e-scale water electrolysis toward the realization of energy transit
ルギー転換実現のための大規模水電解装置

German - Japanese Business and Technology Seminar
Innovative and Sustainable Technologies and Business Models for the Energy Transition from NRW and Japan
Hills House "Sky Room" (Azabudai Hills), October 15th, 2024

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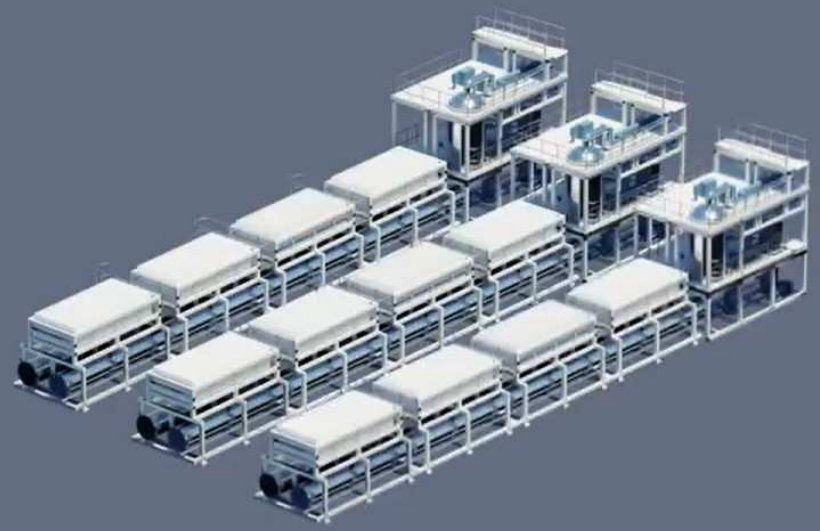
thyssenkrupp
nucera

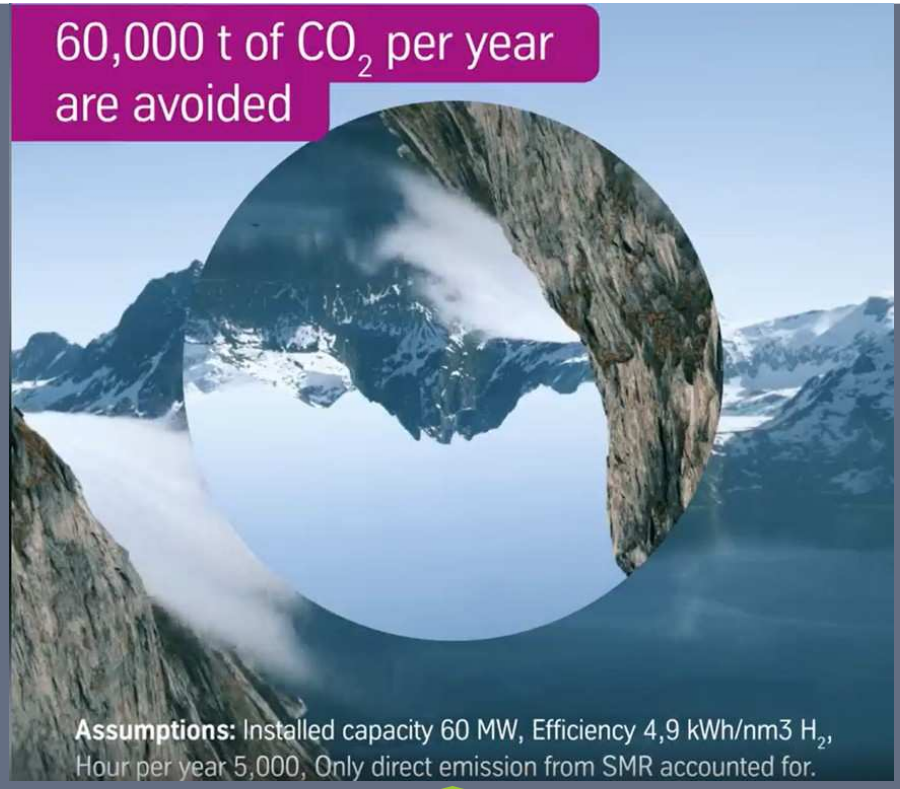
How much CO2 emissions can be avoided with green hydrogen plants in tons of carbon equivalent?

Example:
60 MW green hydrogen plant



60 MW produce about 6,000 t of green hydrogen per year.

60,000 t of CO_2 per year are avoided



Assumptions: Installed capacity 60 MW, Efficiency 4,9 kWh/nm3 H_2, Hour per year 5,000, Only direct emission from SMR accounted for.

In comparison: Grey hydrogen from steam methane reforming has a CO_2 footprint of roughly 10 tons per ton of H_2

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

Renewable energy

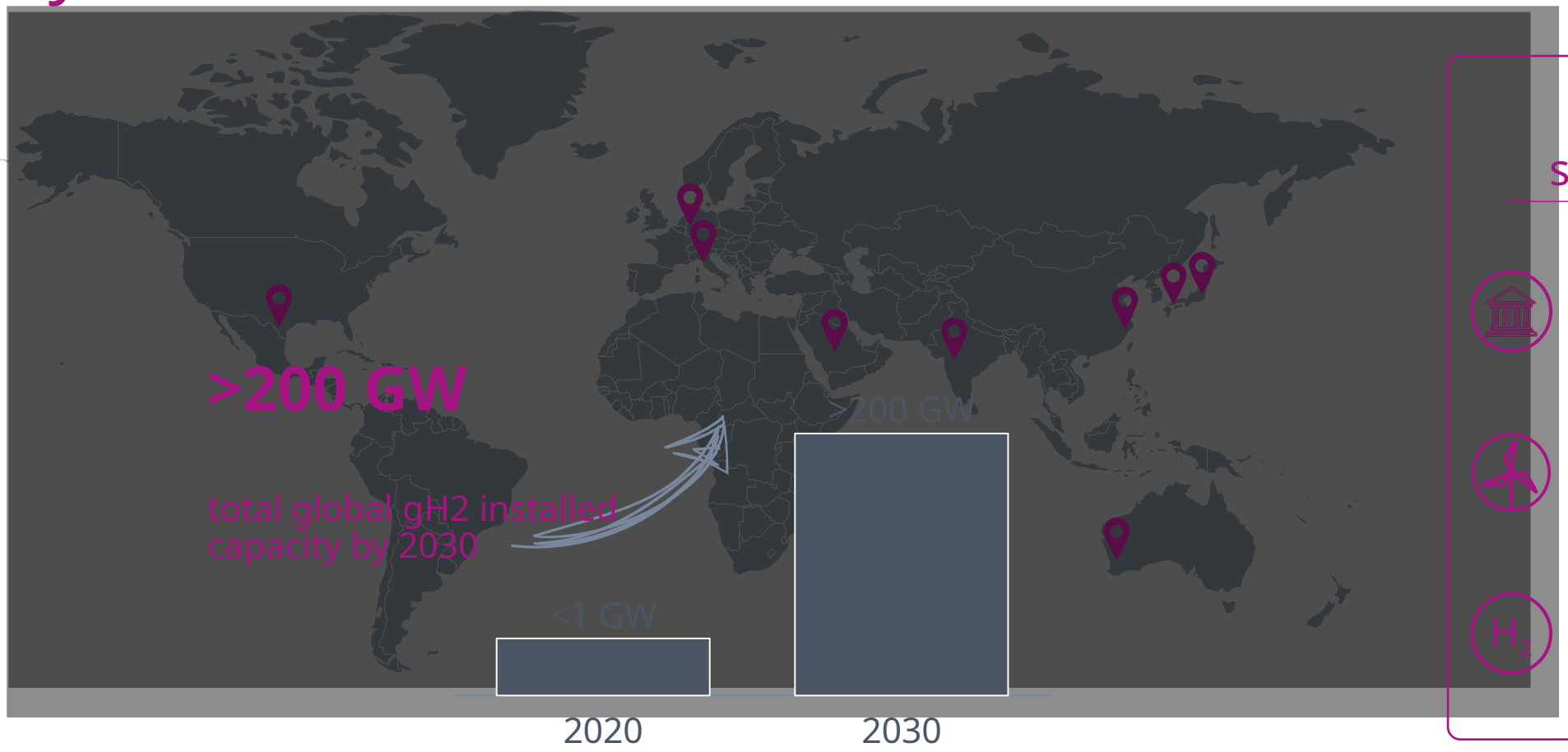
Green hydrogen via electrolysis

Hydrogen markets

Green hydrogen economy drivers

- Climate & environmental protection
- Growing renewable energy sector at low cost
- Appropriate legal frameworks

gH2 market assessment exceed 200 GW installed capacity by 2030



3 main drivers shape the global markets

- Governmental support
- Renewable energy supply
- Hydrogen demand

Local offices ensure global presence of NCA in strategically relevant markets

Status as of Dec ‘23 Sources: Hydrogen Council, McKinsey & Company; Hydrogen Insights 2023

thyssenkrupp nucera

We are the Alkaline Water Electrolysis (AWE) and Chlor-Alkali (CA) technology provider globally

8
regions

750+
employees worldwide

600+
successful electrochemical projects worldwide

3GW+
contracted green hydrogen capacity

150+
modules in execution

3mio+
tons of CO2 can be saved p.a.[1]

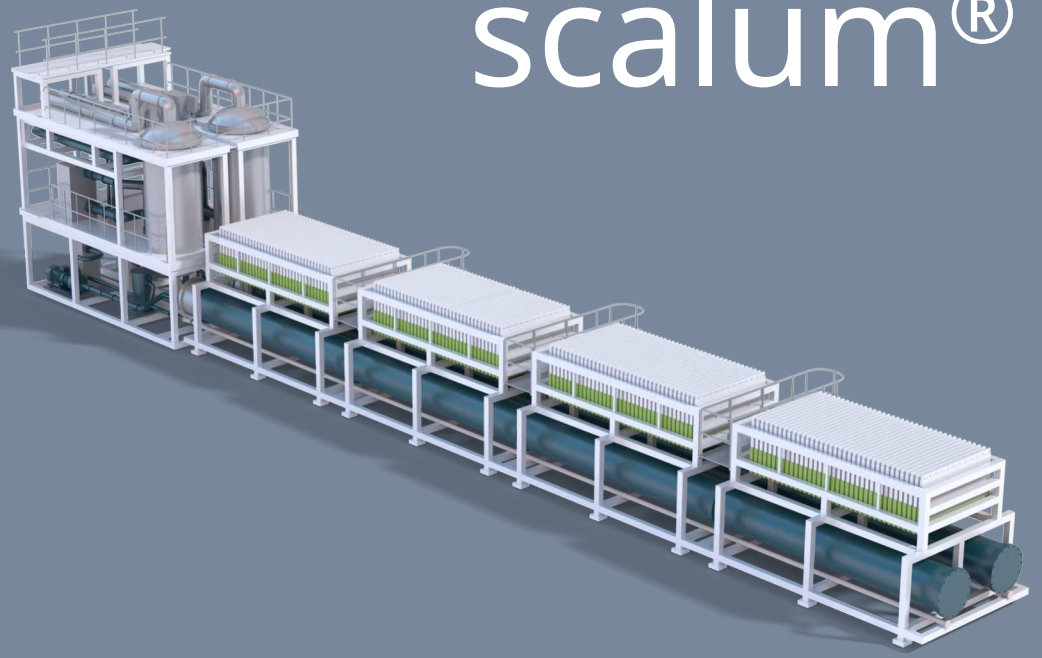
1. Based on 3GW+ contracted green hydrogen capacity.

thyssenkrupp nucera

Enabling green transformation

- AWE technology delivers speed and scale
- Based on proven quality, safety, reliability, and passion for innovation
- A powerful unit with ~ 300 high-efficiency cells
- Standardized modular solution with a system capacity of 20 megawatts (MW)
- Can be easily interconnected and scaled up to match highest demands, up to gigawatt plant size

scalum®



Quality and Longevity

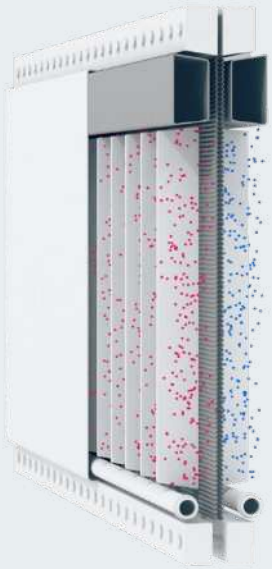
High Performance

Design Certified

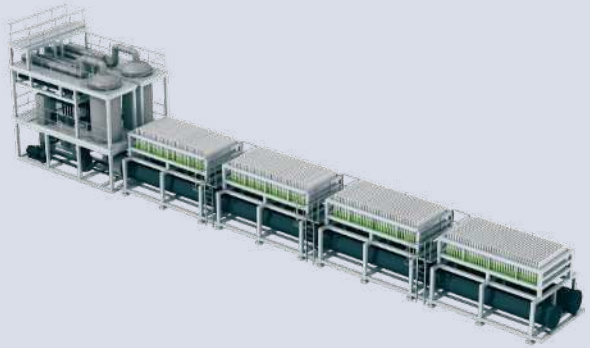
Global Service Network

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

AWE single element



scalum® 20 MW electrolyzer unit

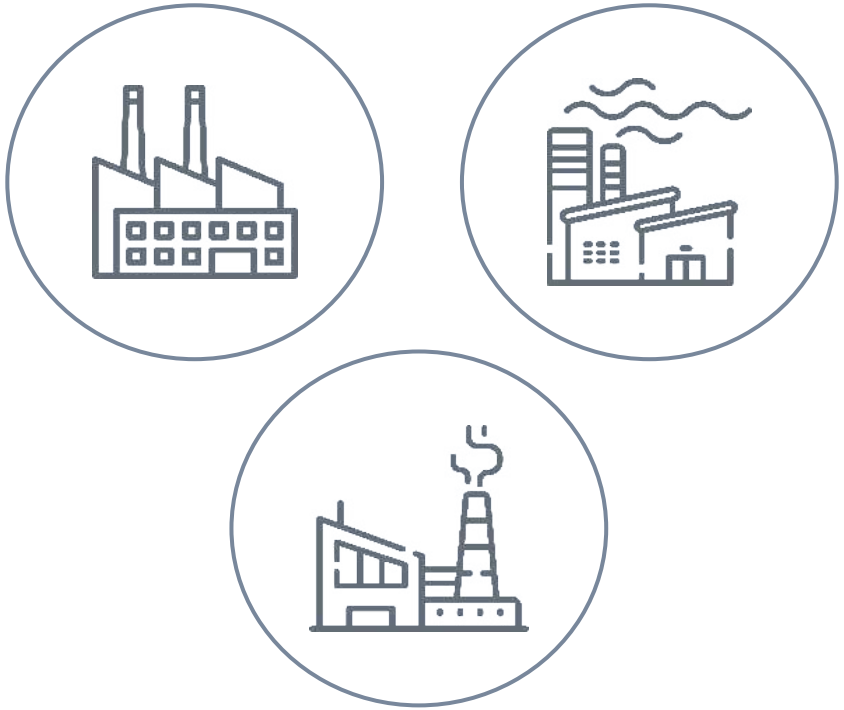


Highly scalable to GW plant size

Evolution to a product-based business to most efficiently serve growing global demand

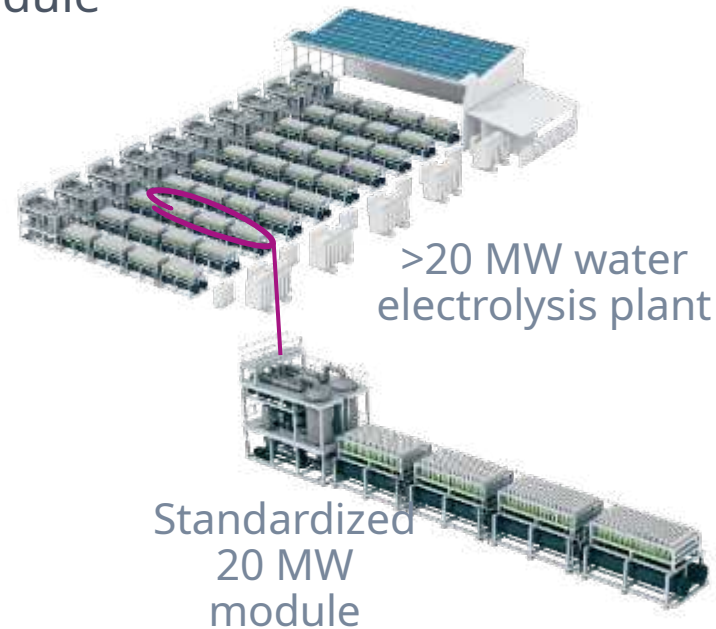
Project business

Full customization per project



Technology provider and product business

thyssenkrupp nucera green hydrogen business prepared for being highly standardized with 20 MW module



thyssenkrupp nucera business in transition from a classical project business to a future AWE product-based business

thyssenkrupp nucera

Current leading projects by thyssenkrupp nucera

04/2018

Carbon2Chem

thyssenkrupp nucera's Duisburg demonstrator hydrogen plant started operations, a green world premiere

04/2021

CF Industries

thyssenkrupp nucera awarded supply contract by CF Industries to deriver a green hydrogen plant to produce green ammonia

12/2021

Neom Green Hydrogen Project

thyssenkrupp nucera signs one of the largest green hydrogen projects in the world to install over 2GW electrolysis plant for Air Products in NEOM

12/2021

Shell

thyssenkrupp nucera to engineer, procure and fabricate Shell's 200 MW hydrogen facility in the port of Rotterdam

04/2022

Air Products

thyssenkrupp nucera to deliver two 20 MW modules for a 10 metric ton per day facility to produce liquid hydrogen in Casa Grande, Arizona

05/2023

H2 Green Steel

thyssenkrupp nucera supplies electrolyzers for H2 Green Steel to build the world's first large scale integrated green steel plant. The hydrogen plant will be the largest in Euroe when operations start. By using green hydrogen in steel, the plant in Sweden can produce up to 95% lower carbon emissions.

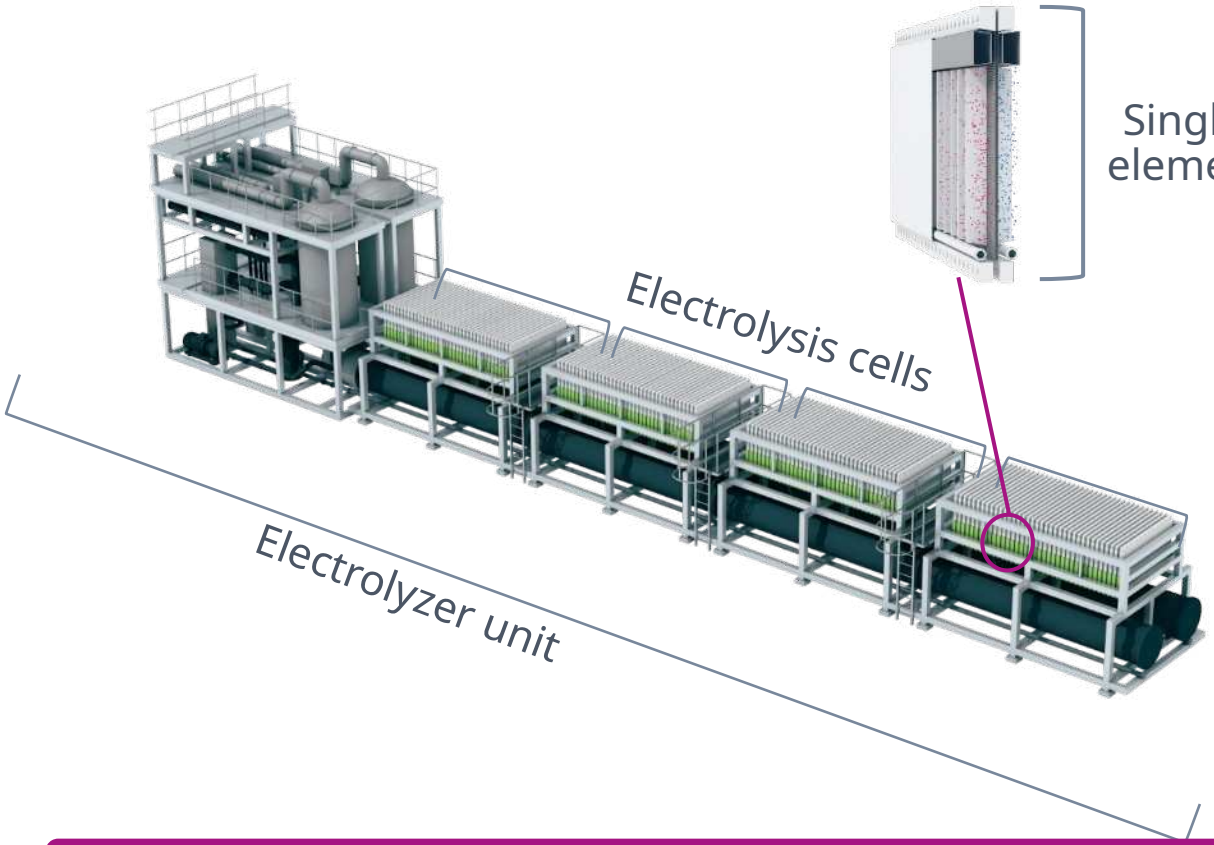
thyssenkrupp nucera makes a difference across every step of the industrial electrolysis value chain

	Engineering	Cell fabrication	Modularization	Piping	Handling	Services
						
Application	More than 600 electrochemical projects realized in the world	Cell and electrolyzer design, manufacturing and assembly	Plant construction and logistics	High quality products in a highly corrosive environment	Handling and use of chlor-alkali products	Full lifecycle service and digital solutions
thyssenkrupp nucera value add	Design most efficient plants and modules with best-in-class safety standards	"IP of Design"[1] of cells and electrolyzers and integrated manufacturing with long-time supplier and partner	In addition to small skid mounted AWE plants, also larger plants in synergy with partner Uhde	Proprietary technology incl. own trademarks	>30 years of experience in handling with H_2	Existing service organization with long-standing suppliers and partners

thyssenkrupp nucera provides leading in-house experience along each step of the electrolysis value chain

1. The cell and electrolyzer shape and structure are designed for best utilization of key electrochemical components (anode and cathode coatings, separator), in terms of efficiency, products quality, durability/longevity, safety. By developing optimization of: Gas-liquid fluids handling, distribution, control of pressure fluctuations; uniform electrical current distribution and low ohmic drops; selection of corrosion-resistant materials; serviceability

thyssenkrupp nucera service portfolio addresses plant operator's key priorities for large scale electrolyzers



Plant operators' key priorities

- Safety
- Reliability
- Performance

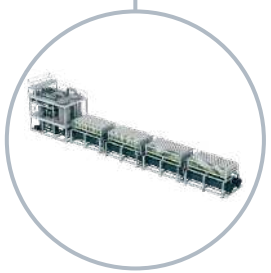
thyssenkrupp nucera service portfolio

Safety, reliability and performance are at the center of thyssenkrupp nucera's service portfolio

thyssenkrupp nucera

Dedicated product development roadmap with focus on performance and overall total cost of ownership

AWE Technology

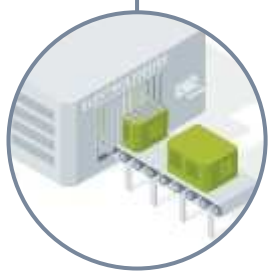


2021

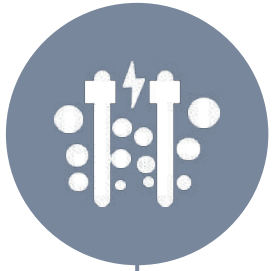
Incremental Development

Continuous design improvements – reducing CAPEX and OPEX

Serial production and automation, for cell and module fabrication at multi-GW scale



H2Giga



2nd gen Electrolysis Design

Advanced next generation architecture for improved TCO

Highly automated

2025 Plan

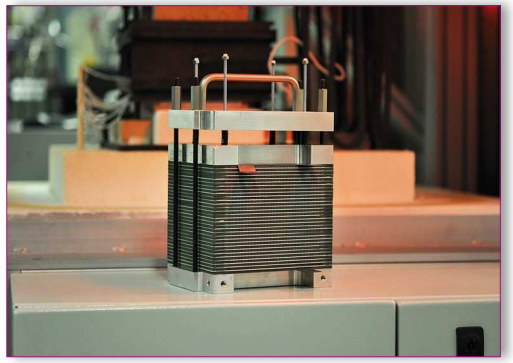
In partnership with De Nora for electrode coatings and manufacturing

X GW Fabrication

Multiple sites

thyssenkrupp nucera and Fraunhofer IKTS Agree on a Strategic Partnership in SOEC Technology

• Technology transfer of the electrolysis chromium-based alloy(CFY) stack technology developed at Fraunhofer IKTS
• Major cost advantage of SOEC technology in the application areas due to high efficiency
• Design for a later production ramp-up depending on the results of the pilot production line to test the existing technology status and achieve the necessary economic efficiency



Key massage
Green hydrogen is a huge opportunity in a fast developing market

High growth hydrogen market will drive growth in water electrolysis

Green hydrogen is the key to the energy transition driven by governmental policies and low cost renewable energy and opportunity for growth

Green hydrogen demand will be determined by the industrial sector – thyssenkrupp nucera's focus market

Thank you