

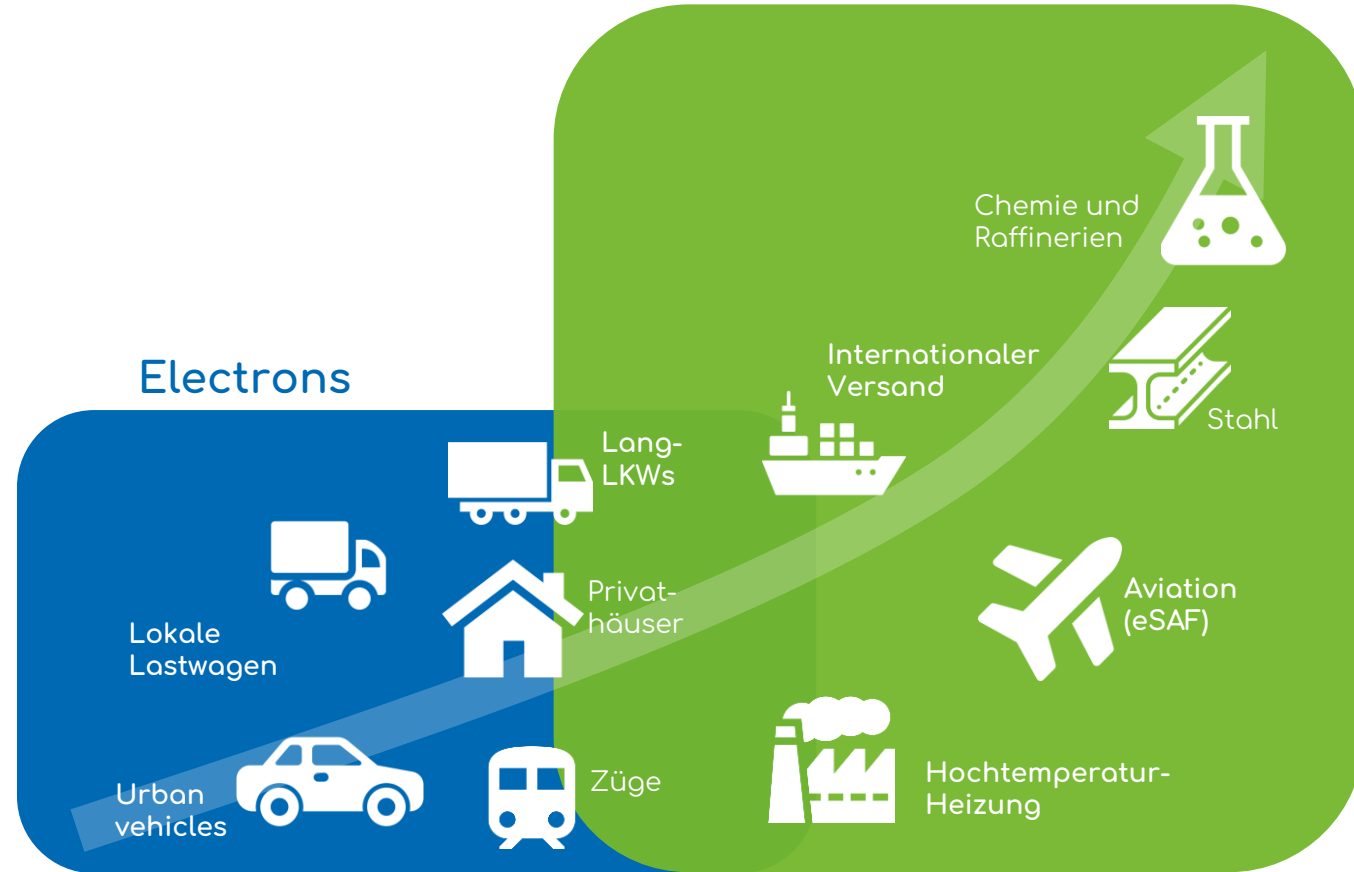


Hello, hydrogen!

Development opportunities in the Baltic Sea Region

18 September 2024

Today: Germany imports 1,000 TWh of Natural Gas per year.
Solar+Wind+GreenHydrogen to change the game of energy.



Molecules
85% of the
Final Energy
Consumption

The new energy paradigm will arrive
faster than most people believe.

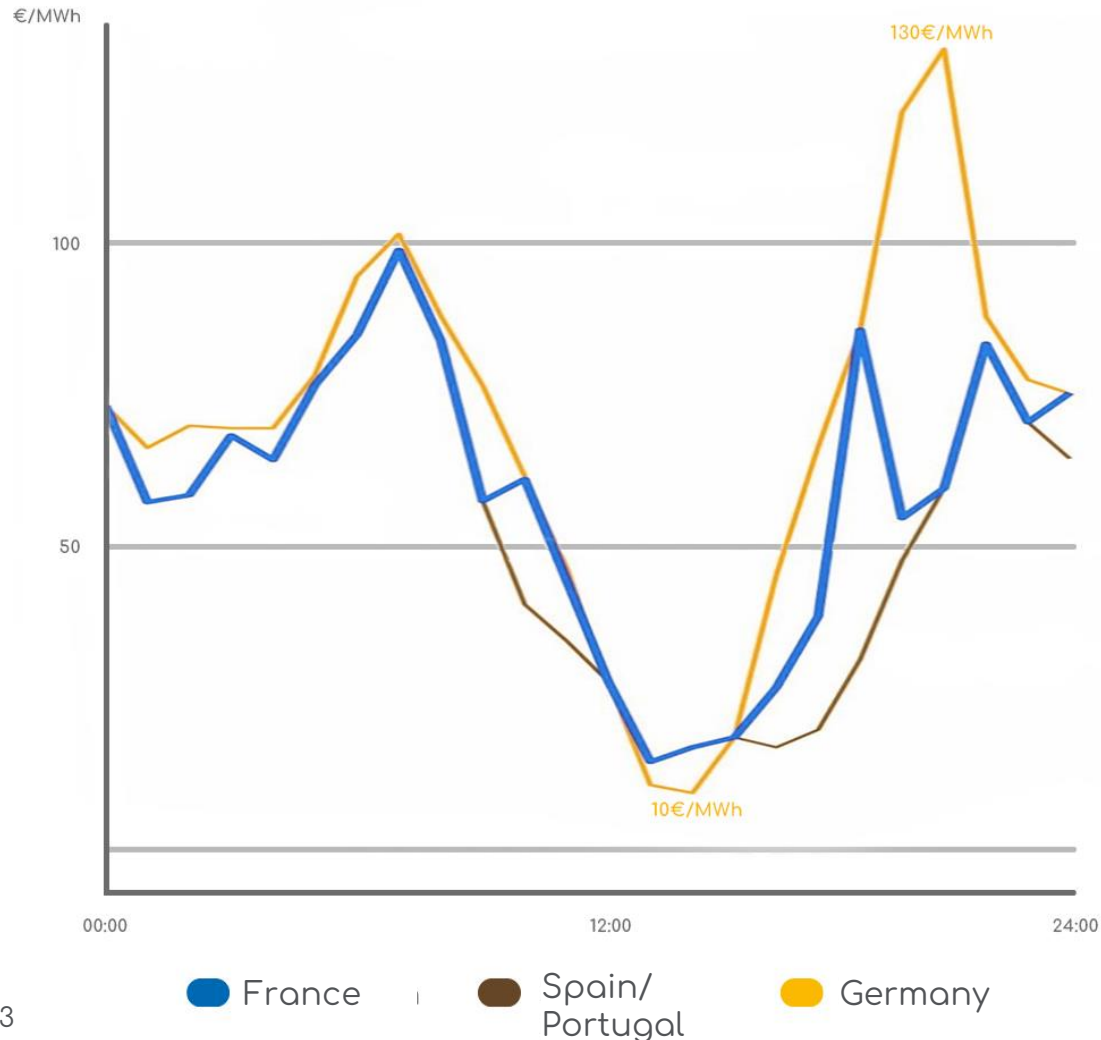


Myth: Curtailment is inevitable, the grid can't handle bright sun and strong wind.



EPEX SPOT / ENTSOE-E Transparency Platform

30/04/2024



In Germany, volatility is higher than in most other EU countries.

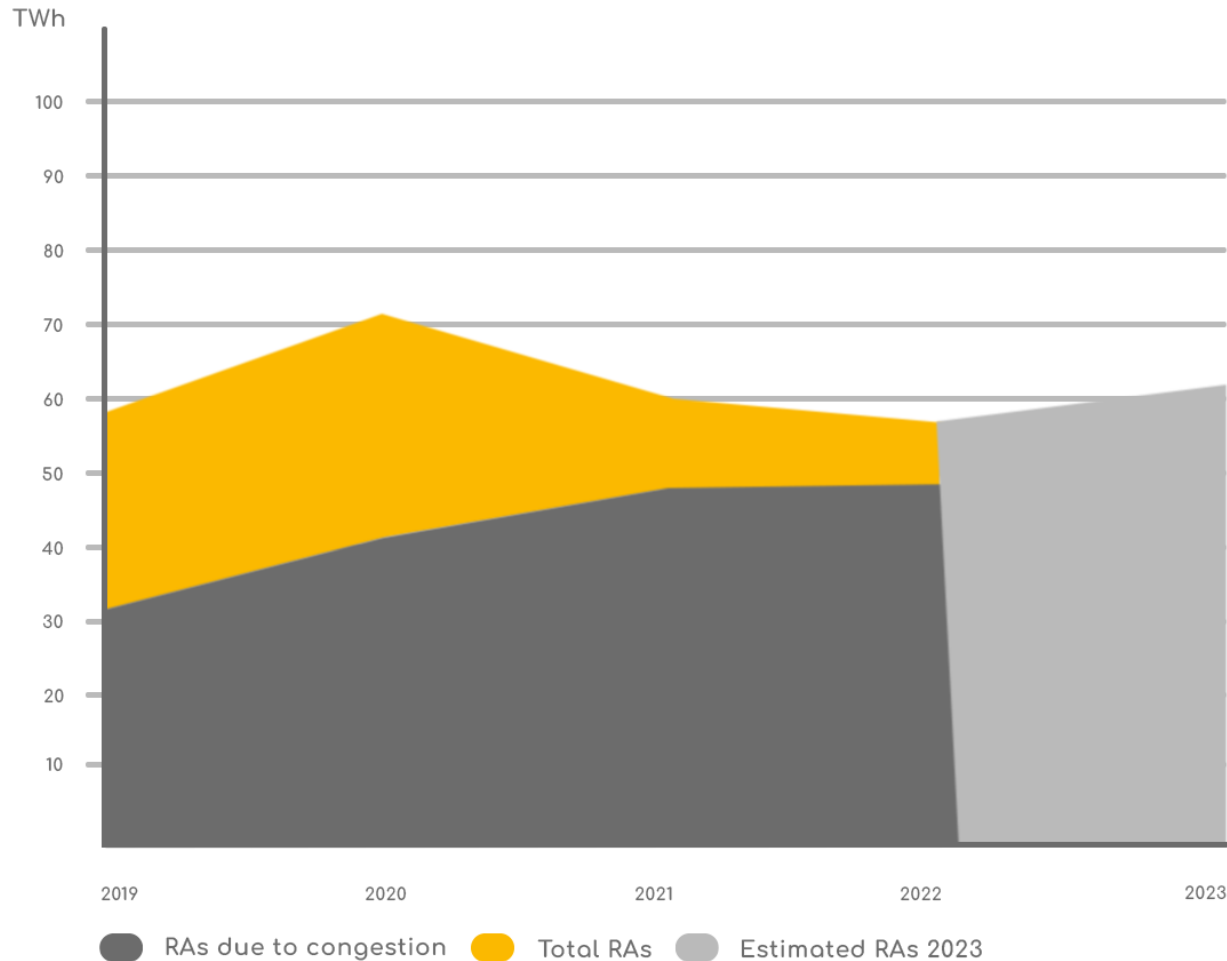
- RES are growing rapidly, but the capacity of power grids cannot follow.
- Expensive gas and coal power plants need to be activated, even if RES are still available.

Today, the energy storage potential of green hydrogen is not taken into account.

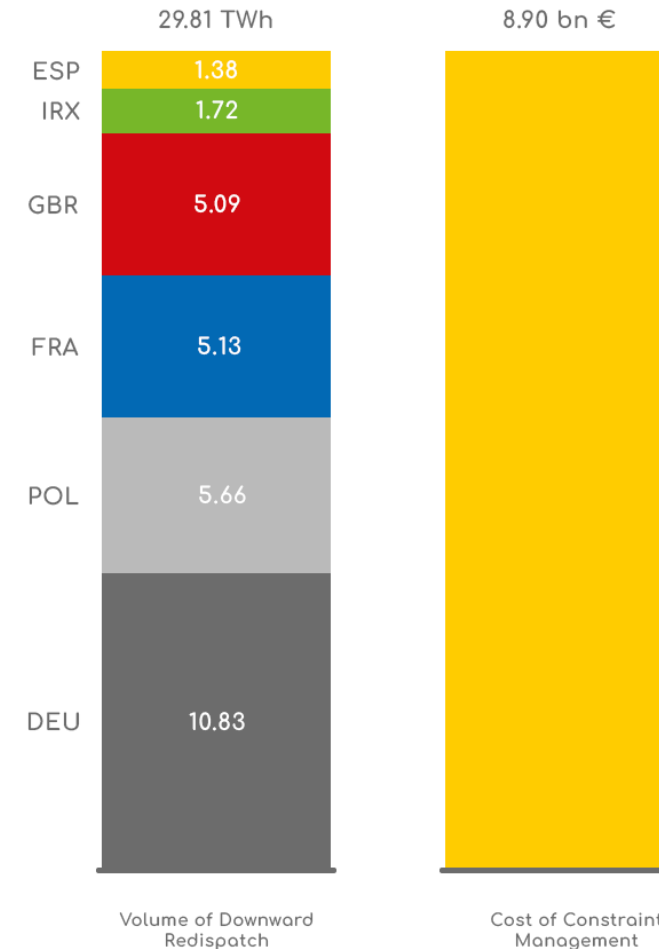
Opportunity: 30 TWh of green electrons in Europe were not authorized to be born in 2023. One third of them in Germany.



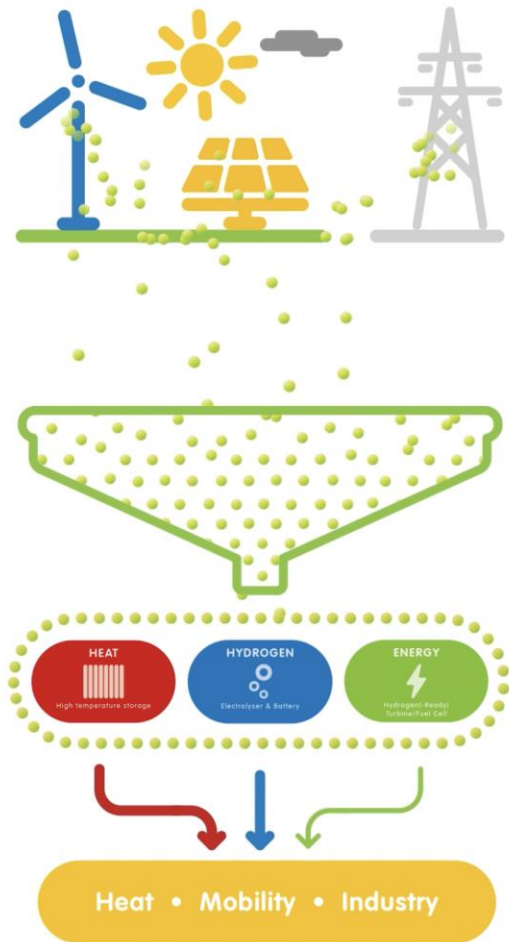
Growth in Remedial Actions (RAs) taken to ease grid congestion across Europe since 2019



Constraint Management measures in 2023 TWh and bn €



We can change the paradigm and let all green electrons come to life!



The HH2E-Werk is a pioneering technology mix that combines a high-capacity battery with an electrolyzer in a single unit, allowing the RES to remain working even when the grid cannot handle the excess power.

A HH2E-Werk with an electrolyser capacity of 100 MW can save up to 20 million euros per year in costs for feed-in limitations and redispatch.

The production of green hydrogen helps to reduce the high costs of curtailment while facilitating the licensing of more solar and wind power sources.

Application: Energy storage
Helping balance power grids



From field to market
Seasonal/perishable

H2E



Efficient storage
Always available

H₂ production in Germany: HH2E-Werk Lubmin
One of the most advanced green H₂ projects in the world

HH2E



Lubmin will develop from an old radioactive past to an attractive economic future based on green energy.



Energiestandort Lubmin: ideale Basis für nachhaltiges Wirtschaften



- Connection size 1000 MW thus $\geq 110\text{kV}$ power grid connection
- Distance to the substation $\leq 4\text{ km}$
 - Connection via cable route or overhead line possible
- Transportation via various options:
 - ✓ Highway
 - ✓ Pipeline

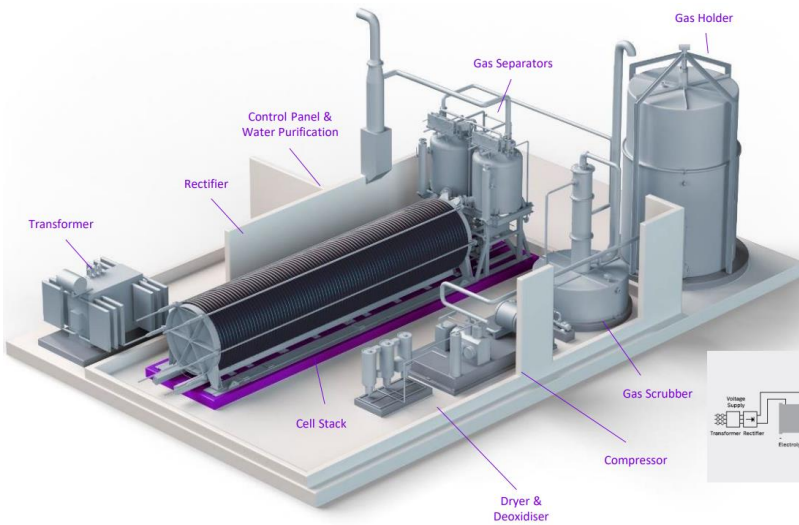
HH2E-Werk Lubmin: a unique Technology-mix capable of capturing RES surplus.



H2 production electrolysis plants of type A4000 from Nel, each with electrolyzers of type A485 and subcomponents.

Battery Energy Storage System (BESS):
40 MW ~ 250 MWh NaS high-temperature battery

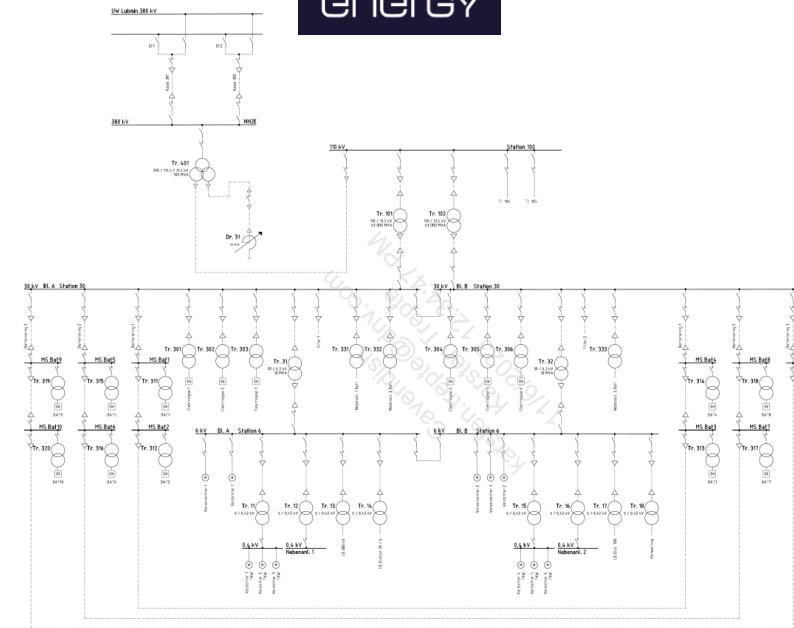
Energy supply
Electrical substation with connection to the 380 kV grid.
Main transformer (380 kV -> 110 kV) + 4 transformers (110 kV -> 30 kV)



NEL A485 Electrolyser Layout (source: Nel)



BASF/NGK containerised NaS battery (source: BASF/NGK)



Lubmin electrical single line diagram

HH2E plan: 4 GW production capacity in Germany by 2030

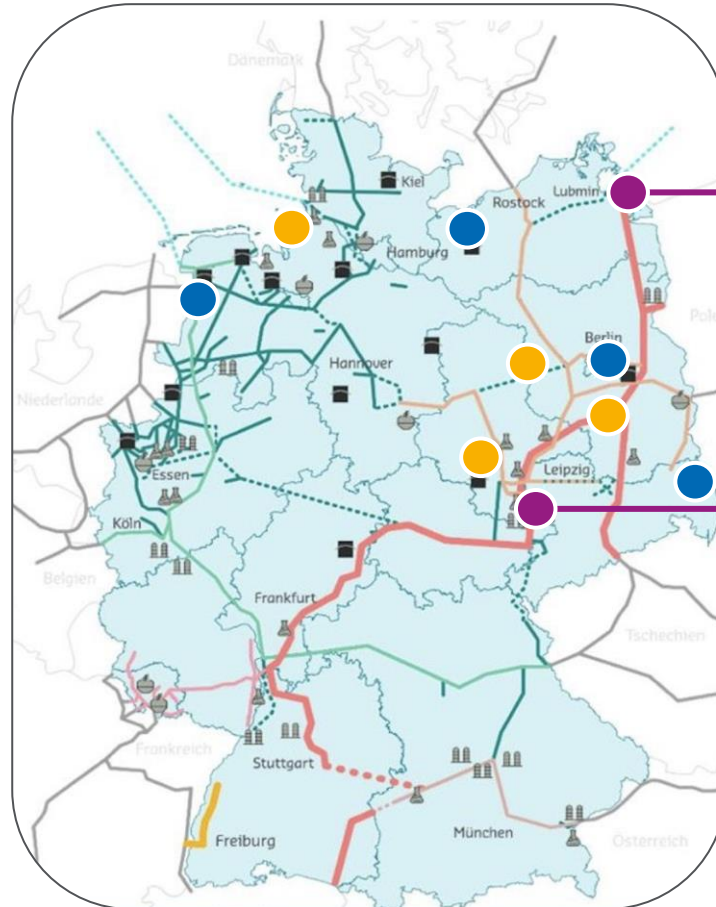


Short-term projects

- 100 MW scalable to 1 GW

Mid-term projects

- 100 MW scalable to 1 GW



Close to FID: Lubmin (1 GW by 2030)

- Former nuclear power plant
- 100 MW input power
- 7,000+ tonnes/year production of green hydrogen by the end of 2025

Thierbach (1 GW by 2030)

- Former power station
- 100 MW input power
- 7,000+ tonnes/year production of green hydrogen by 2026

The locations are selected by existence of pipeline infrastructure and access to renewable energy surplus.

The end of the fossil fuels era in Germany, a country poised to become one of the largest markets for green hydrogen in the world.



Heavy-trucking
0.8 million
tH₂/year

#5 market
worldwide

Industries
2.2 million
tH₂/year

#1 market
worldwide

Aviation
0.36 million
tH₂/year

#1 market
worldwide

Heating & Power (2050)
3.6 million
tH₂/year

#4 market
worldwide

Making the hydrogen economy work.



Q&As

Thank you!

