



Green hydrogen, heat, and carbon-free electricity

12 May 2023

www.hh2e.com

Germany is accelerating
the Energy Transition.



Reducing emissions



Reducing dependence



Secure energy supply

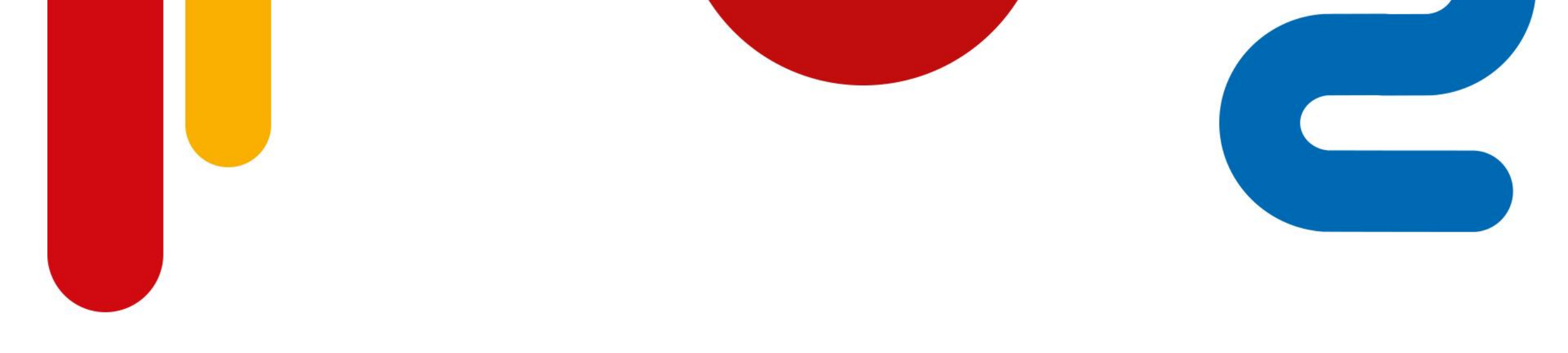
Germany rapidly transforming
into a green-electrons &
green-molecules Nation

HH2E

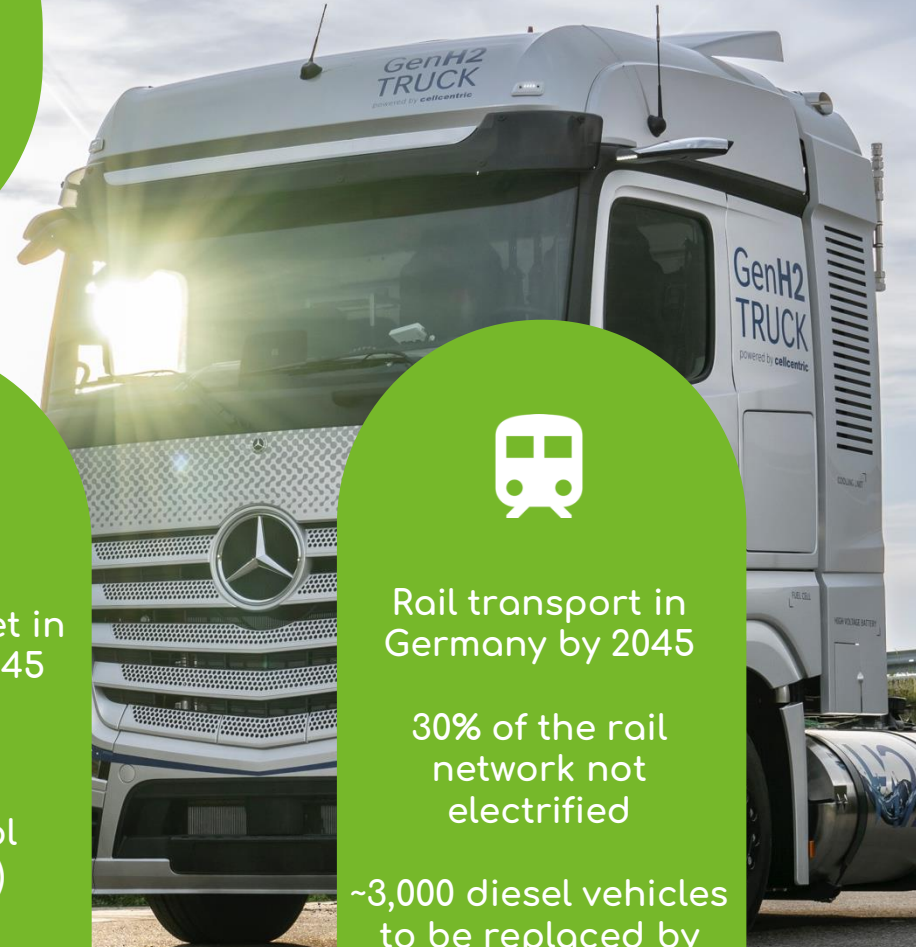
RES goals
80% by 2030
100% by 2045

Germany
Solar Strategy
215 GW by 2030

EU RED-II DA
Green-H₂ Germany
10+ GW by 2030



The market for green hydrogen in
Germany is no longer just hype.



German hydrogen
market demand
1.65 million t/year (today)
13-20 million t/year (2045*)



Hydrogen
Filling stations in
Germany by 2030

300 by 2025
3x today

Target: one
hydrogen filling
station every 100 km,
with 2 tons each

Filling stations at the
most important
logistical hubs



Heavy truck fleet in
Germany by 2045

62% - FCV
34% - BEV
4% - petrol
(h2 scenario)

Demand:
4 million t/year



Rail transport in
Germany by 2045

30% of the rail
network not
electrified

~3,000 diesel vehicles
to be replaced by
hydrogen trains

Demand:
90 thousand t/year



Industry 2045

Green ammonia for
the fertiliser industry
0.6 million t/year

Green methanol for
the chemical
industry
0.4 million t/year

Green hydrogen for
refineries
0.2 million t/year

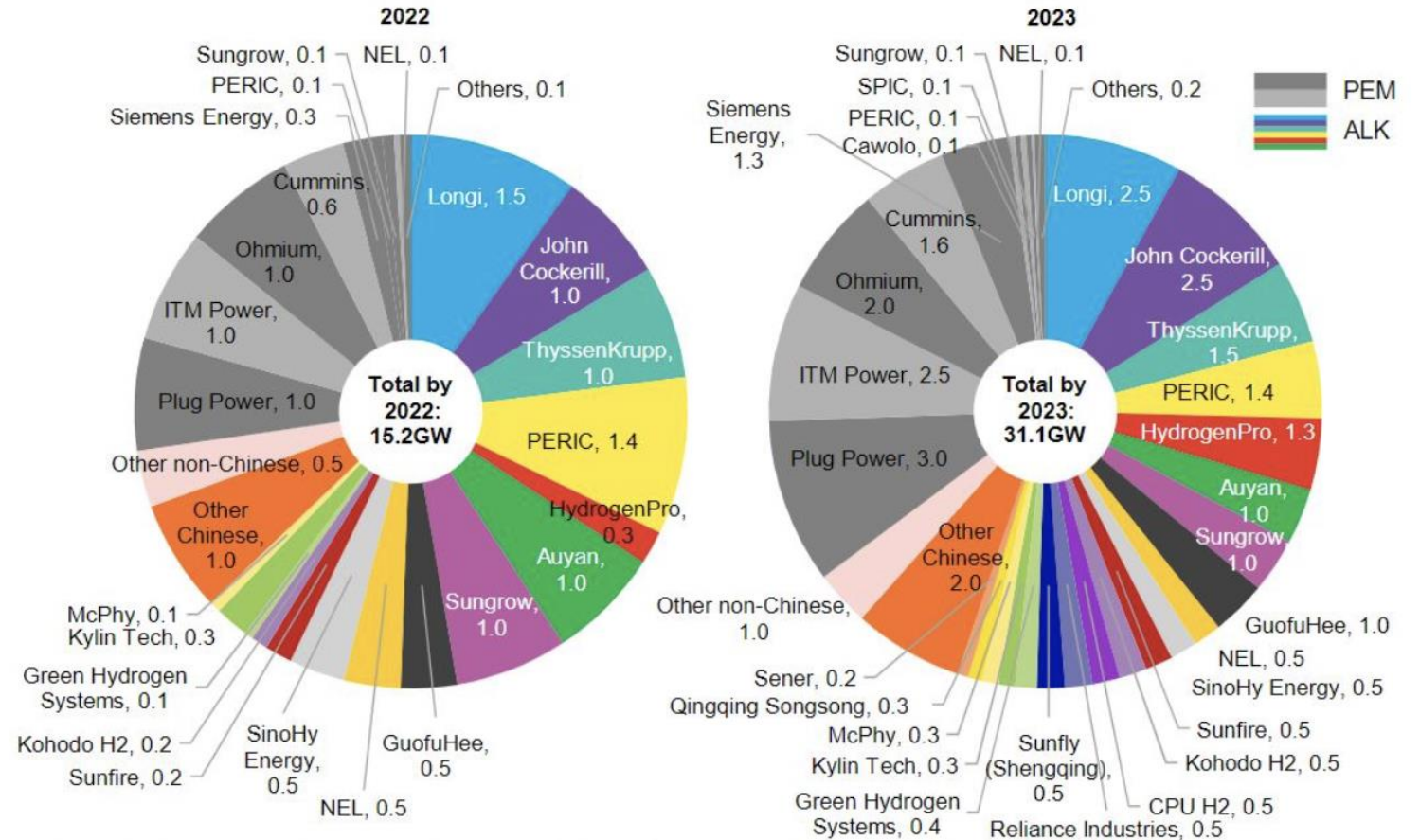
Green steel industry
2.2 million t/year

Electrolyser manufacturers define future availability



Limited electrolyser capacity available

- 350 GW of green hydrogen projects by 2030 (200 GW in Europe) announced but not confirmed
- Target in Germany: domestic production of 1 Mt/y green H2 by 2026 and 2.5 Mt/y by 2028 (25% of EU-wide production target).
- Only 30 GW of electrolysers announced by manufacturers by 2025.



Source: Company filings, industry sources, BloombergNEF. Note: The values refer to year-end capacities.

Green hydrogen is price competitive already

- Current natural gas and carbon prices make grey and blue hydrogen less competitive: 12.85€/Kg at a filling station in Germany.
- Imported overseas green hydrogen will not be more competitive than domestic production.

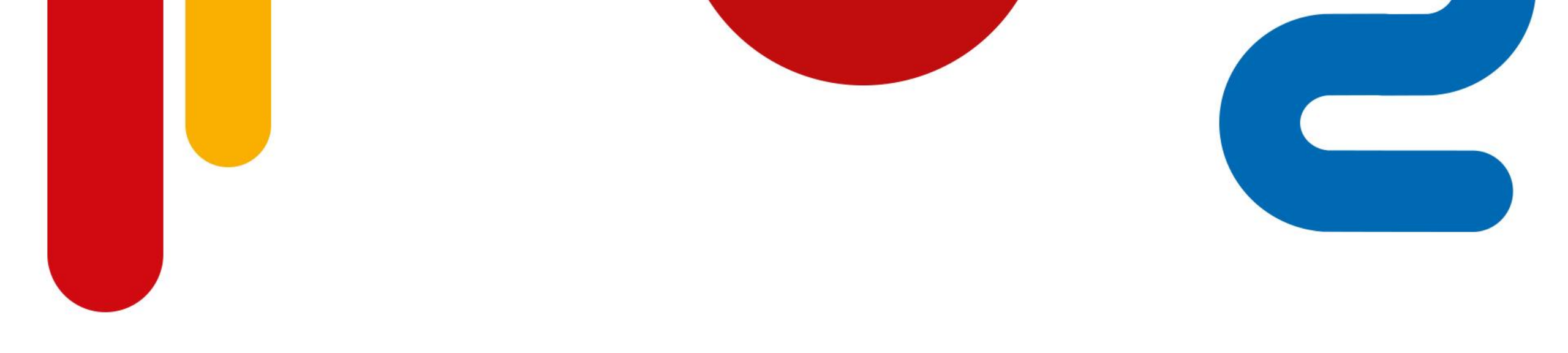
Today: at ~10 €/kg, green hydrogen is already competitive



The German produced H2 is competitive vs imports



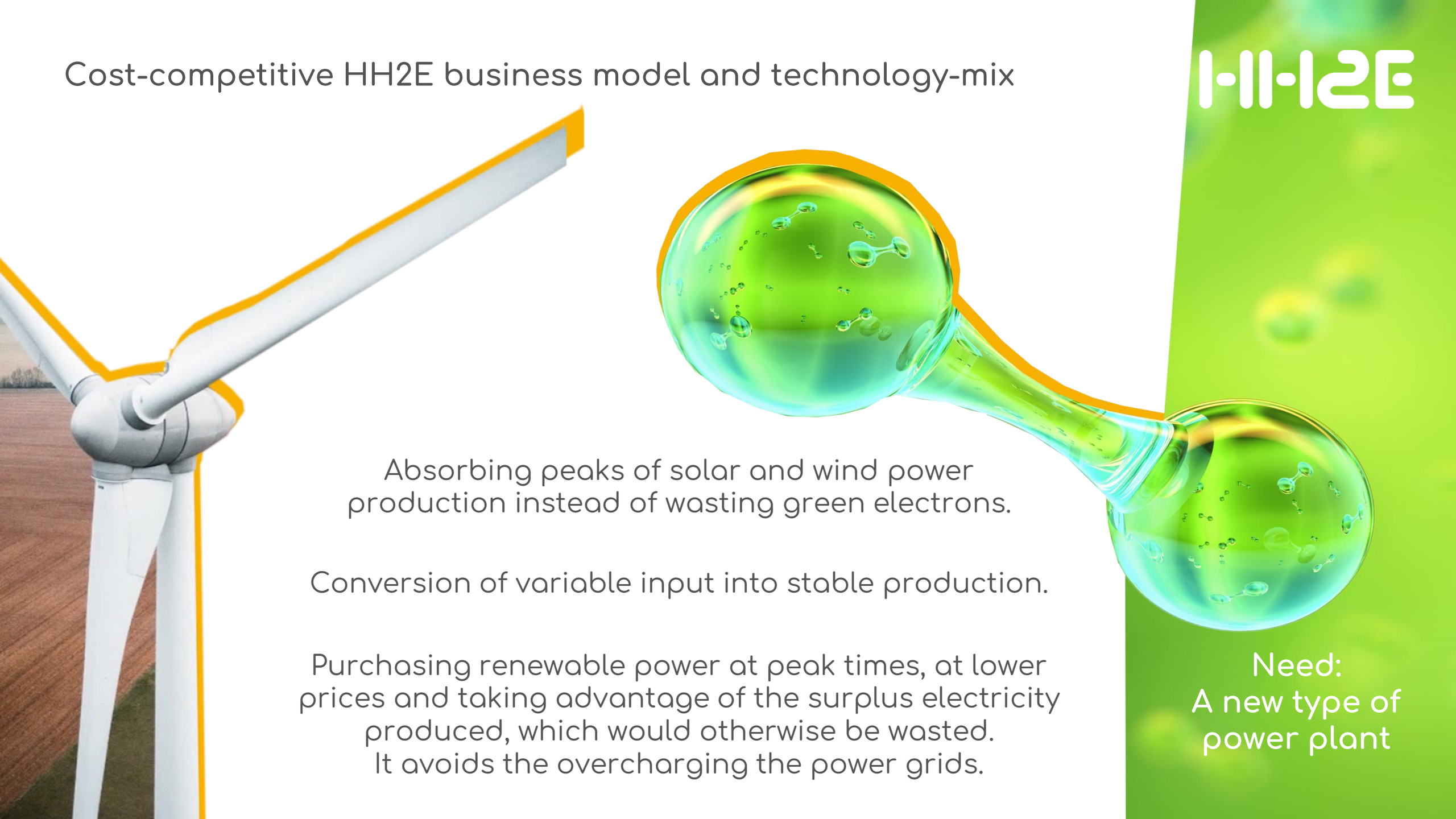
Electrolysis Conversion losses Synthesis of H2 carrier medium CO2 cycle Transport by ship Conversion back to H2 H2 Pipelines



New technologies and smart business models are
needed to achieve the
100% renewable energy dream.

Cost-competitive HH2E business model and technology-mix

HH2E



Absorbing peaks of solar and wind power production instead of wasting green electrons.

Conversion of variable input into stable production.

Purchasing renewable power at peak times, at lower prices and taking advantage of the surplus electricity produced, which would otherwise be wasted. It avoids the overcharging the power grids.

Need:
A new type of
power plant



From field to market
Seasonal /
volatile

H-E

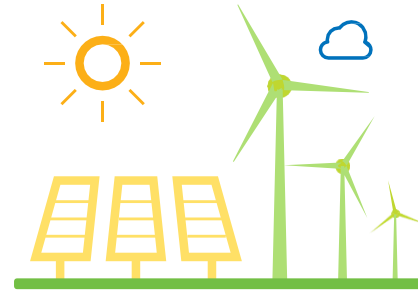


Storage
The whole year /
always available

The HH2E-Werk

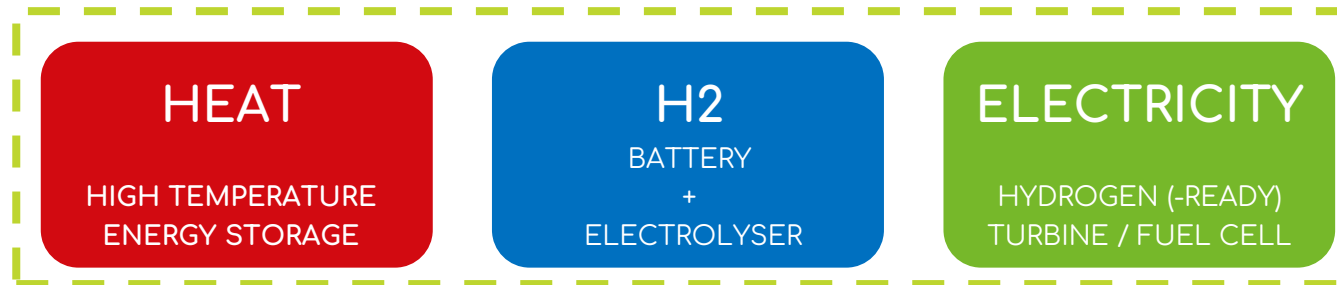


Few hours
POWER INPUT



Primary energy from
renewable sources

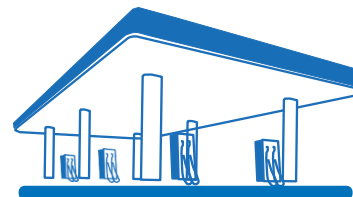
Heat →
Green H₂ →
Electricity →



Demand-driven energy
supply for customers



Cities and municipalities



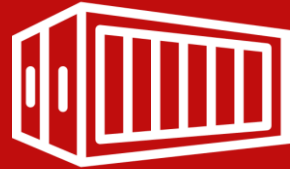
Hydrogen filling
stations



Industrial customers

24 / 7
GREEN H₂
OUTPUT

HH2E has been developing relationships and securing options with suppliers of critical components



The high-temperature storage system can store large amounts of wind and solar energy in the form of heat.



Alkalyn-Electrolyser

— combined with —

High-capacity battery

HH2E plan: 4 GW capacity in Germany by 2030



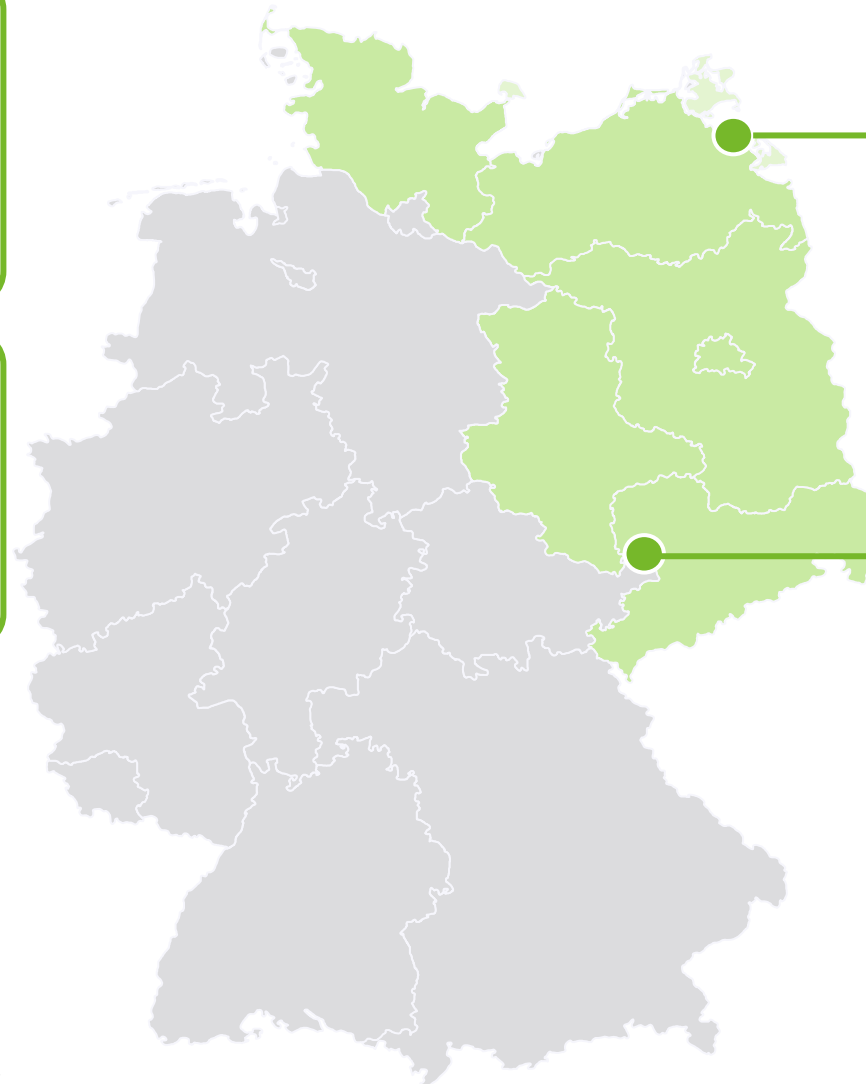
Project A (1 GW by 2030)

- Chemical Industry Park
- 100 MW input capacity by 2025
- 6,000 tonnes/year production of green hydrogen by 2025

Project B (1 GW by 2030)

- Former power plant
- 100 MW input capacity by 2025
- 6,000 tonnes/year Production of green hydrogen by 2026

Foresight and HydrogenOne investment funds committed 600 M EUR for developing the first sites



HH2E Lubmin (1 GW bis 2030)

- Former nuclear power plant
- 100 MW input capacity by 2025
- 6,000 tonnes/year Production of green hydrogen by 2025

HH2E Thierbach (1 GW by 2030)

- Former power plant
- 100 MW input capacity by 2025
- 6,000 tonnes/year Production of green hydrogen by 2026

400 MW capacity for RED II compliant green hydrogen by 2025



Securing optimal production locations
is a competitive advantage.

Developing "lost places"

Three stylized cooling towers of different colors (purple, green, and blue) are arranged in a row against a background of a cloudy sky and a green field. Each tower has a yellow outline and a white top section. The purple tower is on the left, the green tower is in the middle, and the blue tower is on the right.

Raising
existing
sites to a
new level

Securing
jobs in
existing
supply
chains

Attracting
new
businesses

The HH2E plant can be installed at existing sites, e.g. in former power plants of any kind.

Maintaining existing sites means safeguarding existing supply chains and jobs.

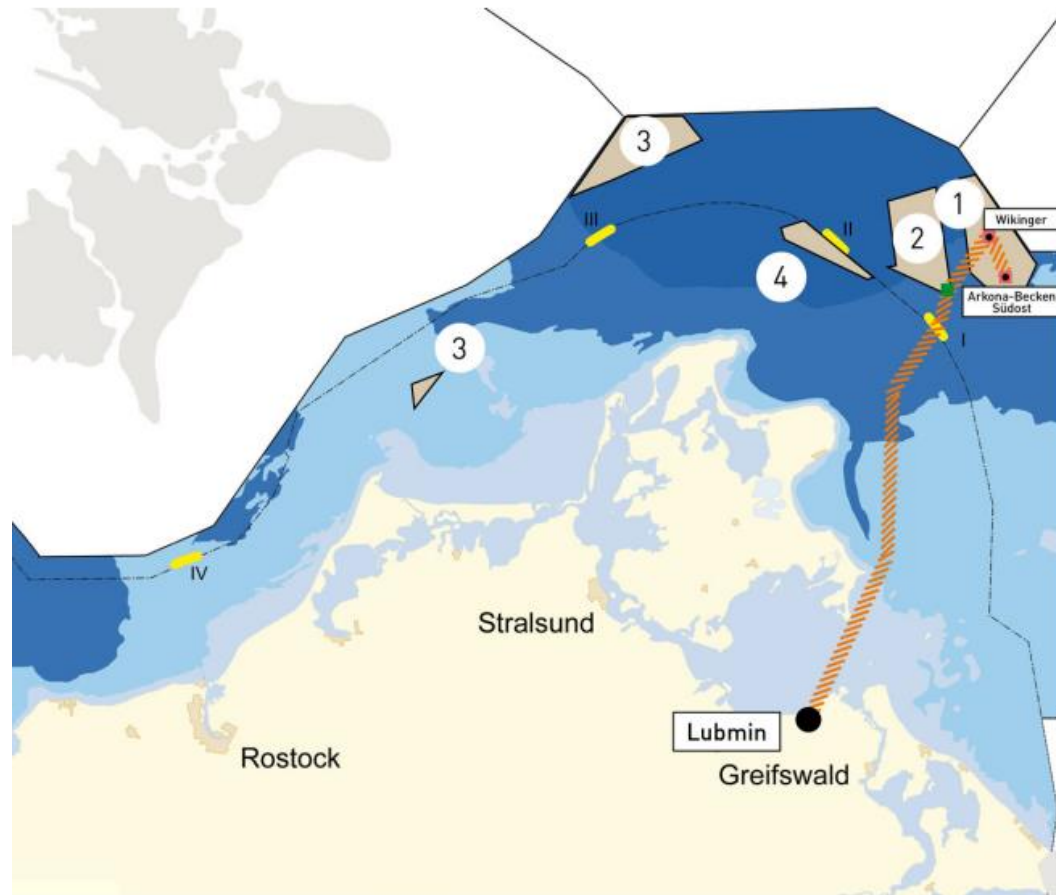
New businesses prefer locations where green energy is available



Im Nord-Osten Deutschlands gibt es eine hohe Verfügbarkeit an erneuerbarem Strom. Daher sollen die HH2E-Werke zunächst dort angesiedelt werden.

Einbindung Lubmin offshore (und onshore) gegeben

Projekt	M-Nr.	Bezeichnung der Maßnahme	Trassenlänge
OST-1-3	M55	AC-Verbindung OST-1-3 (Westlich Adlergrund)	80 km
OST-1-3	M56	AC-Anschluss OWP Wikinger und Arkona-Becken Südost	14 km



- Gute Anbindung an bestehende und geplante Offshore-Windparks, sowie zur Landseite mit Onshore Windparks
- Erhebliches Ausbaupotential
- Landseitig Anbindung an die AC und DC Übertragungsnetze sowie die regionalen Netze
- Regelkraftwerk am Standort Lubmin kann zu einer gleichmäßigen Lieferung ins Hinterland beitragen

Quelle ANHANG ZUM OFFSHORE NETZENTWICKLUNGS PLAN 2025, VERSION 2015, 2. ENTWURF:

Energiestandort Lubmin: ideale Basis für nachhaltiges Wirtschaften



- ✓ Anschlussgröße 1000 MW somit $\geq 110\text{kV}$ Stromnetzanbindung
- ✓ Entfernung zum Umspannwerk $\leq 4\text{ km}$
- ✓ Anbindung über Kabeltrasse oder Freileitung möglich
- ✓ Leistungsfähiger Wasseranschluss
- ✓ Abtransport über verschiedene Möglichkeiten

1. Bauabschnitt

ELEKTROLYSE 50 MW

Umwandlung von erneuerbarem Strom in Wasserstoff und Sauerstoff

BATTERIE 50 MW

Speicherung von Strom für die Elektrolyse

2. Bauabschnitt

ELEKTROLYSE + BATTERIE bis 1.000 MW

Asynchrone Umwandlung von erneuerbarem Strom in Wasserstoff, Sauerstoff und Strom

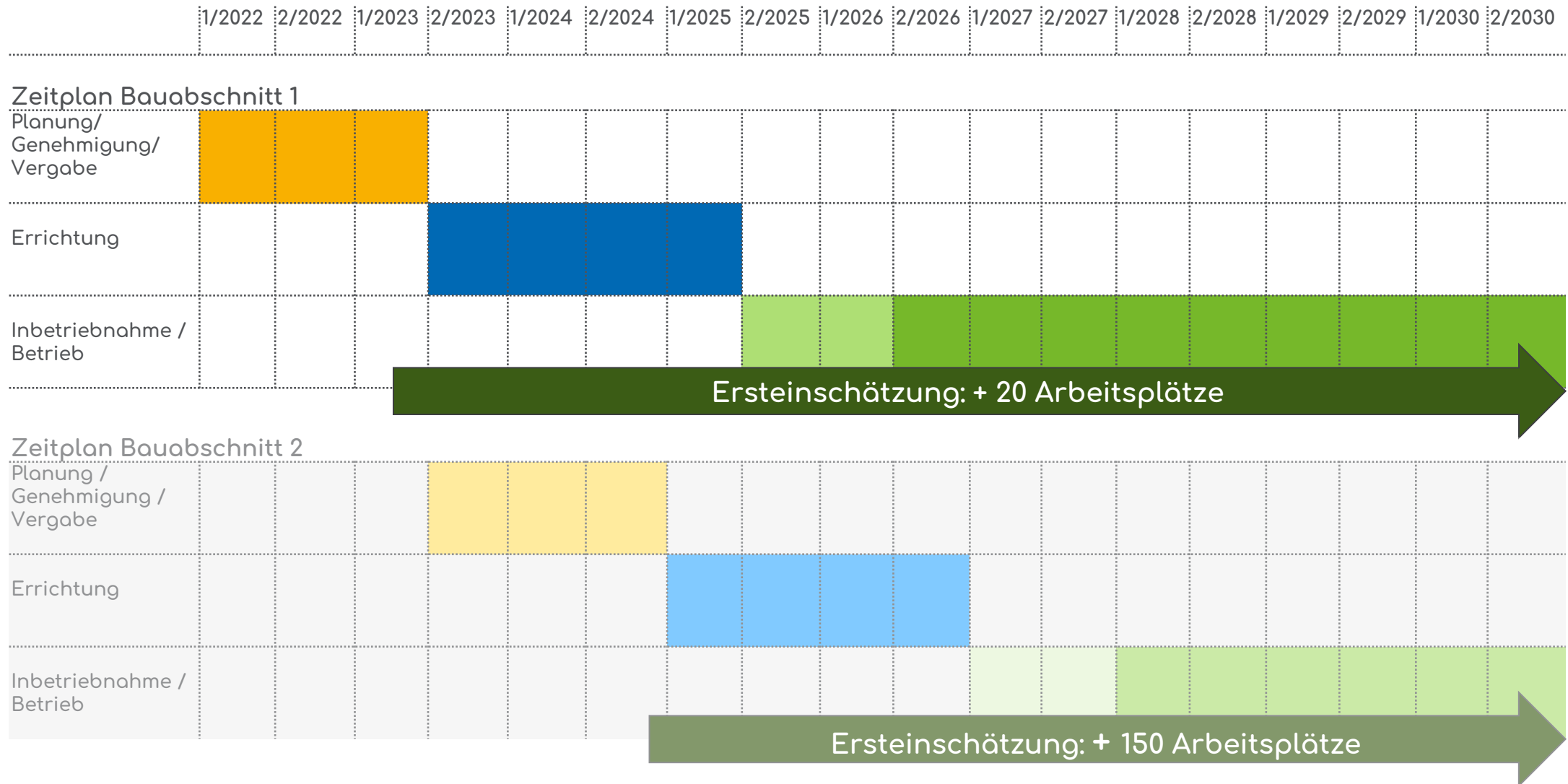
HOCHTEMPERATURSPEICHER (HTS)

Asynchrone Umwandlung von erneuerbarem Strom in Prozessdampf

INNOVATIVE GASTURBINE (GT)

Bereitstellung von Dampf und Stromerzeugung

Zeitplan HH2E-Werk Lubmin – 1. und 2. Bauabschnitt



HH2E-Werk Lubmin

- 100 MW input capacity by 2025, scalable to 1 GW by 2030.
- 6,000 tonnes/year production of green hydrogen by 2025, increasing to 60,000 tonnes by 2030.
- Phase 2025: 50 MW alkaline electrolyser + 250 MWh battery, enabling constant production of green hydrogen without constant supply of renewable energy.
- Phase 2030: 10x the capacity.
- Feed-in of renewable energy from offshore and onshore wind farms and solar farms in the region. Long-term power purchase agreements (PPAs).
- Supply of hydrogen to transport and industrial customers in Germany.



HH2E in brief



- Innovative green energy company with a focus on industrial customers.
- 24/7 stable supply of CO₂ -free energy (heat, hydrogen, electricity).
- Competitive by 2025. HH2E will produce competitively priced green hydrogen in Germany.
- Projects developed on old sites (power plants, industrial parks, etc.). In the future also on greenfield sites.
- The heart of the innovation: the new zinc electrolyser (or battery+alkali electrolyser) in combination with the high-temperature storage unit enables constant production with only a limited number of hours of renewable electricity supply.
- HH2E aims for scalable projects starting with a capacity of 100 MW and an investment volume of several billion euros in the first wave of projects. The goal is to create 4 GW of green hydrogen capacity by 2030.
- HydrogenOne Capital LLP and Foresight Group took equity and invest directly in the first five large-scale projects. Estimated cost of €600 million.



Change the game of energy!

HH2E



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