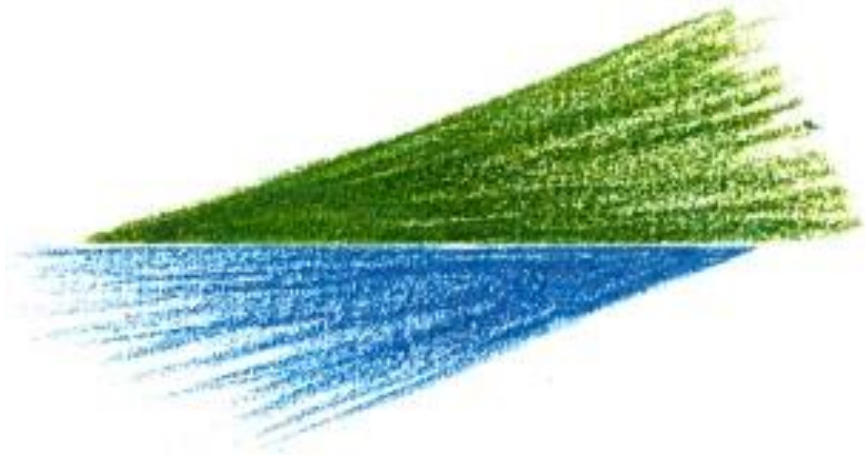


Green Bio Power b.v.



CO₂ to Methanol

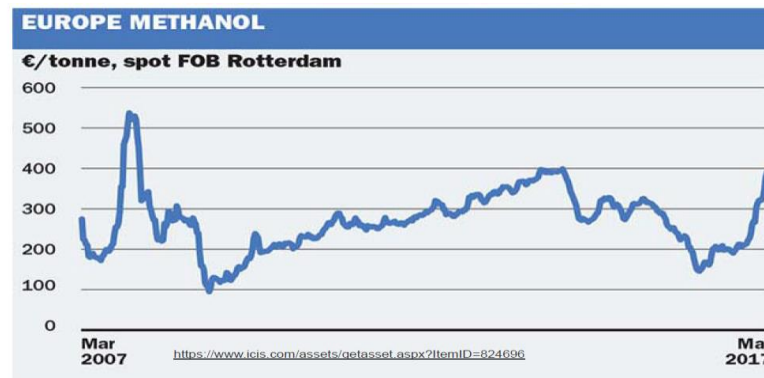
Product development

Ing J.H.F Veldhuis MBA

Businessdevelopment

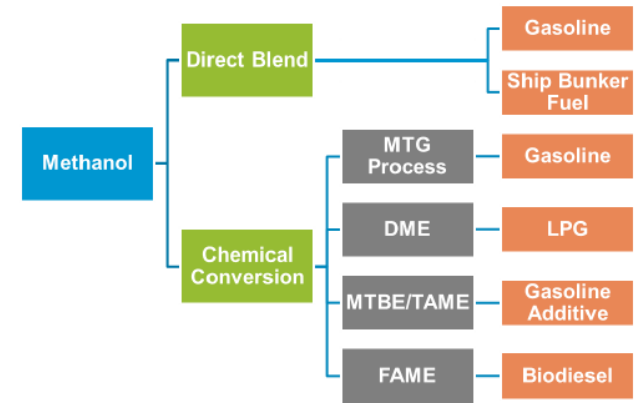
Methanol market

- 72 Mtonne per year production globally (Main producer and consumer)
- 2/3 is produced by Natural gas Steam reforming, 1/3 Coal gasification
- Market is moving from Chemicals to Energy fuel
- Methanol can be used as: Blending fuel (15 % in gasoline), Monofuel or Hydrogen carrier
- High octane number: 115, No PM emissions, low NOX/SOX
- Offtakers: Marine fuel, Heavy duty trucks
- Cost price SMR/Coal gasification route: USD 326-376/tMeOH
- Sales price Methanol:

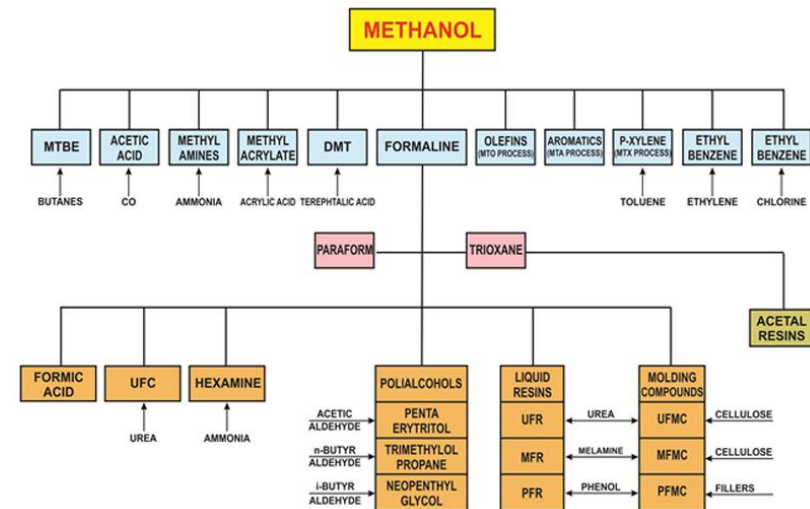


Methanol market

- Methanol as fuel



- Methanol as building block



Renewable Methanol

- H₂ made from Electrolysis, Europe
- In these regions USD 60/MWh is possible with load factor (around 4500 h, >4000 h required)
- Large Electrolyser costs (400 MW): USD 450 per kW → USD 3-4 /Kg H₂

- Methanol price: USD 700 /tonne

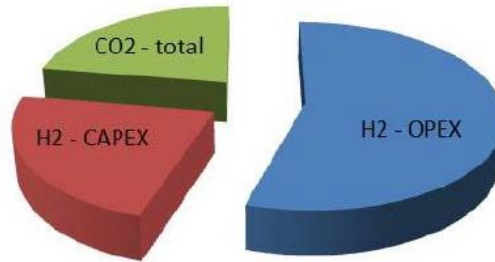
- Syngas can be also made from Wood, Biomass
- Cost Methanol: varying from USD 225-1300/t for wood, USD 280-700 for waste

Twente case

- Electricity price: 10 USD/MWh



e^-



@ 0.01 € / kWh_{el}

OPEX (electrolysis) (60 kWh/kg H₂; 0,1875 kg H₂/kg MeOH)

0.11 € / kg MeOH

CAPEX (, ,) (@ 1000 € / kW_{el}; 8000 h ; 10 yr)

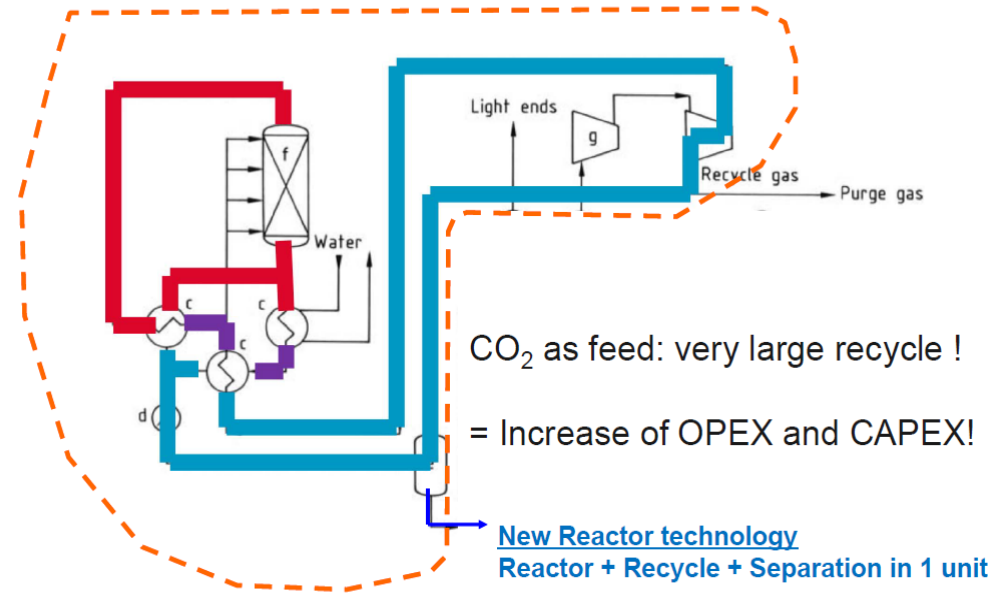
0.14 € / kg MeOH

CO₂ (50 \$/ton CO₂; 1.375 kg CO₂/kg MeOH)

0.07 € / kg MeOH

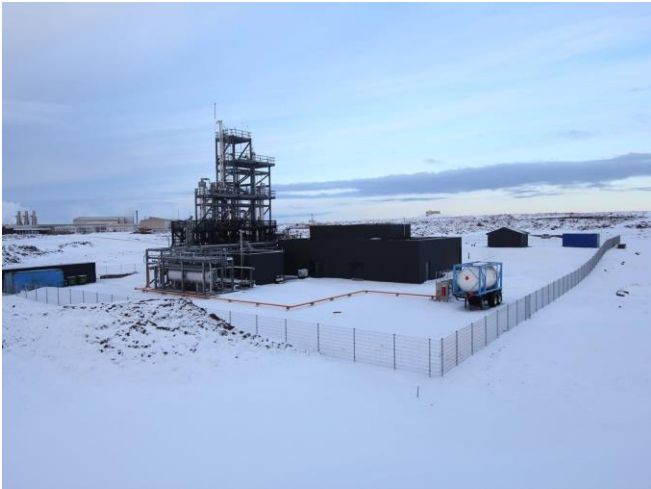
320 € / ton MeOH

For cost-competitiveness: electricity at max. around 0.01 € / kWh_{el} is needed !



Process implications when shifting from CO to CO₂

Companies present in “bio” methanol



CRI first of its kind Emissions-to-Liquids facility in Iceland
George Olah (GO) Renewable Methanol Plant, Svartsengi, Iceland

First commissioning: 2012

Capacity expansion: 2015

CCU throughput: 5,600 t/yr CO₂

Electrolyzer capacity: 800 t/yr H₂(1200 Nm₃/hr)

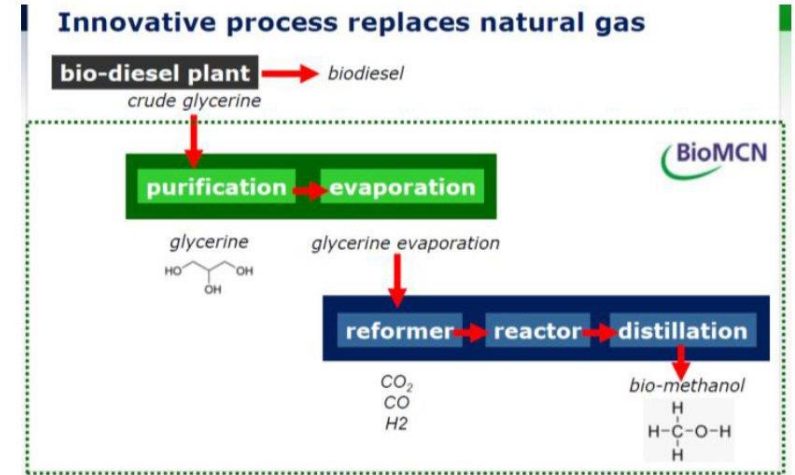
Production capacity: 4,000 t/yr methanol

Enerkem in Rotterdam: partnerships will help accelerate Enerkem's global expansion

In 2018, a consortium of companies comprising Air Liquide, AkzoNobel Specialty Chemicals, Enerkem and the Port of Rotterdam has signed a project development agreement covering initial investments in an advanced waste-to-chemistry facility in Rotterdam. The facility will be the first of its kind in Europe to provide a sustainable alternative solution for non-recyclable wastes, converting waste plastics and other mixed wastes into new raw materials.



Infographic courtesy of Akzo Nobel



Carbon Recycling International -



Enerkem



Follow up in project Twente

- CO₂ to Methanol is part of industrial bio-energy project Twente: CO₂ utilization
- Part of Power to Products program: green gas, bio-LNG , Methanol out of Bio Methane
- October 2018: Greenpower Twente offers a development program with new innovative Methanol reactor and scale up in collaboration with TU Twente

