The role of hydrogen in the competition for sustainable energy carriers

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St. Gallen, 20th of June 2024

Agenda

Energy Technologies and Efficiency

New role and challenges of electricity

Hydrogen and synthetic energy carriers

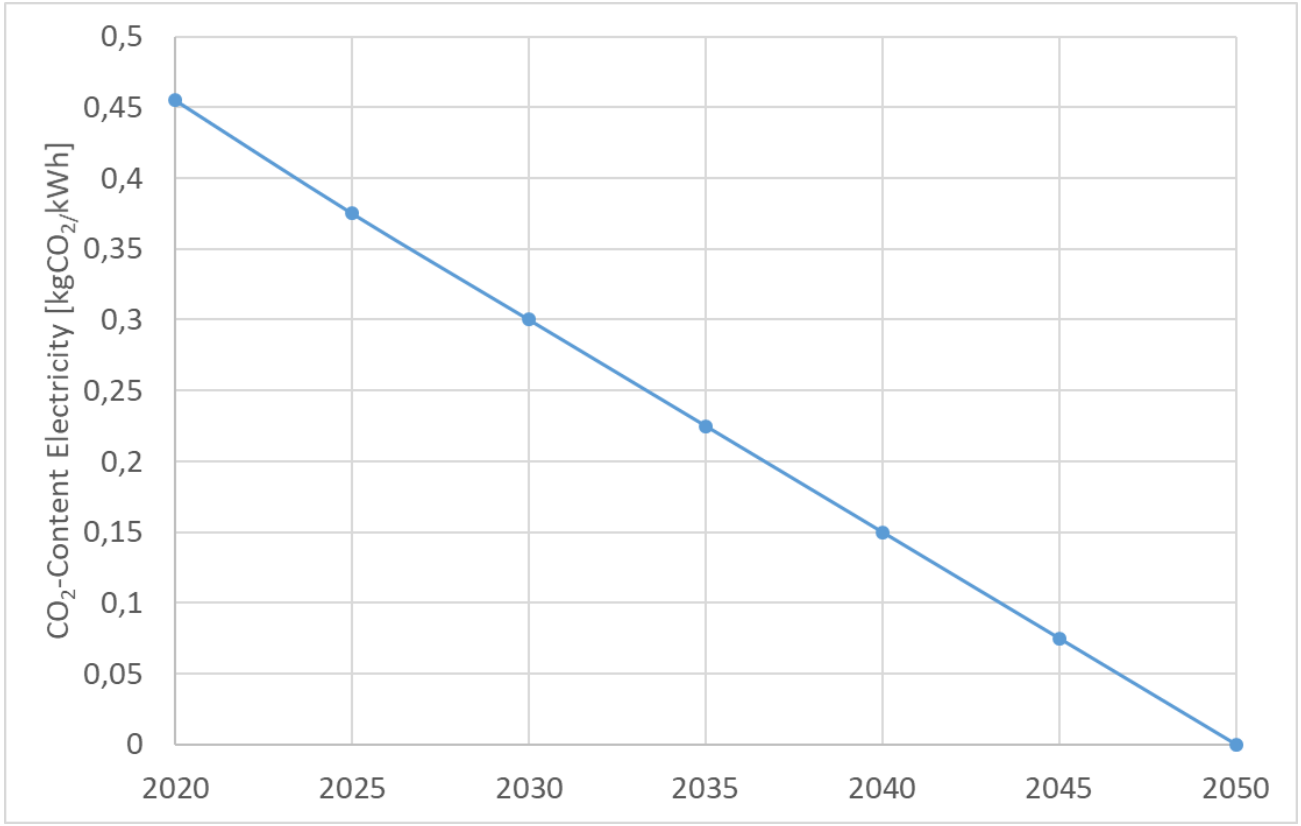
Hydrogen Projects at Technical University of Munich

Hydrogen and the electricity market

The role of a strong European Energy cooperation

Conclusion and Outlook

Energy Technologies and Efficiency

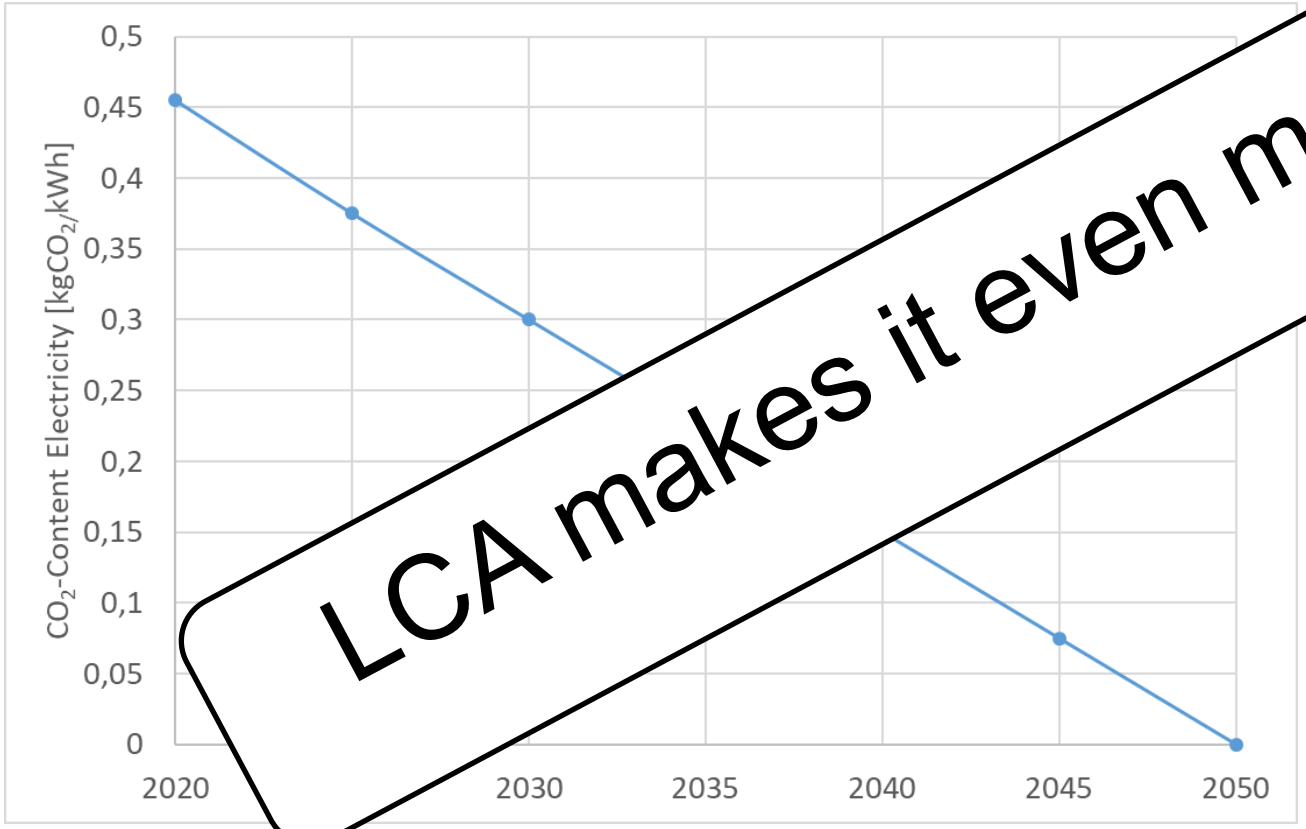


Heat pump: COP 3,
Specific Emissions at 450 gCO_2/kWh in the electricity system:
150 gCO_2/kWh

Electric Car: 20 kWh/(100 km),
Specific Emissions at 450 gCO_2/kWh in the electricity system:
90 gCO_2/kmg CO_2/km

Hydrogen: $\eta = 70\ \%$
Specific Emissions at 100 gCO_2/kWh in the electricity system:
143 gCO_2/km

Energy Technologies and Efficiency



LCA makes it even more tricky

...s at 450 gCO_2/kWh in
...ty system:
...gCO_2/kWh

Electric Car: 20 kWh/(100 km),
Specific Emissions at 450 gCO_2/kWh in the electricity system:
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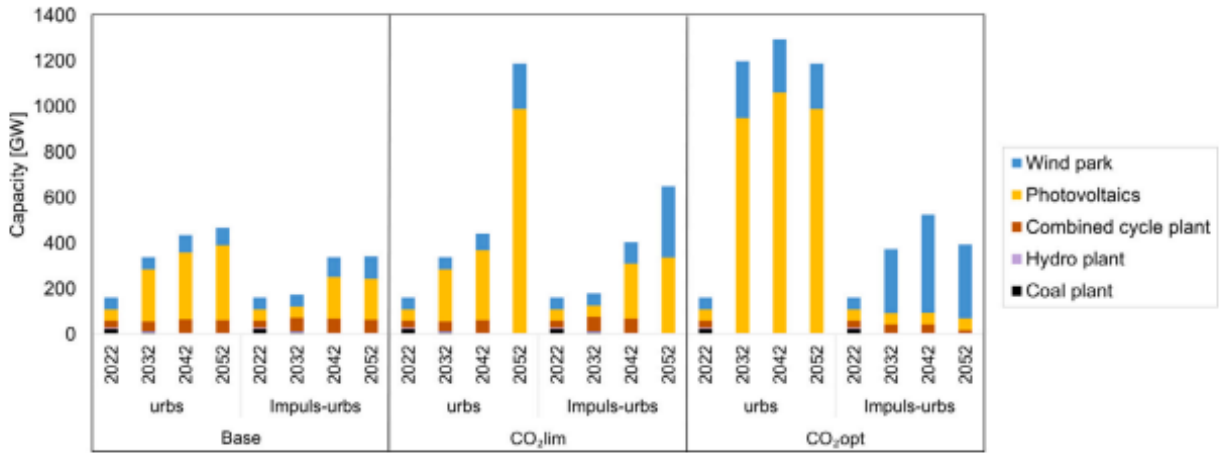

Fig. 7. System total installed capacity in all scenarios.

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Impuls-urbs: Integration of life cycle assessment into energy system models

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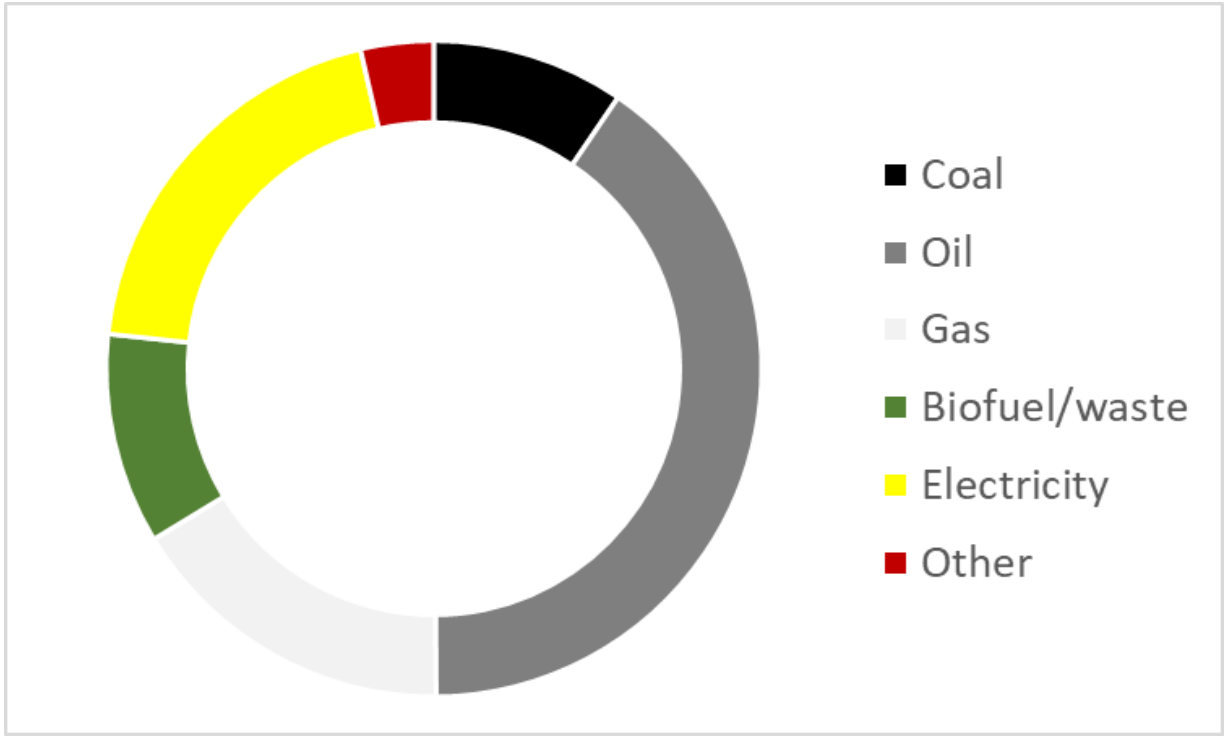
The new role of electricity

Which fraction of final energy will be supplied by electricity?

Will electricity be able to become the dominant source?

This will be a major shift of the whole energy industry, with oil companies being since recently the biggest companies in the world.

Final Energy 2019: 418 EJ (116111 TWh)
Source: IEA



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Hydrogen and synthetic energy carriers

Final Energy for ships, aviation, heavy track and trains

Feed stock for chemical and material industries

High temperature and reduction

Transport and storage

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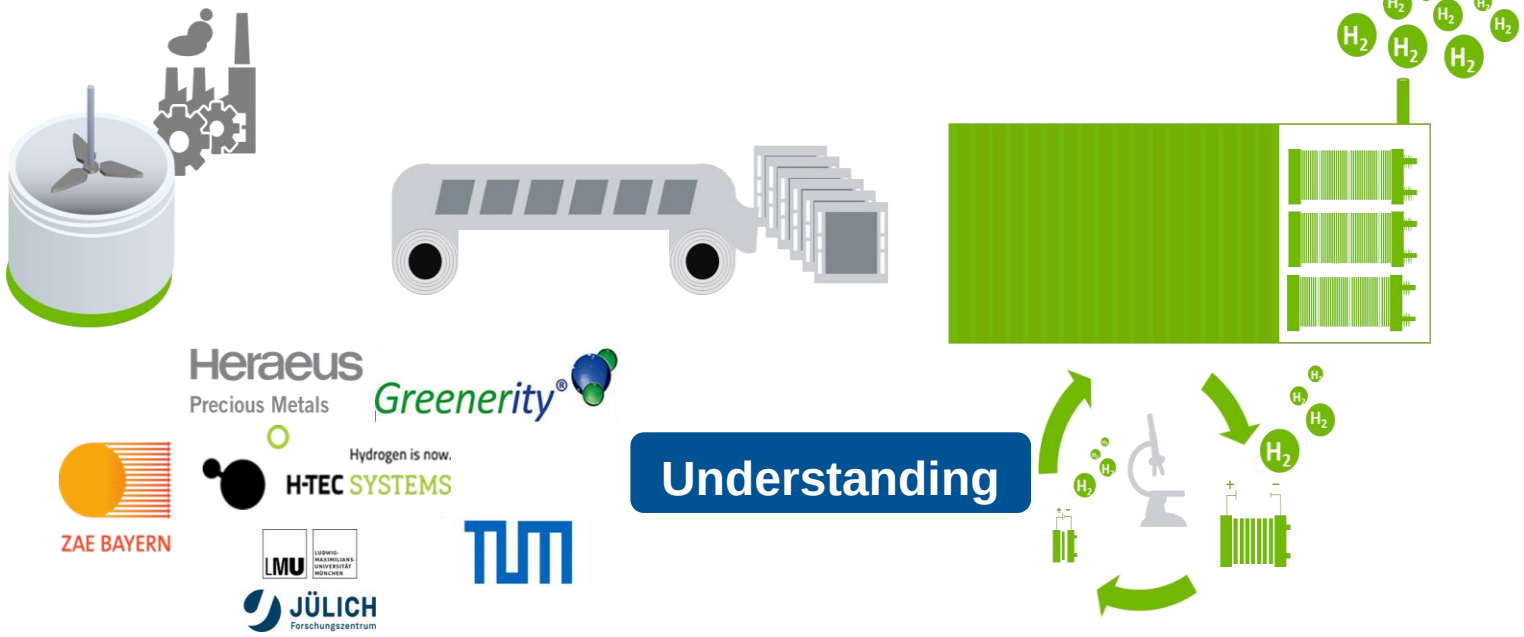
Iridios Consortium and Objectives

Catalyst **MEA Production** **MW PEMWE**



Investigation of low-IR electrodes on the relevant scales: **single-cell, short-stack and full-stack** using in- and ex-situ analysis

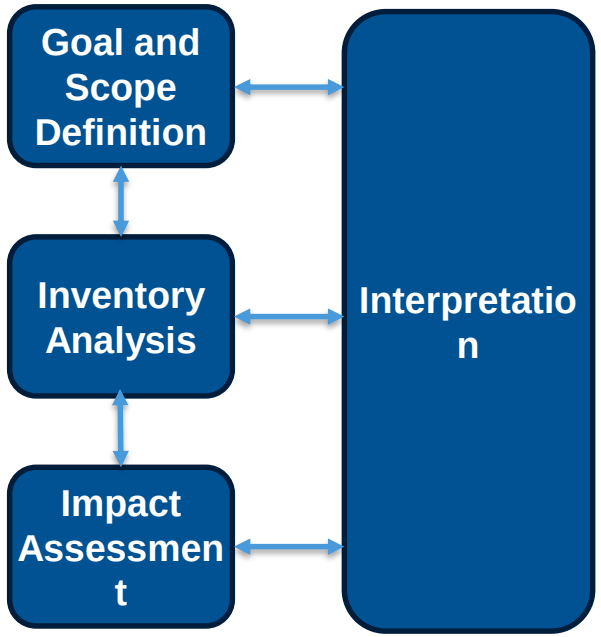
Implementation of catalysts from Kopernikus P2X, new membranes and PTL(Porous Transport Layer) concepts

Scaling up electrode production and implementation in **MW electrolysis systems**

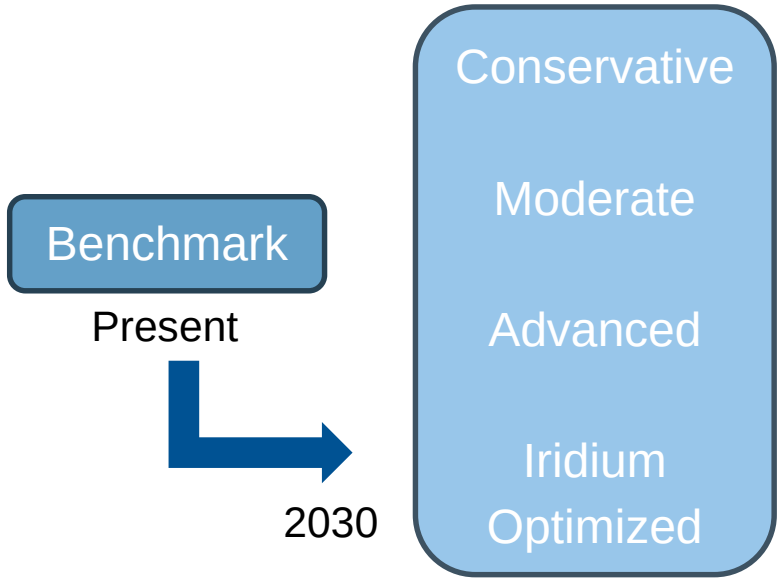
LCA of all components during upscaling, evaluation of the impact of efficiency, service life and recycling (2nd Life)

WP 6: Life Cycle Assessment of Upscaling

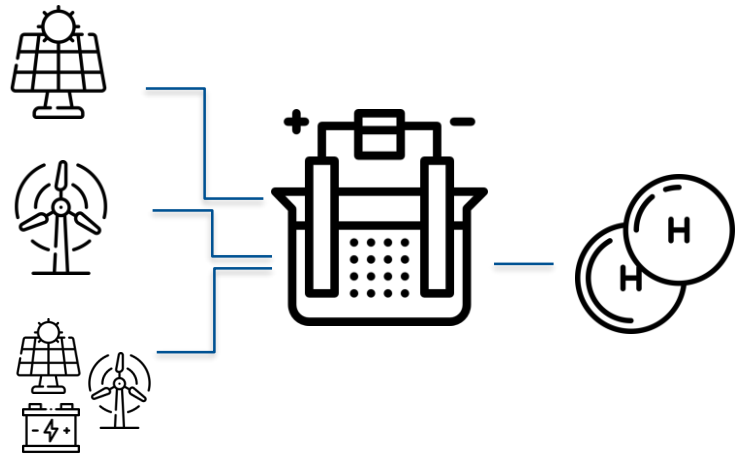
Analysis of the upscaling of manufacturing processes to produce low Iridium PEM Electrolysis, as well as consideration of the ecological impact of the electrolyzer efficiency and lifetime



Assessing the environmental and social footprint and establishing the circularity measures for the end-of-life.

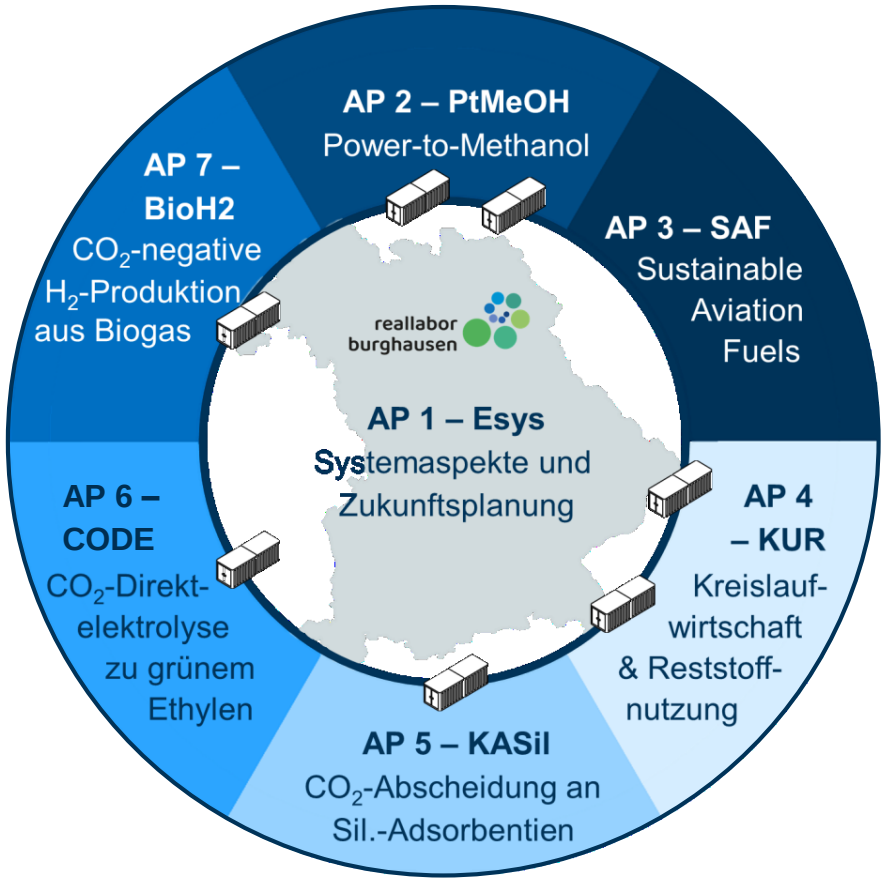


Analysis of different technology development levels by 2030 in comparison to the state-of-the-art PEM Electrolyzer.



Analysis of green hydrogen production under different electricity scenarios: PV, Wind or Optimized Wind-PV integration.

Objective of the "H_2-Reallabor Burghausen" is the creation of the research basis and initial technology demonstration



Source: H2-Reallabor Burghausen – Vorstellung Reallabor

"H_2-Reallabor Burghausen" (regulatory sandboxe Burghausen):

Investigation of sustainable processes for the provision of basic and specialty chemicals

Analysis of energy and raw material requirements for the identification of acute supply gaps

Identification of synergy effects within the site and opportunities for sector coupling

Analysis of the medium and long-term coupling of the site to the overarching energy system

Analysis of possible local and international value chains based on climate-neutral chemistry

Summary of findings to secure the chemical industry in Germany and development of a roadmap for the transformation of the chemical industry

In working package 1, the transformation to a climate-neutral chemical industry is analyzed through energy system modelling

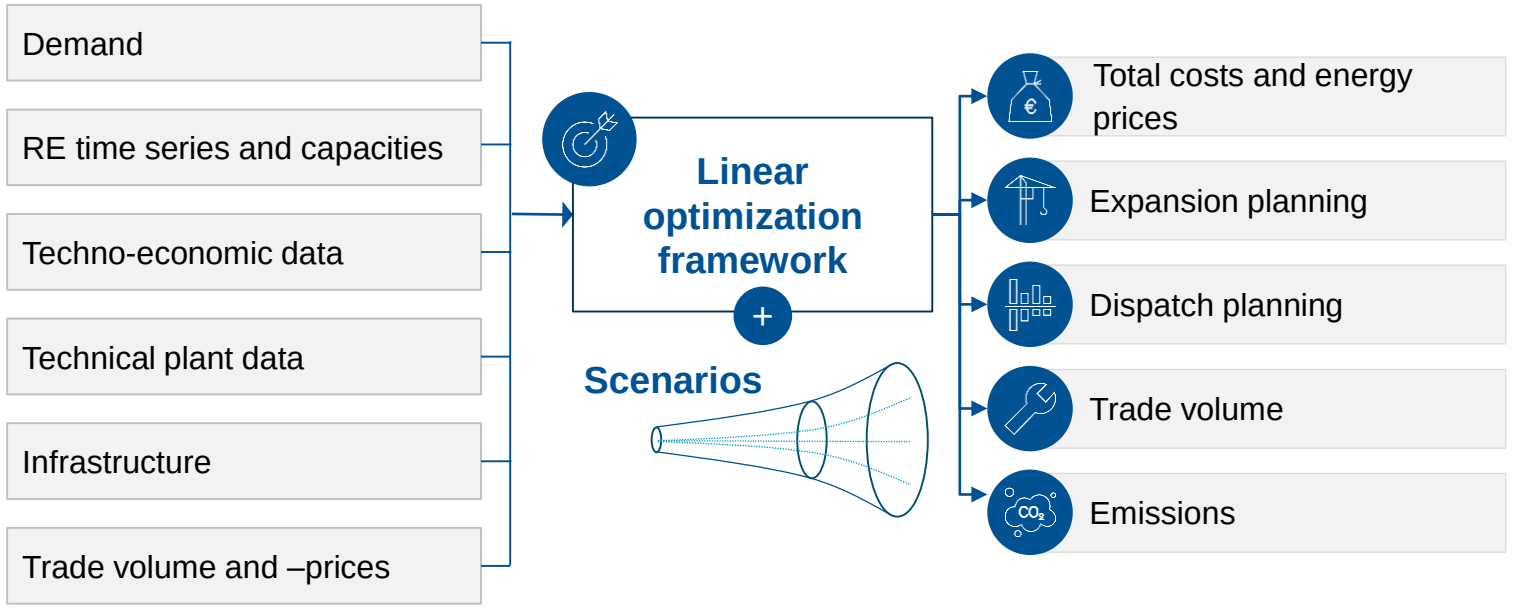
Objective of WP1

Identification of the requirements for the local energy and material system for the transformation towards a completely climate-neutral chemical industry

Analysis of the influence of the European energy system and investigation the implications of the **development of the global hydrogen market**

Identification and evaluation of possible transformation paths in varying scenarios

Methodology



The energy system modelling is performed in three interconnected models with varying regional resolution

Energy system modelling

	District model (WP1.1.1)	Europe model (WP1.1.2)	Global model (WP1.1.3)
Input	Energy and material demand Energy prices	Available H_2 import volumes European RE potential Energy and material demand	RE-potentials Costs of transport and transport routes Global H_2 demand
Output	Economically optimized load profiles Structural optimization per scenario → Transformation paths	H_2 demand Expansion planning for plants and infrastructure	Volumes and prices of H_2 and H_2-derivatives for Europe
Regions			

Common features

- Technology database for the standardization of technical and techno-economic model assumptions
- Modelling scenarios
- Harmonized demand and RE potential

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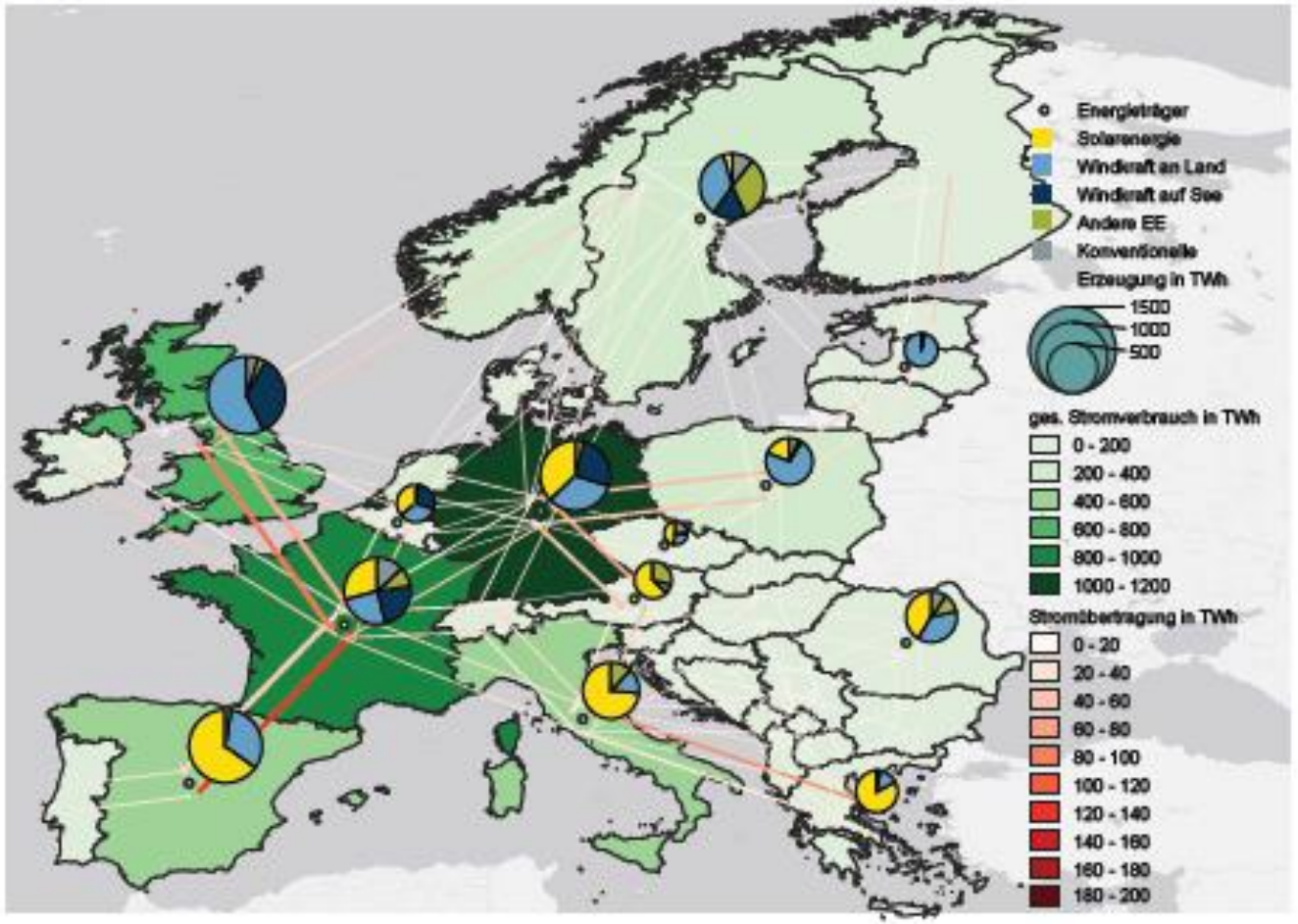
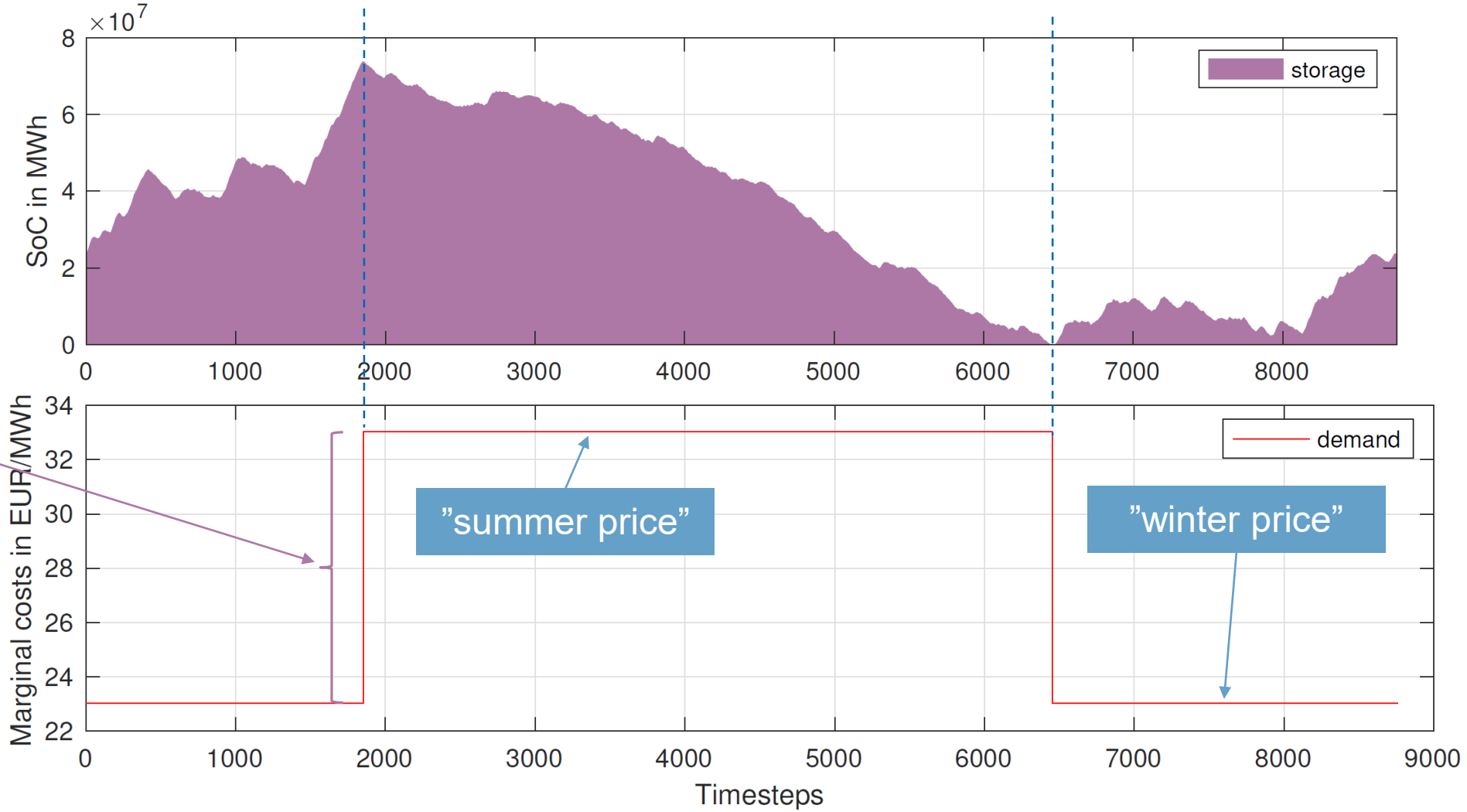
European Model

- European Electricity and Hydrogen model
- Zero emissions in 2050
- Strong distributed generation within Europe
- Either strong power or hydrogen transport
- Seasonal hydrogen storage options used



Scenario 3a – SoC and dual solution of demand equation



Known observation

Economic dispatch makes no sense in renewable dominated system.

Naive observation?

Investment costs are smoothed in a world with large hydrogen storages. Can they then be introduced into the market?

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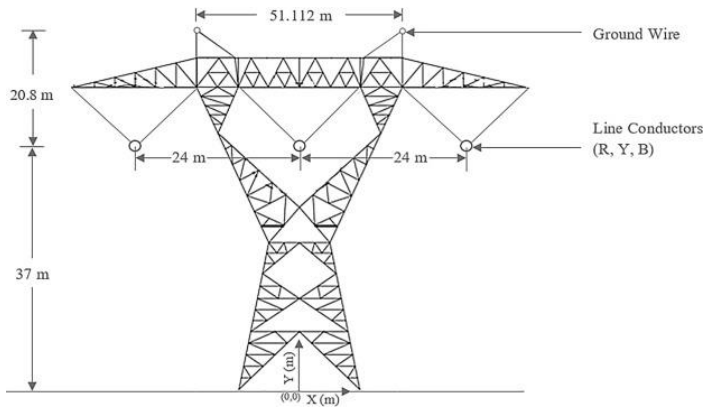
Strong European energy cooperation

Strong European power grid a very high priority



Open for a renewable/nuclear mix

Common research and development on new synthetic fuel energy technologies and infrastructure

Energy

CERN

Source: https://doi.org/10.1016/j.asej.2021.11.011., wikipedia „Kraftwerk Temelin,

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Conclusion

A stronger European cooperation is necessary:

A strong power grid is of high priority

Piiking winners seems attractive to reduce risks but is not possible on a global scale and is misleading

Europe is still one of the most forward looking project after the Second World War. It requires all our energy to bring this back into our minds.

No European country alone will be able to withstand global power, Europe as a whole is.