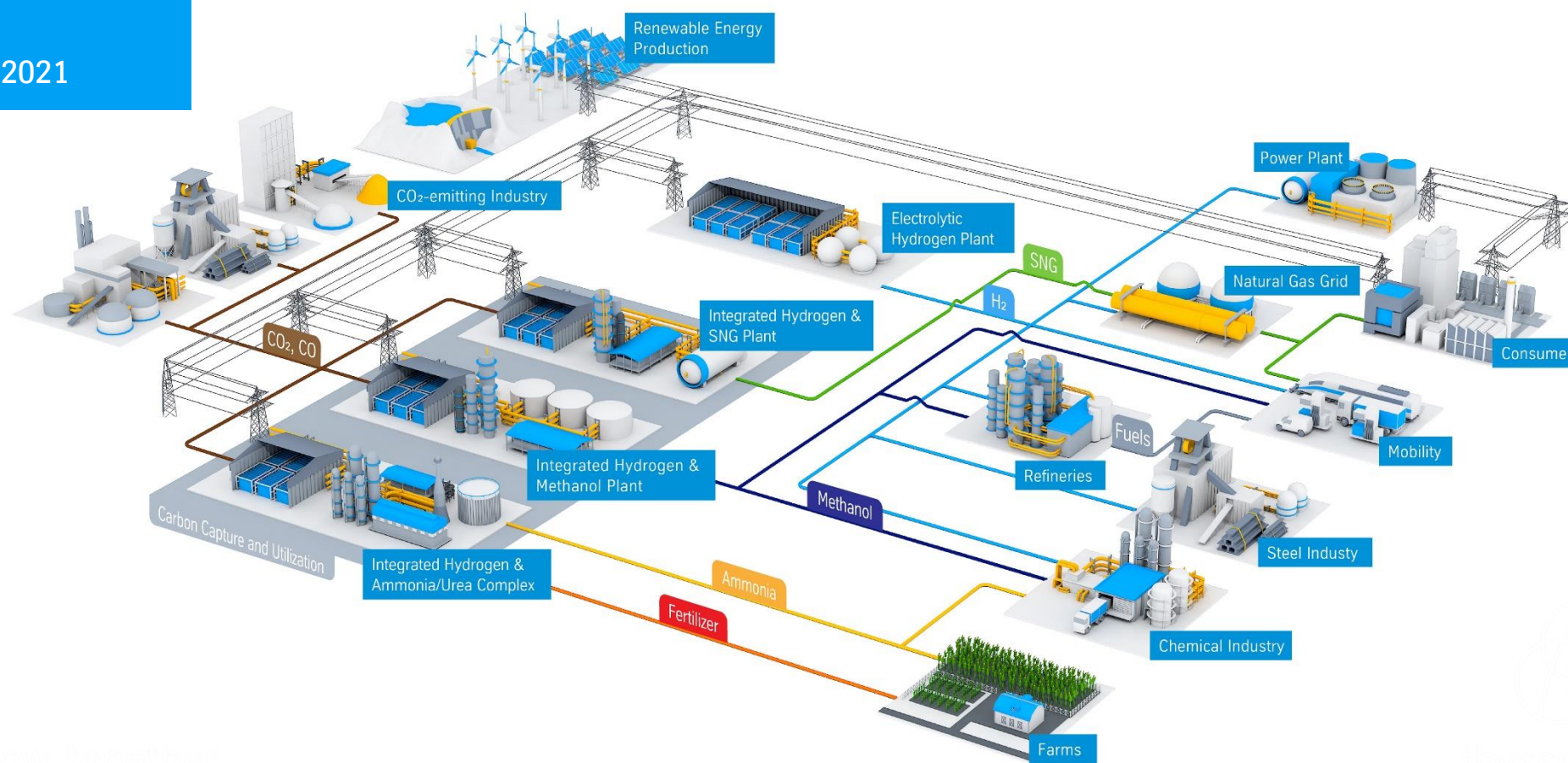


# Flexible green ammonia synthesis and

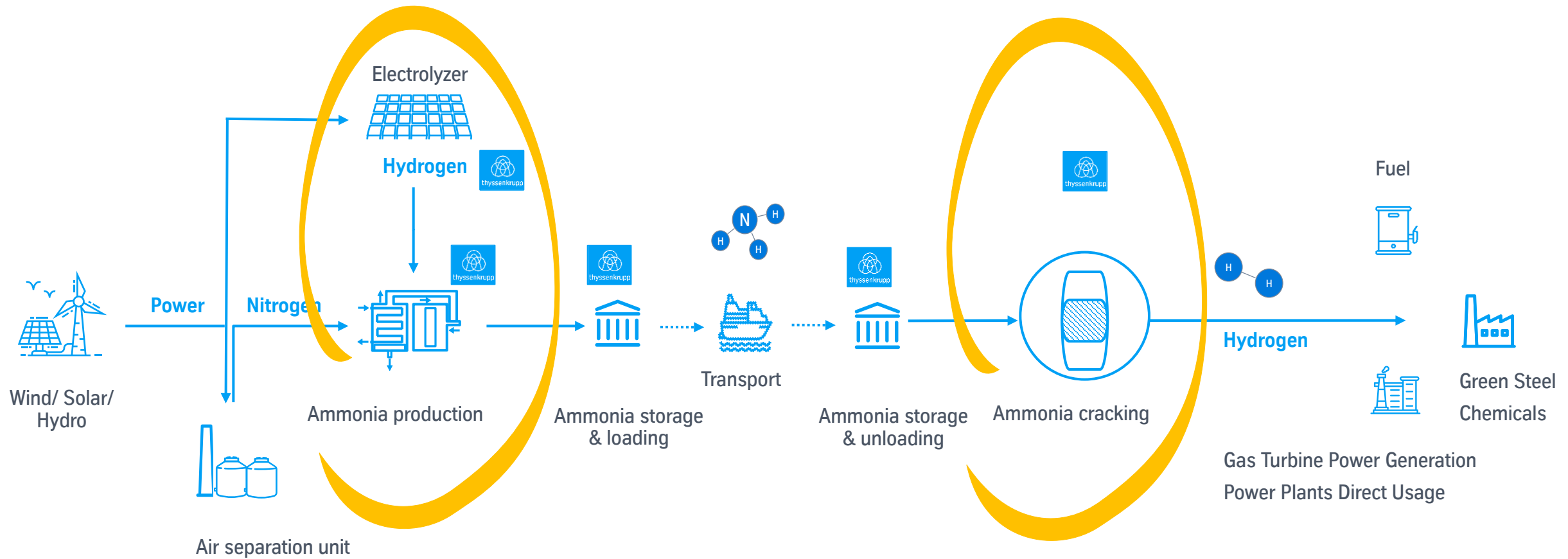
# Large scale ammonia cracking technology by Uhde®

AEA Conference  
thyssenkrupp Uhde  
Karan Bagga | August 2021



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

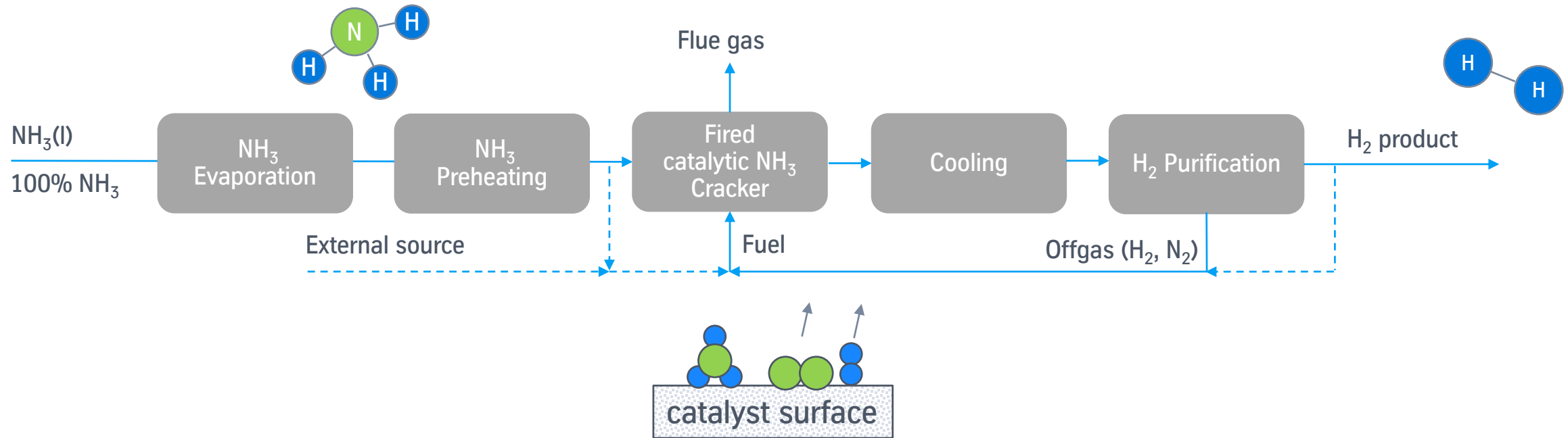
The complete solution from one source



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



# Ammonia cracking based on Uhde® proprietary equipment, high hydrogen yield and adaptable to user requirements



Suitable for large scale applications



Overall hydrogen recovery of ~78%,  
after taking into account all fuel

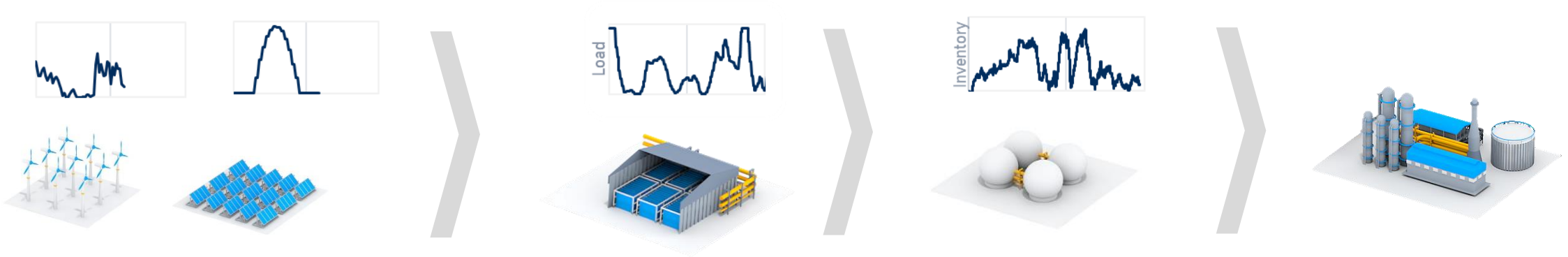
With 1 kg  $\text{NH}_3$  0.13 kg  $\text{H}_2$  as final product



Purities of 99.96% or higher are  
possible

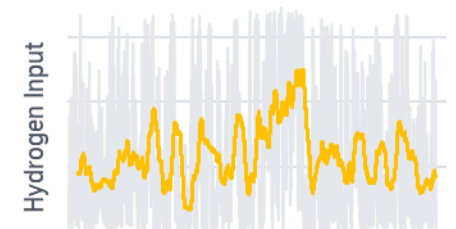
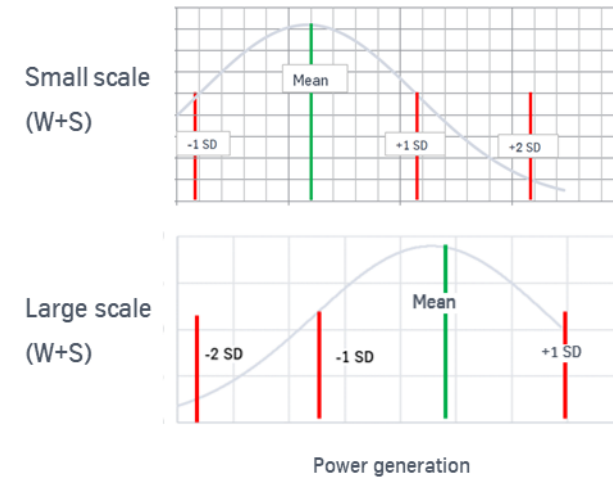
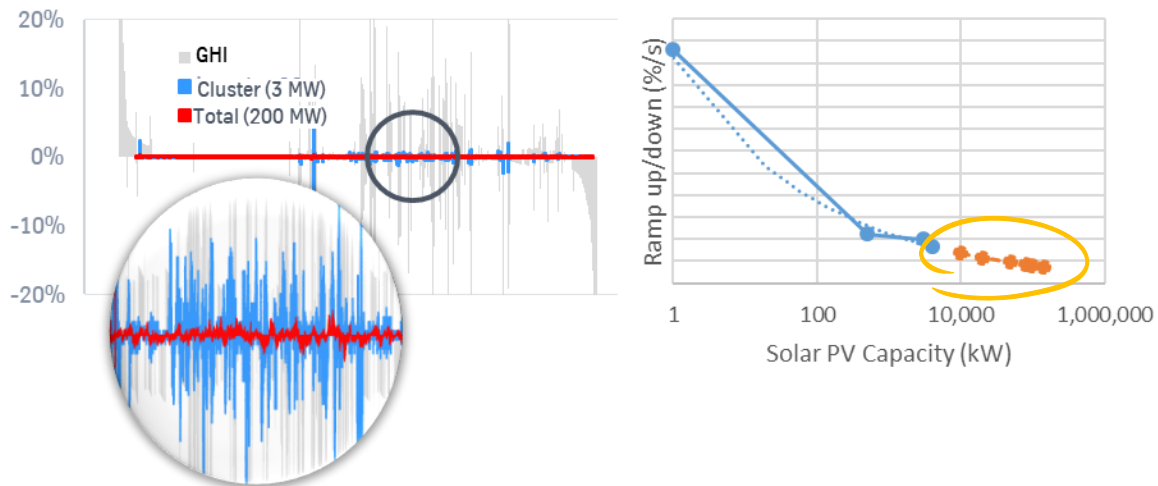


# An techno-economically robust solution is a matter of minimising the entropy in the system



**System:** Right scale & energy mix, avoid over-compensation

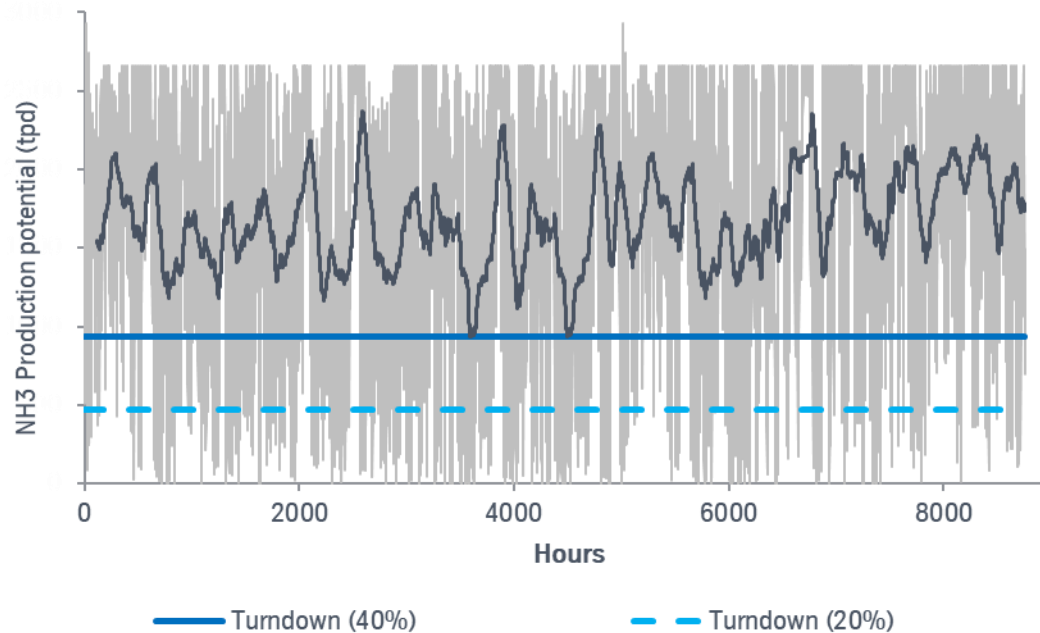
**Technology:** Flexible, robust and efficient



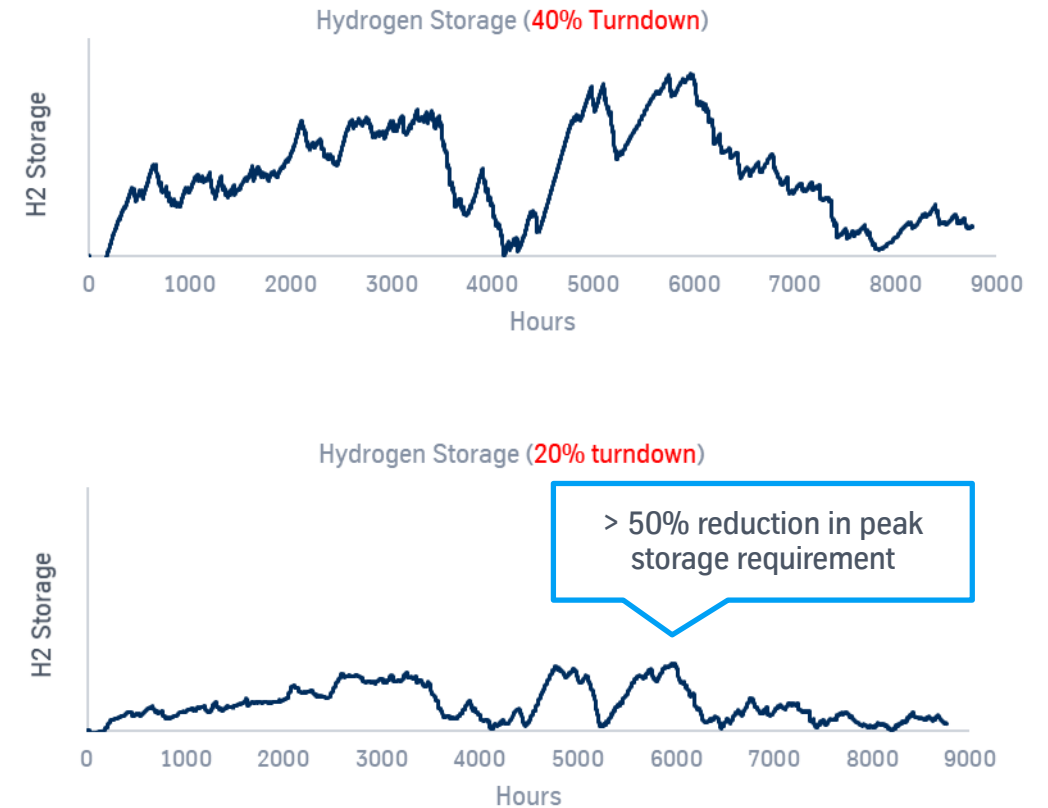
# 1. Deep turndown - key to minimising hydrogen storage

## Synthesis Loop Turndown Performance

- Limited by machinery performance and reaction parameters



## Hydrogen Storage Requirements

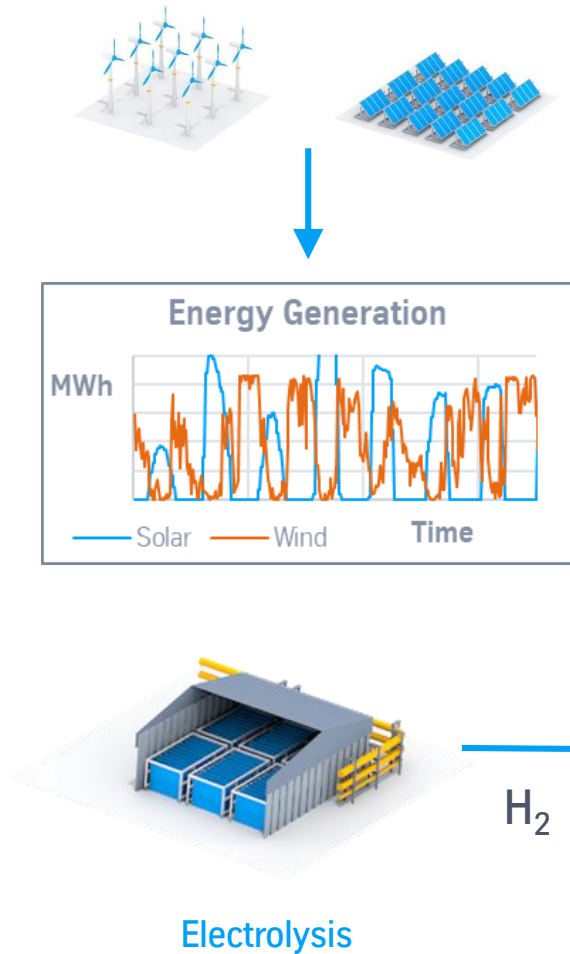


Deep turndown and dynamic response enables lower CAPEX, however ultimately it is a matter of Total Cost of Ownership (TCO)



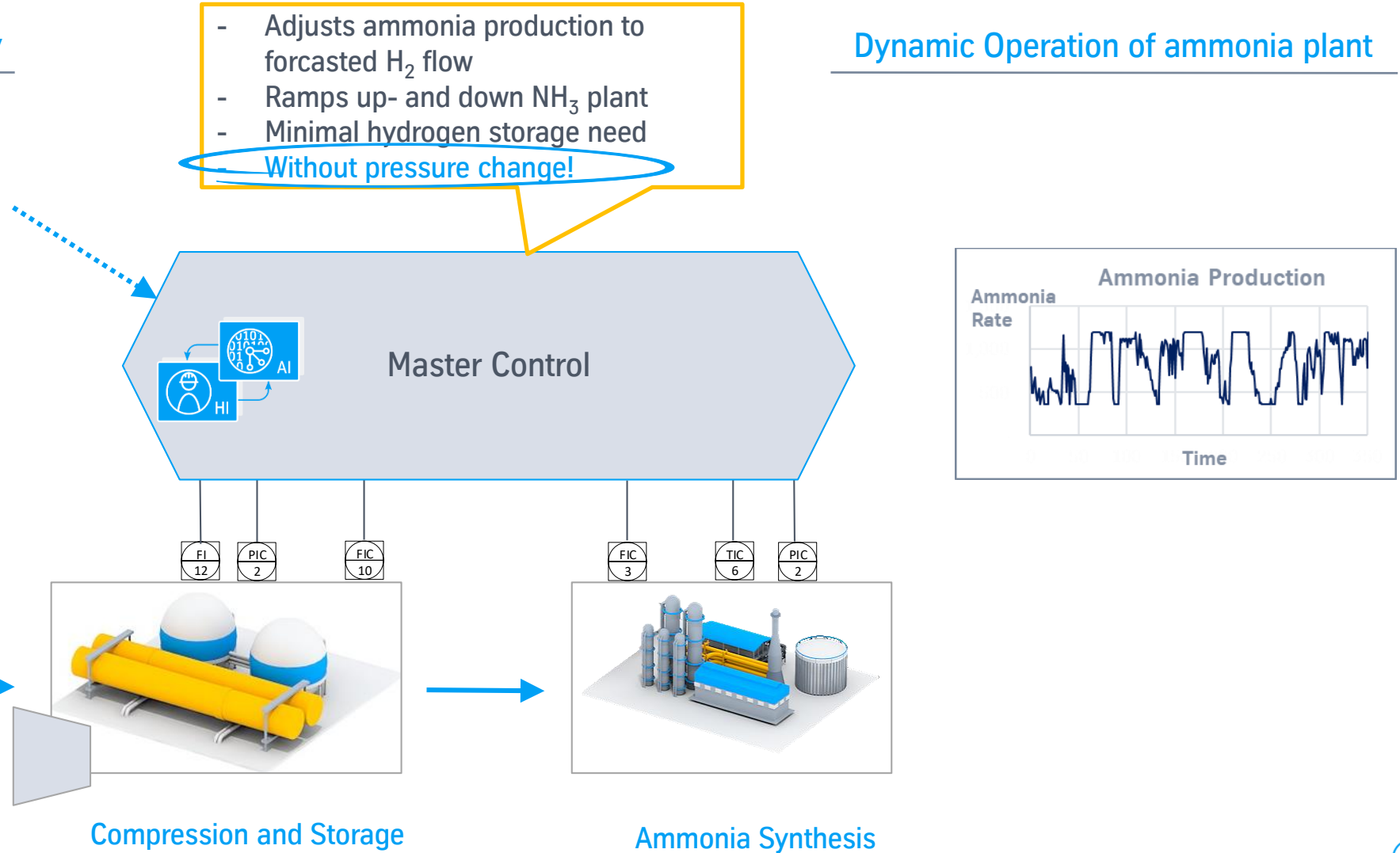
## 2. Dynamic performance - Uhde® high flexibility ammonia synthesis, based on advanced digital solutions, for large scale direct coupling with renewables

### Fluctuation of renewable energy



- Adjusts ammonia production to forecasted  $H_2$  flow
  - Ramps up- and down  $NH_3$  plant
  - Minimal hydrogen storage need
- Without pressure change!**

### Dynamic Operation of ammonia plant



engineering.  
tomorrow.  
together.

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