# Ramboll

# Engineering consultancy services

# Green Methanol

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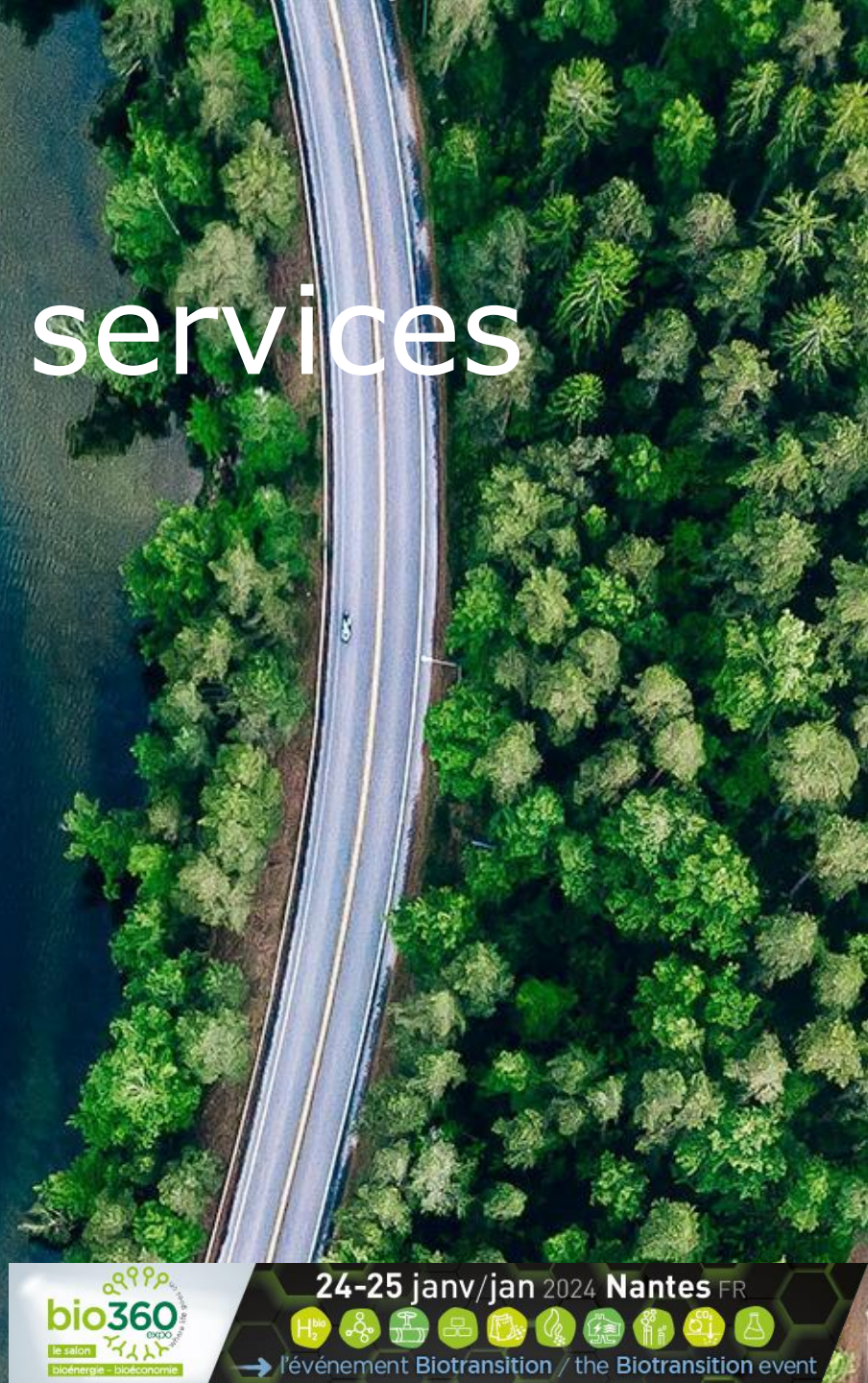
Bio360 EXPO

Nantes, France

RAMBØLL

Bright ideas.
Sustainable change.

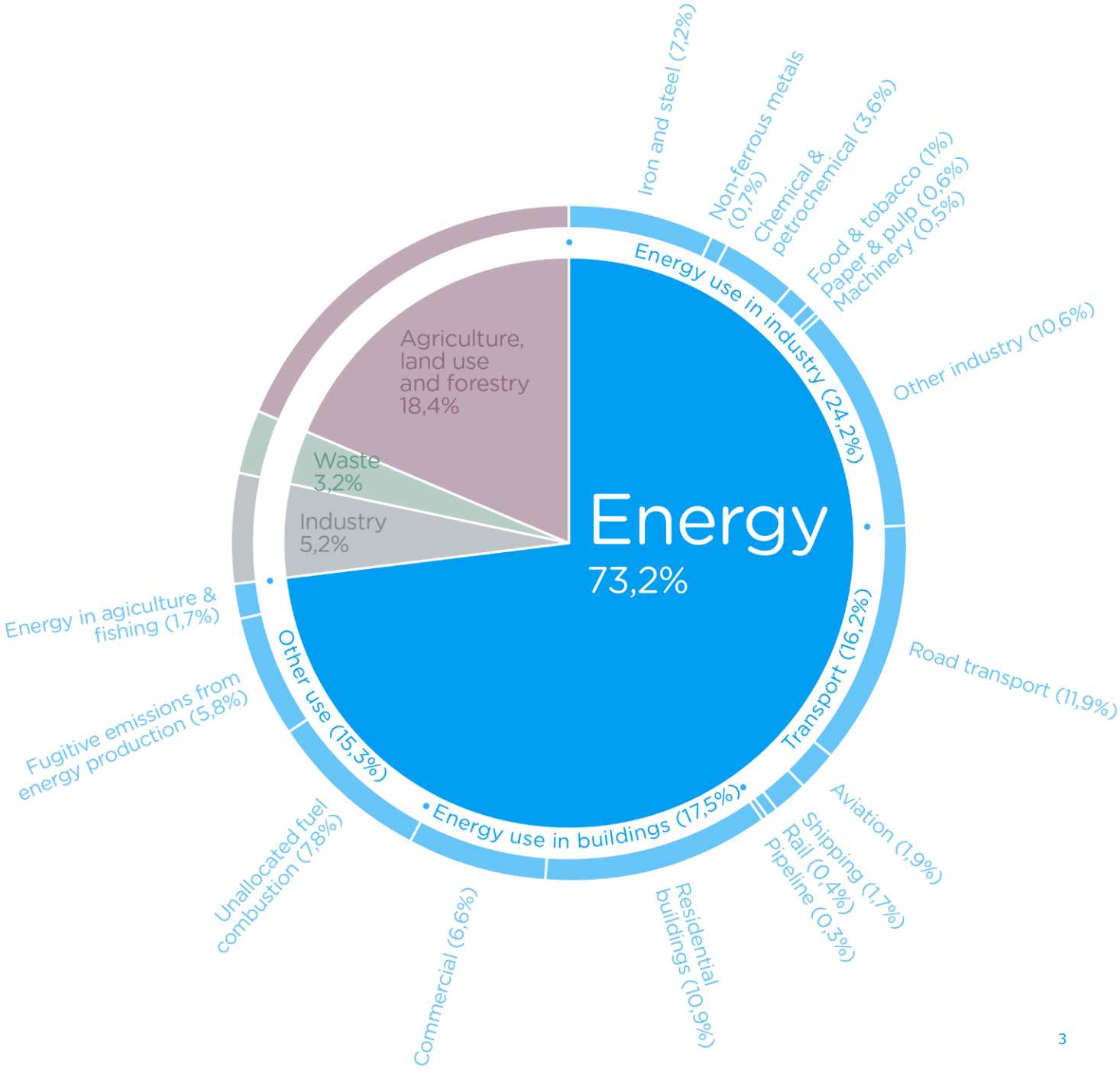



# Ramboll in brief

- **Independent architecture, engineering and consultancy company**
- Founded 1945 in Denmark
- More than 18,000 employees
- Present in 35 countries
- Particularly strong presence in the Nordics, the UK, North America, Continental Europe, and Asia Pacific
- Creating sustainable solutions across markets of **Buildings**, **Transport**, **Energy**, **Environment & Health**, **Water**, **Management Consulting** and **Architecture & Landscape**.
- EUR 2.2 billion revenue (2023)
- Owned by Rambøll Fonden – The Ramboll Foundation

# The energy sector is key in the green transition

Energy is the biggest GHG emission source




Source: IEA statistics, 2021

# Setting the scene – Aviation & Shipping, long-term targets

**ReFuelEU** (aviation)

| | | | | | | |
|---|---|---|---|---|---|---|
| Volumetric SAF targets | 2% | 6% | 20% | 34% | 42% | 70% |
| e-Fuels mandate | | 1.2/2% | 5% | 10% | 15% | 35% |

**FuelEU Maritime** (2020 baseline, well-to-wake* basis)

| | | | | | | |
|---|---|---|---|---|---|---|
| GHG intensity reduction targets | -2% | -6% | -14.5% | -31% | -62% | -80% |
| **Time line** | **2025** | **2030** | **2035** | **2040** | **2045** | **2050** |

**Sustainale Aviation Fuel (SAF)**

Current consumption approx 300 million tons/year.

0.1% is SAF.

**Shipping**

Green MeOH production capacity forecast, to meet shipping demand in 2050: 540 Mt.

Capacity today: 0.5 Mt

Source: Bloomberg NF

* Well-to-wake: refers to entire process from fuel production and delivery to using onboard ships, and all emissions produced therein.

# Green methanol as part of the new green fuels and chemicals solutions

**MeOH - versatile compound – precursor to many other chemicals**

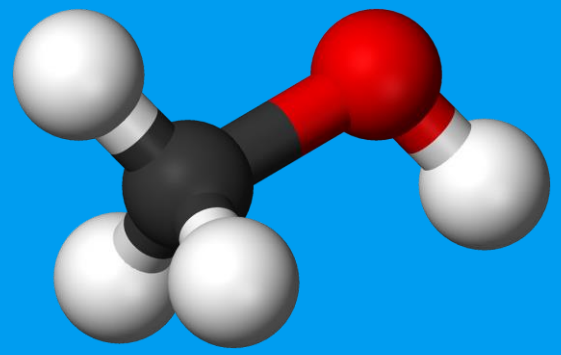
- Formaldehyde
- Olefin
- Propylene
- Petrol
- Jetfuel
- DME
- …

Easy to transport and store.

**Global production**

- ~100-110 million tons per year
- 90-100 large scale NG based MeOH plants (>2000 MTPD*)

$CH_3OH$



* MTPD = Metric Ton Per Day

# MeOH plant

Reactions:

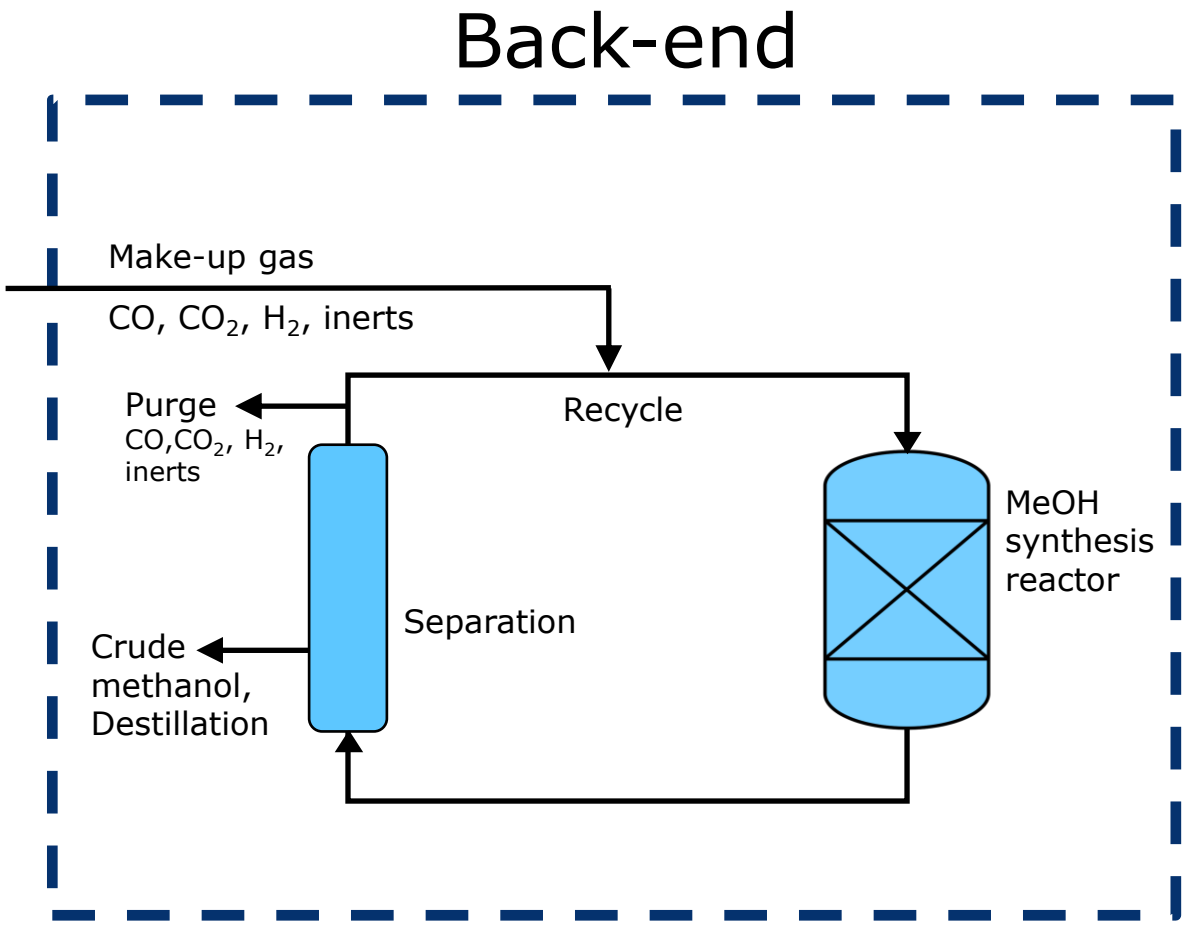
$CO_2 + 3H_2 \Leftrightarrow CH_3OH + H_2O$

$CO + 2H_2 \Leftrightarrow CH_3OH$

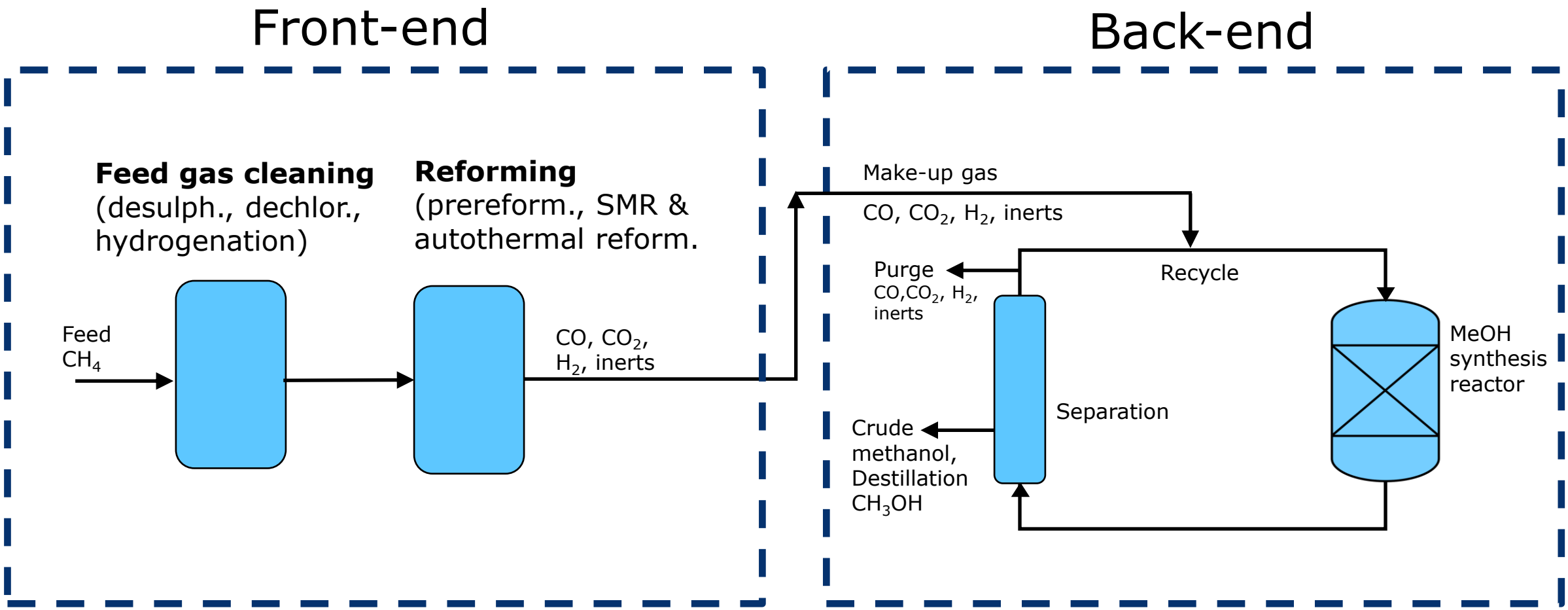
$CO_2 + H_2 \Leftrightarrow CO + H_2O$

+ side reactions/by-products

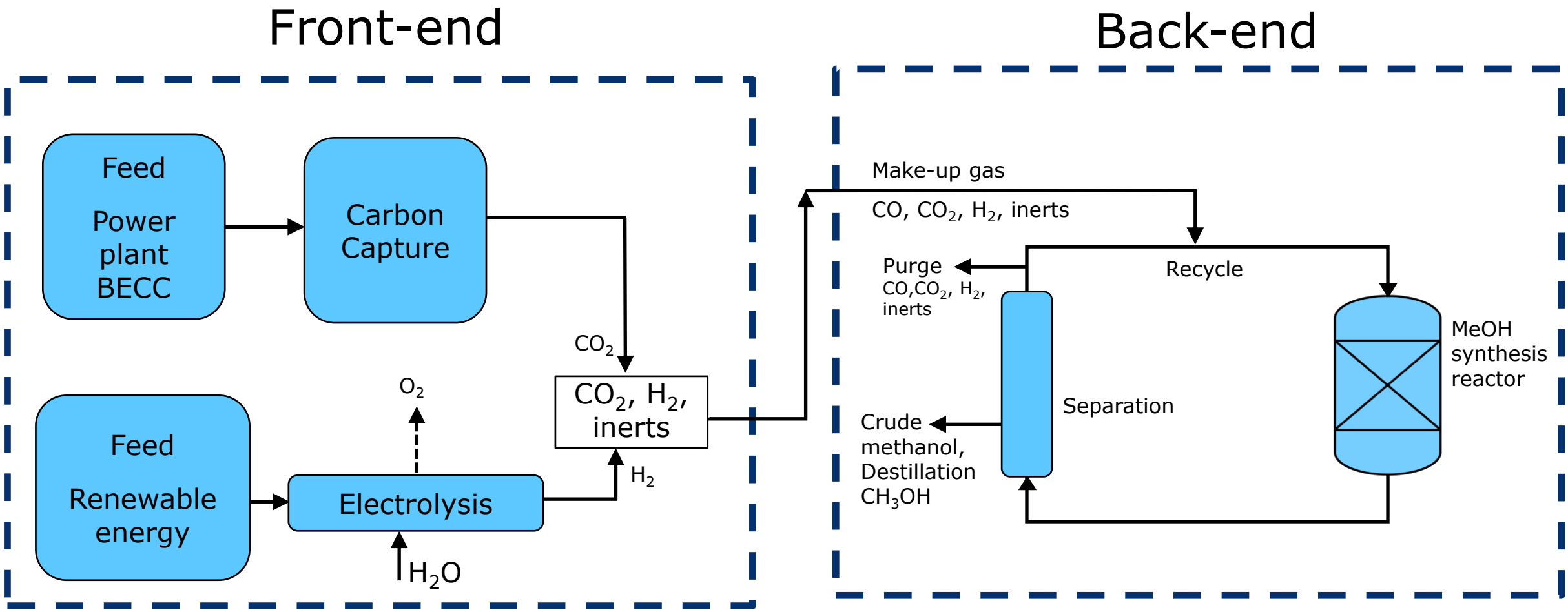
Module M = $\frac{[H_2] - [CO_2]}{[CO] + [CO_2]}$ = approx. 2.1



# Traditional MeOH plant (fossil NG based)



# Green MeOH plant (eMeOH)



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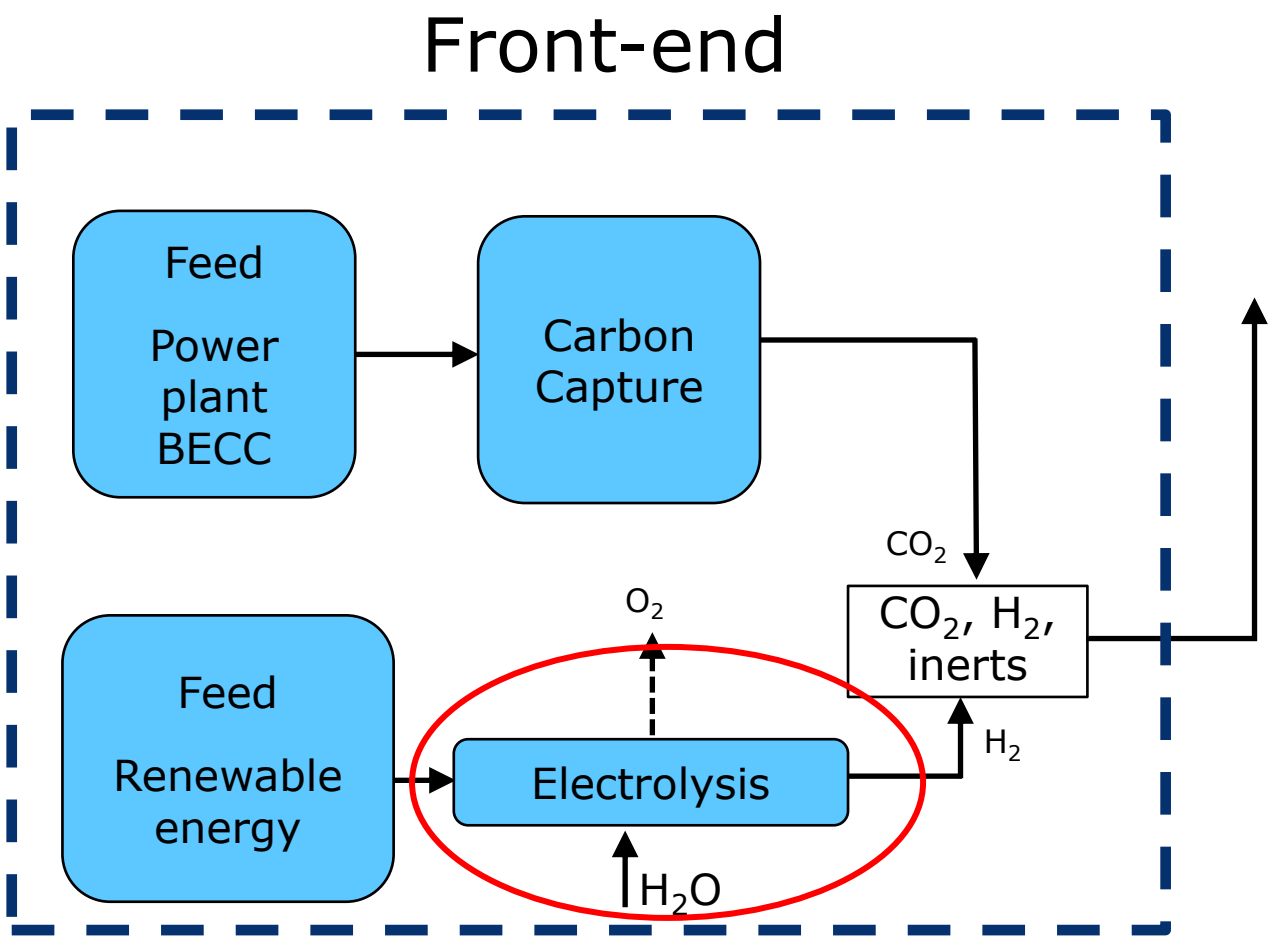



Electrolyzer:

1 GW electrolyser capacity

approx. 2500 MTPD MeOH plant
approx. 500 tons $H_2$/day
(at full electrolysis capacity)

Water:

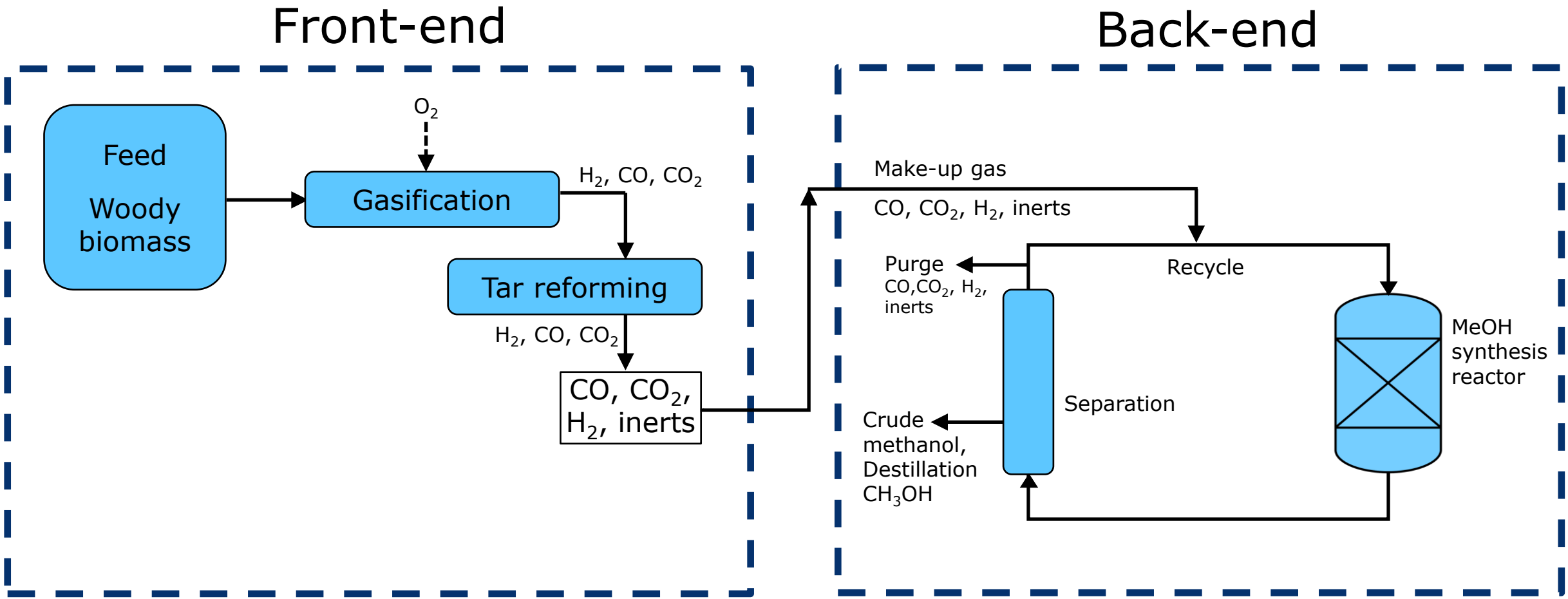
1 kg $H_2$ requires 9 kg of $H_2O$.

Renewable energy:

Competition with direct electrificataion of energy intensive processes and society in general.

Biogenic $CO_2$:
Future availability.

# Green MeOH plant (Bio-MeOH, biomass gasification)



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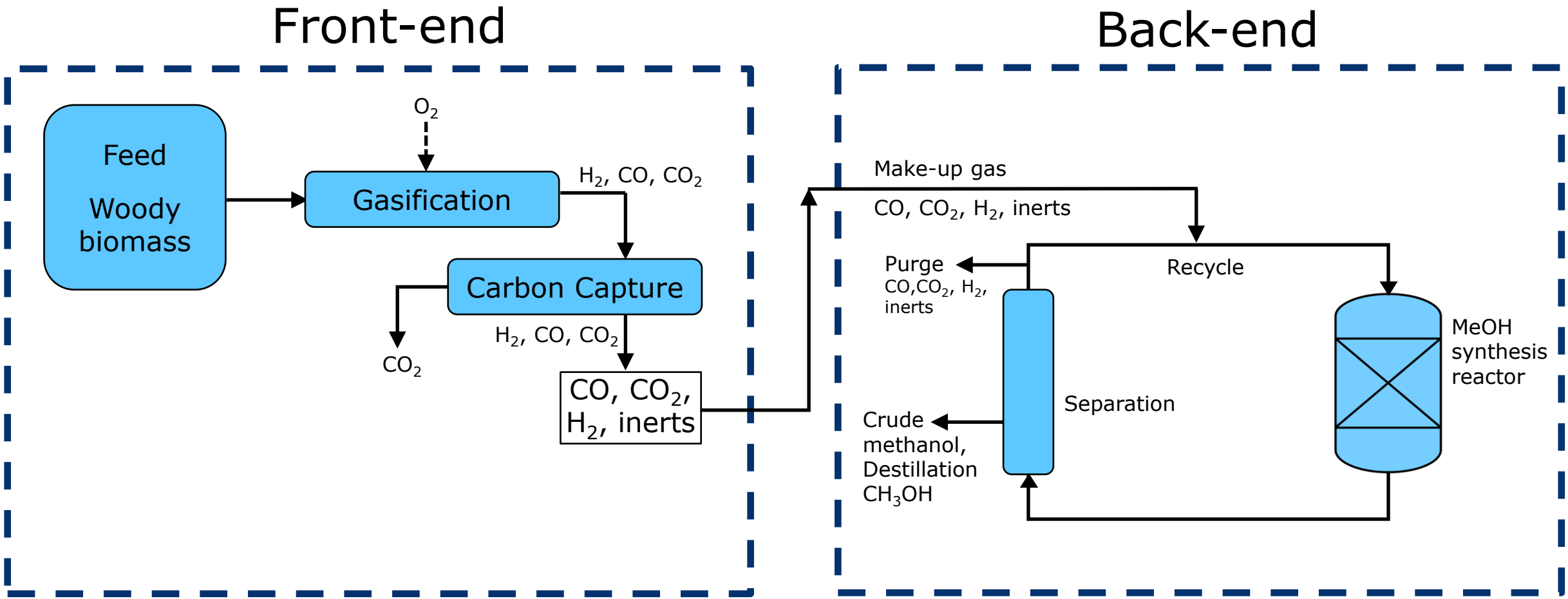
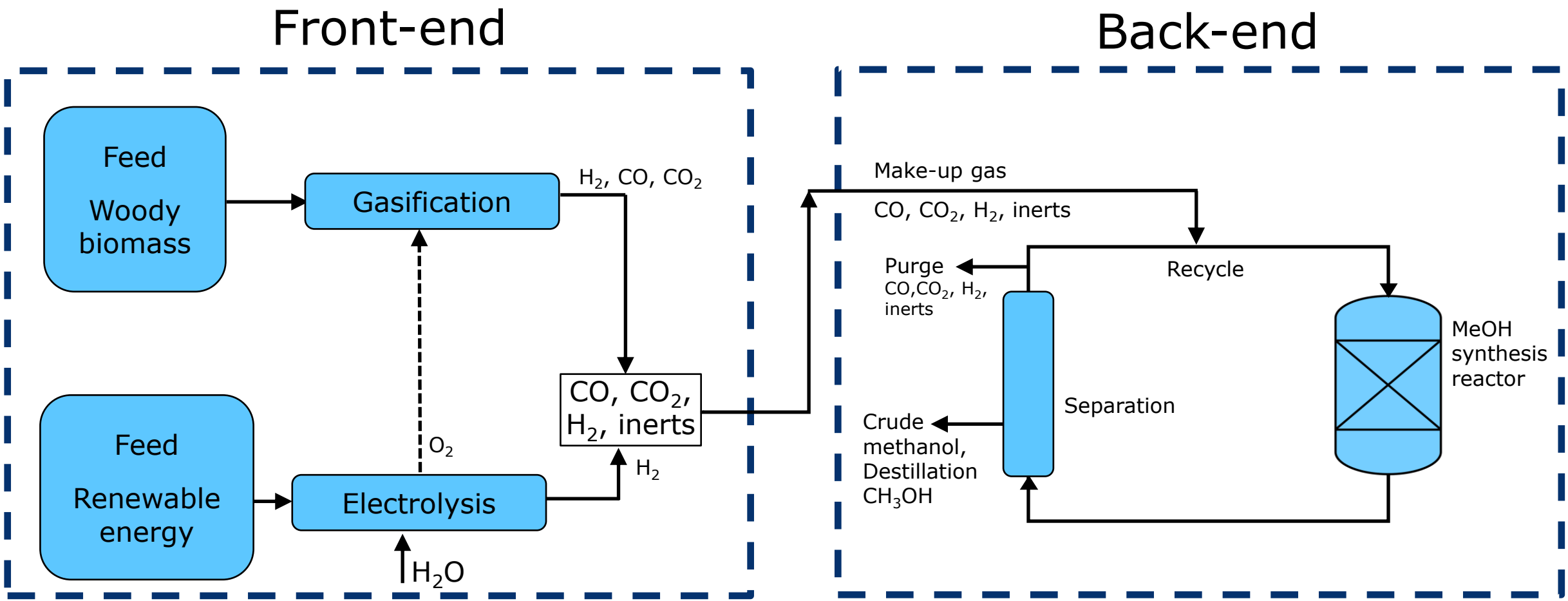
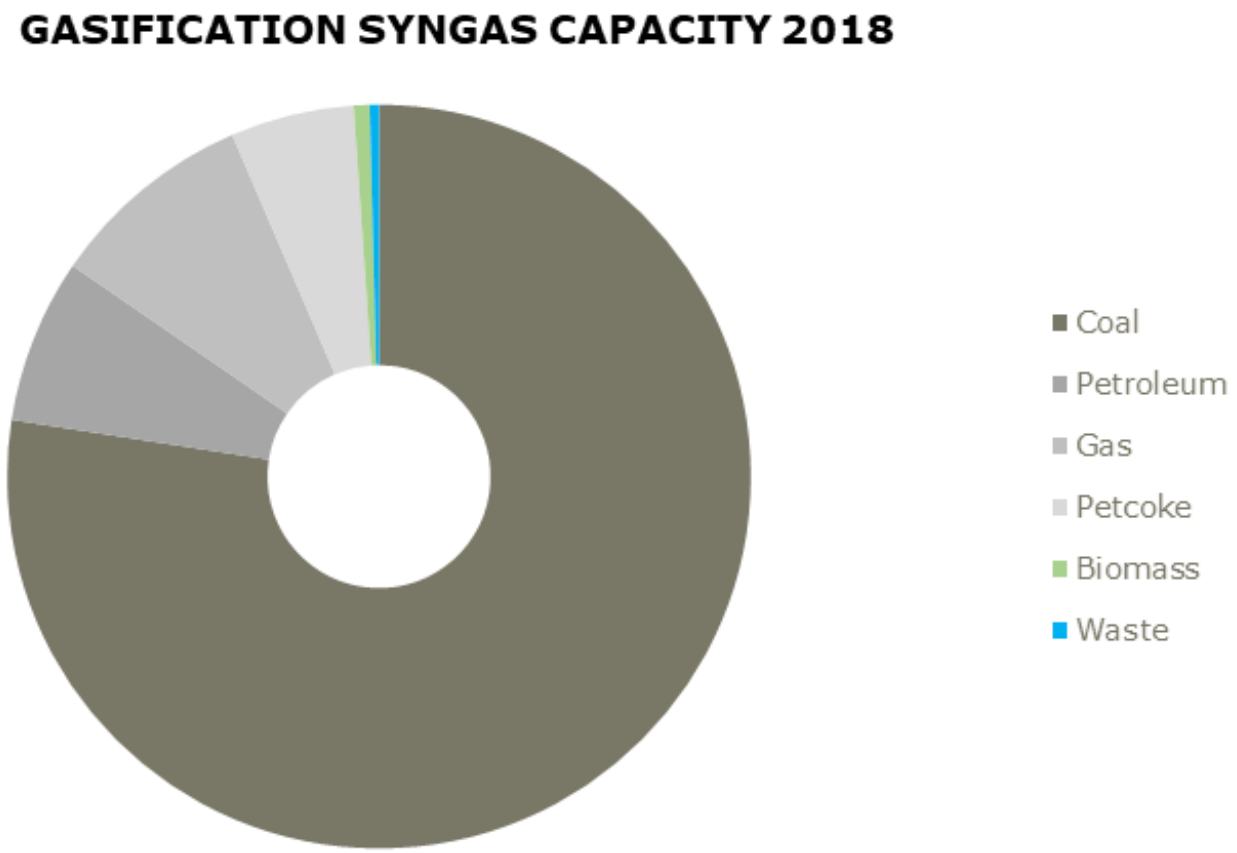


# Green MeOH plant (Bio-eMeOH)



# WORLDWIDE GASIFICATION FEEDSTOCKS




[Global Syngas Technologies Council 2019]

# Thermochemical conversion processes biomass/waste under controlled reaction conditions for a desired output

Thermochemical conversion processes are used to produce heat, solid, liquid, and gaseous products and a wide variety of each type depending on reaction conditions.

### Degree of conversion

\-

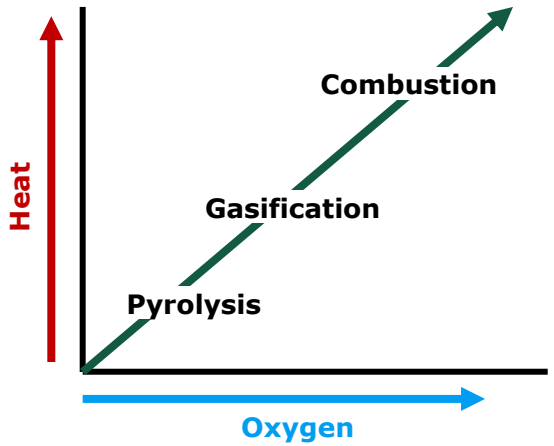
**Pyrolysis**
Feedstock is heated to high temperatures without adding air

**Gasification**
Feedstock is heated with the addition of small quantities of oxygen/air

\+

**Combustion**
Feedstock is heated with excess air supply, causing total combustion

Heat and oxygen almost completely control what kind of thermal conversion will occur




### Process comparison

| | Pyrolysis | Gasification | Combustion |
|---|---|---|---|
| **Reaction environment** | Zero oxygen | Reducing, low oxygen | Oxidizing, excess stoichiometric oxygen |
| **Oxidizing agent** | None | Air/$O_2$/steam | Air |
| **Temperature** | 400-800°C | 500-900°C (air) 1,000-1,500°C (other gasifying agents) | 850-1,200°C |
| **Main outputs** | Liquids & solids | Gas | Heat |
| **Produced gases** | CO, $H_2$, $CH_4$ and other hydrocarobons | CO, $H_2$, $CH_4$ $CO_2$, $H_2O$ | $CO_2$, $H_2O$ |
| **Pollutants** | $H_2S$, HCl, $NH_3$, HCN, tar, particulates | $H_2S$, HCl, $NH_3$, HCN, tar, particulates | $SO_2$, $NO_x$, HCl, PCDD/F, particulates |

# Biomass/waste gasification technical challenges

In fact not easy with biomass, but worse with waste/RDF

- **Tars!** Sticky/smelly/toxic aromatic compounds
  - Fouling pipes, heat exchanger, rotating equipment, …
  - Serious trouble for most gas cleaning
  - In residuals and waste-water
- **Ash properties**
  - Ash can get sticky at process temperatures
- **Inerts**
  - Solids often handled in augers. Inerts can be difficult to remove from reactors.
- **Particle size**
  - Fluidized bed reactors have both narrow upper and lower particle size limits
  - Gasification kinetics are slower than combustion, thus large particles convert slower.
- **Sulphur and metals**
  - Catalytic synthesis requires low ppm levels in the syngas

**Current trends** in the gasification industry are towards:

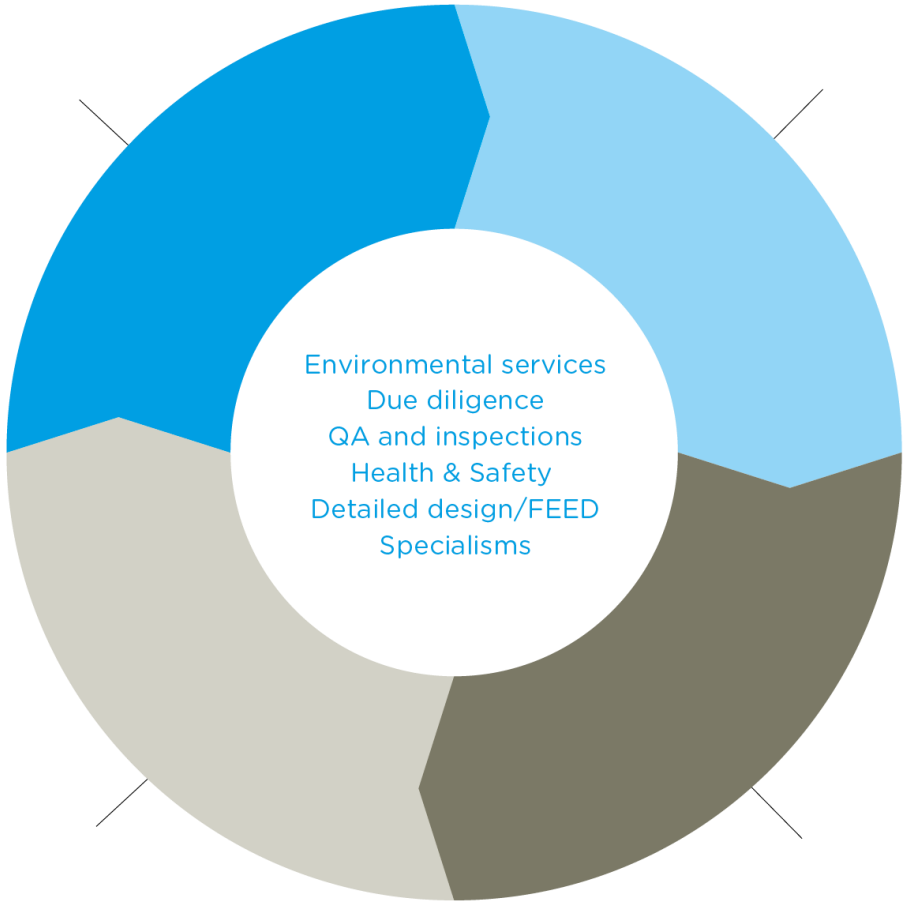
- **Biomass** and **waste/RDF** as the feedstock
- From boilers/engines **towards synthesis into fuels/chemicals**

**Green transition increases demand for green fuels** and thus the resources and interest from investors

# Full range of project lifecycle services

**LIFE EXTENSION**
Remnant life assesment
Life extension & plant upgrade evaluation
Tendering
Project management
Site supervision

**PROJECT DEVELOPMENT**
Feasibility studies
Conceptual design & FEED
Contracting strategy
Tender document preparation
Tender evaluation




**O&M SUPPORT**
Specialist technical support
Online process optimisation
Outage planning & management
Training
Trouble shooting & root cause analysis

**OWNER'S ENGINEER & EPCM**
Project management
Design Review
Interface management
Factory inspections
Site supervision
Performance guarantee tests

# Management Consulting
## Example - Market analysis

**1 Market analysis** on selected target countries and regions

Which market to enter?

Selection of the most relevant markets based on a high-level evaluation

Assessment of markets based on e.g.
- Trends and drivers
- Market size
- Potential competitors and off-takers
- Framework and regulatory conditions
- Value chain maturity
- Potential deep dives on the most relevant regions

**2 Go-to-market strategy** on most attractive markets

Where and how to enter the market?

Development of go-to-market strategy in the most relevant market, containing three phases:

Baseline understanding
- Establish baseline understanding of firm capabilities, perceived USP

Market and opportunity assessment
- Define and analyze opportunity spaces relevant to the specific market and value chain segment (including entry mode)

Go-to market-model
- Development of go-to-market model within the defined opportunity spaces

**3 Site selection** to demonstrate technology in an attractive market/region

Which sites to target?

Facilitating a process for optimal site selection satisfying production and off-taker requirements.

Development of specific screening criteria
- 5-10 screening criteria (mix of qualitative and quantitative elements) serve as the foundation

Prioritization and analysis of most relevant sites
- Sites within relevant segments and regions identified in the go-to-market strategy are analyzed for strategic fit

Deep dive on high-priority sites
- Shortlisted prioritized sites are specified and described based on the screening criteria.

# RAMBOLL
## FULL-SERVICE PARTNER


**01 PROJECT INITIATION**
Is it possible to get any subsidies for the project?

- Due diligence for site selection
- Environmental and geotechnical investigations on the land

**02 PROJECT PLANNING**
What is the optimal layout of the project?

- Conceptual design
- Assistance with process planning
- Assistance with logistic planning
- Listening and implementation of sustainable arrangements

**03 TENDERING AND CONTRACTING**
How do I find the best local contractor with sufficient capacity and resources?

How do I find the necessary permits from authorities and utility companies?

- Contact with local authorities and supply companies
- Preparation of Tender
- Prequalification of local contractors
- Tender period
- Negotiations with the contractors

**04 DURING CONSTRUCTION**
How can I ensure that the contractor delivers the facility on time and comply with the agreed price and quality?

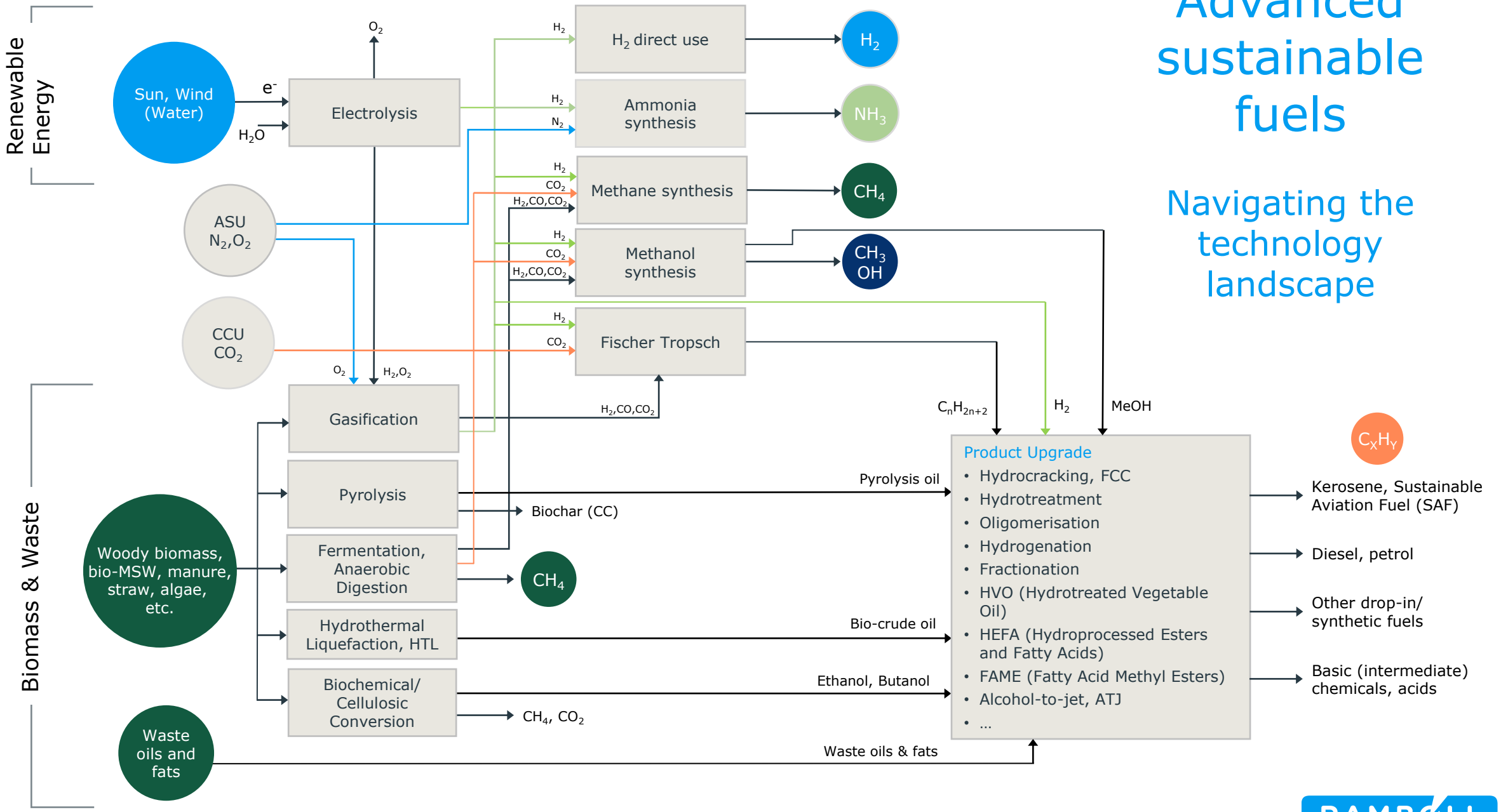
- Detailed design
- Site supervision throughout the construction period
- Project folow-up
- Commissioning

**05 AFTER HANDING OVER**
How do I ensure that the facility is put into operation as fast as possible?

- Preparation of Taking Over certificate
- Handing Over of the facility to the client
- Assistance in connection with the start-up period of the client

# Advanced sustainable fuels

## Navigating the technology landscape



# Thank you

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Sustainable change.