

Uhde innovate 2024

Different paths to renewable methanol utilizing green methanol technology

06.06.2024 | Dr. Alexander Schulz
thyssenkrupp Uhde

engineering.tomorrow.together.



thyssenkrupp

A close-up, low-angle shot of a white offshore wind turbine, showing its nacelle and part of a blade. In the background, another wind turbine is visible against a clear blue sky and the ocean.

Topics

- 1 Introduction
- 2 Power-to-Methanol
- 3 Biomass-to-Methanol
- 4 Hydrogen Innovation Development Center/HIDC II
- 5 Summary



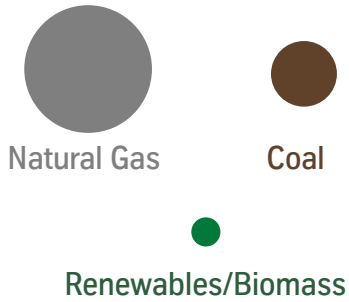
1. Methanol General

Feedstock and Applications

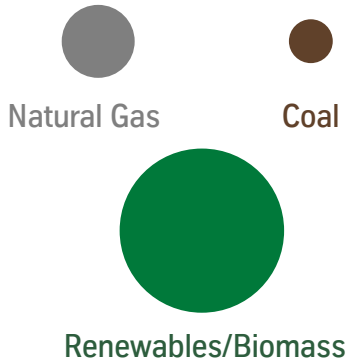
Methanol is a clear liquid organic chemical and the simplest alcohol.

Feedstock

Today



Future



Applications

Derivative Chemicals

- Acetic Acid
- Silicone
- Olefins/Aromatics
- Methyl Methacrylate (MMA)
- Formaldehyhde
- ...



Appliances



Automotives



Pharma



Construction



Electronics



Paints

Fuels

- Gasoline Blending/Substitute
- Diesel Blending/Substitute
- Bio-Diesel Production
- Methyl tert-butyl ether (MTBE)
- Dimethyl-ether (displacing LPG)
- Sustainable Aviation Fuel (SAF)
- Marine Fuel



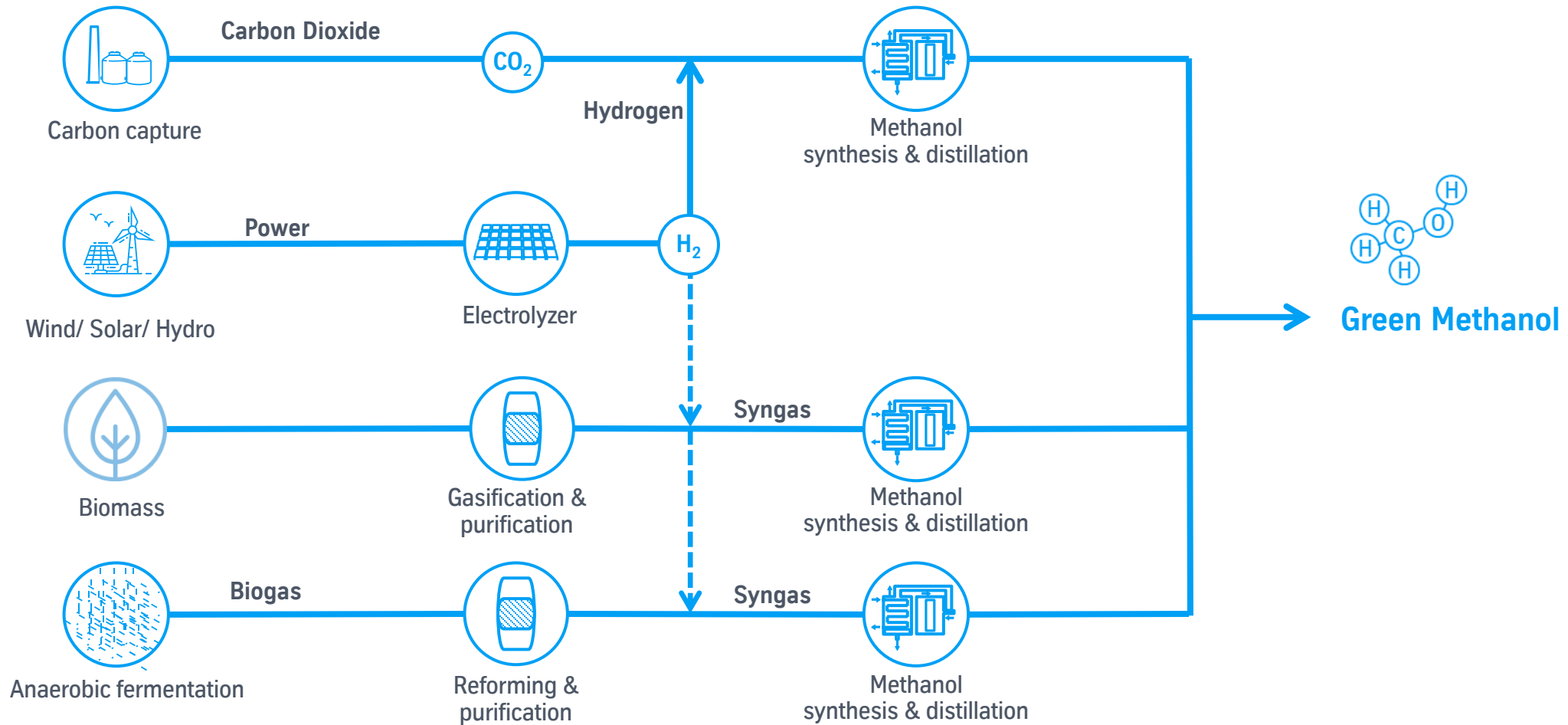
Fuel



Marine



1. Renewable Methanol Production - Overview



Different promising paths to renewable methanol



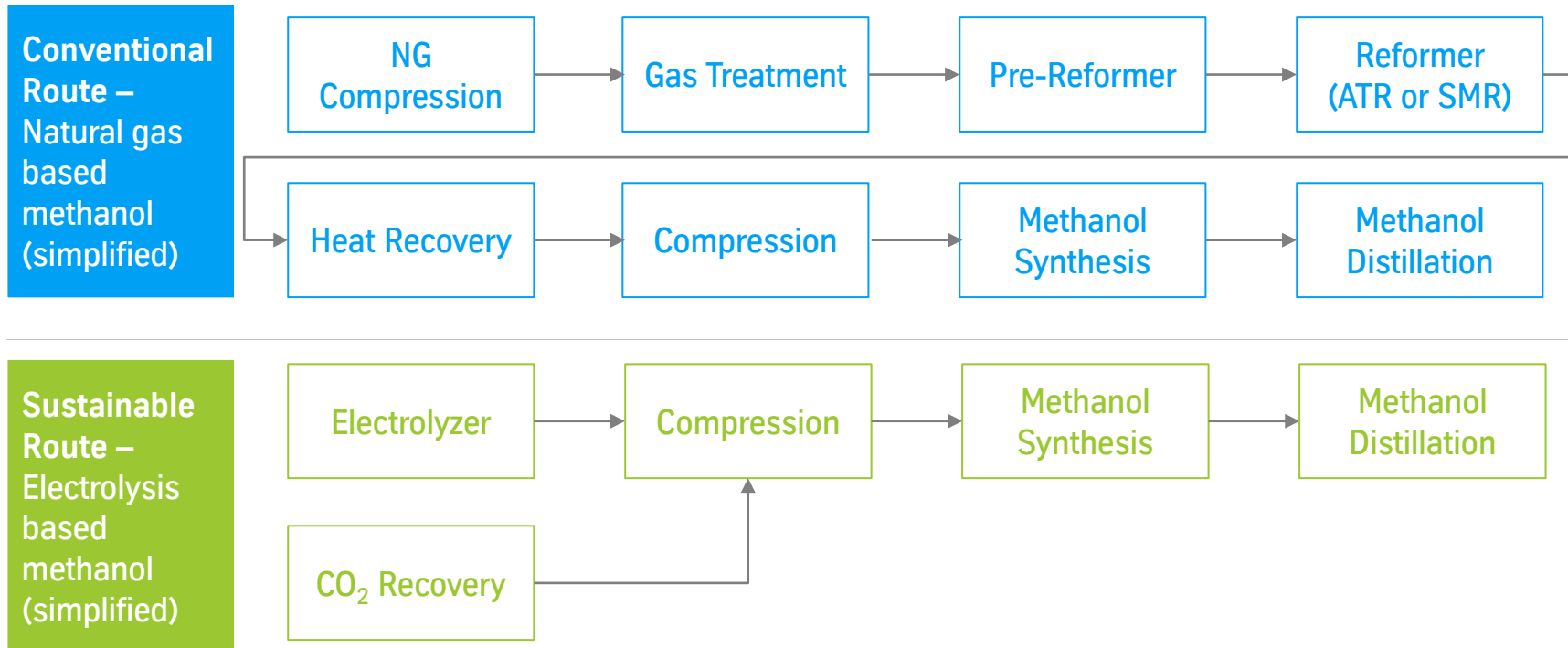
2. Power-to-Methanol

Conventional vs Electricity-based methanol production



Experience
since 1964

Process description



Key points

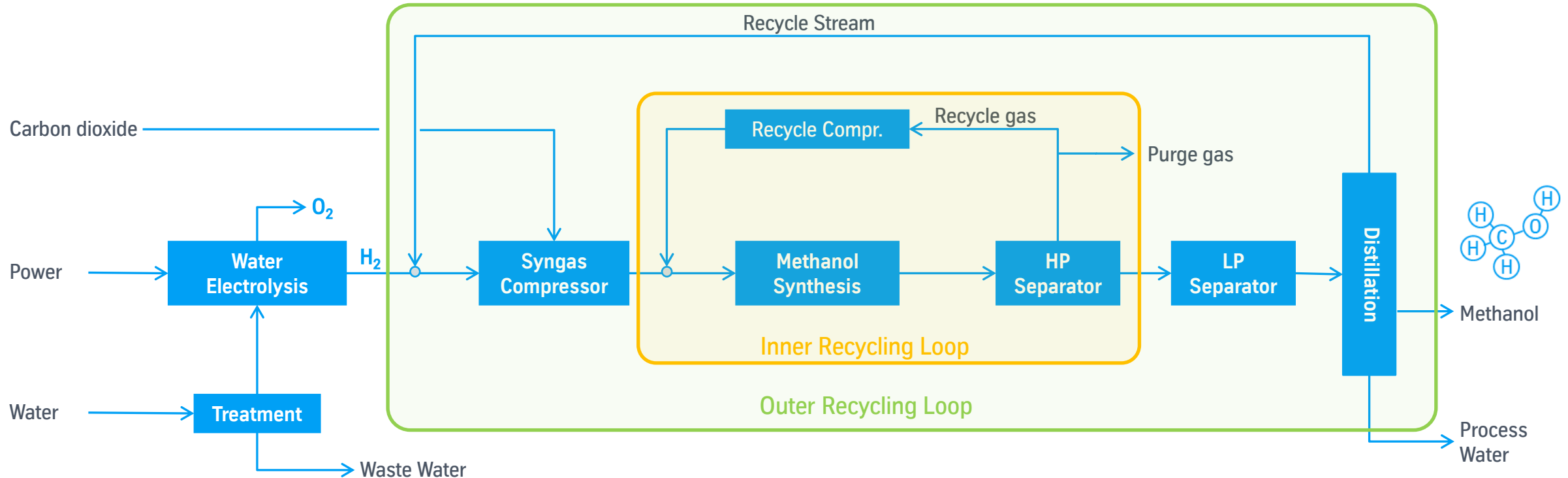
- Other than the differences in H₂ source, the only major difference is the need for a CO₂ source or CO₂ recovery unit.
- Sustainable route is less complex and operates under lower severity conditions, eliminating the need for high temperature and pressure to produce syngas from NG.
- Green methanol technology builds on the proven know-how and extensive experience from conventional methanol production, ensuring reliability and credibility with only refined differences

tk Uhde offers world-class technologies for both the conventional and sustainable route to methanol



2. Power-to-Methanol – uhde® Green Methanol

Advanced and patented plant configuration optimized for renewable methanol



$$\eta_{CO_2} = \frac{CO_2 \text{ in methanol}}{CO_2 \text{ feed}} \sim 99.5\%$$

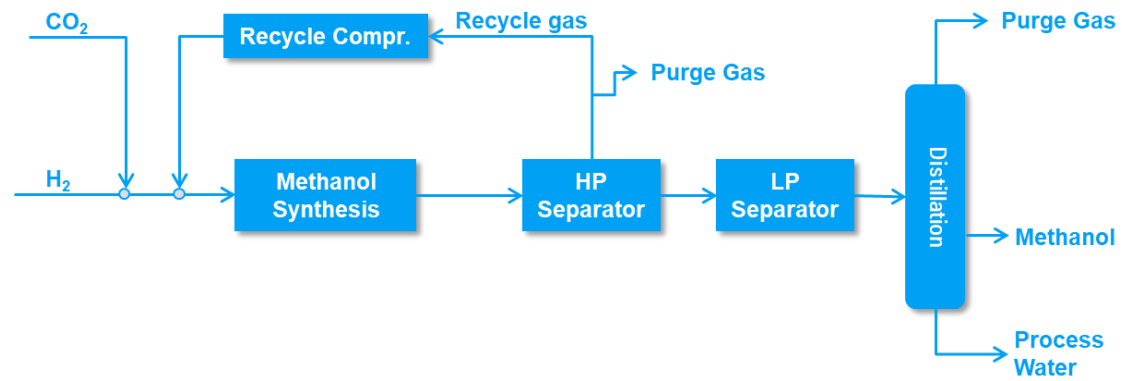
Our advanced technology for industrial scale renewable methanol plants shows best H_2 and CO_2 efficiencies



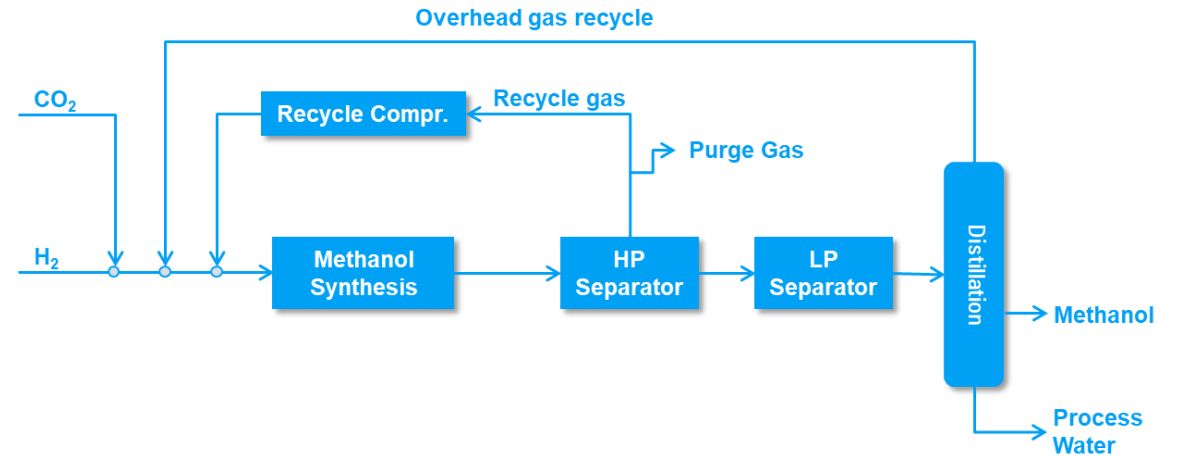
2. Power-to-Methanol – uhde® Green Methanol

Comparison w/ and w/o overhead gas recycle

Standard configuration w/o overhead gas recycle



uhde® Green Methanol with overhead gas recycle



uhde® Green Methanol compared to standard configuration

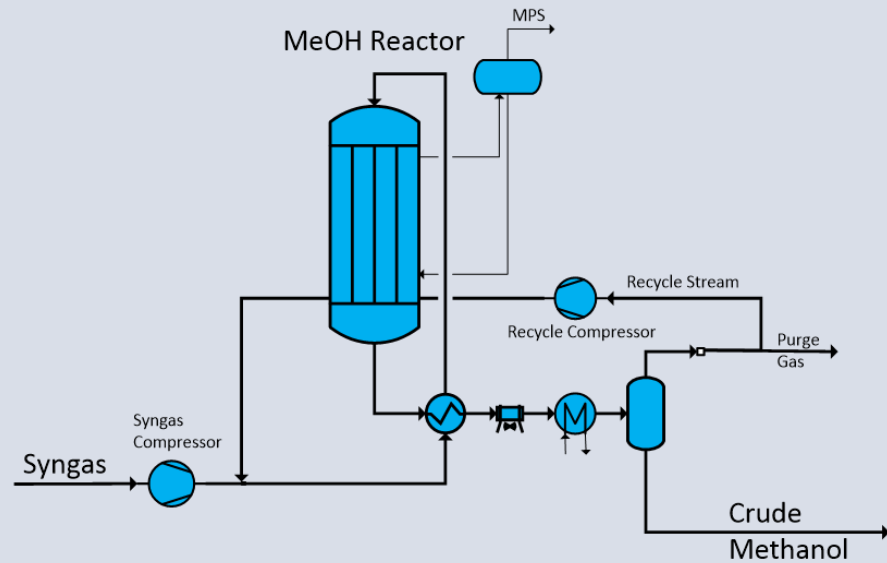
H ₂ consumption	up to 1.0 % lower
CO ₂ consumption	up to 2.5 % lower
Purge Gas	smaller flow by ~ 80%

With uhde® Green Methanol not only H₂ and CO₂ can be saved, but also CO₂ emissions can be reduced significantly

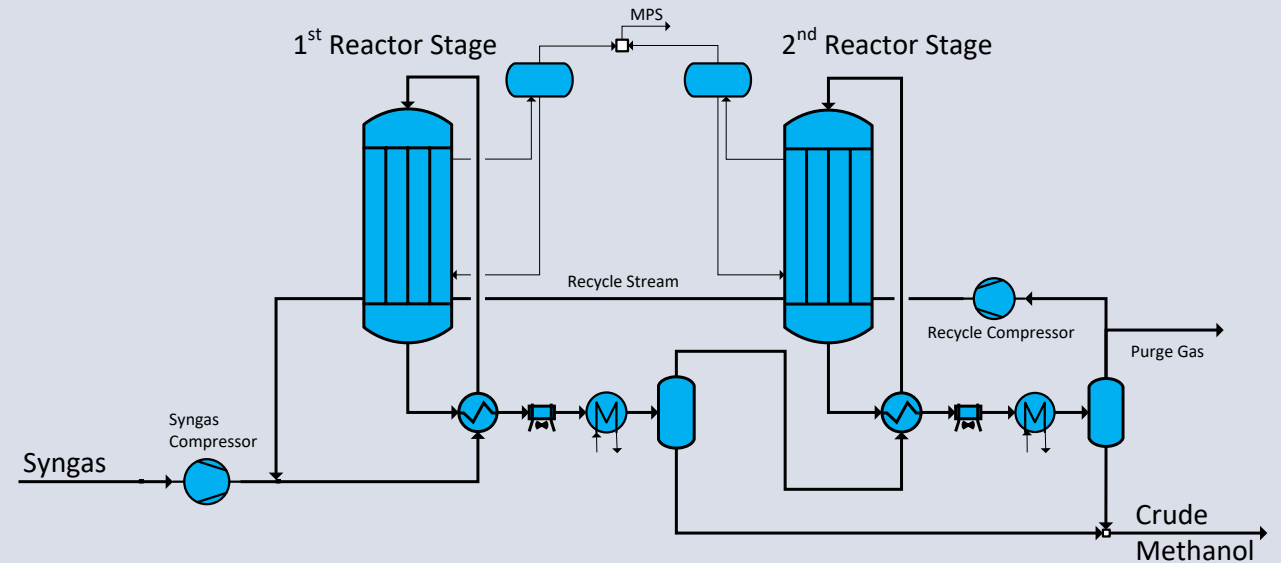


2. Power-to-Methanol – uhde® Green Methanol

Methanol Synthesis – Isothermal Reactor



One-stage reactor system for small/medium size methanol plants

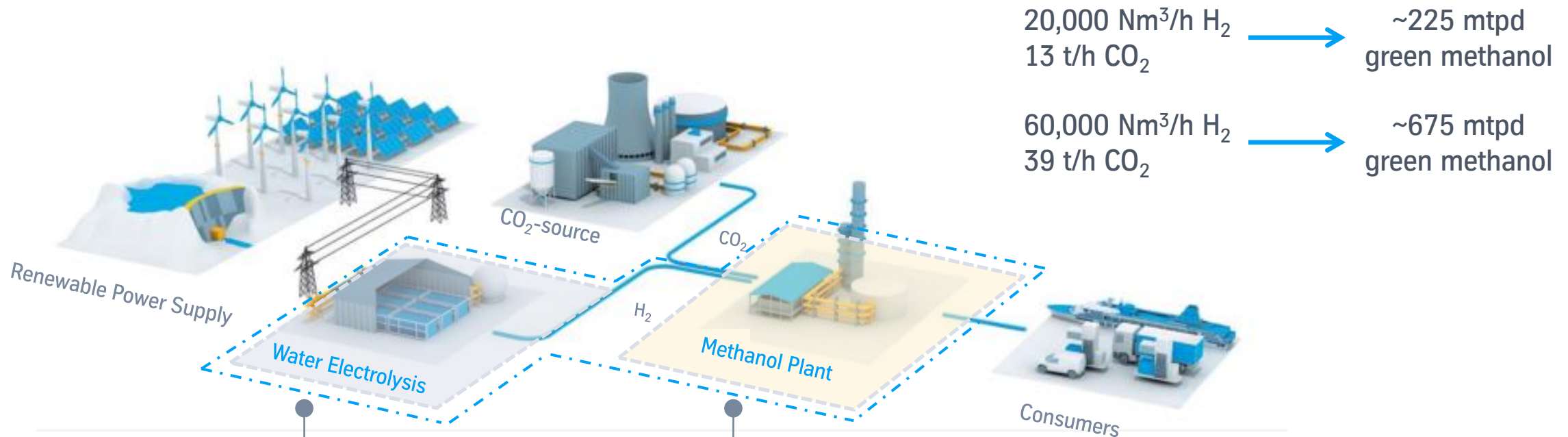


Two-stage reactor system with intermediate condensation for larger capacities

State-of-the-art isothermal reactor – same reactor type as in conventional methanol plants

2. Power-to-Methanol – uhde® Green Methanol

Typical performance data



Electrolysis



Methanol synthesis



Specific consumption figures (SOR)

Electric power: ~ 10.6 MWh/t_{CH₃OH}

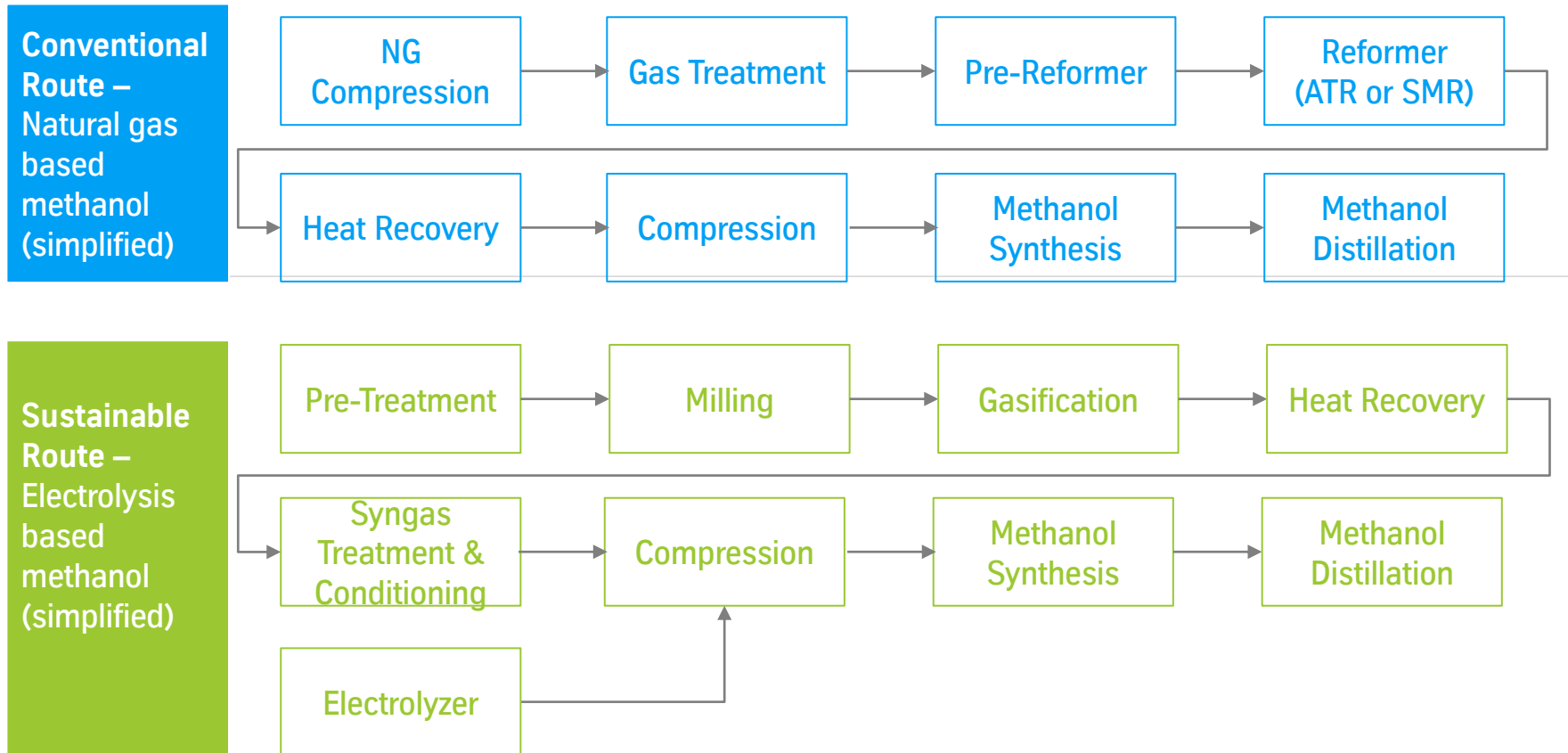
CO₂: ~ 1.38 tons/t_{CH₃OH}



3. Biomass-to-Methanol – uhde® Green Methanol

Conventional vs Biomass- and Electricity-based methanol production

Process description



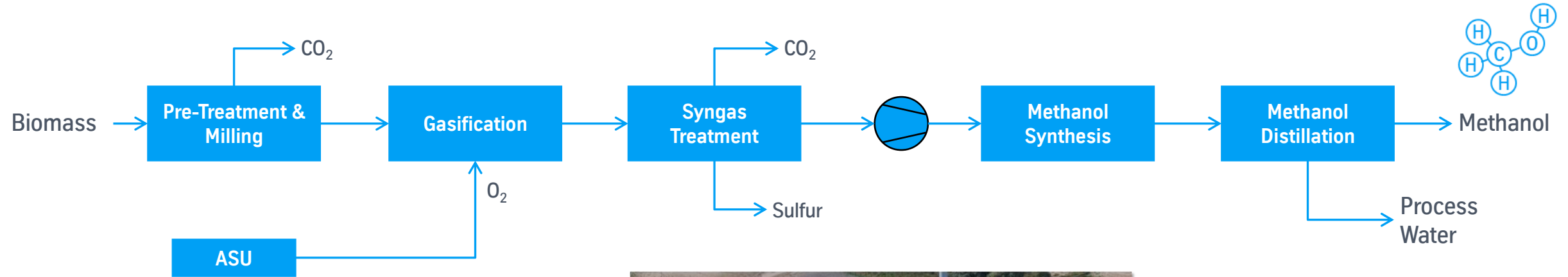
Key points

- Biomass provides biogenic carbon and biogenic hydrogen.
- With the combination of biomass gasification and water electrolysis most of the biogenic carbon can be used and converted to green methanol.
- Uhde has an extensive knowledge in the three fields of gasification, electrolysis and methanol synthesis.



3. Biomass-to-Methanol – uhde® Green Methanol

Standard plant configuration with CO₂ removal



PROJECT **BioTfuel**

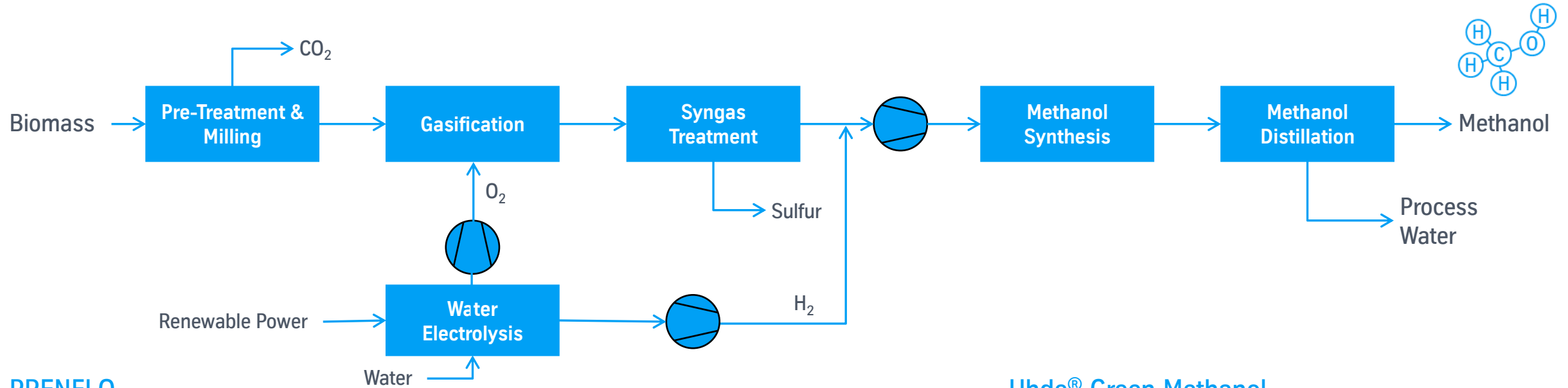
BtL demonstration plant, Dunkirk,
France, 15 MW_{th}

uhde® entrained flow gasification is well suited for conversion of biomass as demonstrated in > 1,000 h operation time in BioTfuel-project



3. Biomass-to-Methanol – uhde® Green Methanol

Advanced plant configuration with renewable hydrogen



PRENFLO

- Referenced technology
- Proven & robust gasifier
- High carbon conversion rate & throughput
- Multiple burner concept
- Feedstock flexibility
- Water cooled membrane wall

Uhde® Green Methanol

- High level of process integration leading to low CAPEX & OPEX
- High efficiency process chain
- Various product grades possible
- Flexibility between CO₂ & biomass as feedstock

With this plant configuration, the biogenic carbon can be almost completely converted into methanol.



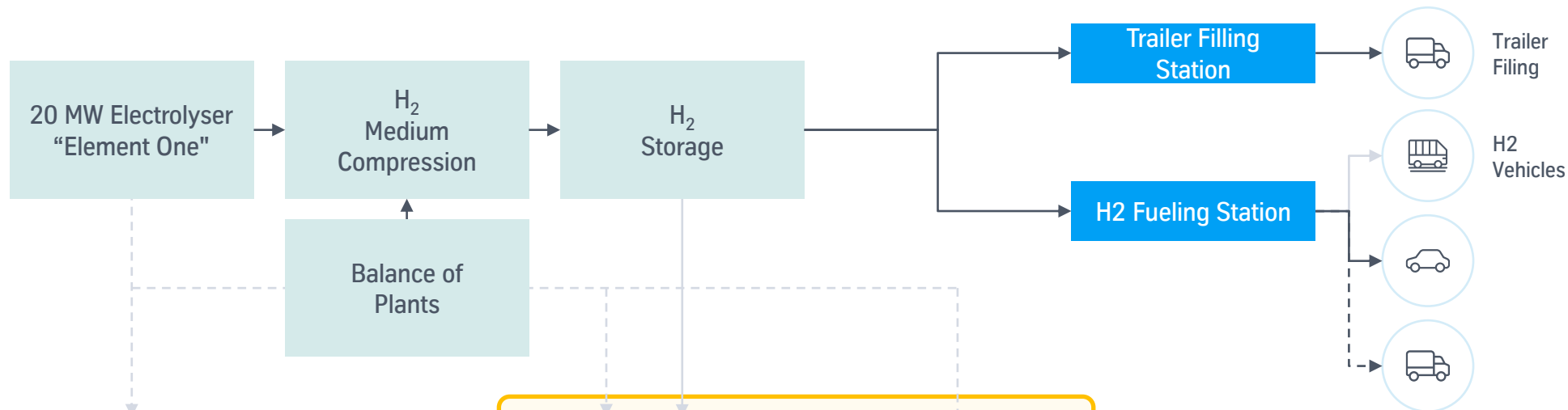
4. Hydrogen Innovation Development Center – HIDC II

Phase 1: H₂ value chain and utilities – NEOM Green H₂ Company
(NEOM, Acwa Power, Airproducts)

Phase 2: e-fuels value chain – ENOWA and Aramco

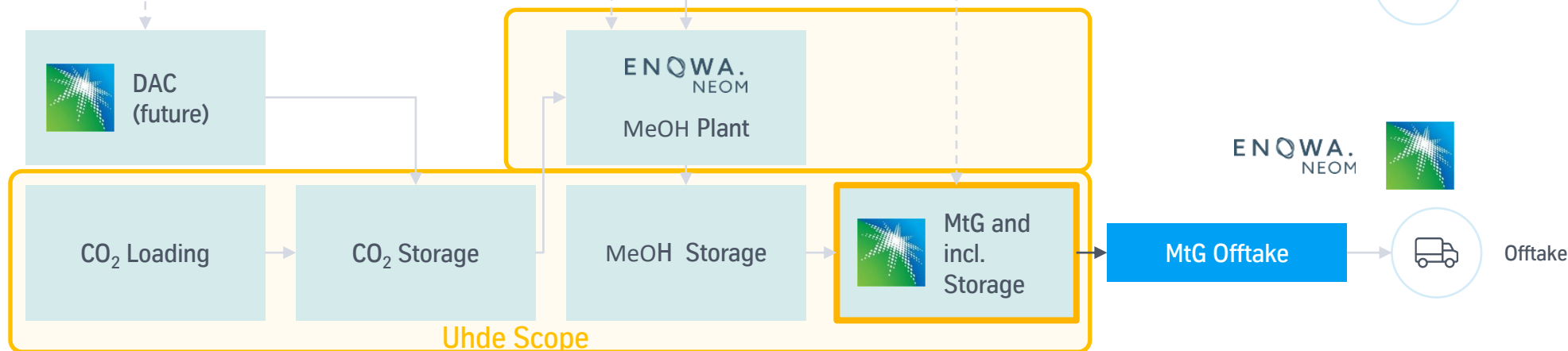
HYDROGEN VALUE CHAIN

Phase 1 CSU: Q3'24



E-FUELVALUE CHAIN

Phase 2 CSU: Q3'25



ENOWA.
NEOM

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13 | 06.06.2024 | Different paths to renewable methanol utilizing green methanol technology | Dr. Alexander Schulz



4. Hydrogen Innovation Development Center – HIDC II

HIDC II

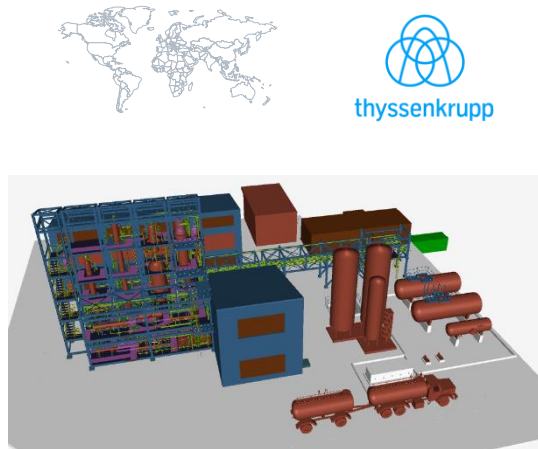
CO₂ to methanol

Demonstration plant; 12 mtpd methanol / EPC ongoing

Neom (ENOWA)

Located in Oxagon, Neom

Green hydrogen as feedstock for green methanol



HIDC II

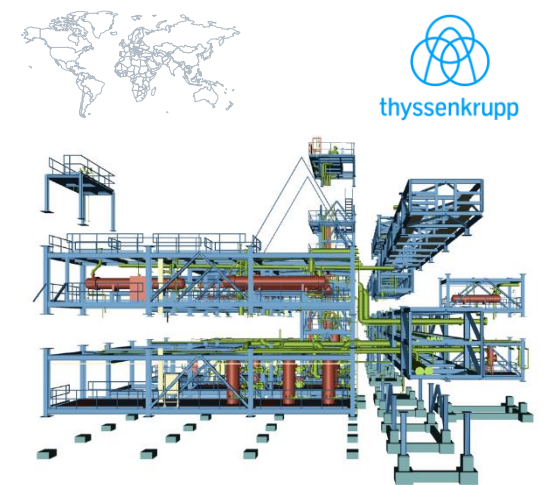
Methanol to gasoline

Demonstration plant; 35 bpd gasoline / EPC ongoing

Aramco

Located in Oxagon, Neom

Green methanol as feedstock for green gasoline



Aramco and ENOWA to
develop first-of-its-kind e-fuel
demonstration plant

DHAHRAN, October 24, 2023



Aramco Executive Vice President of Technology & Innovation, Ahmad O. Al Khowaiter, left, and ENOWA Chief Executive Officer Peter Terium, right, during the signing which took place at the seventh edition of the Future Investment Initiative, in Riyadh, on October 24.



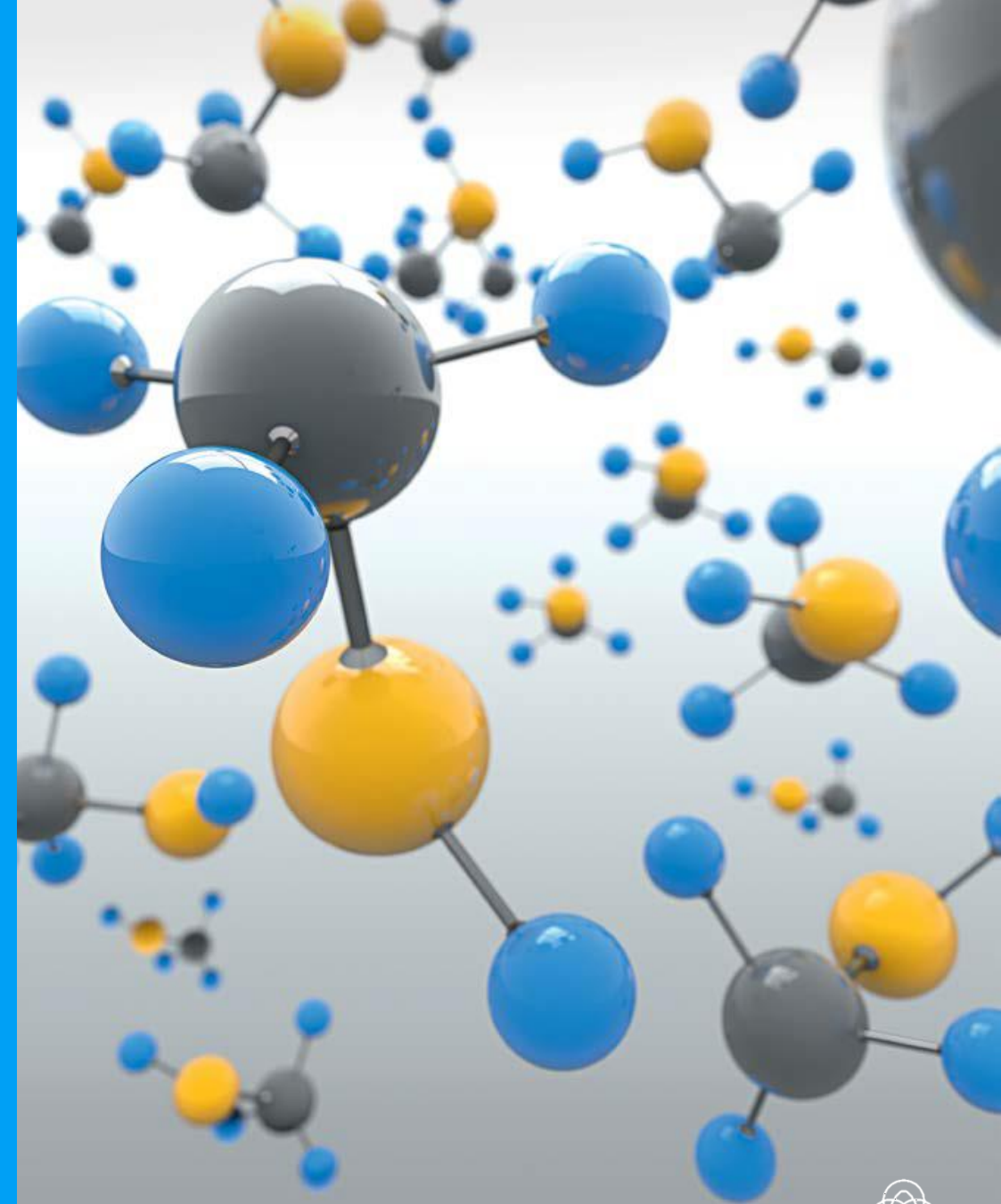
5. Summary

Power-to-methanol and biomass-to-methanol are suitable production chains to meet the expected high demand for green methanol.

Our uhde® Green Methanol technology is a highly efficient methanol process – high carbon and hydrogen efficiencies can be achieved due to the advanced and highly integrated process arrangement.

Our uhde® Green Methanol technology is based on proven state-of-the-art items and equipment that have been adapted to meet modern requirements for low investment costs, high efficiency, and high availability.

Uhde is ready with our technologies to contribute to global decarbonization by offering and building power-to-methanol and biomass-to-methanol plants.



Thank you for your attention



Head of Process Methanol



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