

thyssenkrupp Uhde

Clean chemicals

Creating sustainable value



thyssenkrupp





**“Decarbonization and
defossilization of whole
industries are big levers
for climate protection.
We are ready to shape the
green transformation.”**

Dr. Cord Landsmann
CEO thyssenkrupp Uhde



Climate change is the most serious problem we have to tackle today.

Only together can we become carbon-neutral because only together can we create a liveable planet. Water-electrolysis technology combined with thyssenkrupp's patented and proven green hydrogen-based technologies can lay the foundations for an environmentally sound future.

With over 100 years of success and expertise in engineering ammonia, methanol, SNG and many other chemical plants, we can create plants that are tailored to your needs. Our integrated approach as licensor and contractor covers the entire value chain from production, storage and transport to reconversion and hydrogen. Let us lead the way to a carbon-neutral future where chemistry connects energy.

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Improve your carbon footprint with clean green ammonia

Clean green ammonia is a carbon-neutral multi-talent – the most efficient green hydrogen carrier with established infrastructures all over the world. Green ammonia can also be used for direct energy generation in turbines, as clean ship fuel, and enables climate-friendly fertilizer production.

With over a century of experience in handling ammonia, we can be your reliable partner for the entire green ammonia value chain from electrolysis through synthesis and storage to ammonia cracking.

With our plants you can economically and reliably synthesize up to 5,000 mtpd and manage renewable energy fluctuations with flexible plant operation and optimized hydrogen or battery storage system.

Application areas

- Hydrogen carrier
- Maritime fuel
- Direct-use fuel
- Energy generation
- Fertilizer feed

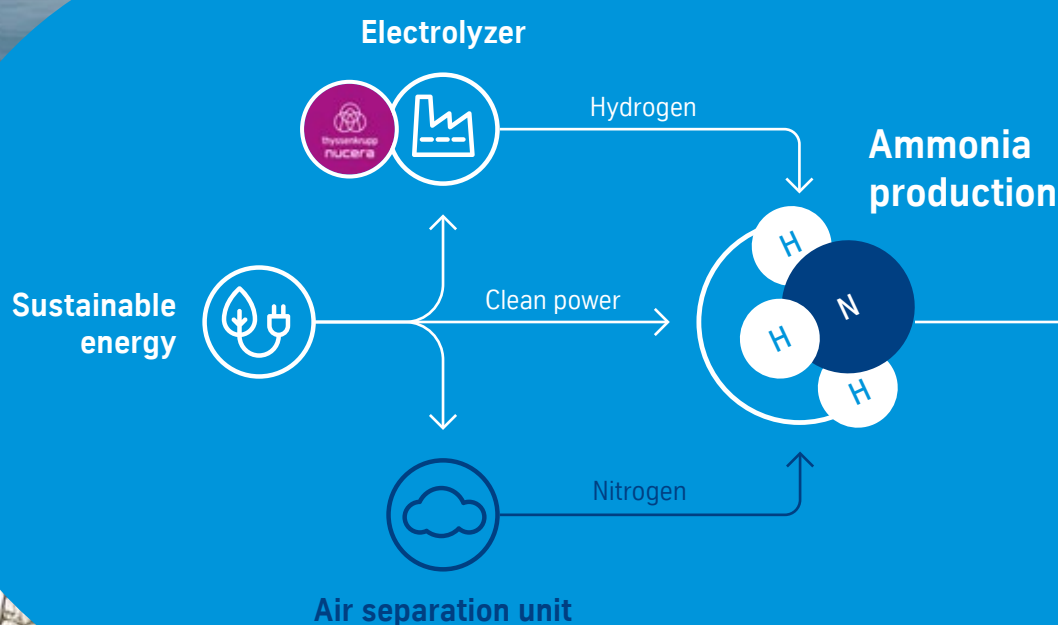
Key benefits

- Fast dynamic operation
- Low turndown (<10%)
- Low specific energy demand
- Modular skid-mounted design
- Fully integrated Power-to-Ammonia solution with thyssenkrupp nucera AWE technology
- Integration with other electrolysis technology
- EPC turnkey execution solution worldwide
- Green revamps for existing plants



Design capacity

50-5,000 mtpd



Key data

Fully modularized and standardized capacities	50/300/600/1,200/2,500/3,400 mtpd
Dynamic operating window	<10 % – 100 %
NH ₃ product quality	99.8 %
NH ₃ synthesis pressure	80 – 260 bar

Deliver the green ammonia storage solution ...

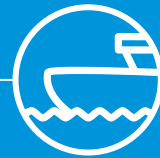
up to

45,000

mt storage volume



Ammonia storage



Transport

As green ammonia is the most important green hydrogen and fuel carrier, storage and handling are of increasing importance.

Based on our extensive experience with storage installations involving storage facilities, refrigeration systems, ship and truck unloading and loading equipment, and pipeline transfer facilities, you will be able to store up to 45,000 mt of ammonia.

Application areas

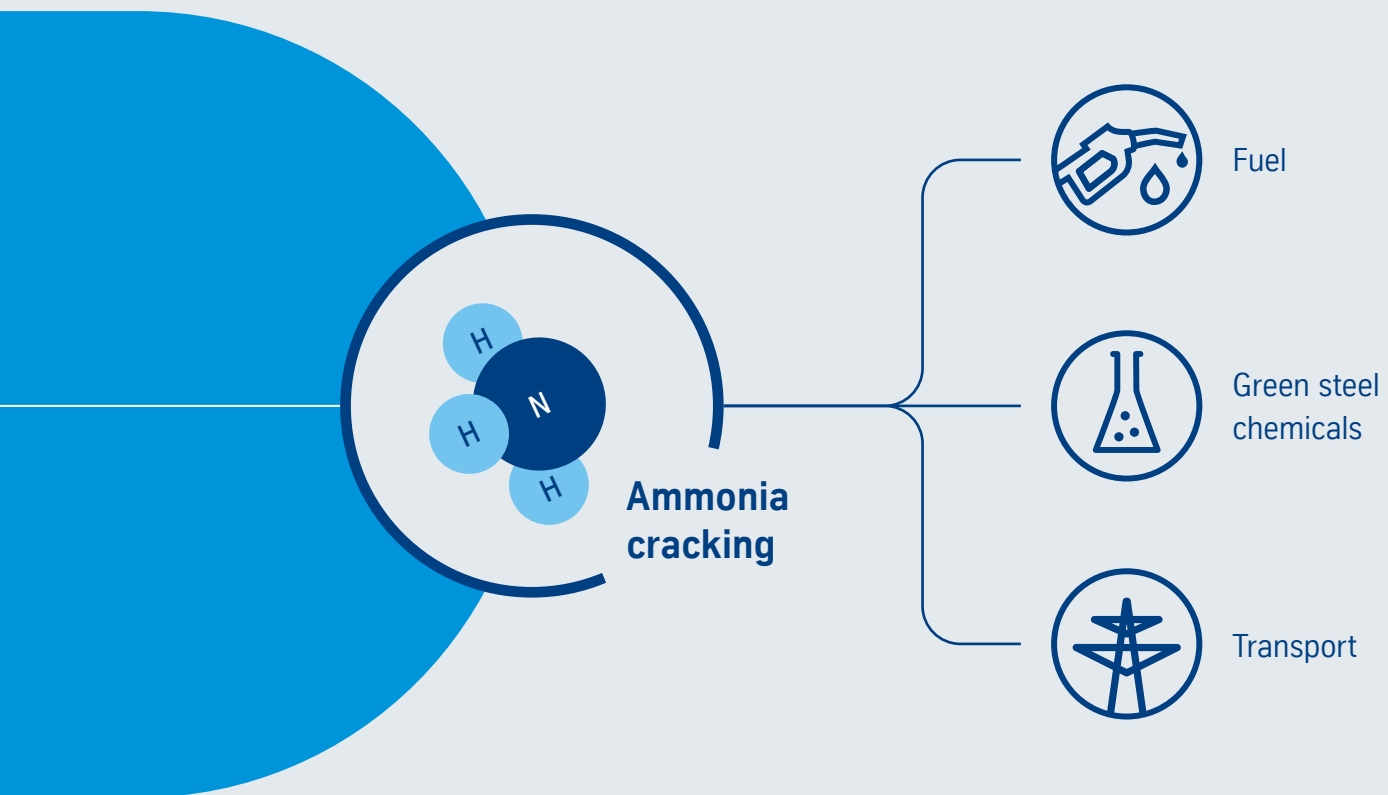
- Chemical feedstock, fuel, raw material
- Mixing to national H₂ and or CH₄ grid
- Methanation of H₂ to CH₄ and blending to national gas grids
- Fuel cell application and power generation

Key data

Atmospheric tanks	5,000 – 4,5000 mtpd built (pressure 60 mbarg at -33 °C)
Pressurized tanks	100 – 5,000 mtpd built (pressure 16 bara at 40 °C)
Cracking capacity	50 – 3,000 mtpd cracked ammonia
Cracking efficiency	>90% NH ₃ to H ₂

thyssenkrupp Uhde's ammonia cracking unit enables you to produce carbon-neutral green hydrogen for applications ranging from green steel and green chemicals to power generation and fuel – wherever in the world your industry is located.

Our optimized, well-engineered heat integration technology provides you with the highest ammonia-to-hydrogen ratio. At thyssenkrupp we will deliver the standard of purity you need to fulfil the requirements of your specific application.



... and crack the
ammonia to produce
green hydrogen

Mitigate greenhouse gases with renewable methanol



At thyssenkrupp Uhde we turn methanol production from a CO₂-emitting industry to a green solution with the potential for an environmentally friendly future.

By synthesizing renewable methanol from green hydrogen and carbon dioxide we can help to tackle climate change by mitigating the impact of greenhouse gases.

While the green hydrogen feed is generated by renewables, the CO₂ can be taken from all different kinds of sources working as

a CO₂ sink. It is recovered from biogas or other fermentation plants, from applications such as flue and waste gases from chemical and petrochemical complexes, cement plants, or steel manufacturing plants and direct air capture.



Sustainable energy

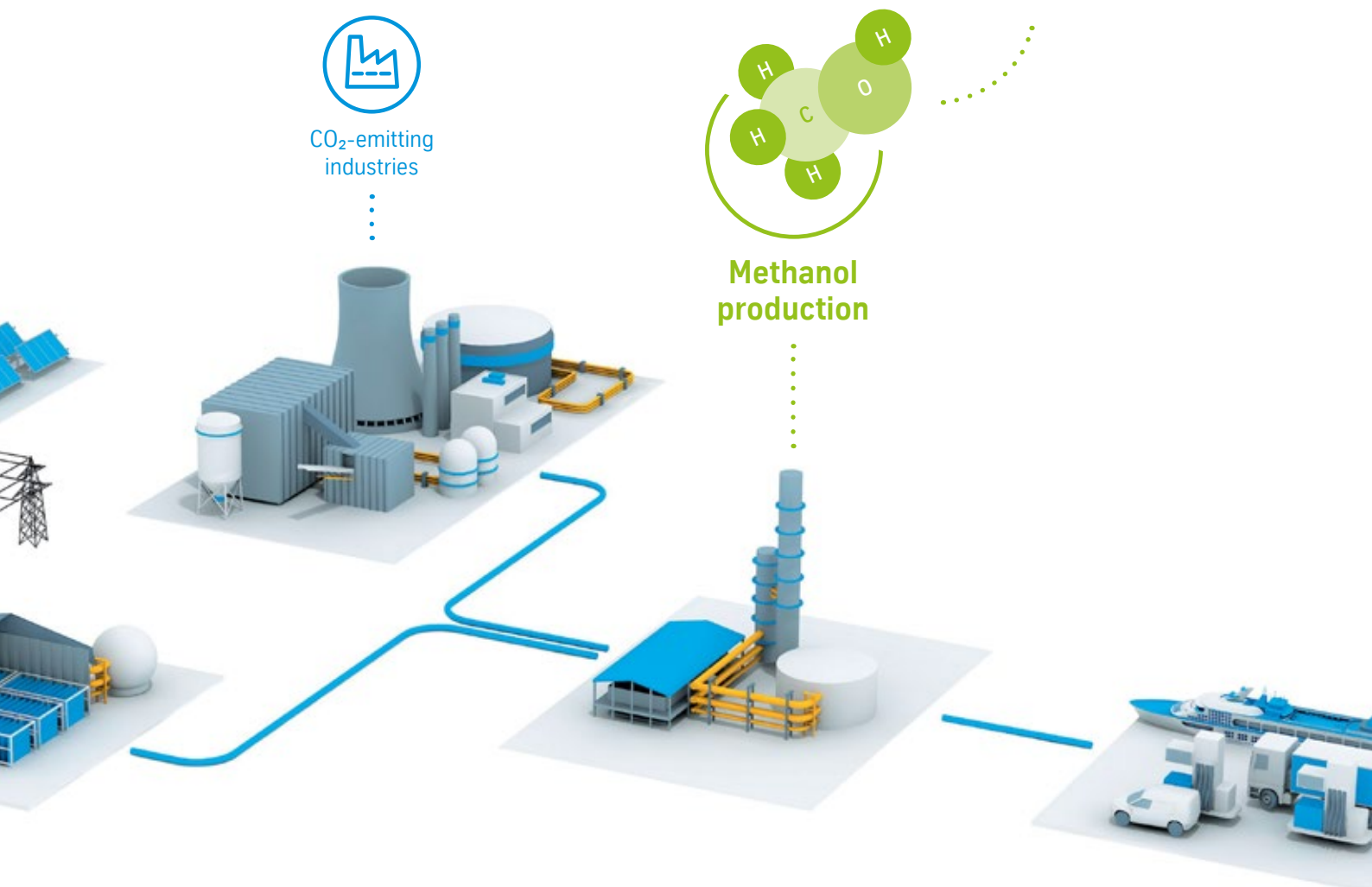


Electrolytic hydrogen plant

“Green methanol has a great potential to revolutionize many different areas of industries and turn previously grey processes into climate-neutral ones.”

Thore Lohmann

Head of Operating Unit Fertilizer & Methanol
thyssenkrupp Uhde



Key benefits

- Fast dynamic operation
- Low turndown (<25 %)
- Low specific energy demand
- Modular skid-mounted design
- Fully integrated Power-to-Methanol solution with thyssenkrupp nucera AWE technology
- Integration with other electrolysis technology
- EPC turnkey execution solution worldwide

Application areas

- Maritime fuel
- Direct-use fuel
- Energy carrier
- Hydrogen carrier
- Feedstock of derivatives (e.g. gasoline, plastics, etc.)
- Energy storage
- Energy generation

Key data

Feedstock	H ₂ & CO ₂ , H ₂ & CO ₂ /CO mixtures
Capacities	12 to 10,000 mtpd
Packaging	From stick built to fully modularized
Operating load range	<25 % to 100 %
Methanol quality	Fuel quality, MtX quality, IMPCA, Grade AA

CO₂ removal for climate protection

Environmental protection and reduction of CO₂ emissions are key topics in the energy and chemical industries. In this context, Uhde has developed a highly efficient CO₂ removal process that enables the separation of CO₂ from chemical process offgases and from combustion flue gas streams.

The CO₂ removal process is based on the utilization of a specific aqueous amine solution in a combined absorption process. Thanks to this specifically developed process, the removal of CO₂ from gas flows with very low pressure and large volumes is technically and economically feasible. In addition, the process can be designed for different kinds of waste gas qualities and is characterized by low regeneration energy demand and low solvent-related costs.

Key achievements in the thyssenkrupp Uhde solvent development process

Solvent developed for CO₂ removal from power plant flue gas



Comprehensive solvent screening and laboratory analysis work



Successful intensive pilot plant testing



Ready for commercialization



Application on flue gas from gas-fired steam reformer and power plants



Application areas

- Chemical industry
- Gasification and power plants
- Cement and calcination units



Capacity up to

250,000
 $\text{m}^3 (\text{Vn})/\text{h CO}+\text{H}_2$

Gasification for CO_2 -free biofuels

With decades of experience in the design and implementation of gasification plants based on eight different technologies, and more than 100 gasifiers built, we can proudly say that our current PRENFLO[®] gasification process is the result of continuous research, development and optimization.

Key benefits

- Reduced operating costs
- Use of low-value feedstock or waste
- Higher-value products, e.g. methanol, ammonia, urea, DME, SNG, jet fuel (SAF), gasoline/LPG, diesel/naphtha, hydrogen, waxes
- Environment-friendly solutions
- High electrical efficiency in power generation
- Multi-fuel capability
- Sellable by-products
- Basis for carbon capture and storage/utilization (CCS/CCU)
- Carbon-reduced or even completely CO_2 -neutral value chains

Application areas

For carbonaceous feedstocks, such as biomass and biogenic waste, to synfuels and chemicals.

Finding the sweet spot for your green investment: Concept modeling and optimization

Our techno-economic modeling tool RHAMFS® models hydrogen and chemical production in real time.

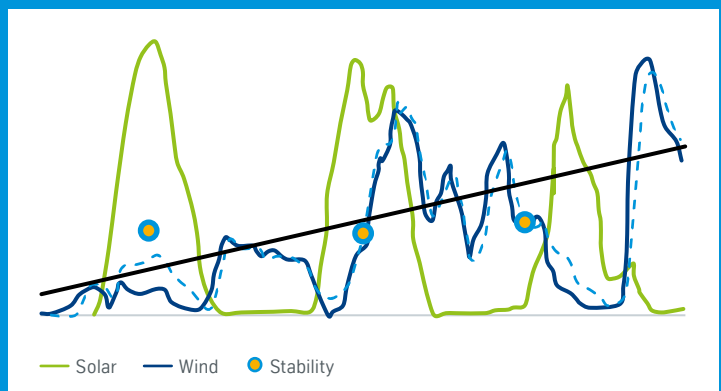
RHAMFS® has been specifically developed for holistic performance modeling across the whole green hydrogen value chain from power feed characterization to product dispatch. Based on our decades of technical and economic data, it can perform dynamic and multivariable modeling to determine the most practical and cost economic concept for any power-to-X application, be it greenfield or brown-field. Our technical configuration models are matched with equally robust economic evaluation modules based on market-tested cost metrics. As a result, multiple concept configurations can be efficiently and iteratively tested for economic viability.

Key activities and outputs

- Economic modeling of centralized and distributed hydrogen and chemical facilities
- Real-time modeling of electrolyzer utilization and production (H₂ and derivatives)
- Hydrogen storage optimization
- Sector coupling assessment
- Total cost of ownership
- Estimation of emissions' footprint

Renewable power stability analysis

Renewable energy mix optimization

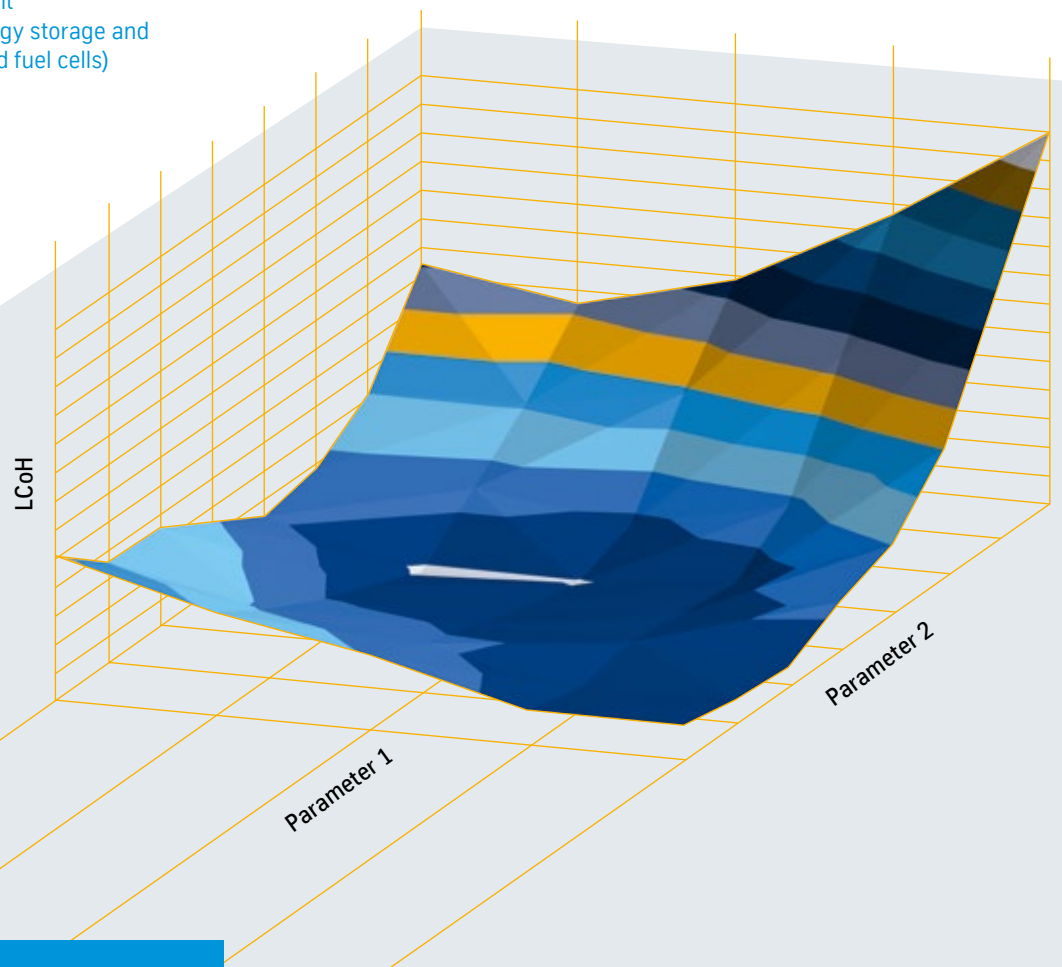


Concept harmonization

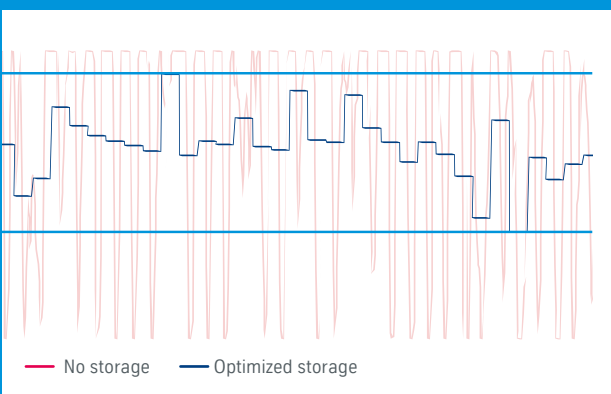
- Energy storage modeling (in front of and behind the meter)
- Optimization of electrolysis utilization depending on the application
- H₂ storage optimization
- Grid power arbitrage assessment
- Intermittency management
- Synchronization with energy storage and P2P elements (battery and fuel cells)

Economic benefits

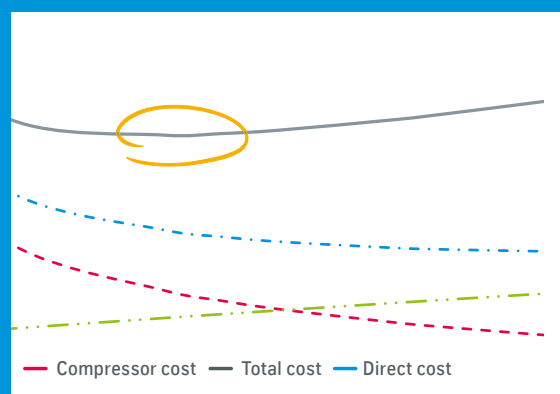
- Levelized cost of H₂ and derivatives
- Total cost of ownership



Green hydrogen & chemical production modeling



Hydrogen storage optimization





Value-adding service and solutions

After plant realization we support our customers with world-class services and state-of-the-art digital products targeting continuous improvement of plant performance and availability.

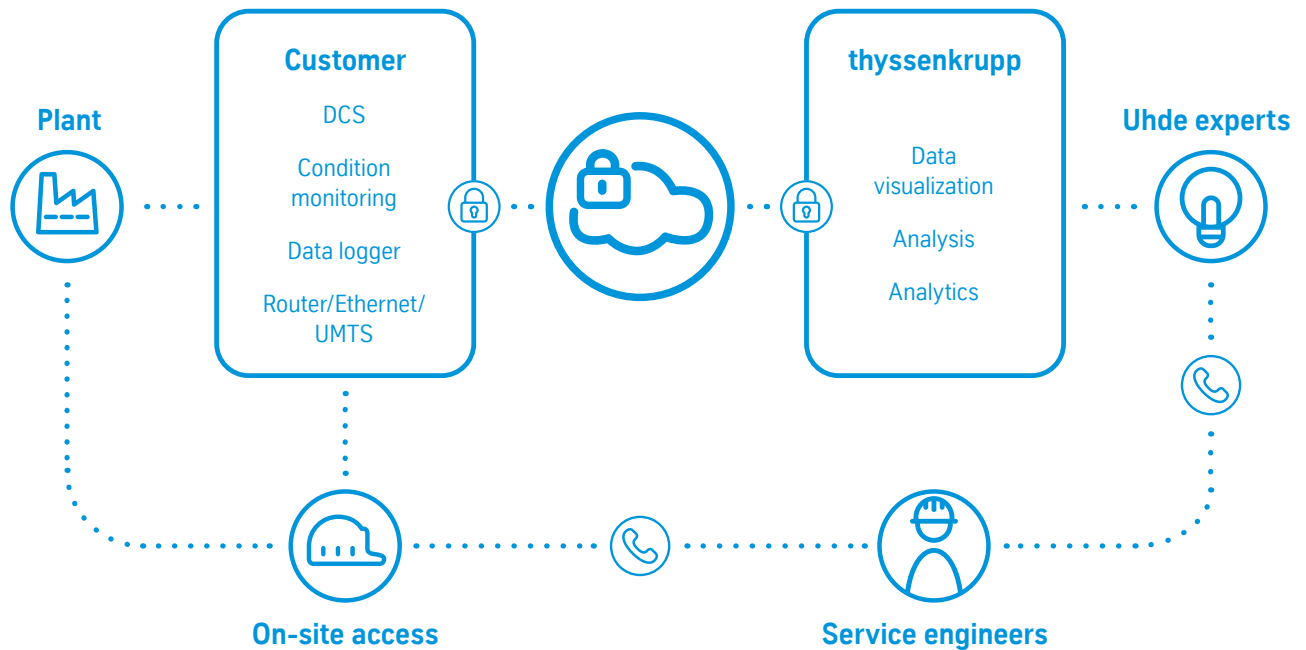
Integrated Asset Management (IAM)

IAM is a structured approach to operate and maintain (O&M) customer assets based on customers' strategies and organizational objectives.

Our IAM portfolio includes four IAM service categories – consulting, technical guidance, maintenance contracts, and operation and maintenance contracts – that are all designed to increase performance and enhance asset lifetime at optimum costs and reduced risks but with different duration and levels of responsibility.

Our services range from operational assistance up to full outsourcing of operations and/or maintenance.

thyssenkrupp Uhde Industrial Internet of Things Cloud



uhde® digital products

Uhde offers a wide range of digital products to support our customers in the operation and maintenance of their plants.

Customers benefit from the combination of Uhde's unique expertise in process technologies and engineering with state-of-the-art data analytics and artificial intelligence (AI) methods that bring together the best of both worlds.

Typically, our services start by enabling data transfer from a process plant to our technology experts, which nowadays is mainly realized via a secure data connection to a cloud. Based on this, our customized performance reports and dashboards give our customers the greatest possible transparency.

Additional products help to further optimize plant performance, such as:

- **Digital twin** is a virtual representation of the real plant based on a process simulation. Process performance of the real plant is continuously compared with this parallel-running simulation to enable the possibilities outlined below.
- **AI assistant** will detect deviations between the process simulation and the real plant and will recommend new process parameters to be used by the operators to optimize plant performance.
- **AI Controller/Advanced Process Control (APC)** represents the next level in process control and will automatically adjust set points for process parameters to optimize production (closed-loop).

➞ For further information about our digital products please visit our website by clicking on the button:

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