European Energy Sovereignty 2050
Quo Vadis?

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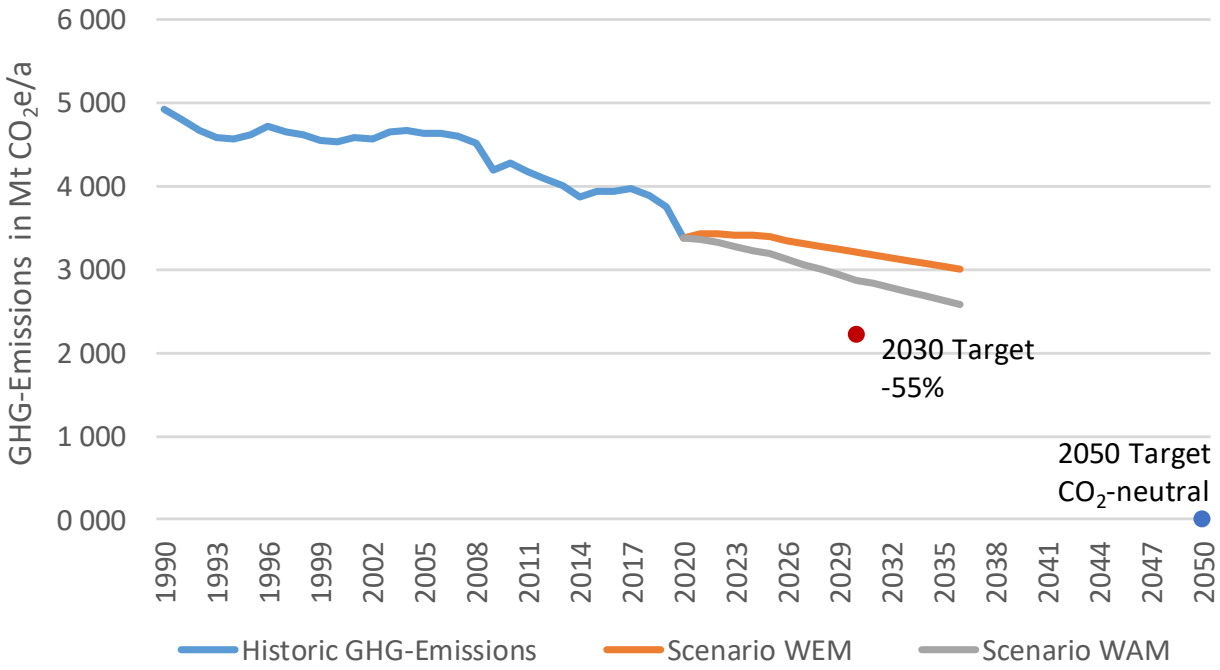
Global Situation

Climate pledges

- As the first continent: climate neutrality in Europe by 2050 (GreenDeal, FitFor55)
- Some states are aiming for more – Finland 2035, Austria 2040, Germany 2045
- CO_2-Emissions are falling (but not fast enough)
- European energy demand in sideways movement

→ Reason for CO_2 reduction: Expansion of renewables.
Energy efficiency measures compensate only economic growth

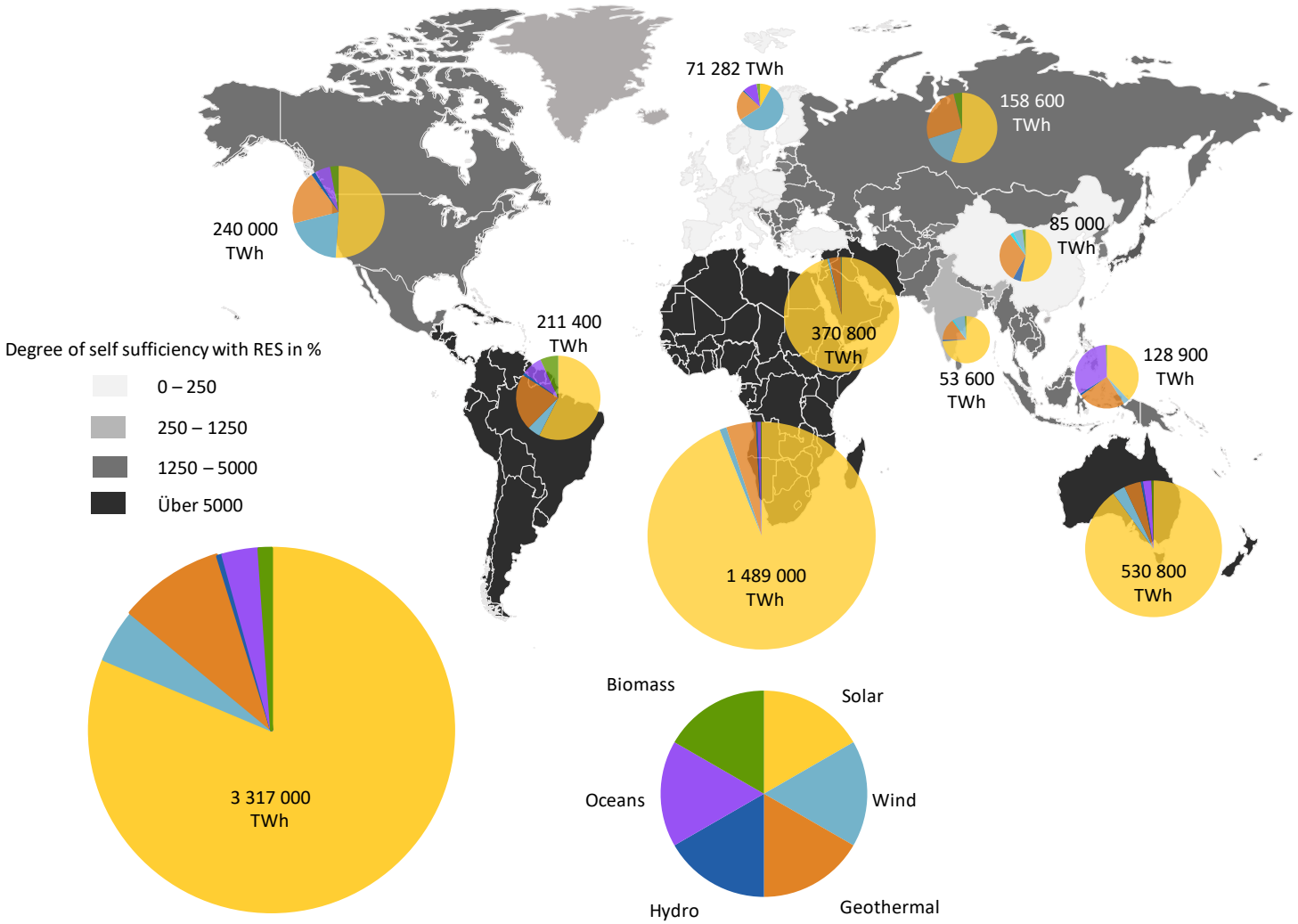


Source: European Environment Agency 2022

Hypothesis I: Assuming proper RTI policy, the European climate targets can push technology exports.

Conclusion: Both must go faster and more comprehensively, switch to Renewables (RES) and to energy efficiency

Renewable Energy Sources (RES)



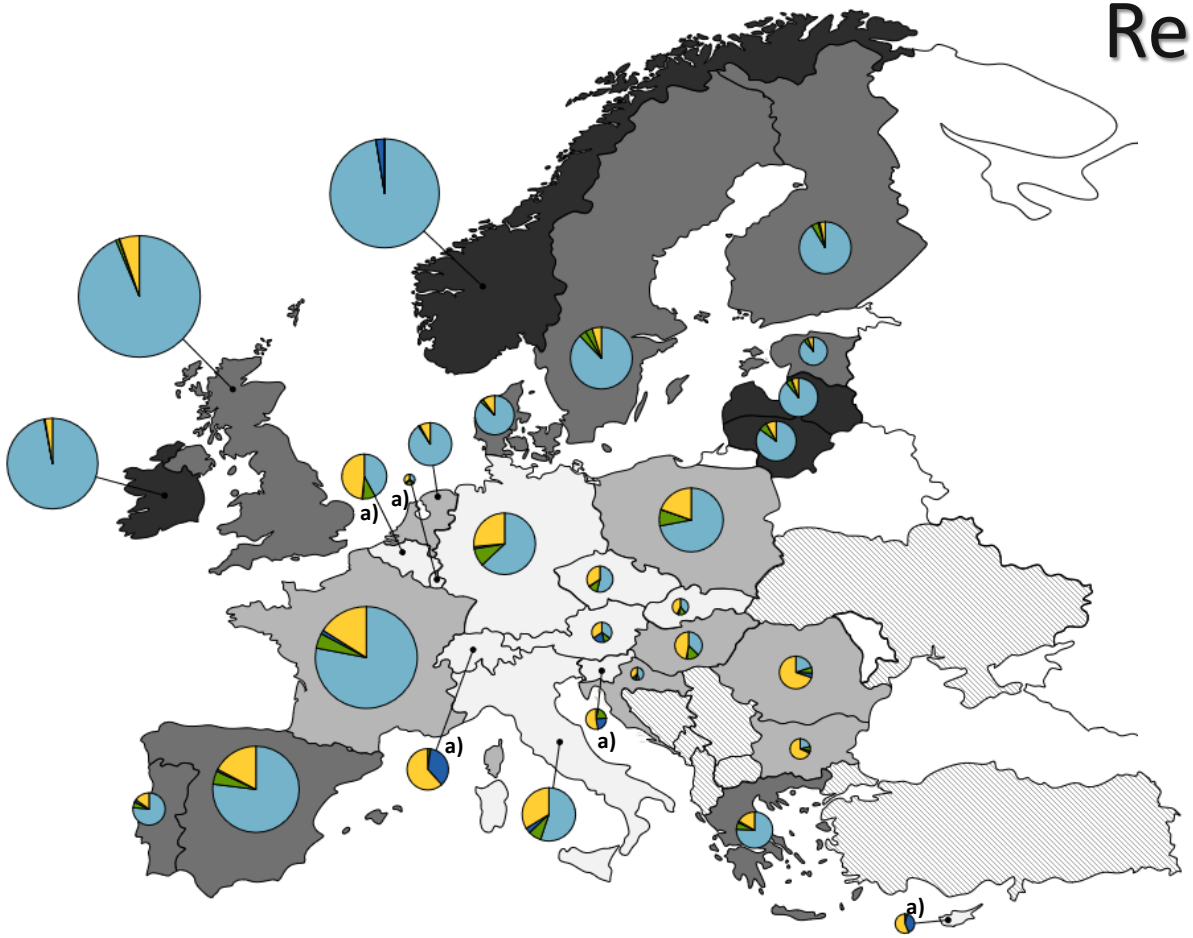
Sources: IPCC 2011,ffE2017, Shell 2022, Eurostat 2022

Renewables in Europe are more limited than elsewhere in the world

- Availability of space but also low acceptance, and slow expansion and adaption of the energy infrastructure.
- Other world regions have better natural conditions for renewables: higher full load hours → lower costs → Better utilization of raw materials:

Hypothesis II: Europe will need renewable imports.

Renewable Energy Sources (RES)

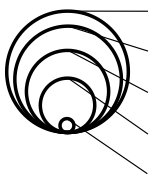


Degree of Self Sufficiency with RES in %

- keine Daten
- < 100
- 100 - 200
- > 200 - 1000
- > 1000

Source:ffE2017

Technical potential in TWh/a



8284.8
6000.0
4000.0
2000.0
748.3

- Wind
- Biomass
- Hydro
- Solar

a) Acctual potential 10-times Smaller as shown

Technical potentials (PV, wind, water and biomass) in EU27:

- Approximately 51,500 TWh/a

Gross domestic consumption EU27 in 2021

- Approximately 15,400 TWh/a

Exploitable potentials:

- ratio between technical- and exploitable potentials usually between 3-5

Hypothesis II: Europe will need renewable imports.

Exploitable potentials 2050?

EU reference scenario (2021) – follows the WAM (With Additional Measures) approach

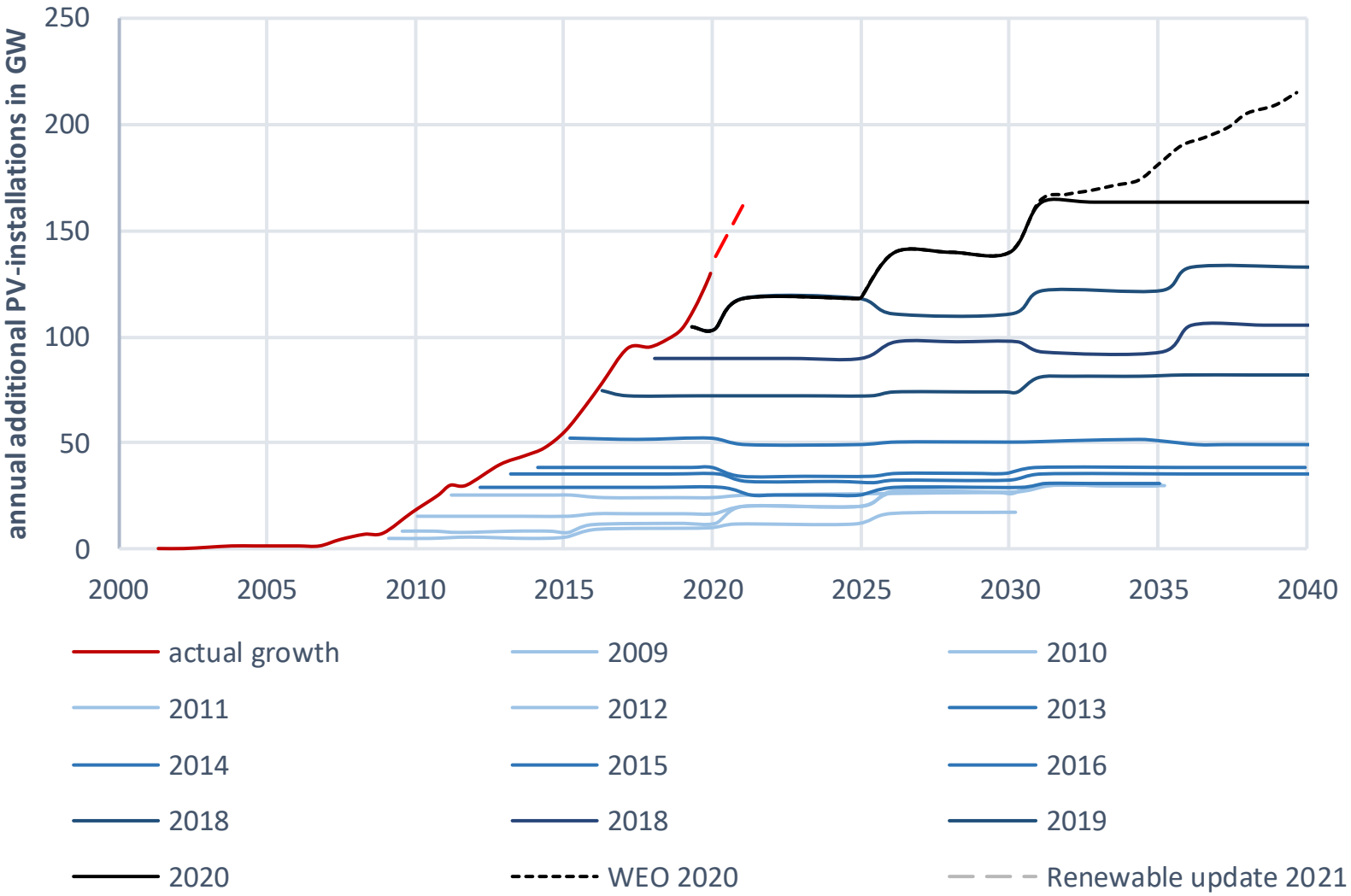
approx. 6,400Twh/a RES until 2050

Maybe a bit hesitant, but the „Gold Standard“

Cost and penetration rate development

for renewable electricity and hydrogen

- Renewable electricity is already significantly cheaper than conventional electricity generation
- Development of global expansion is massively underestimated!
- Infrastructural framework conditions are lagging behind the actual expansion speed especially for grids



Source: IEA 2021

Cost and penetration rate development

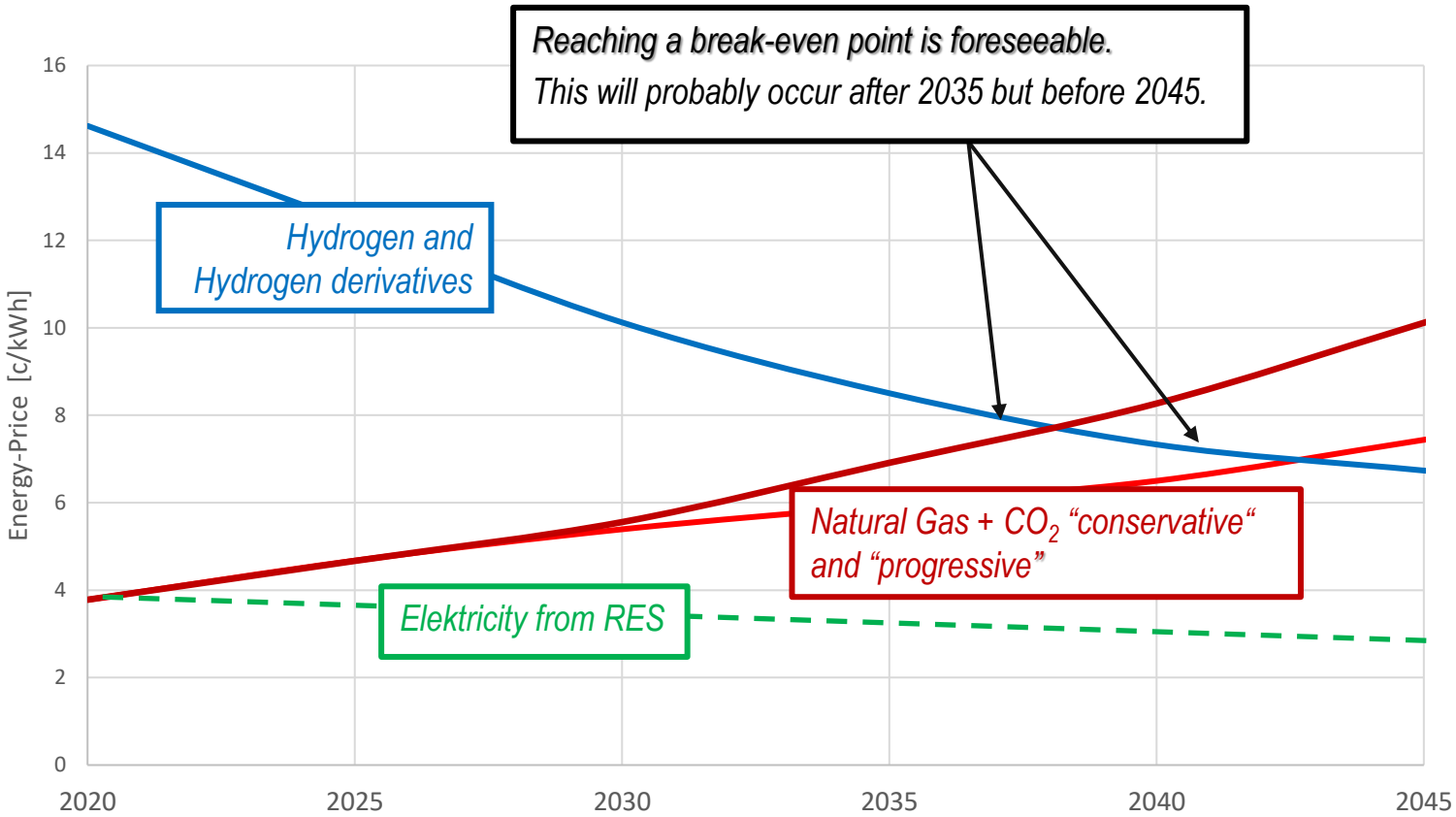
for renewable electricity and hydrogen

Total cost for natural gas remain expensive

- Natural gas price currently at around 40 €/MWh. (2019, appr. 30 €/MWh)
- **But,** also at low energy prices, clear CO_2-price trajectories from the EU ETS (phase III,FitFor55)

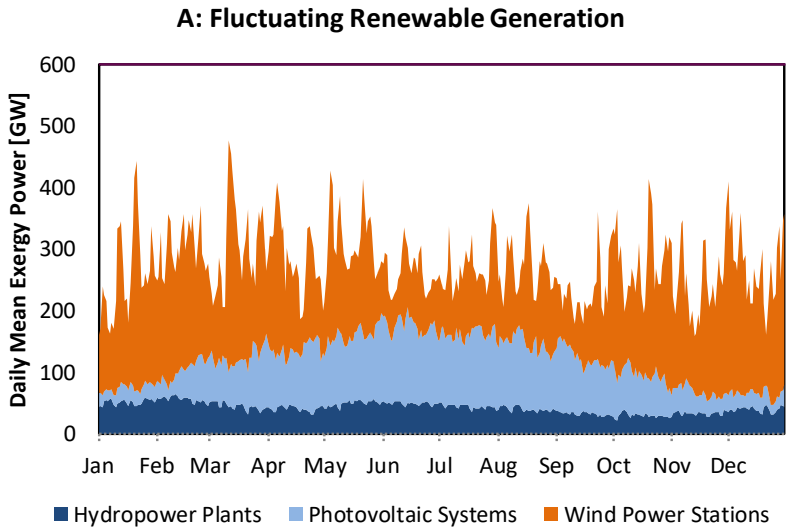
Cost down potential green hydrogen

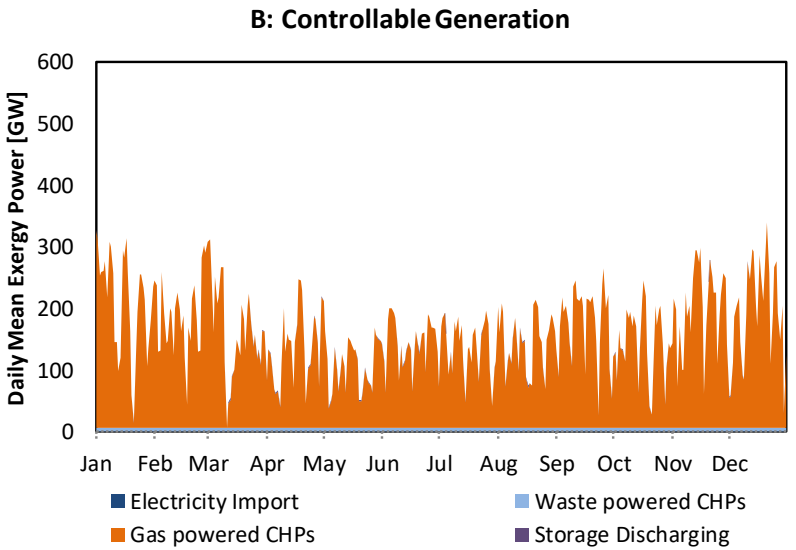
- Electrolysis allow for mass production
- PV and wind power costs are about to decrease further
- **But,** high losses due to conversion and transport…

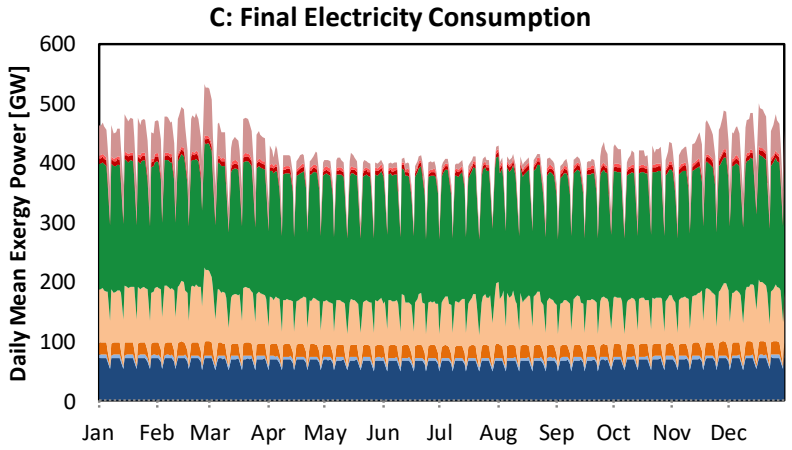


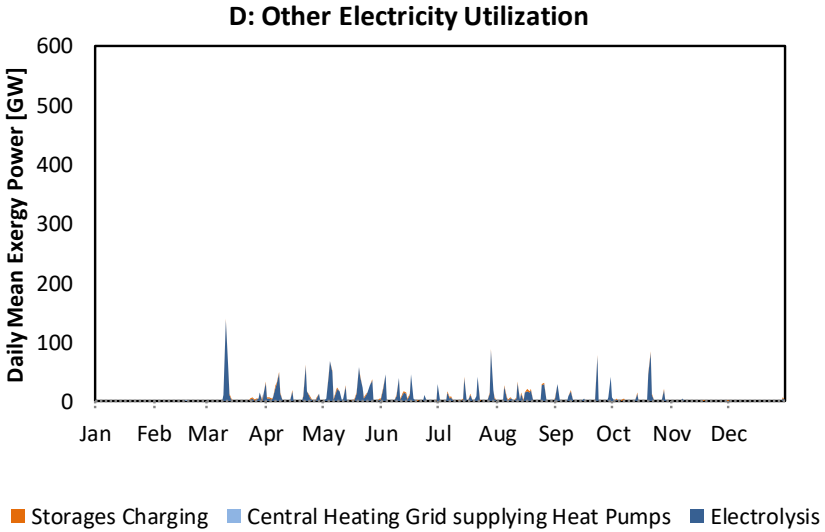
Hypothesis III: Electricity will not be imported to Europe on a large scale, but Hydrogen and/or its derivatives. These will be expensive. The less to be imported, the better. Big lever: energy efficiency

Szenario Maximizing Energy Efficiency: Electricity 2050





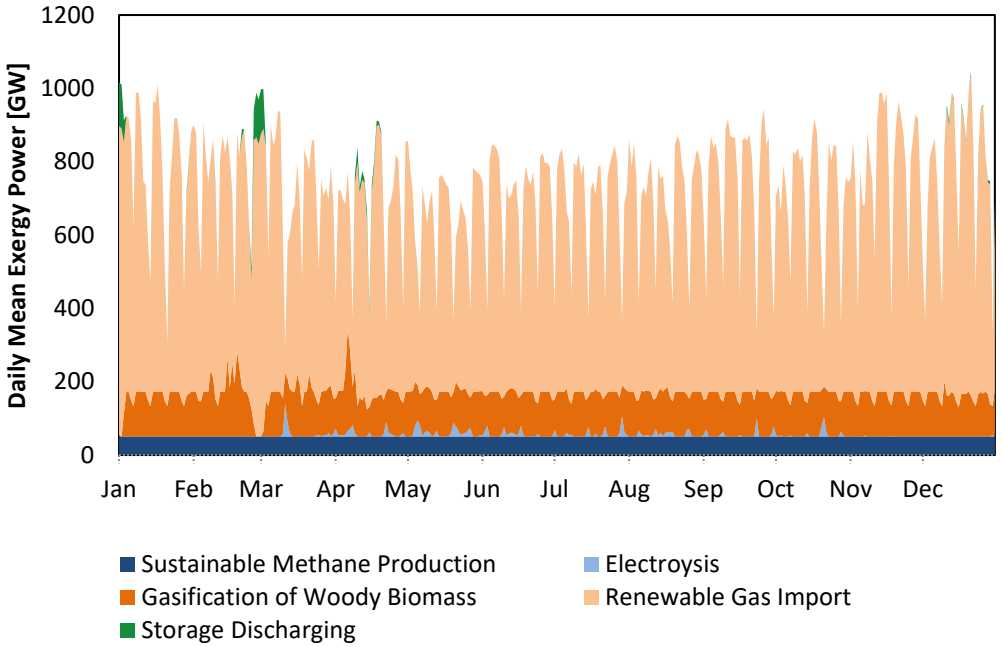




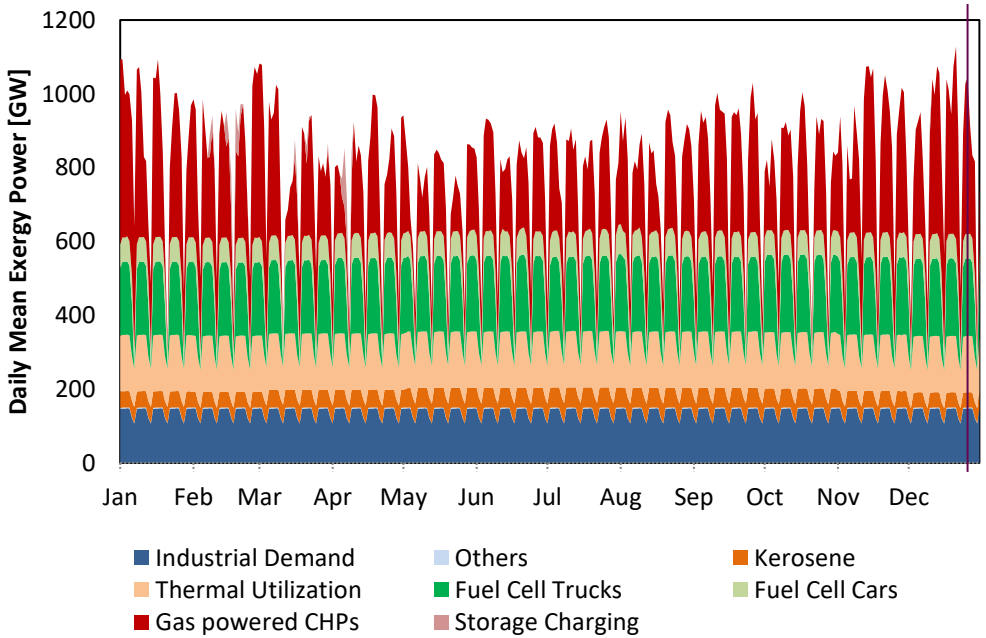
- Hardly any seasonal components in electricity generation - wind and PV balance each other out surprisingly well across Europe
- Electrification of demand: Heat pumps in northern Europe, extensive electrification in the mobility sector, some electrification in industry.
- Positive residual loads (Shortages) covered by thermal power plants (CCGTs), whose waste heat provides space heating and –cooling
- Negatives residual loads (Overlaps) very low - low electrolysis capacities in Europe(with quite high full load hours)

Szenario Maximizing Energy Efficiency: Gas 2050

A: Gas Supply



B: Gas Utilization



Gas (or derivatives) exclusively for supplying highly exegetical needs:

- As feedstock in the steel and chemical industry and for high-temperature applications
- For aviation, as maritime fuel and for parts of heavy duty trucks
- To supply CCGT power plants

- Import needs for gas (or derivatives) depend exclusively on the expansion of renewables.

Conclusions

Energy efficiency optimization allows the identification of „No regrets Measures“:

Electrification and efficient technologies often go hand in hand
heat pumps, BEVs

Final energy:

- "All Electric“ thinking makes no sense – Gas or gas- derivative demands will also exist in the future (feedstock, high temperature applications, long haul transport).
- The less efficiently we use energy, the higher becomes the (expensive) need for gas or derivatives: „Technology-Open" status-quo thinking makes no sense either.

Energy sector

- The more renewables are expanded, the lower the gas- or derivative demand for thermal power generation and the higher the European electrolysis capacity

Thermal power plants and electrolysis do not require seasonal storage in a pan-European perspective and allow high full-load hours

If grids are expanded thoroughly

- Hypothesis: Without climate-neutral gas or H_2-Derivative imports is the Energy transition not possible!

Recommendations for action

- Expansion of European renewables as quickly and comprehensively as possible!
- Support for efficient technologies (heat pumps for buildings and industry, BEV) as quickly and comprehensively as possible!
- Increased expansion of the electrical transmission grids to enable wind-solar balancing. Expansion of district heating networks to be able to use waste heat.

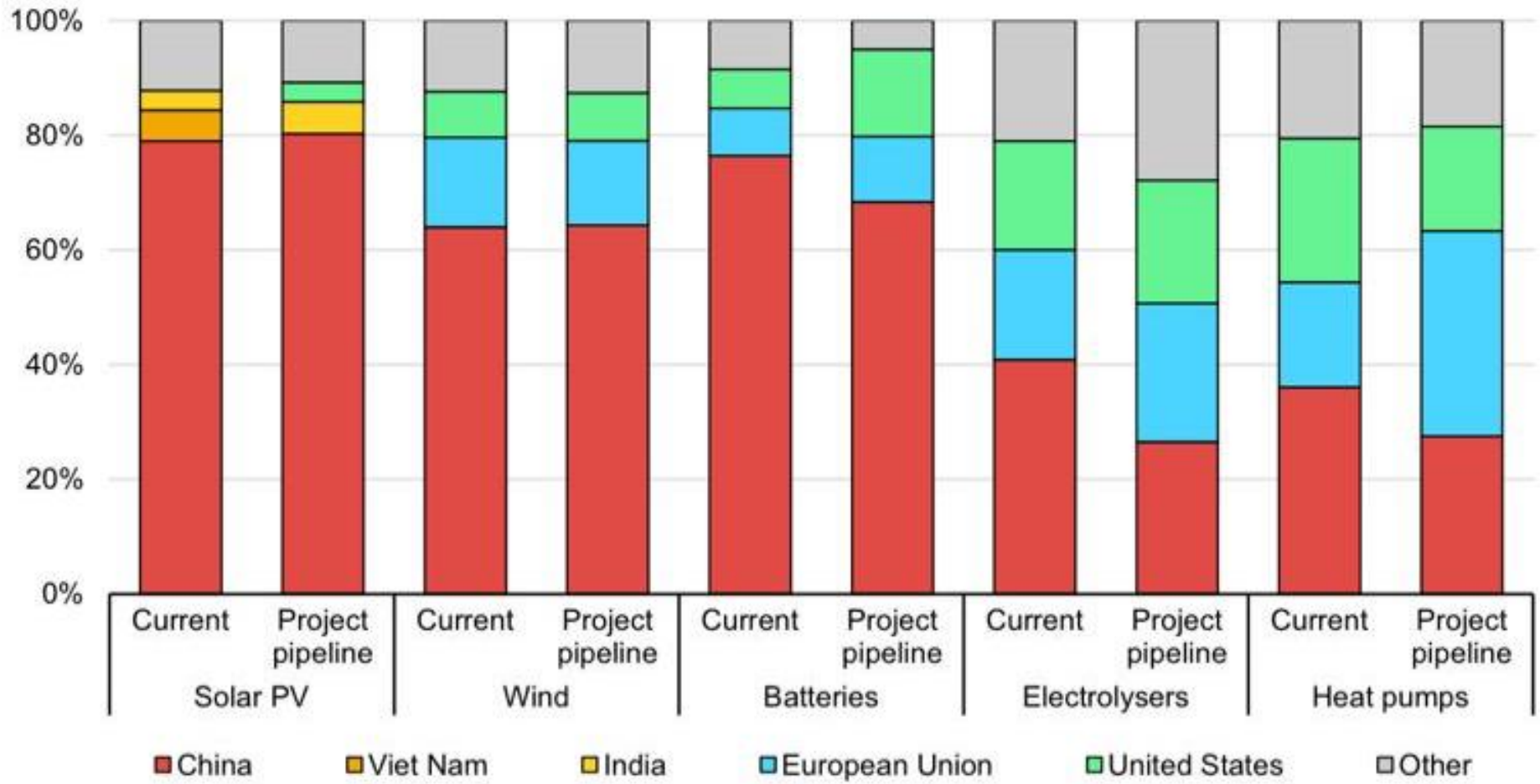
By Today!

*High number of full load hours: **Enables investments in the energy sector***

- Intensify research on hydrogen production from renewables, heat-pumps and technologies for climate neutrality in industry such as CCU/S, Recycling, hydrogen based processes, ect..

*At PV and batteries, Europe has lost technology leadership, **here not yet***

Current and projected geographic concentration for manufacturing operations for key clean technologies



Source: IEA 2023

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Excellent opportunities for today's fossil fuel industry.

- Robust import routes for renewable gases and derivatives are to be developed.

Thanks for your attention