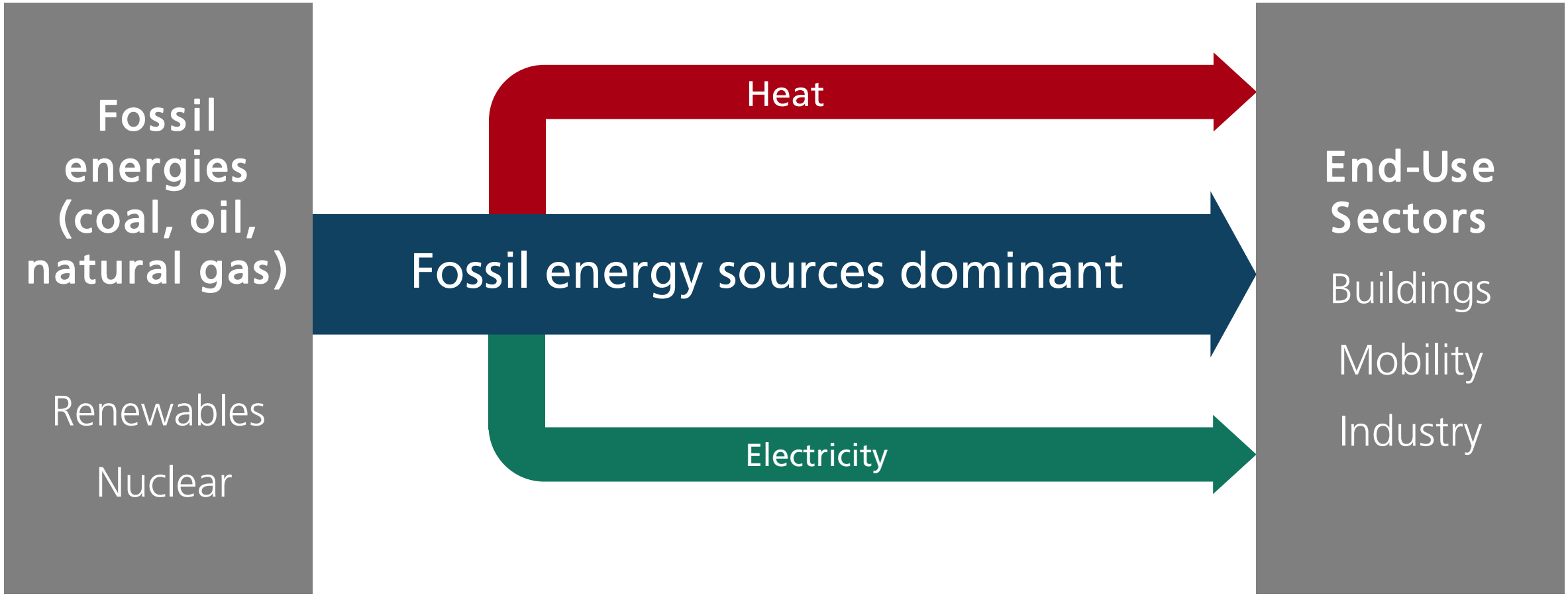
The Guardian, March 11th 2020:
“Polar ice caps melting six times faster than in 1990s”

Time, May 22nd 2020:
“The Taste of Bordeaux Is Going to Change”

BBC, May, 22nd 2020:
“Cyclone Amphan batters India and Bangladesh”

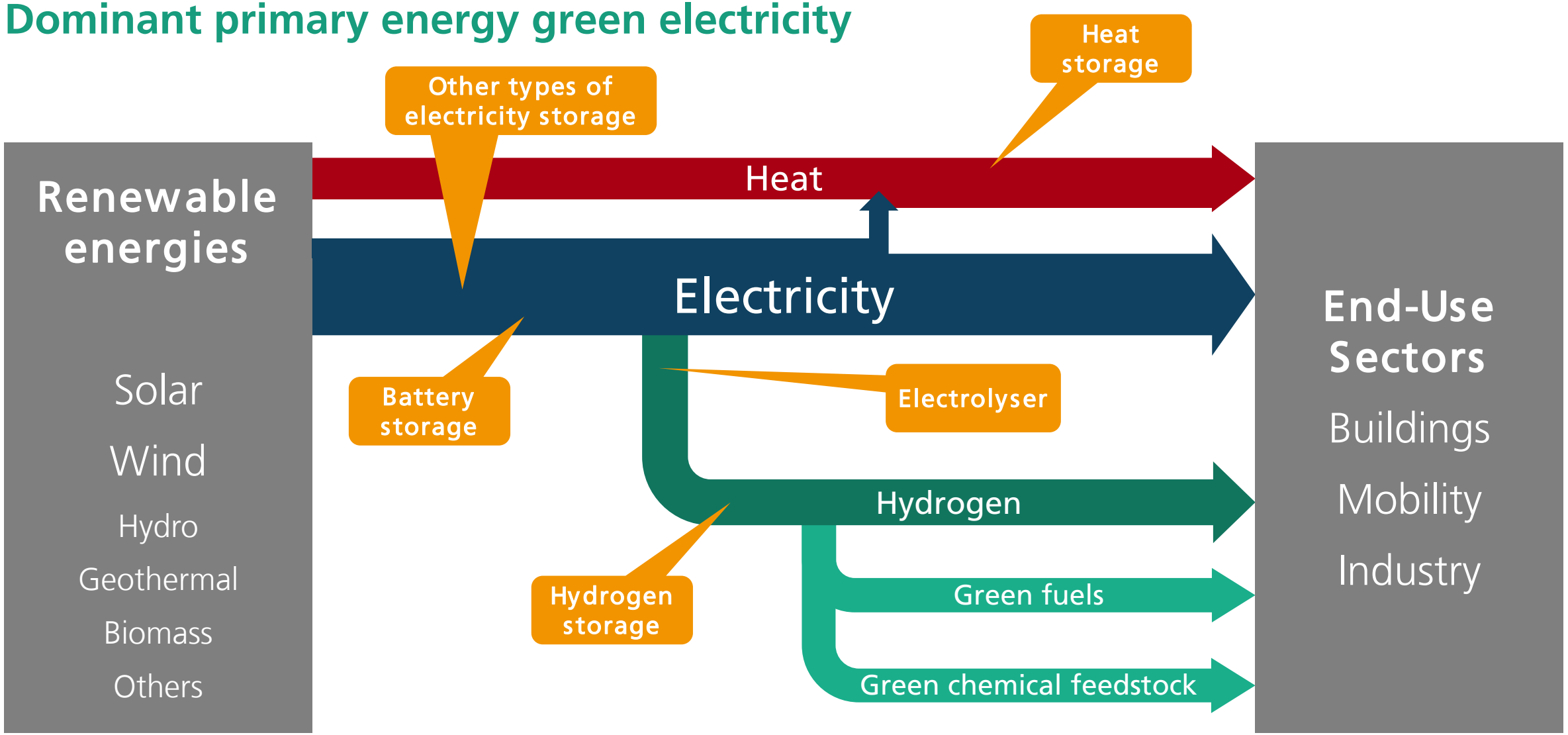
Content

The energy system of the past
Dominant primary energy fossil



The future energy system

Dominant primary energy green electricity

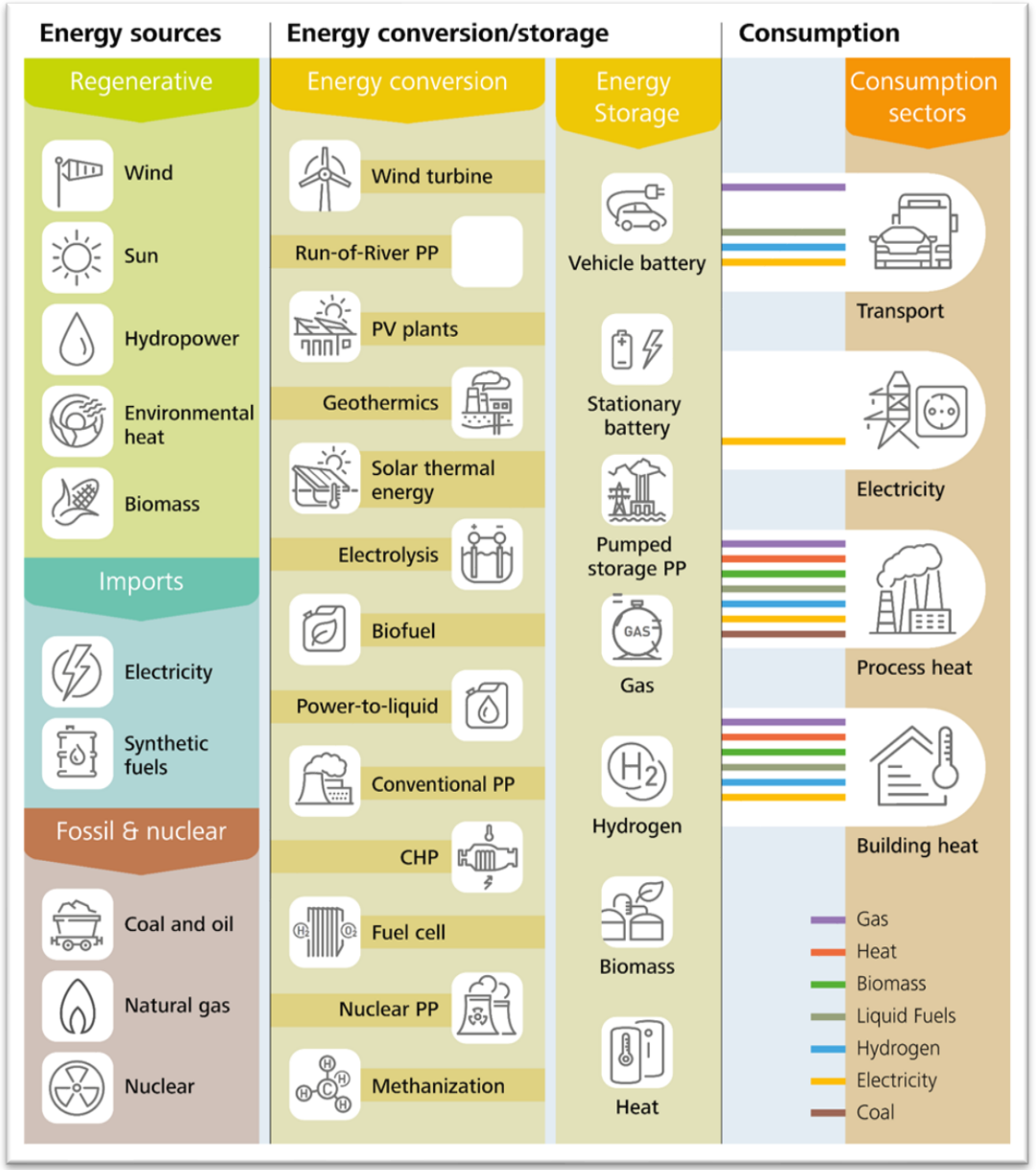


Fraunhofer ISE

Content

System analysis – Methodology
Renewable Energy Model »REMod«

- **Strictly model-based techno-economic optimization of transformation pathways**
  - Consideration of all sectors and energy sources
  - Comprehensive simulation of energy systems (hourly time scale)
  - Mimimize total transformation cost

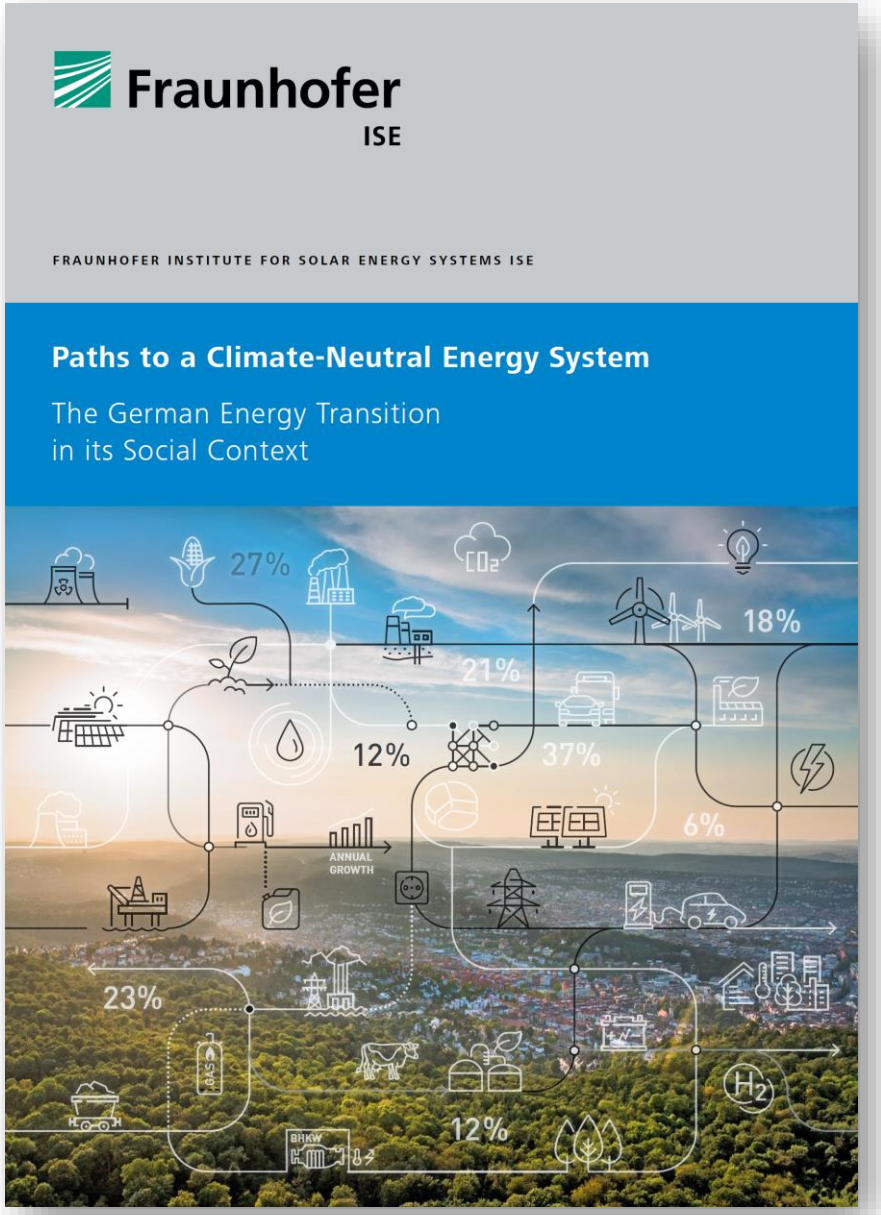


Fraunhofer ISE

Pathways to a climate neutral energy system

Broad investigation of factors influencing system development

- Societal behaviour
- Development of prices of globally traded green hydrogen and fuels
- Remaining CO_2 budget and resulting target pathway



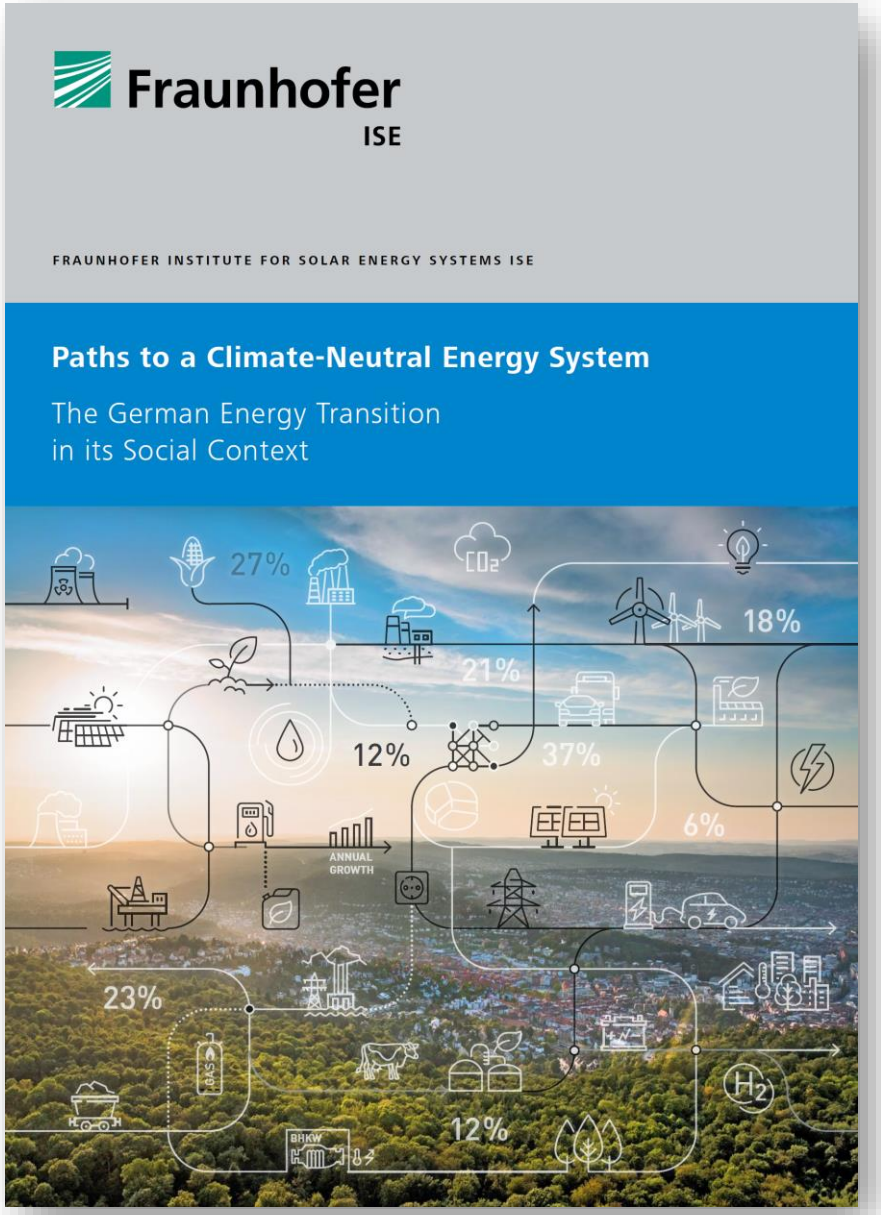
Original study, published February 2020,
Link: https://www.ise.fraunhofer.de/en/publications/studies/paths-to-a-climate-neutral-energy-system.html

Pathways to a climate neutral energy system

Broad investigation of factors influencing system development

- Societal behaviour
- Development of prices of globally traded green hydrogen and fuels
- Remaining CO_2 budget and resulting target pathway

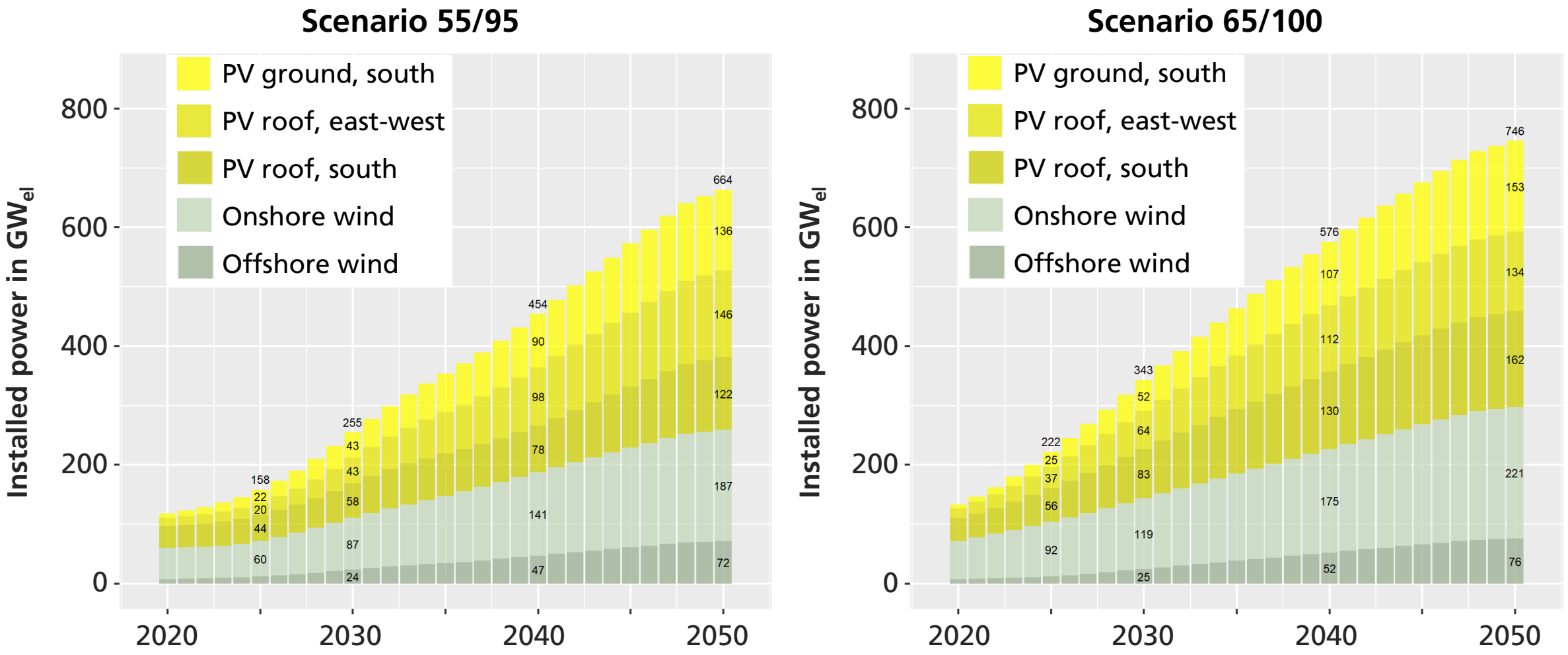
Scenario	Recent targets	Strengthening of targets
2030	- 55 %	- 65 %
2050	- 95 %	- 100 %



Original study, published February 2020,
Link: https://www.ise.fraunhofer.de/en/publications/studies/paths-to-a-climate-neutral-energy-system.html

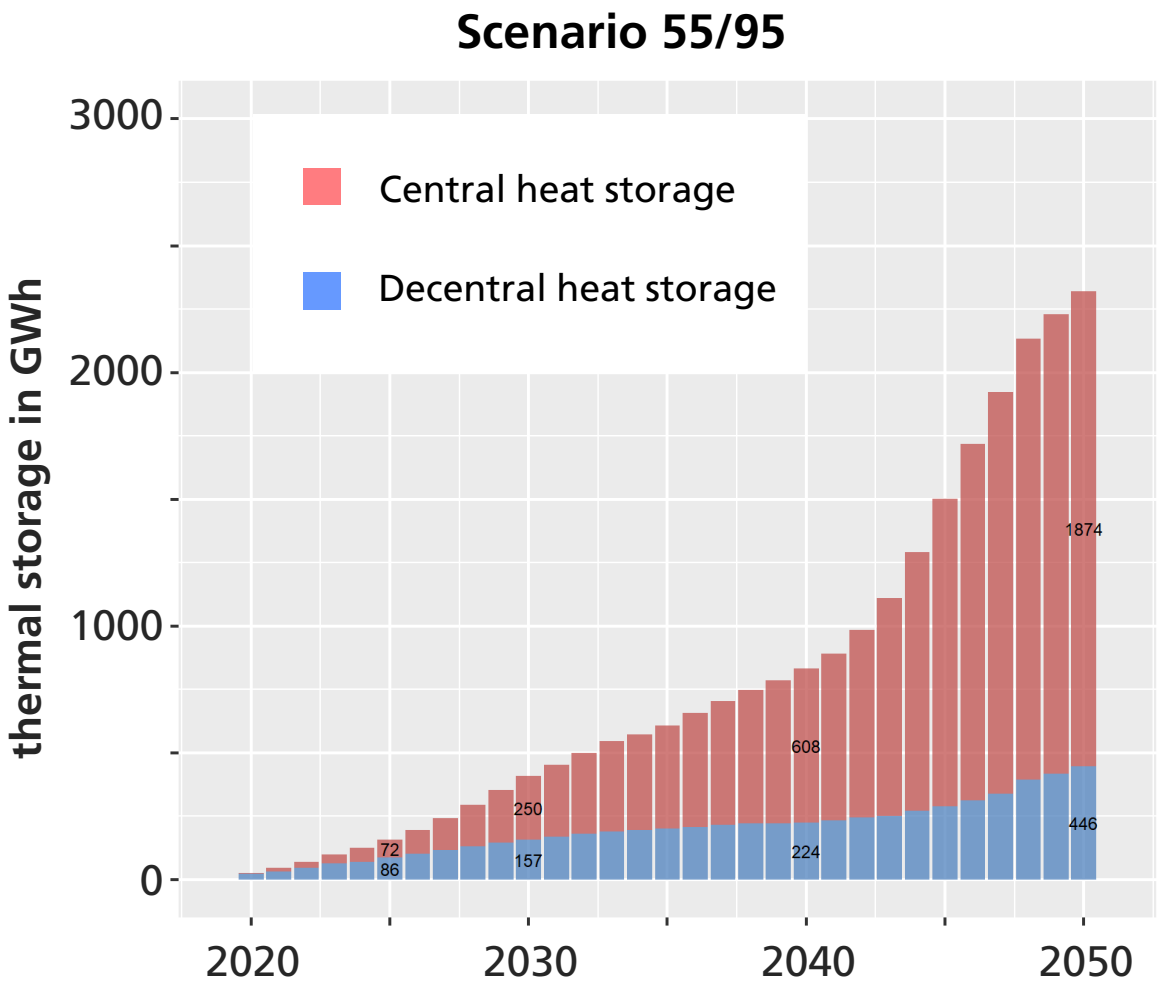
Fraunhofer ISE

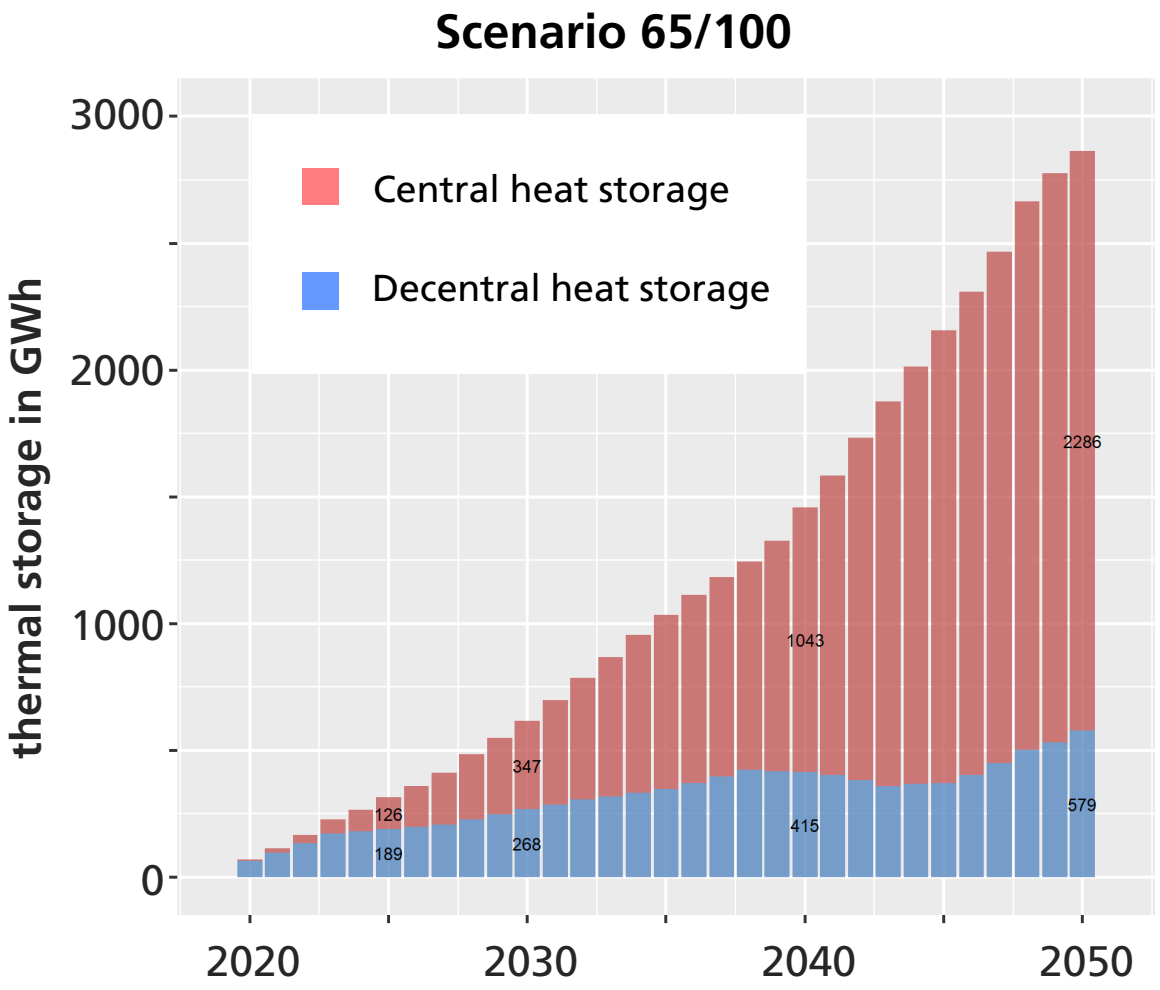
Development of photovoltaic and wind power



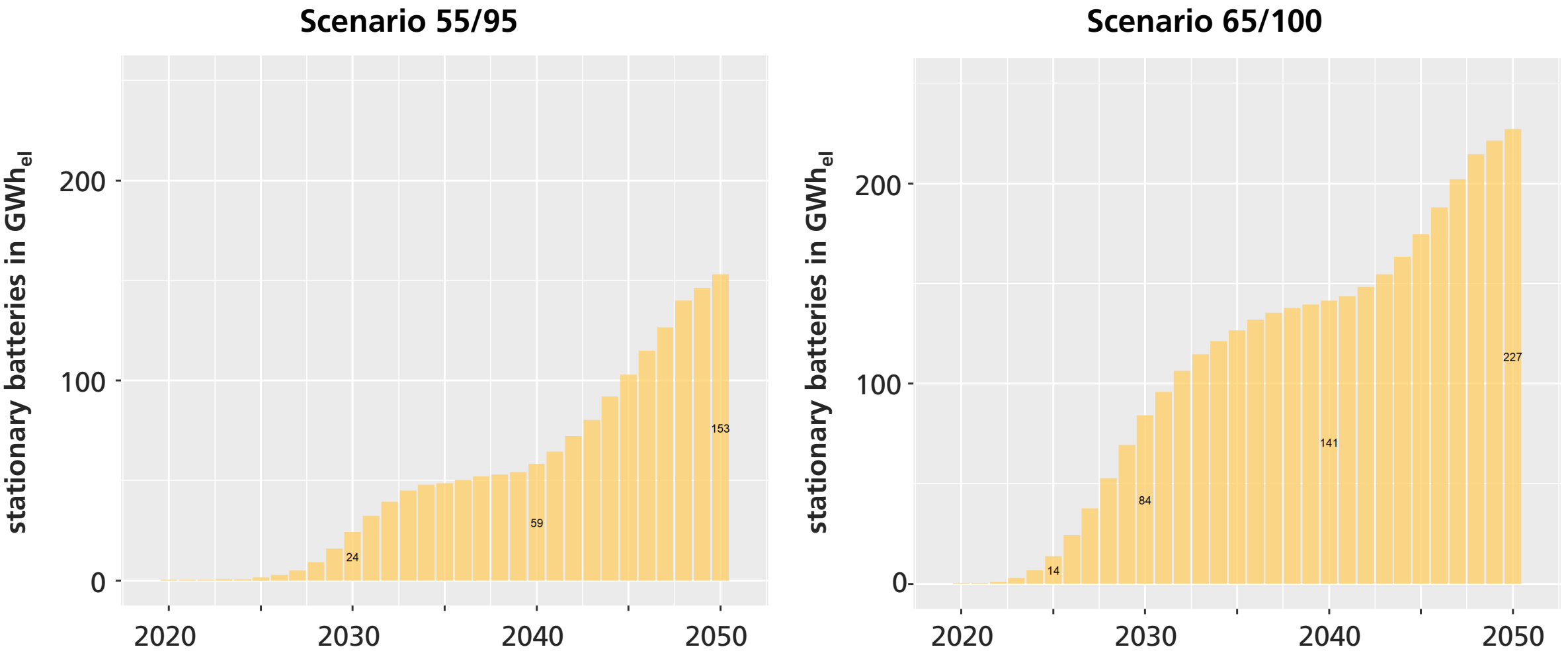
Fraunhofer ISE

Development of heat storage





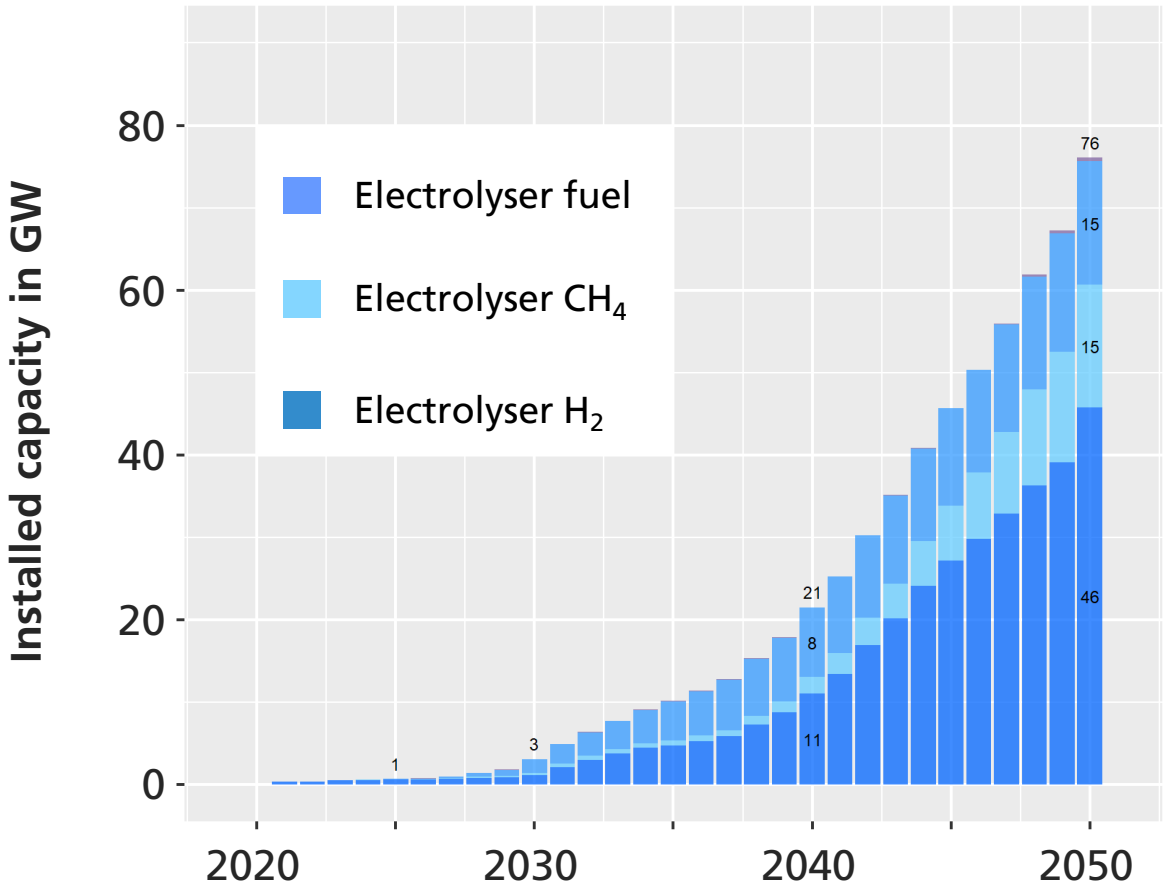
Development of stationary batteries



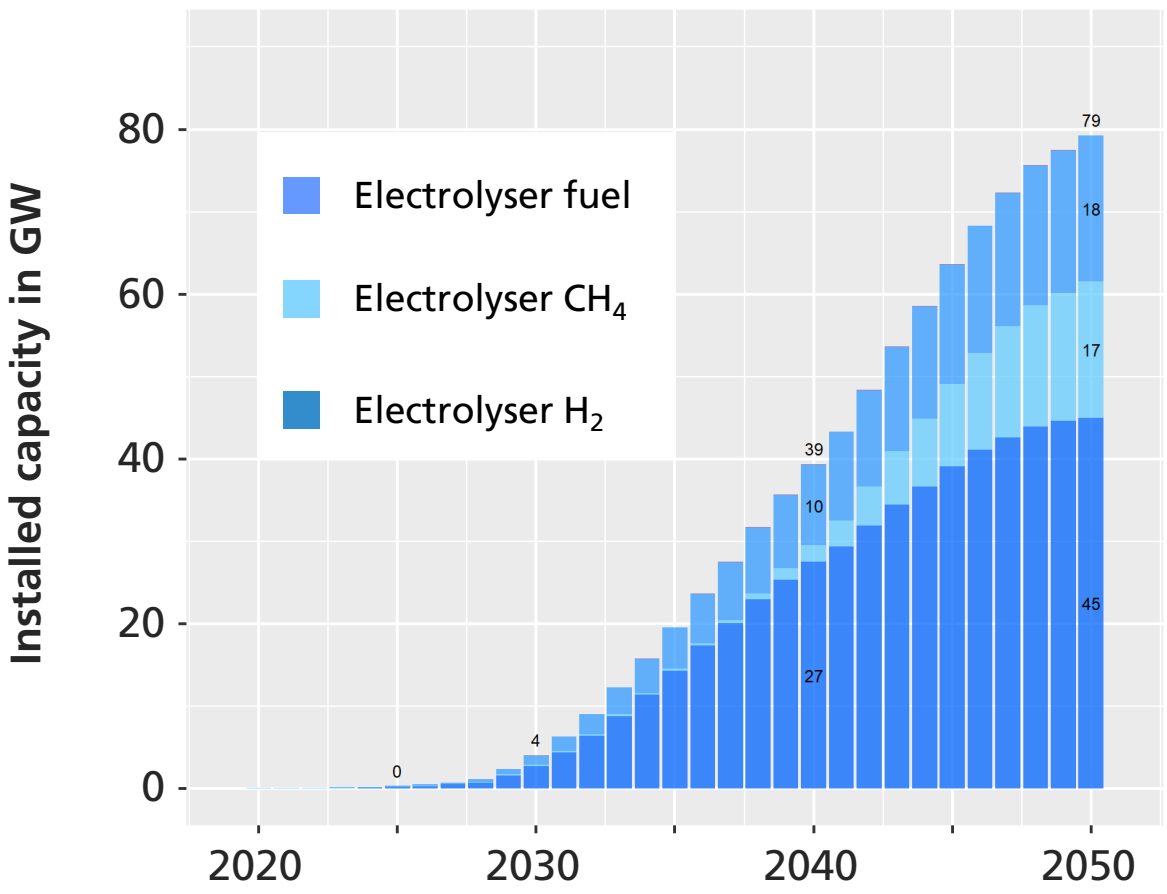
Fraunhofer ISE

Development of hydrogen technologies

Scenario 55/95



Scenario 65/100



Fraunhofer ISE

Content

Conclusion 1/2
A paradigm shift is needed

We will only succeed in the transformation of the energy system towards a complete reduction of greenhouse gas emissions, if we understand the **fundamental new character** of the new system.

- **Fossil energy has to be completely replaced**; thus also their inherent ability of storage has to be substituted.
- **Variable renewable electricity** becomes the main primary energy.
- Thus, not only **demand** but also **supply becomes time dependent.**
- To cope with this change a **full sector integration** by using electricity directly (e.g. heat pumps, verhicles) and indirectly (hydrogen, synthetic gases & liquids) is needed.

Fraunhofer ISE

Conclusion 2/2
A paradigm shift is needed

We will only succeed in the transformation of the energy system towards a complete reduction of greenhouse gas emissions, if we understand the **fundamental new character** of the new system.

- **Various types of energy storage** located at various places in the overall system are needed.
- The transformation has to be stimulated by **appropriate market frameworks.**
- A **powerful and intelligent control** is necessary to assure a save and reliable system operation and orchestration.
- A **strengthening of the european emission targets** will increase the importance of all types of energy storage.
- Implementing a **circular economy** is a key requirement for a fully sustainable energy system.

Many Thanks for Your Attention!

Foto © Fraunhofer ISE

Fraunhofer Institute for Solar Energy Systems ISE, www.ise.fraunhofer.de

Prof. Dr. Hans-Martin Henning, hans-martin.henning@ise.fraunhofer.de

Fraunhofer ISE