

Large-scale water electrolysis for decarbonized industries

Green hydrogen technology for multi- and gigawatt installations

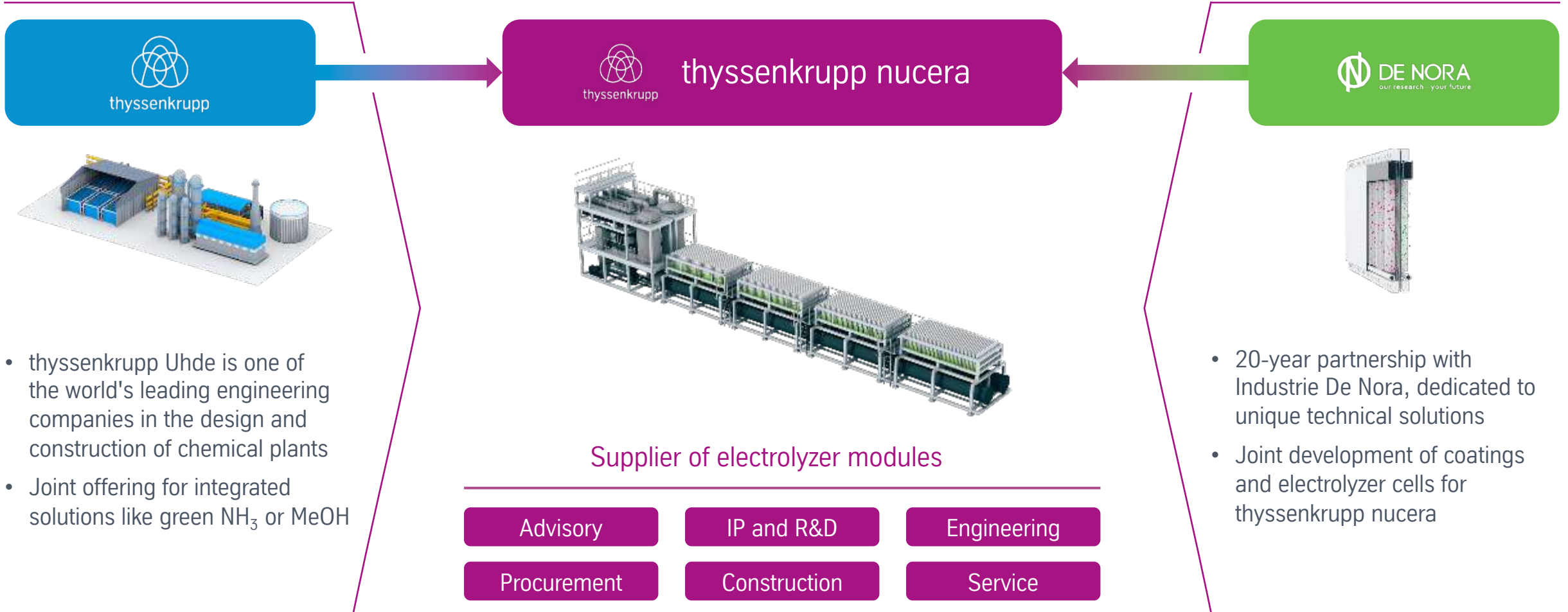


thyssenkrupp
NUCERA



Who we are

A leading Alkaline Water Electrolysis (AWE) and Chlor-Alkali (CA) technology provider globally with strong partners



Experienced management team is building on a leading global organization with a network close to customers

Experienced management team



CEO | Dr. Werner Ponikwar



CFO | Dr. Arno Pfannschmidt

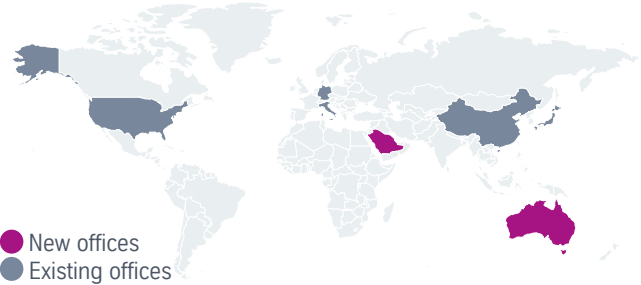


COO | Denis Krude



CTO | Fulvio Federico

Worldwide footprint



- Expansion of existing offices in capacity and capabilities
- Establishment of **new offices** in **Australia** and **Saudi Arabia**

Growing workforce



- Well on track to build-out nucera platform
- Strong talent attraction across functions
- >500 headcount in October 2022

thyssenkrupp nucera is well prepared for the future of rapid growth

Purpose:
We shape the new era.

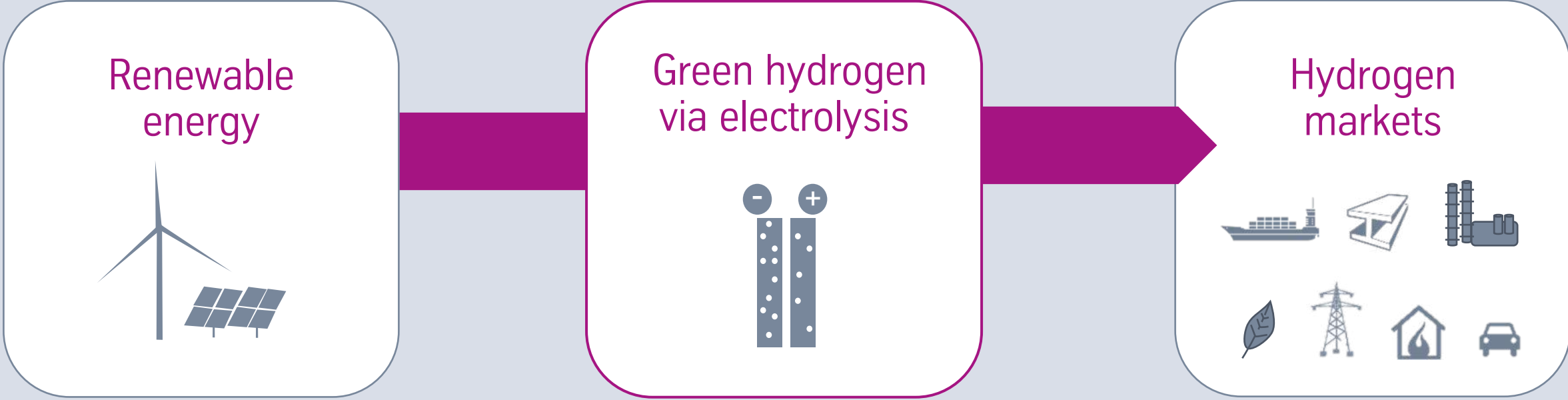
Vision:
#1 provider for hydrogen and
chlorine technologies.

Mission:
With passion for innovation, we enable our
customers to make superior electrolysis
products and minimize the CO₂ footprint.



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Electrolysis connects the renewable energy sector with a wide range of industries and enables industry decarbonization



Green hydrogen economy drivers

Climate & environmental protection

Growing renewable energy sector at low cost

Appropriate legal frameworks



Our product

Our standardized 20 MW electrolyzer module

10 Gigawatt

installed Power¹
(incl. Chlor-Alkali electrolysis)

50 years

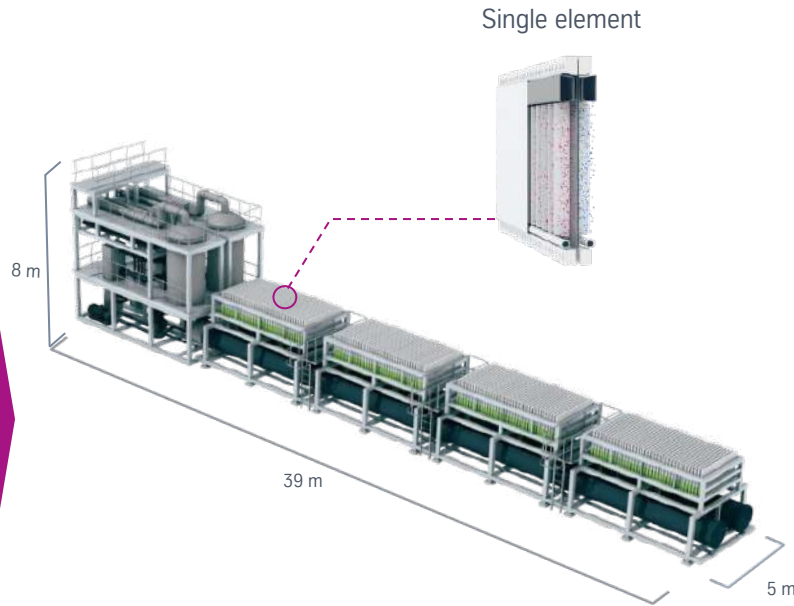
expertise in design, construction and operation

> 1 Gigawatt

manufacturing capacity for water electrolysis equipment in Germany

> 600

electrochemical projects realized worldwide¹⁾

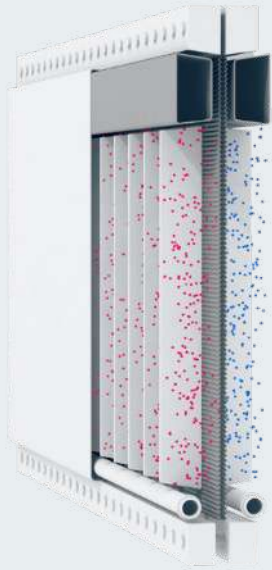


- ✓ **Safety** | Non-pressurized design | single element monitoring
- ✓ **Proven record** | Leader in industrial scale electrolysis
- ✓ **High Performance** | Leading in total cost of ownership
- ✓ **Compact Design** | High current density | small footprint
- ✓ **Reliability** | Reliable operations
- ✓ **Service** | Fit for circular economy and refurbishments
Single element exchange instead of stacks
- ✓ **Longevity** | Proven holistic lifecycle approach
Established service network
- ✓ **Financing** | Well referenced cell design and expertise in electrolysis support a viable banking case

¹⁾ incl. Chlor-alkali electrolysis

thyssenkrupp nucera offers an efficient and highly scalable module concept to match market requirements

AWE single element



20 MW electrolyzer unit



Highly scalable to GW plant size



Our standardized high performance product and its key features

Output from a 20 MW_{el} module

Hydrogen production rate	4,000 Nm ³ /h*
Hydrogen pressure at AWE module	0.300 barg
Hydrogen purity, saturated with H ₂ O at 40 °C	99.9 % (v/v)
Oxygen production rate	2,000 Nm ³ /h*
Oxygen pressure at AWE module	0.200 barg
Oxygen purity, saturated with H ₂ O at 40 °C	99.5 % (v/v)

Operability

The turn down ratio of the electrolysis modules	10 %
The turn up ratio of the electrolysis modules	100 %
Ramp-speed (up and down, hot system)	Suitable to renewable energy sources
Start-up times: Cold to 100 % load	40 – 60 min.
Availability	up to 98 %

Power consumption at start of life (DC)

Electrolyzer, at max. capacity	4.5 kWh/Nm ³ (DC)
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* Nm³ is defined as 1 m³ of gas (100%) at 273.15 K and 1.013 bar



Power consumption at start of life (AC)

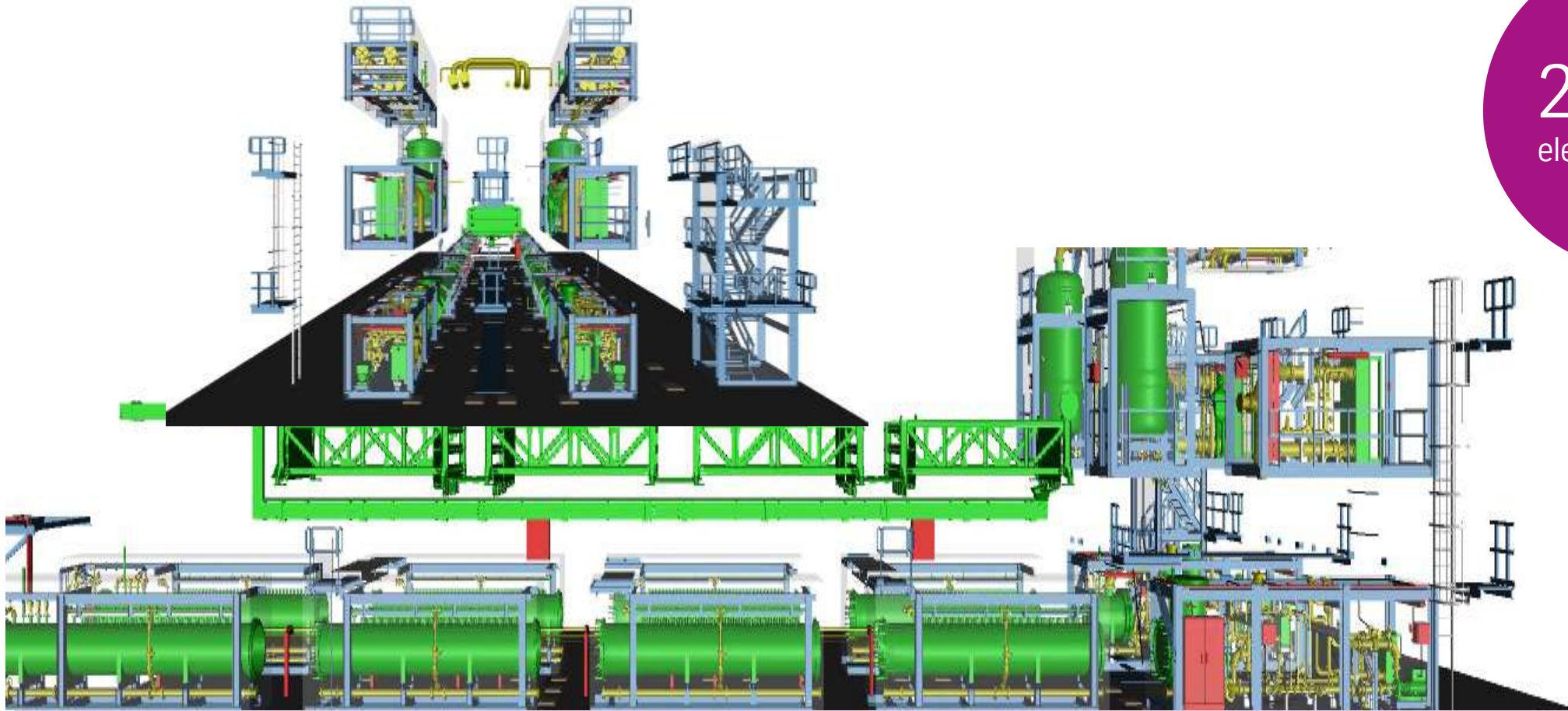
System at nominal capacity:

- › incl. transformation / rectifying
- › incl. hydrogen compression to 30 bar_g
- › incl. all other electrical consumers within battery limits (purification of 99,999 %)

4.9 kWh/Nm³ (AC)

Our 20 MW module has a containerized skid-mounted configuration - transportable anywhere in the world

20 MW
electrolyzer unit



Applying thyssenkrupp nucera's know-how on AWE and engineering provides an attractive solution to serve global demand



thyssenkrupp
nucera
today and
tomorrow

Current projects thyssenkrupp nucera

Unigel

- Three 20 MW standard electrolyzers (= 60 MW)
- Green hydrogen to produce green ammonia
- Located in Camaçari Industrial Complex, Brazil



Air Products

- 40 MW electrolysis in 2023 (estimated)
- Located in Casa Grande, Arizona, USA
- Liquid hydrogen facility for mobility market



Shell

- 200 MW electrolysis plant in 2024 (estimated)
- Located in Rotterdam, Netherlands
- Green hydrogen factory, start up in 2024 (estimated)



CFI

- 20 MW electrolysis in 2023 (estimated)
- Located in Donaldsonville, LA, USA
- Feed green hydrogen into existing ammonia plants to produce green ammonia (decarbonization)



NEOM

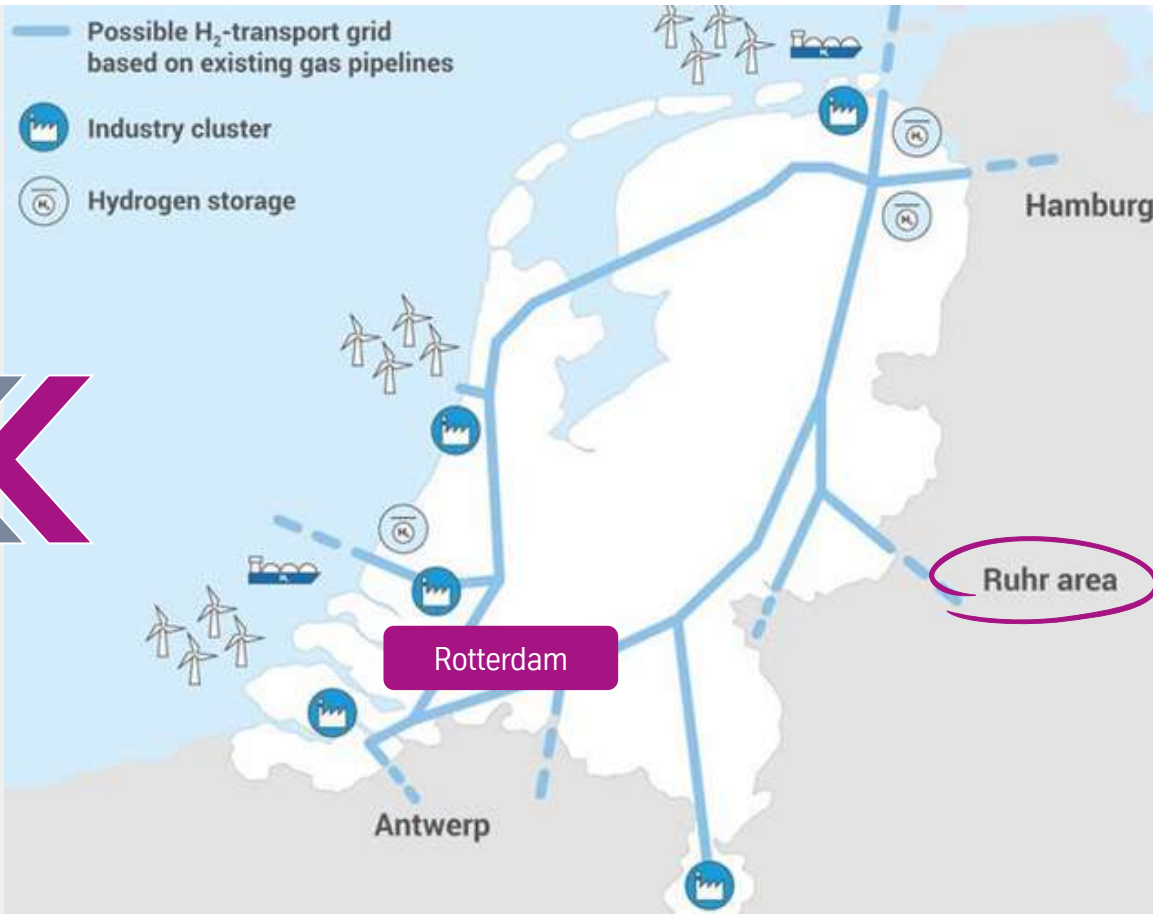
- > 2 GW electrolysis in 2026 (estimated)
- Located in NEOM, KSA
- Green hydrogen (650 t per day) to produce green ammonia (energy carrier)



Rotterdam – an important location for Western Europe’s green energy supply



Source: Shell



Source: Dutch Ministry of Economic Affairs and Climate

Shell

Energy competence meets engineering excellence



Rotterdam, Netherlands



thyssenkrupp nucera to engineer, procure and fabricate a 200 MW electrolysis plant



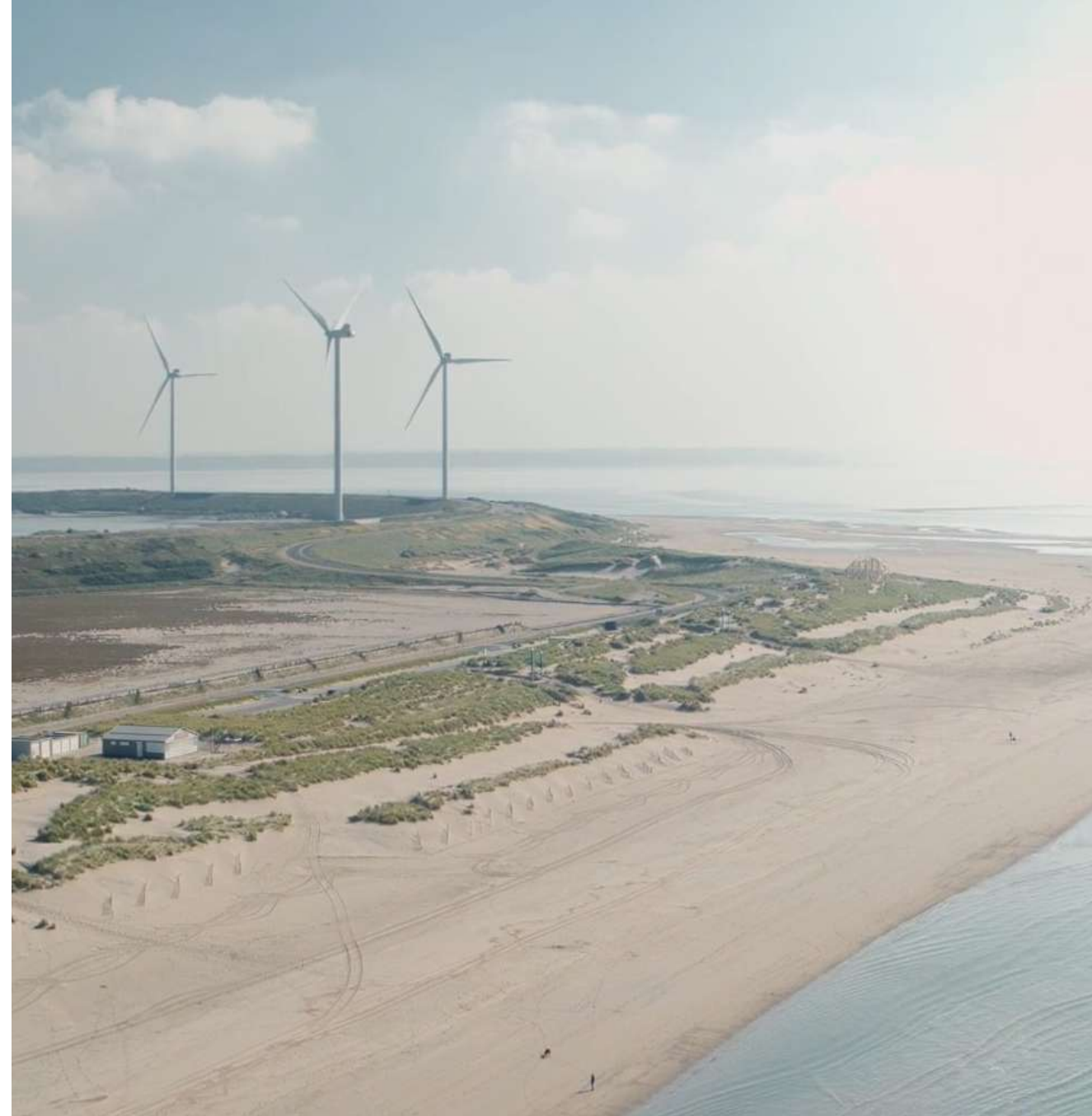
2024 Start-up



Green H₂ for industry and transport



Electricity coming from offshore wind farm
Hollandse Kust (Noord)



The Ruhr region | A new hydrogen valley

- Clustered hydrogen demand and technological expertise for construction and operation of electrolyzers
- A cross-industry blueprint and pioneer for hydrogen-based sector coupling
- Transforming the Ruhr region into a green industrial location in the center of Europe by integrating new green value chains and emissions cycle management in the existing large-scale industry



Demonstrator and test stand of AWE technology Carbon2Chem in Duisburg

Continuous testing of innovative components and materials

- Capacity: up to 2 MW
- H₂ production: up to 440 Nm³/h
- H₂ purity: > 99.95 % (dry)

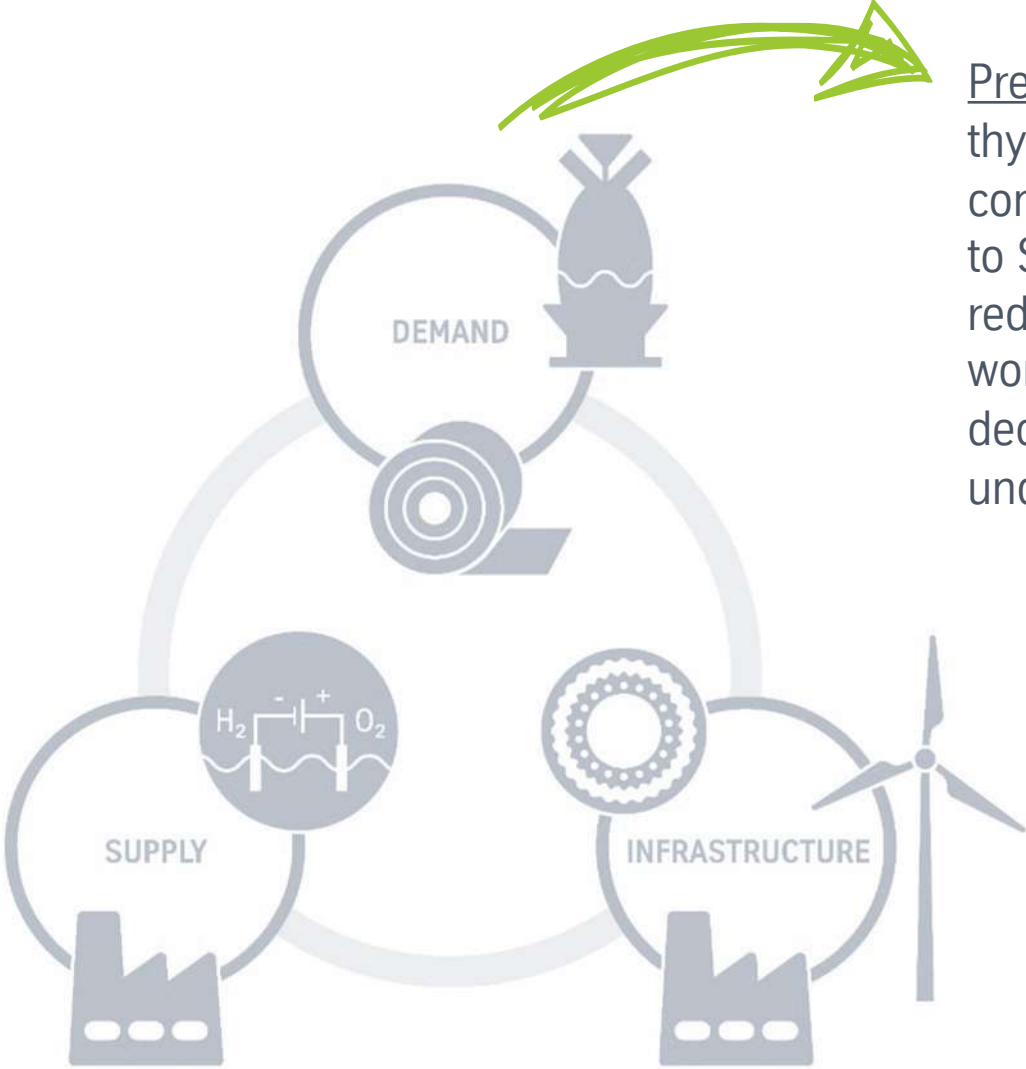
Carbon2Chem® supported by



Federal Ministry
of Education
and Research

BMBF funding numbers
3EK3037 to 03EK3043

thyssenkrupp's hydrogen triangle



Press release March 1st 2023:
thyssenkrupp Steel awards a contract worth billions of euros to SMS group for a direct reduction plant: one of the world's largest industrial decarbonization projects gets underway





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An aerial photograph of ocean waves crashing, showing white foam and deep blue water. The image is partially obscured by a magenta text box in the bottom right corner.

We shape
the new era.