

Path and challenges to world scale green ammonia production

Indo-German Energy Forum - Green Hydrogen-based Chemicals

22nd March 2022 | Dr. Christian Renk
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Fertilizer industry



Portfolio

- Ammonia
- Methanol
- Urea
- Hydrogen & nitrates
- Phosphate fertilizers
- Granulation technologies (UFT)
- Biomass gasification (BioTFuel)
- Services

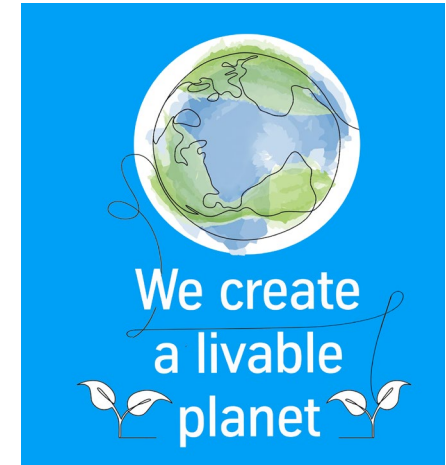


Fertilizer industry & Green Energy



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Clean ammonia is indispensable in a net-zero world

Two fundamental shifts...

...driven by a range of factors

1 Existing uses shift from 'grey' to 'clean' ammonia



Fertilizer & industrial

Regulatory pressure across regions with end of free CO2 allowances in EU ETS most significant

End-consumer demand for climate-friendly food pushes companies to decarbonize value chain

2 New 'green energy' end-uses emerge for which 'clean' ammonia is required



Hydrogen carrier

Spatial mismatch between global H2 demand and supply, whereby key demand regions (i.e., EU, Japan, Korea) have limited local supply options



Maritime fuel

Industry push to decarbonize, as indicated by IMO target of 50% GHG reduction by 2050 and further corroborated by Maersk announcement of 8 ocean going vessels on decarbonized fuel by 2025



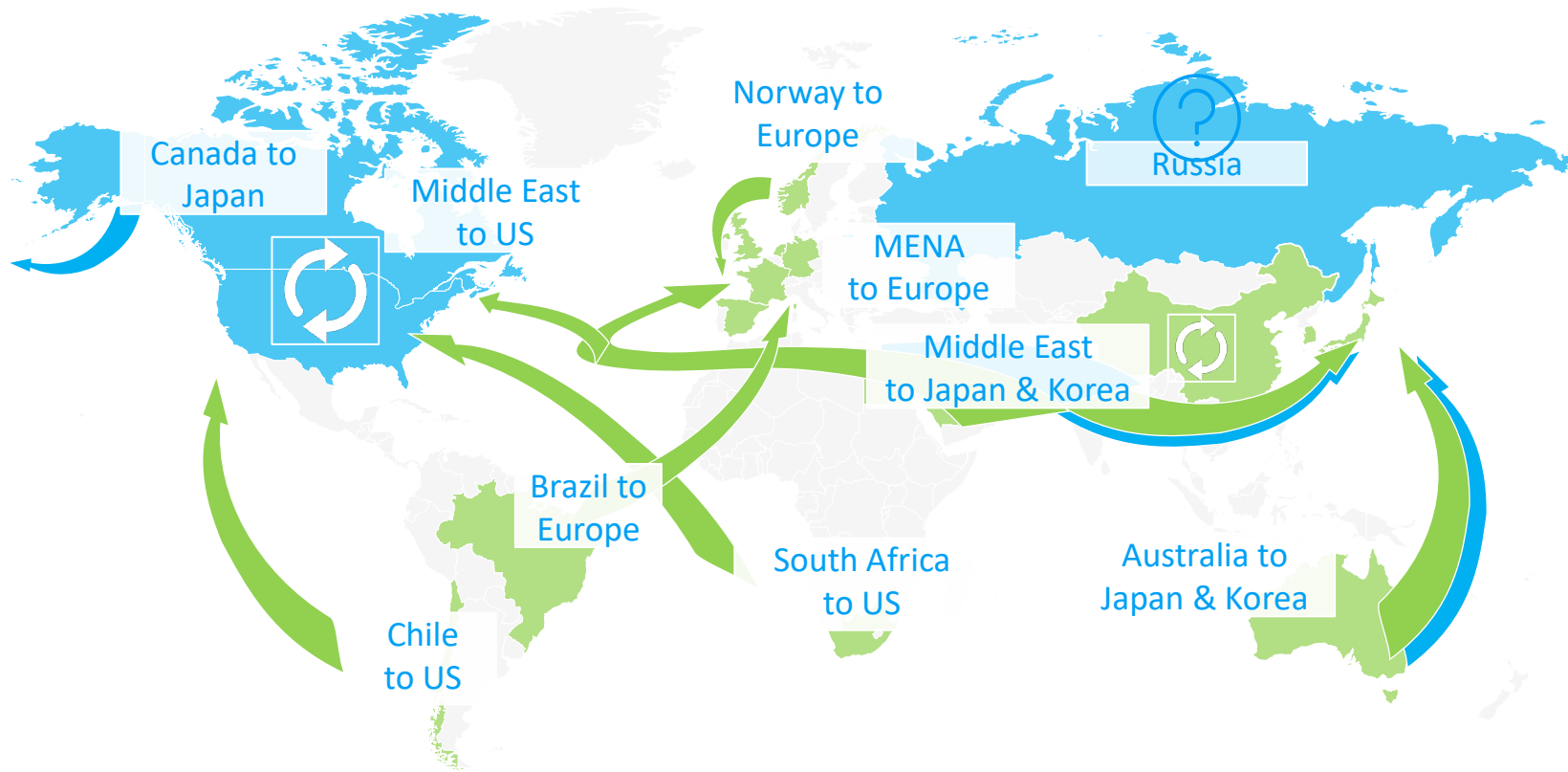
Power generation

Government-mandated quotas in Japan & Korea of co-firing clean ammonia with aim to meet stringent decarb targets while utilizing existing coal assets

The ammonia market is undergoing a fundamental shift, opening up new sectors and increasing the need for 'clean ammonia'

Hydrogen carrier: as H₂ scales, a global shipping network is going to emerge due to a spatial mismatch between demand and supply

Emerging global transport routes for transportation of hydrogen



New paths bring new challenges...infrastructure, ships, utilization, markets...

Development of ammonia market from only fertilizer base chemical to fertilizer plus energy carrier

We are the best partner for both business

2 mln tons p.a.

installed ammonia capacity add-on

Fossil fuel based

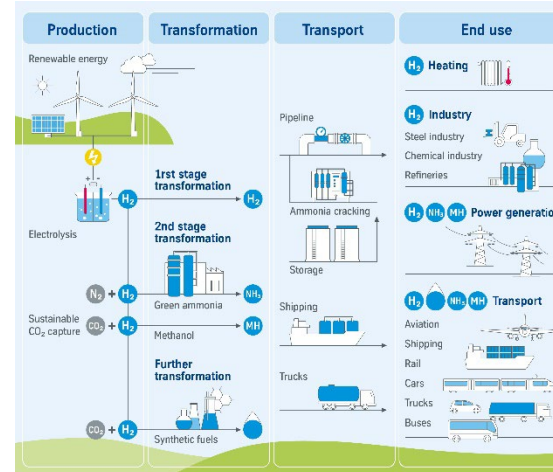
grey ammonia plants

600 to 3,300mtpd

ammonia capacity range

Tailor-made

Design and design requirements



>8 mln tons p.a.

installed ammonia capacity add-on expected

RE based

for ammonia as maritime fuel and as energy carrier

50 to 5,000mtpd

ammonia capacity range

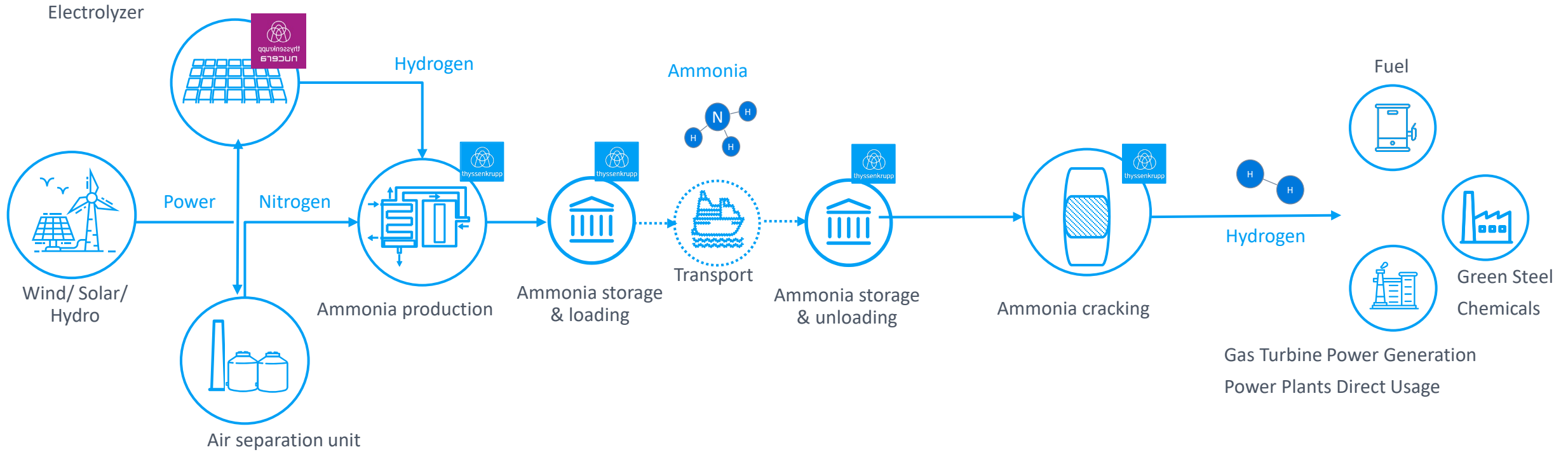
Standardized

Design and design requirements



Green Ammonia as Energy carrier – Set up along the whole energy supply chain

The complete solution from one source



Ammonia usage for energy transport, utilization as energy carrier or re-conversion to hydrogen



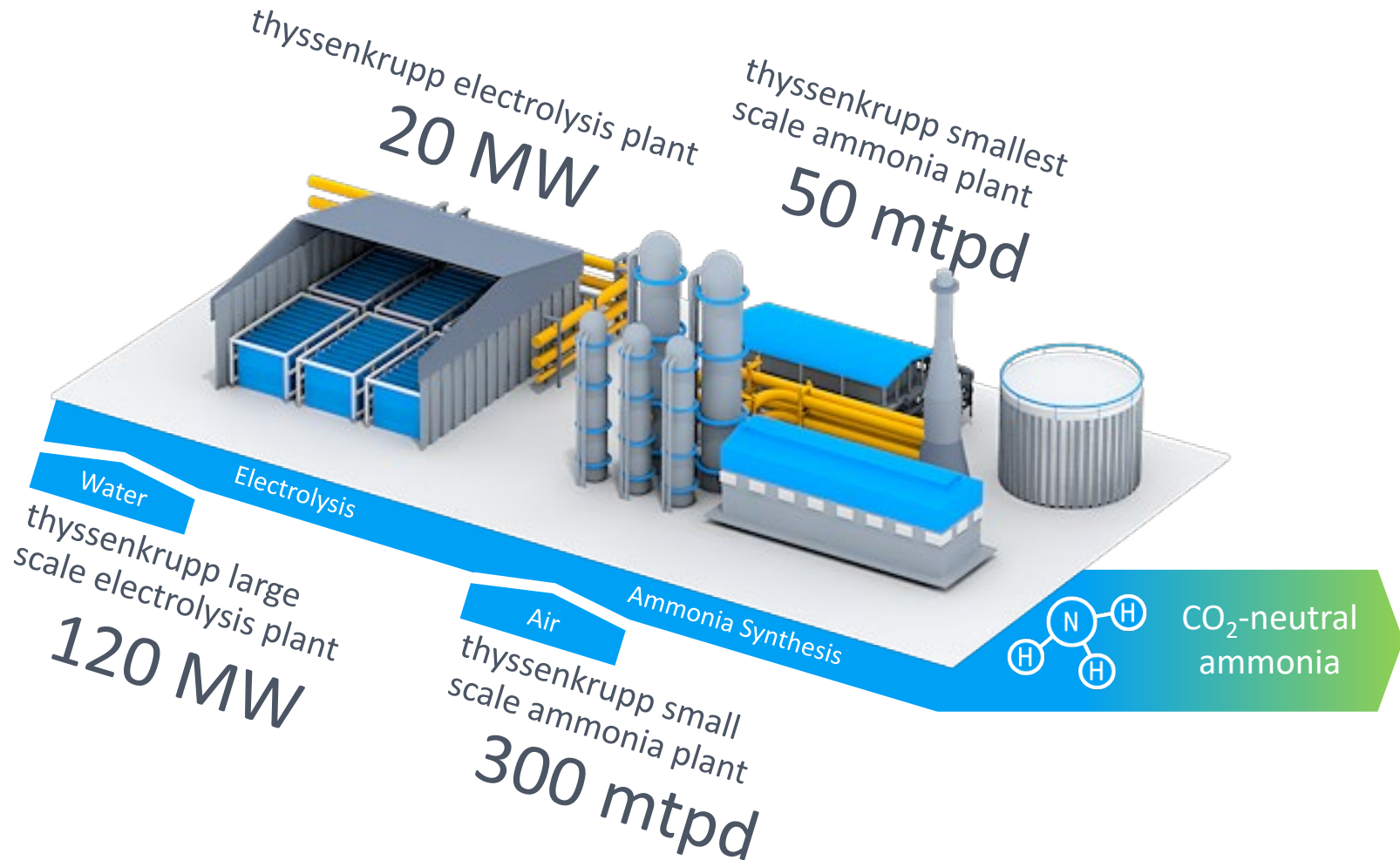
Introducing Green Ammonia by thyssenkrupp

2 worldwide leading processes

1 holistic solution

0 CO₂ emissions¹

¹ depending on E-power source

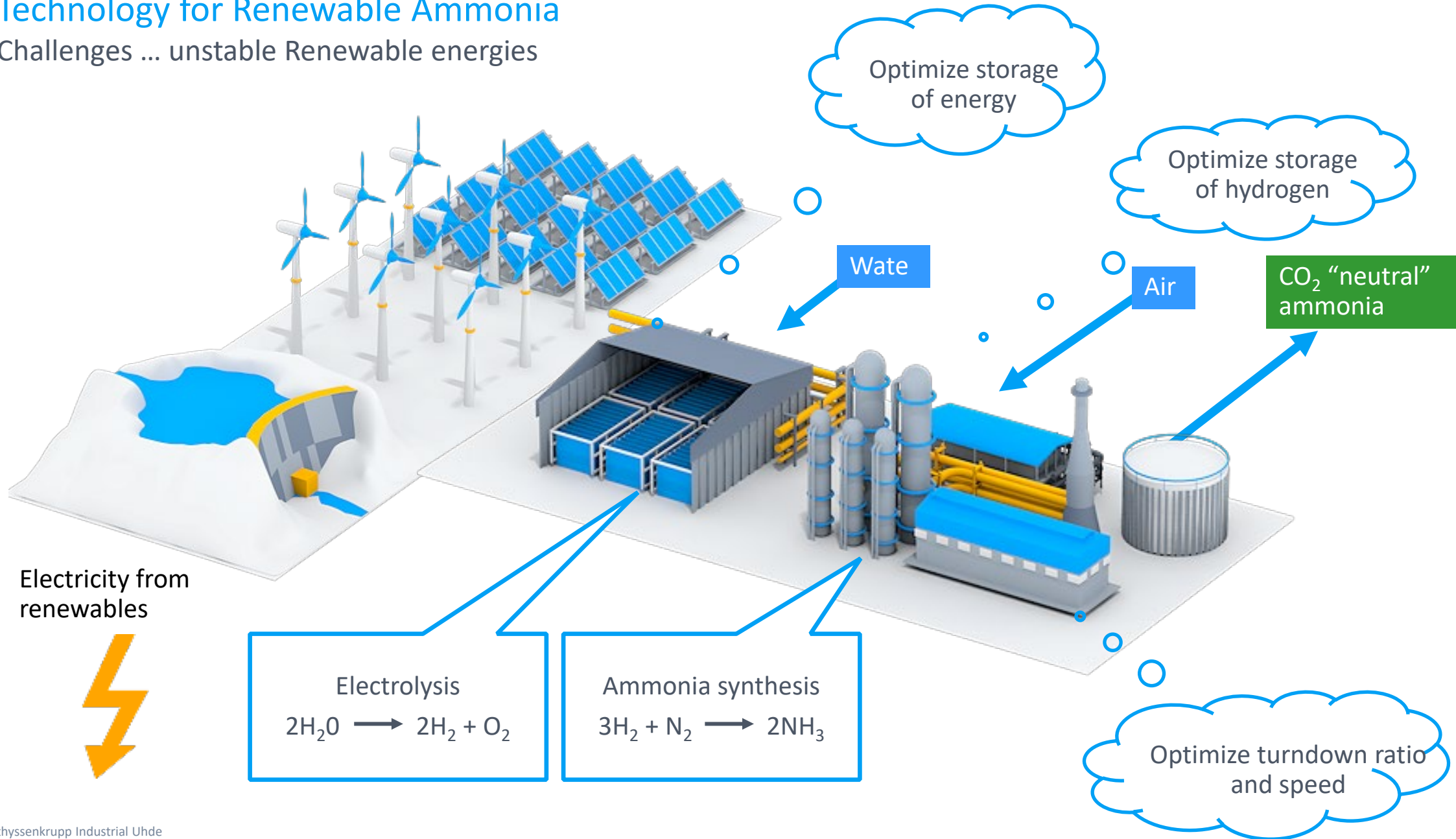


20/50 and 120/300 being fully modularized and standardized ready for the market, tailor-made up to 5000mtpd



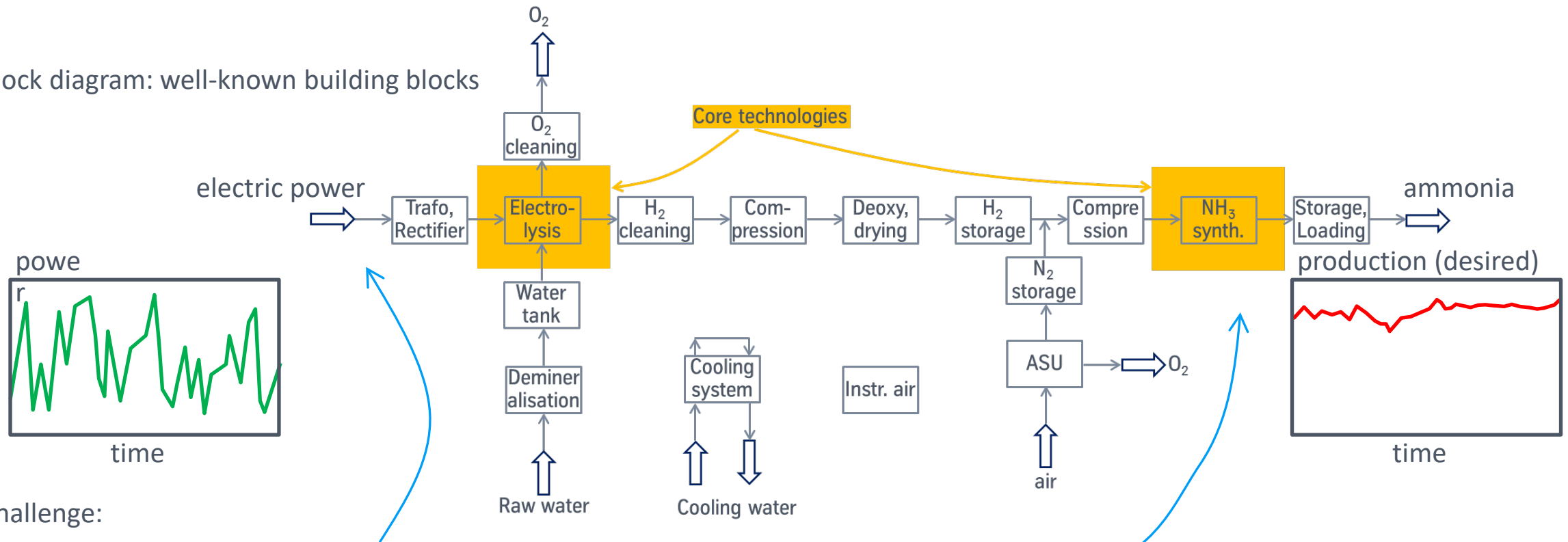
Technology for Renewable Ammonia

Challenges ... unstable Renewable energies



Ammonia Plants based on Green Hydrogen

Block diagram: well-known building blocks



Challenge:

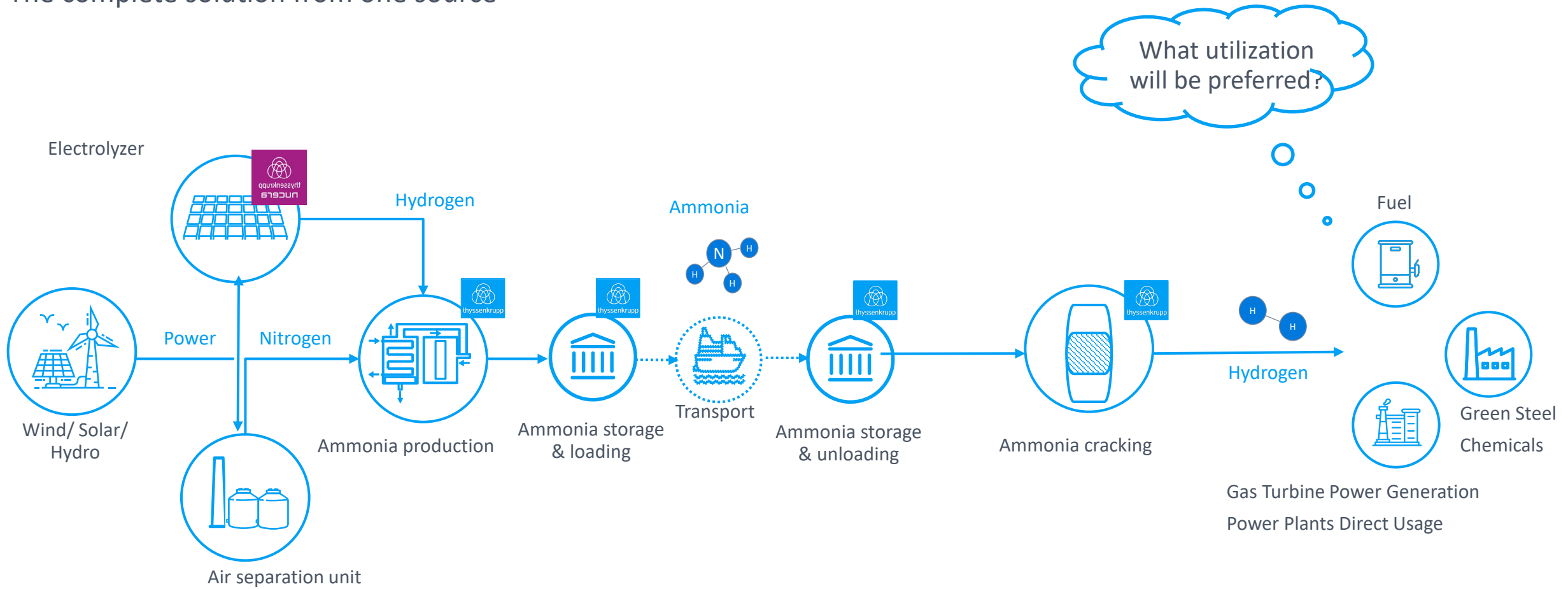
- Fluctuating availability of electric power
- Stable operation of ammonia synthesis desired

Solution required to match fluctuating availability of energy with stable operation



Green Ammonia as Energy carrier – Set up along the whole energy supply chain

The complete solution from one source



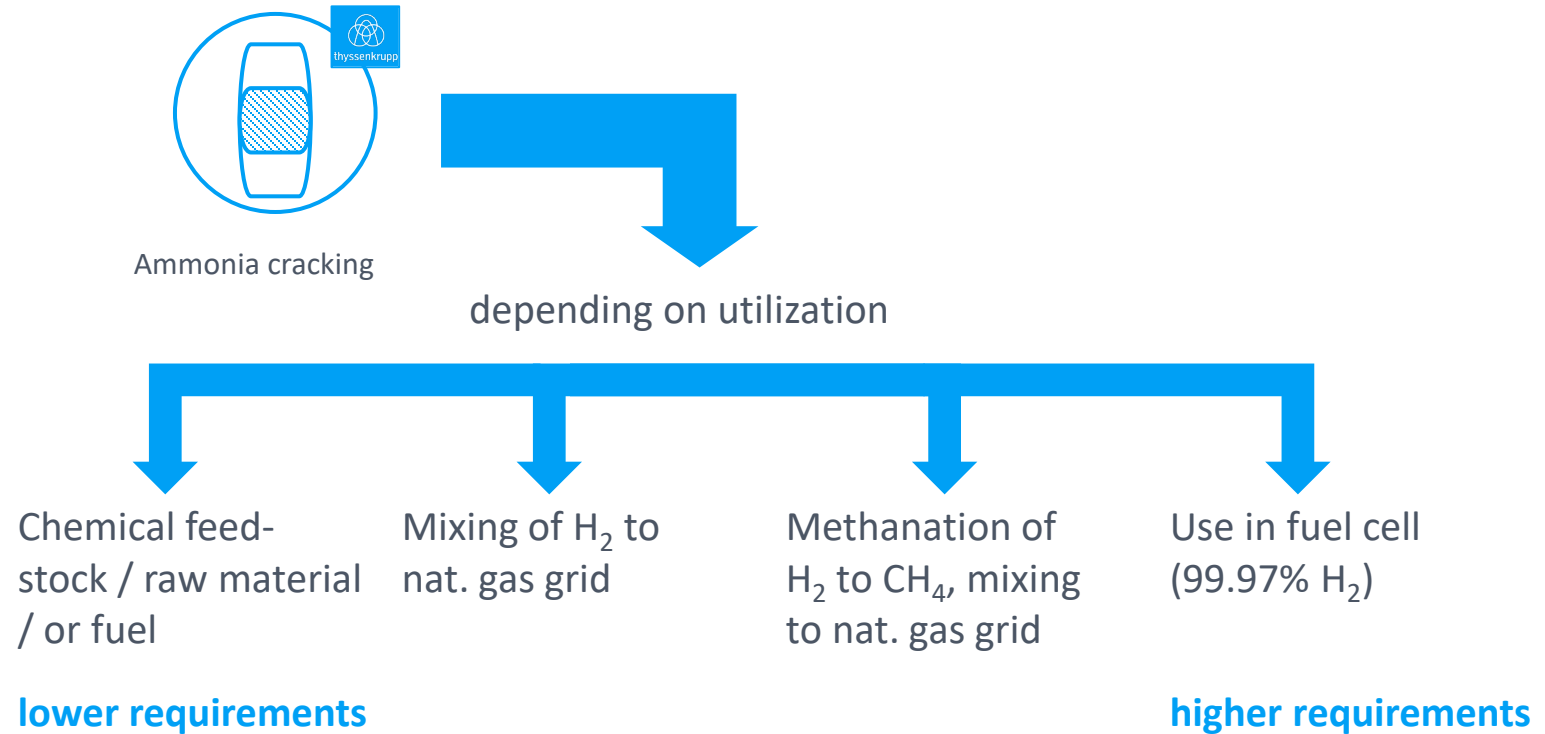
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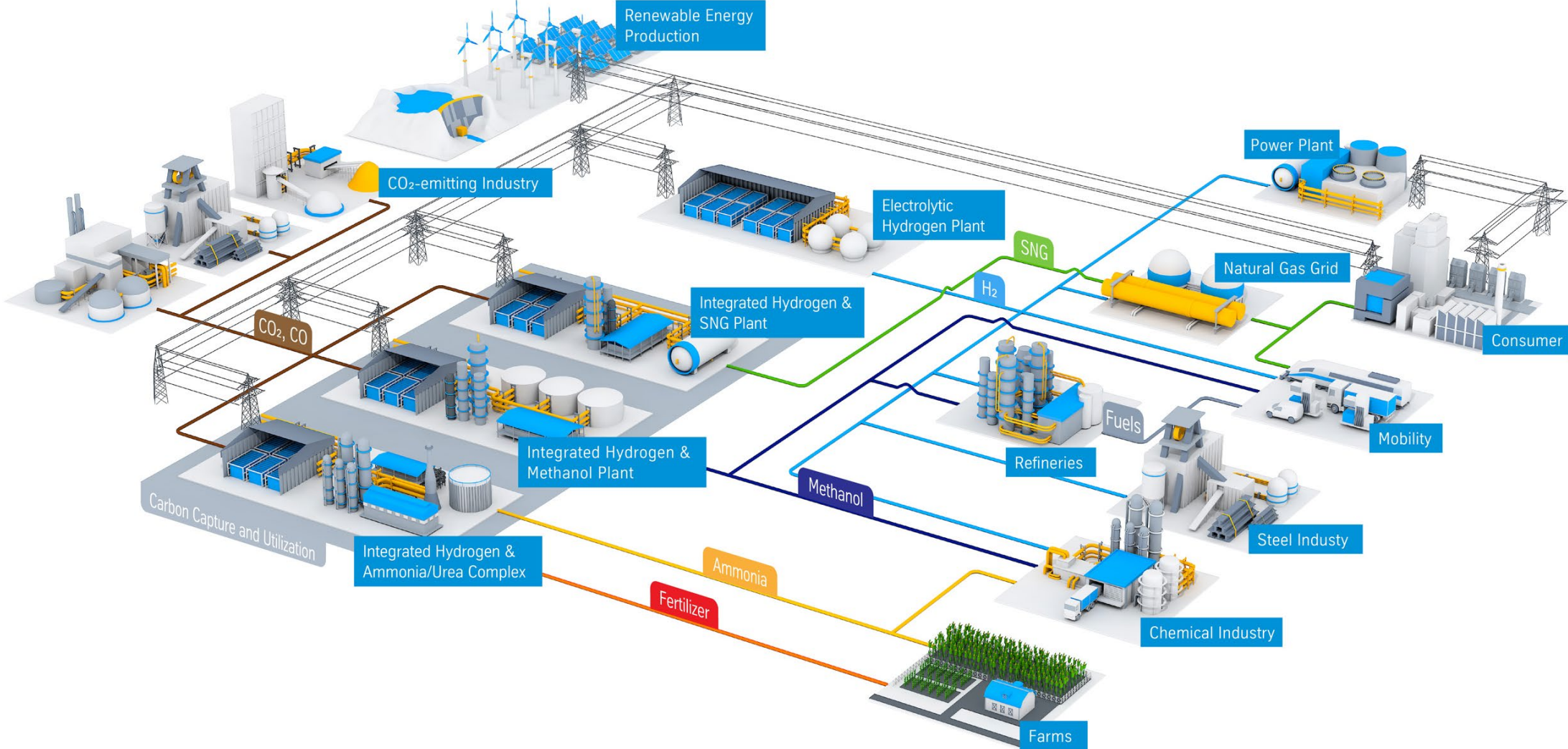
Ammonia Decomposition (Hydrogen from Ammonia)

Paths and challenges

- Heat source (should be “green”), also electrical energy possible
- Product purity with respect to residual NH_3 and N_2 content



Many paths develop and many challenges arise thereby...



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