

Member Country Summary: Norway

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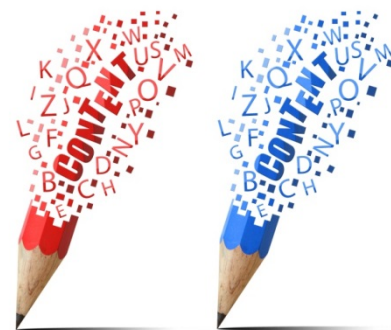
SINTEF Energy Research

IEA Task 33 meeting

Gothenburg, Nov 2013

Content

- Biomass gasification in Norway
- Biomass gasification Lab: SINTEF Energy Research
- Avinor project – BioJet production in Norway?
- Summary



Biomass gasification in Norway

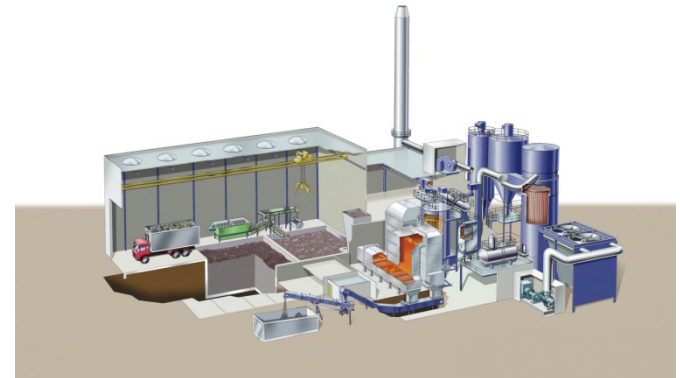
- Norway has large unused biomass resources
- Still no economic advantages or incentives for biomass gasification in Norway:
 - Fundamental research at Universities
 - Applied research
 - No large scale gasification facilities
- Small scale waste-to-energy applications
- Some interested larger companies :
 - Statkraft
 - Akershus Energi
 - Avinor (BioJet-A1)

Small scale applications

- In Norway both the people and the biomass are spread
- The distances are large, hence high transportation costs



- Small scale applications
 - Energos
 - Agder Biocom



Energos plant

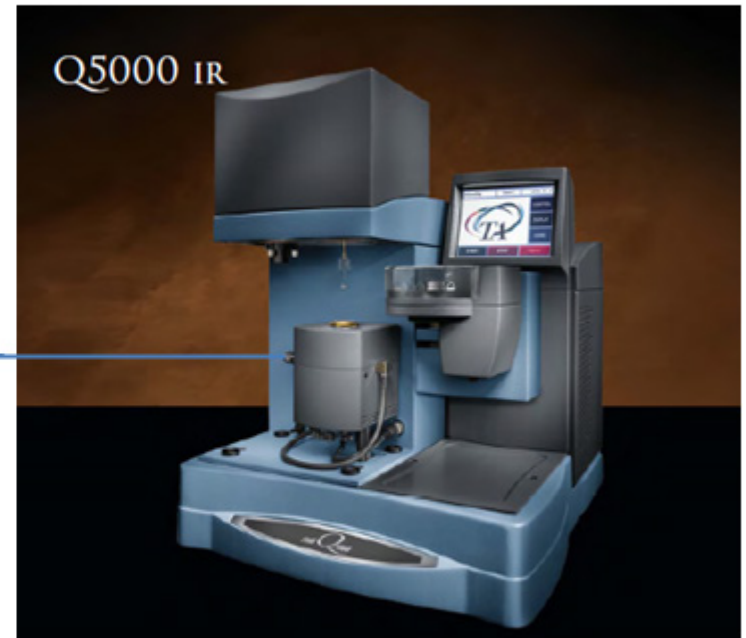
Both use two-step (gasification-combustion) technology for heat production

Biomass gasification Lab: SINTEF Energy Research

Bench-scale reactors for biomass reactivity and yield measurements

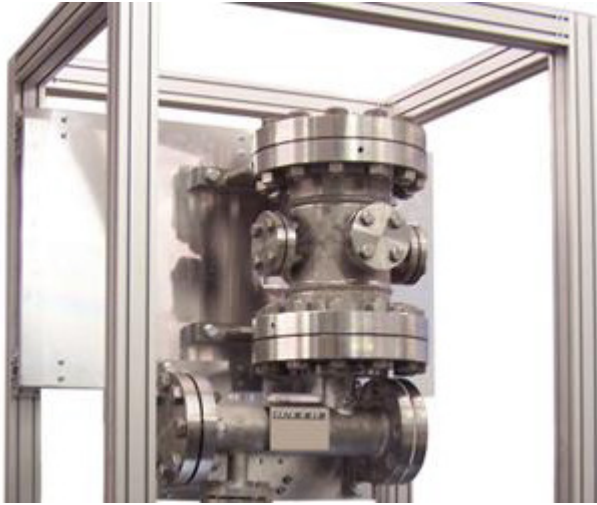


1-10 mg samples: small transport effects, high time resolution (seconds)



Variables: heating rate, temperature, reaction gas, fuels and fuel mixtures

Bench-scale reactors for biomass reactivity and yield measurements



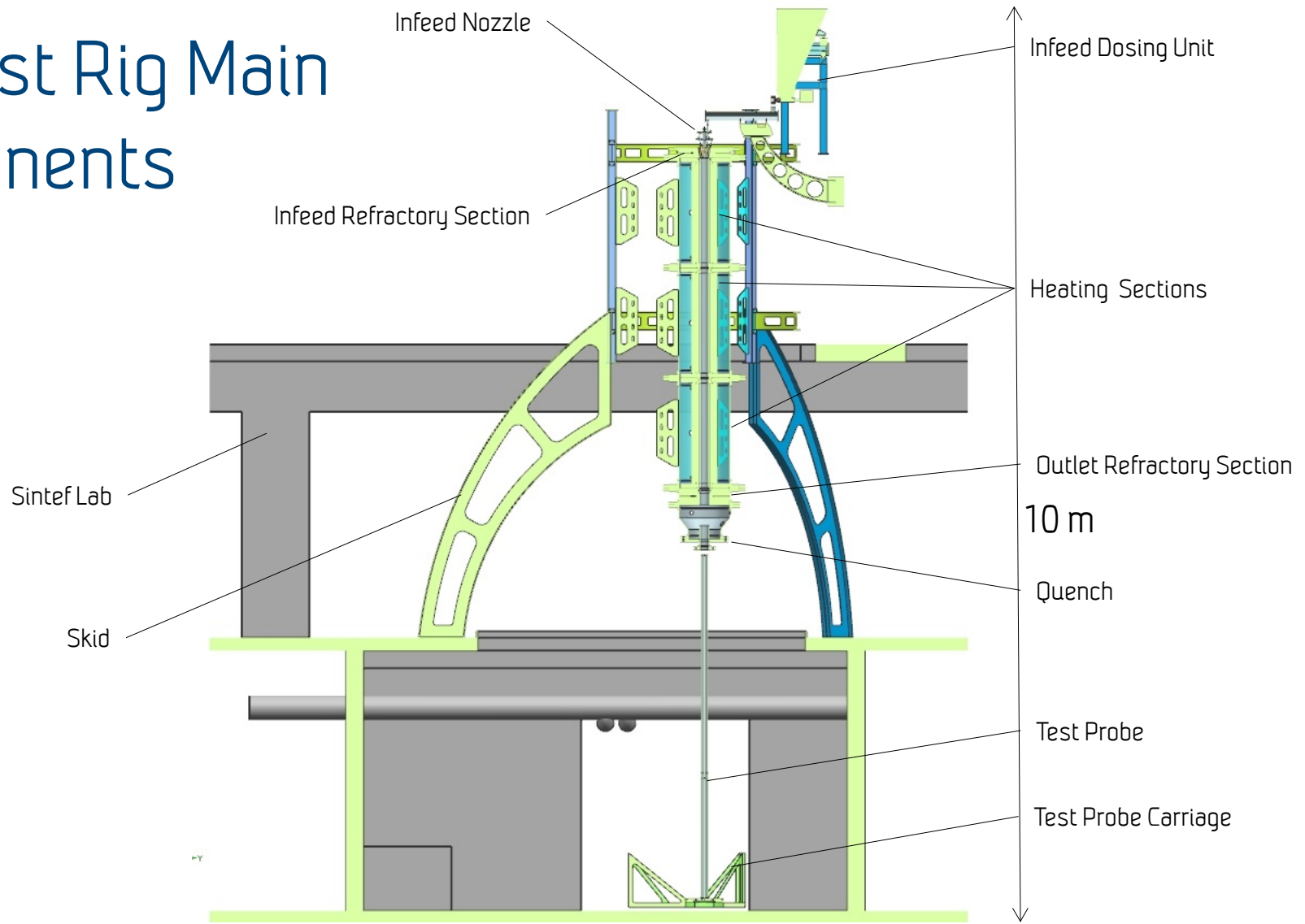
STA instrument (simultaneous thermal analyzer)

- Temperature range: RT up to 1100°C
- Vacuum: 10E-4mbar
- Heating rate: 0.1 up to 20°C/min
- Temperature resolution: $\pm 0.1^\circ\text{C}$
- Temperature accuracy: $\pm 0.3^\circ\text{C}$ (substance calibration)
- Data evaluation rate: max. 10/s
- Pressure control: up to 50 Bar (adjustable, software controlled)
- Atmosphere: inert, red., vac., oxid. (SiC heater)

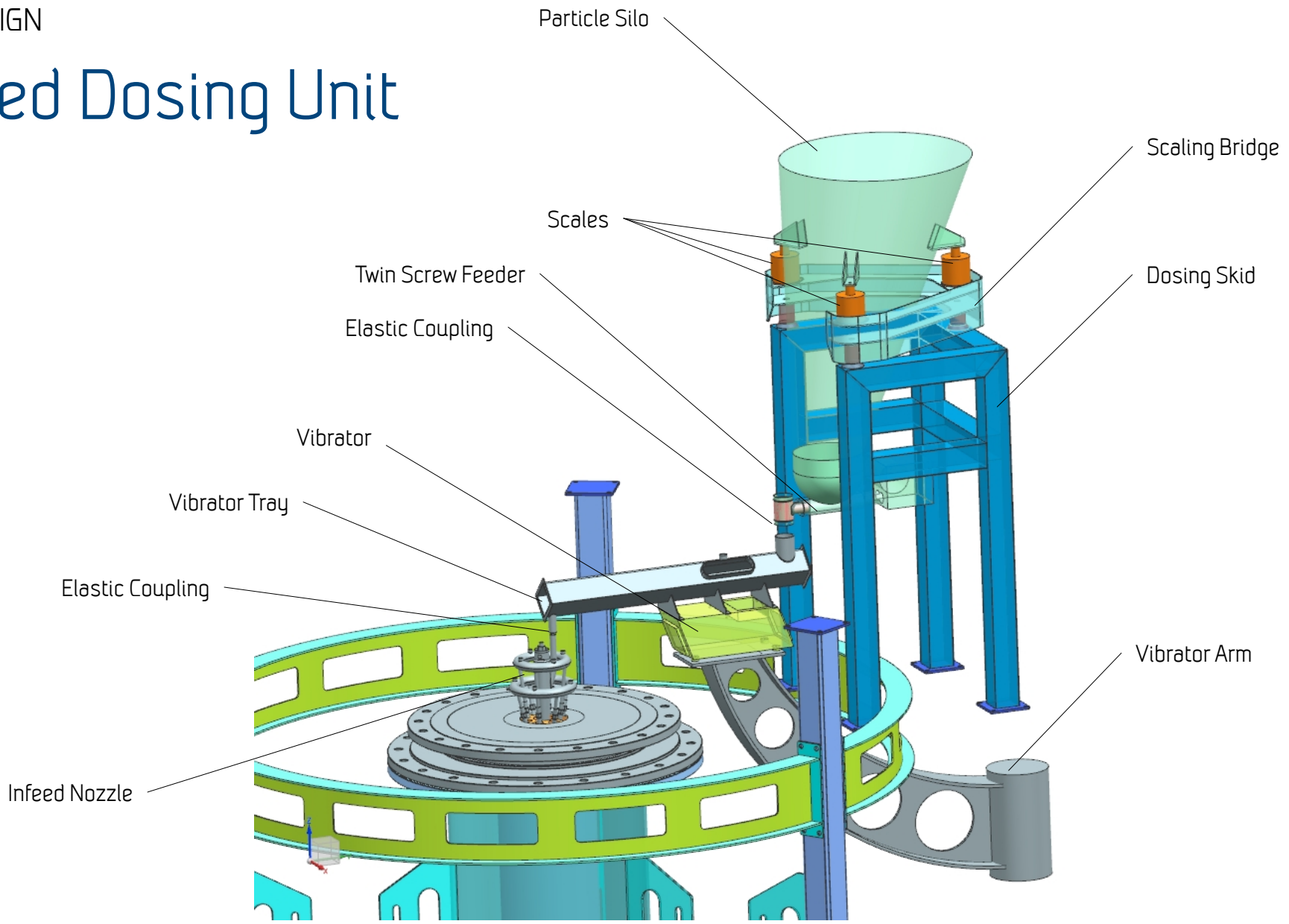
Biomass gasification to second generation biofuels – Entrained Flow Reactor

- Design a vertical high temperature particle fed reaction cylinder
- Capable of using a variety of infeed materials and sizes
- Of durable quality
- With ease of maintenance
- With interchangeable parts
- MAKE IT CHEAP

The Test Rig Main Components

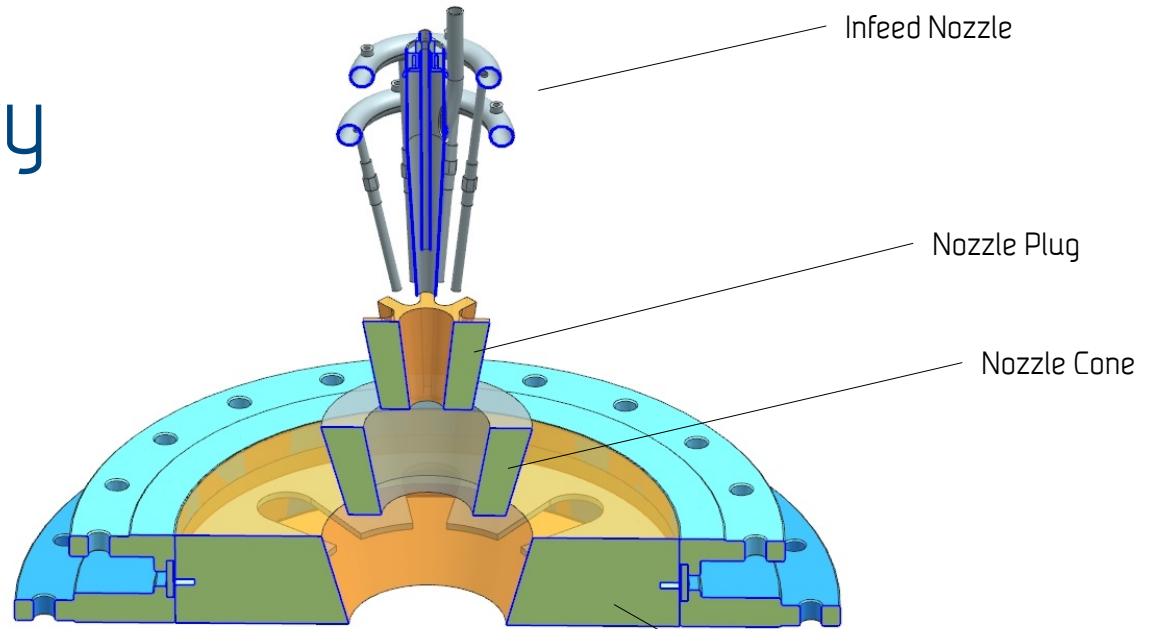


Infeed Dosing Unit

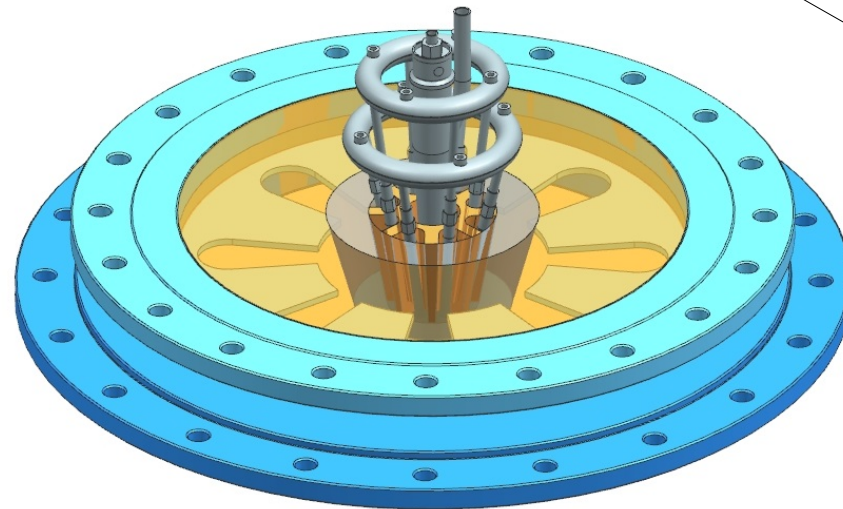


Infeed Refractory Section

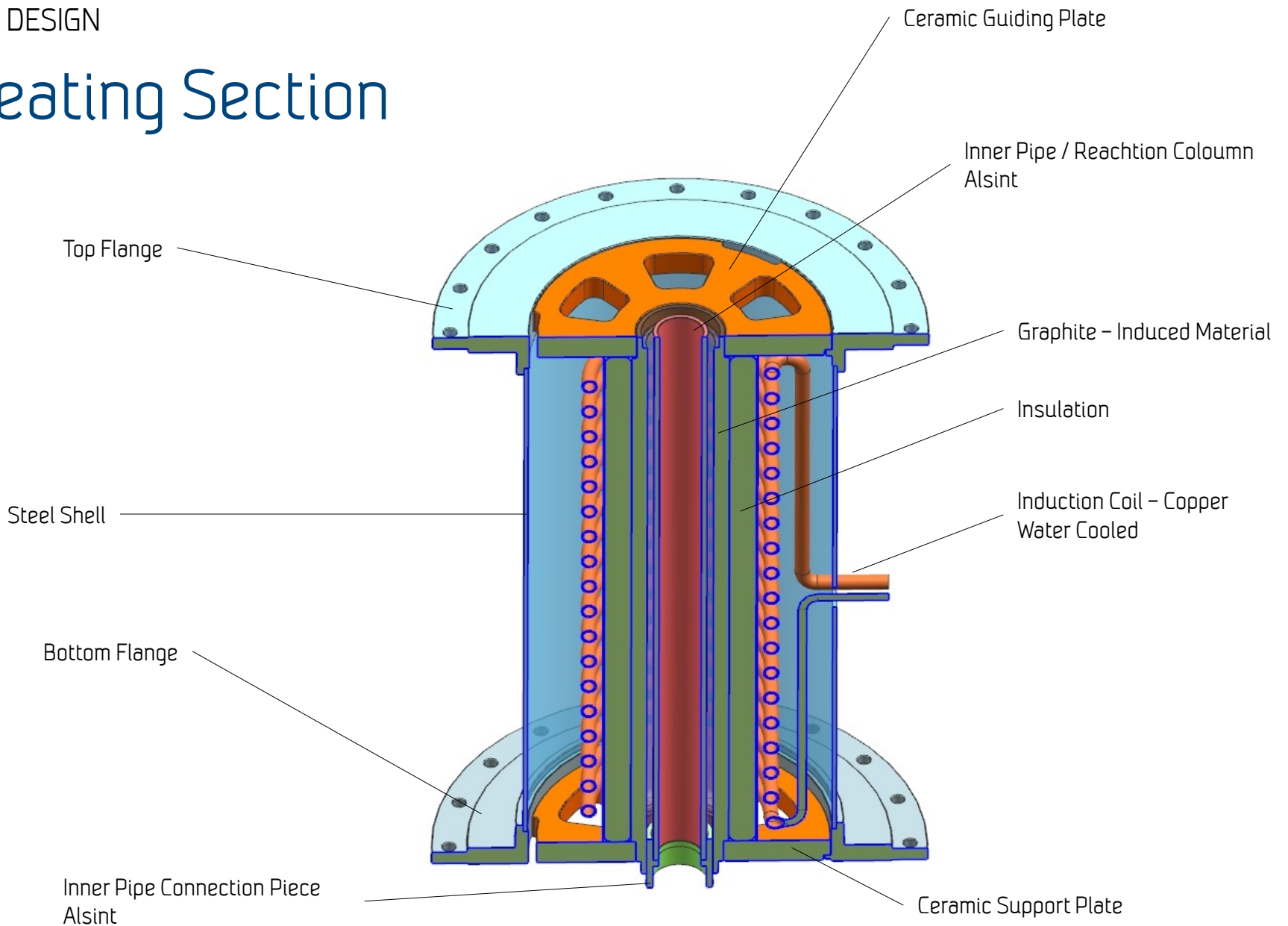
Exploded Cross Section



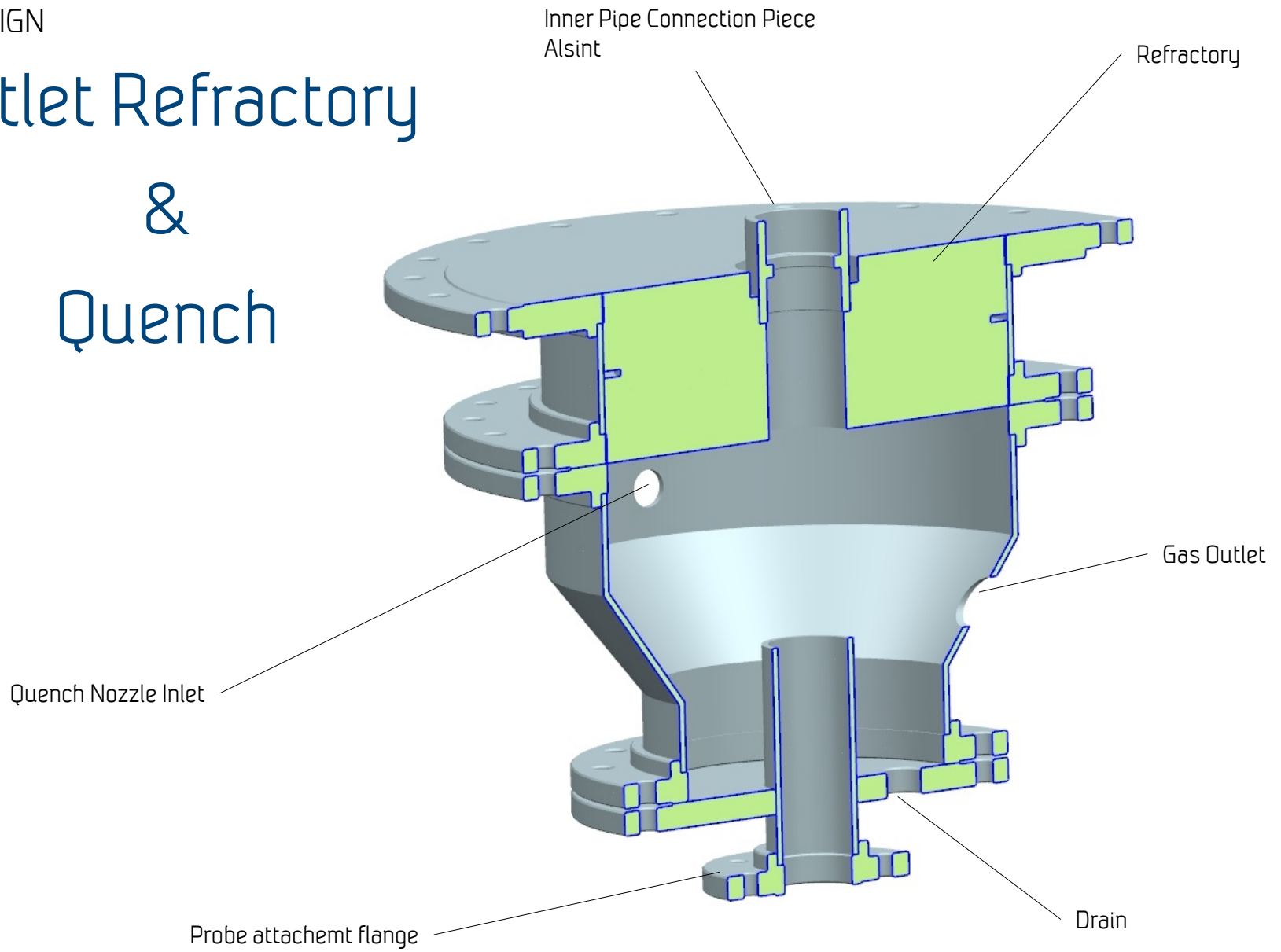
Assembled Section



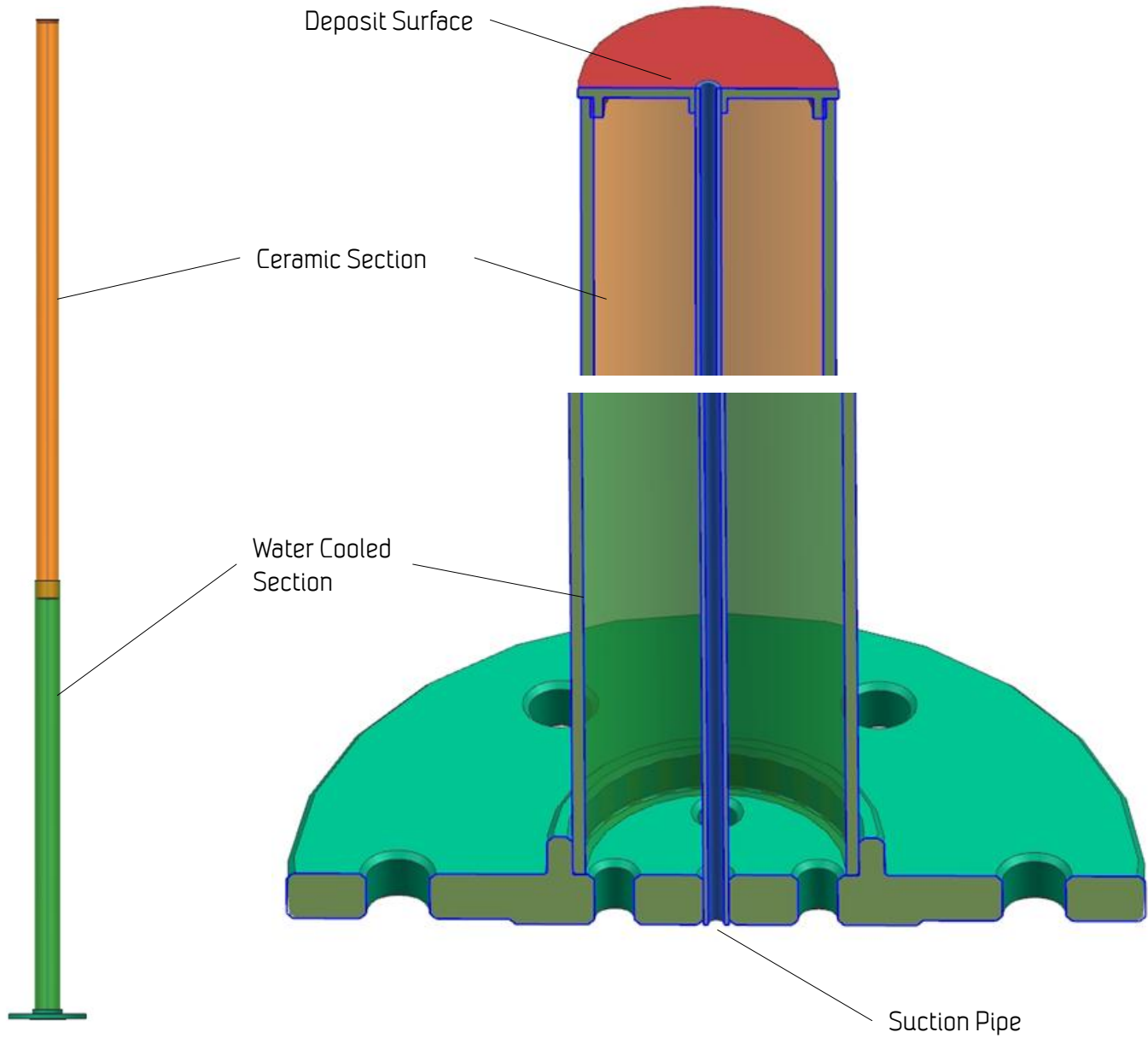
Heating Section

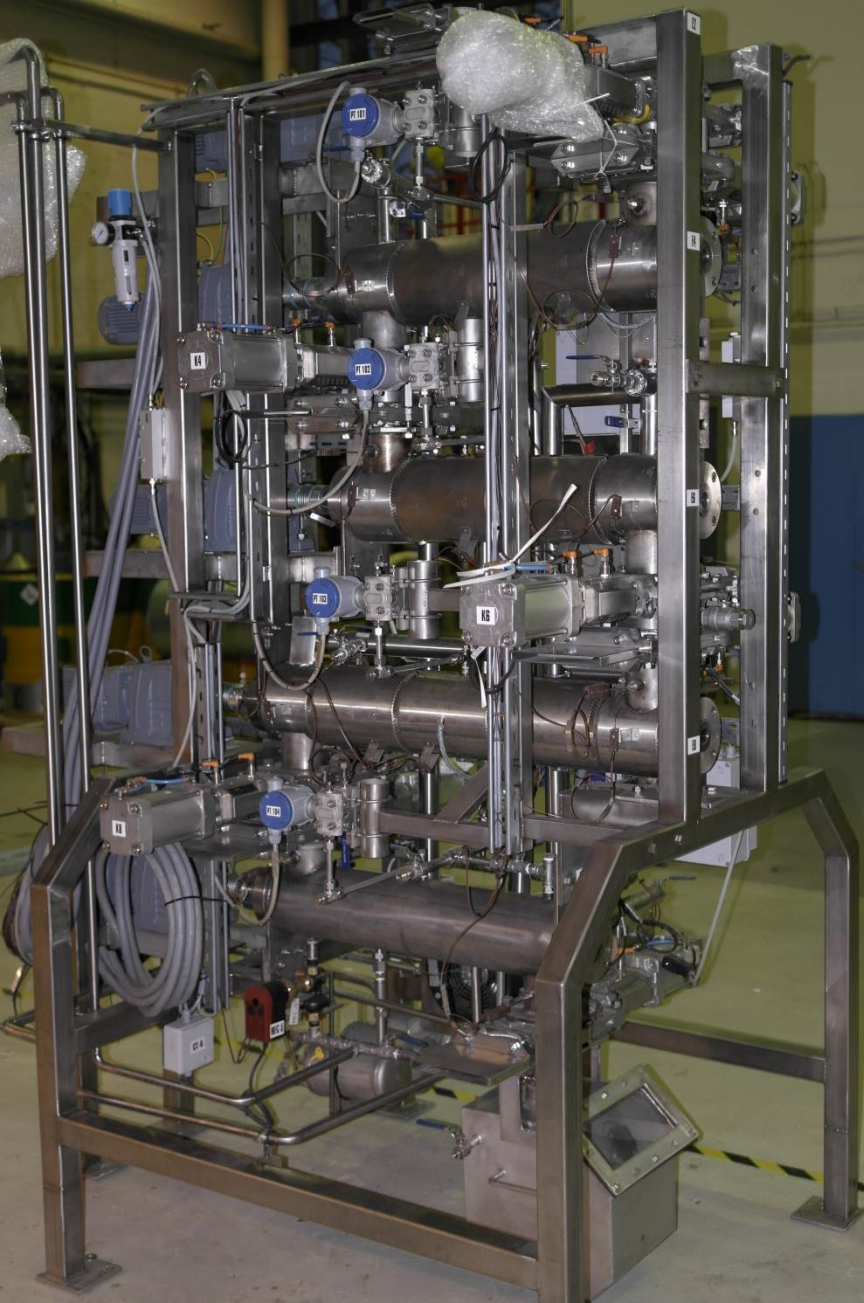


Outlet Refractory & Quench



Test Probe





Torrefaction reactor

Characteristics

Feed type	Woodchips, sawdust, straw, pellets, ...
Capacity	0.2 – 7 kg/h
Temperature	200 – 300 °C
Fuel size	1 – 25 mm
Bulk density	100 – 600 kg/m ³

Main Components

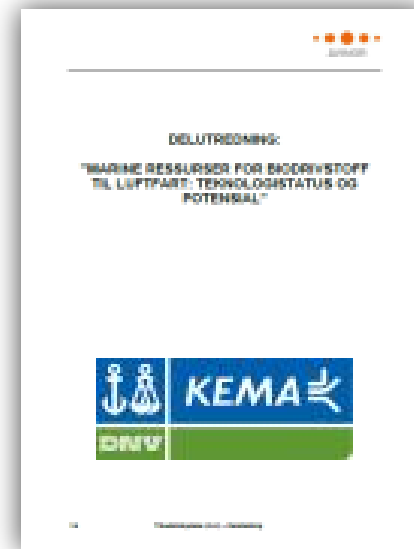
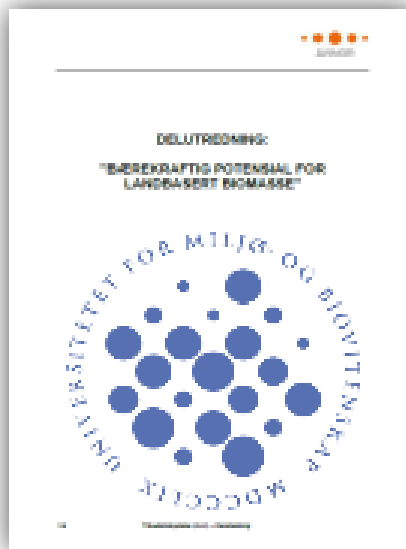
- Bin for raw material
- Feeding screw
- Drying conveyor
- Heating conveyor
- Torrefaction conveyor
- Cooling conveyor
- Sliding feeder between conveyors

Avinor project – BioJet production in Norway?

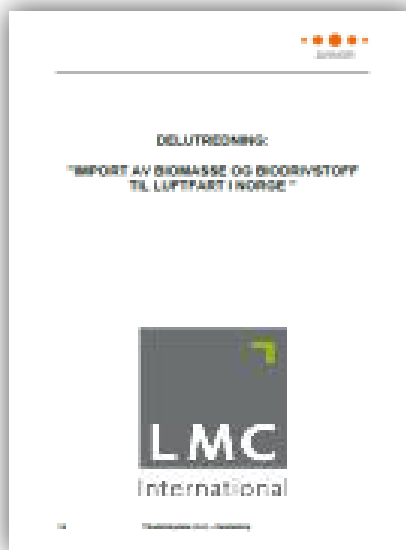
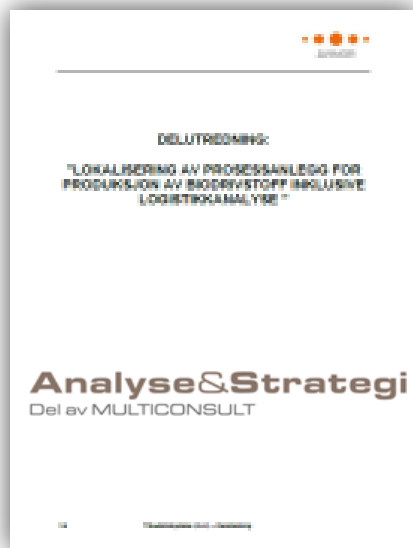
Avinor – Sustainable Bio Jetfuel for Norwegian Aviation

- **Feasibility study** initiated by Avinor, SAS, Norwegian and NHO Luftfart fall 2011
- Study the potential for **”Sustainable and commercially profitable production of sustainable bio jetfuel in Norway”**
- **Results** from the project were published **April 2013**
- Research question: What is the **cost** of one liter of sustainable **bio jetfuel** in Norway in 2020 and 2025?
 - what is the effect on **carbon emissions** (in the whole value chain)?





TECHNOLOGIES



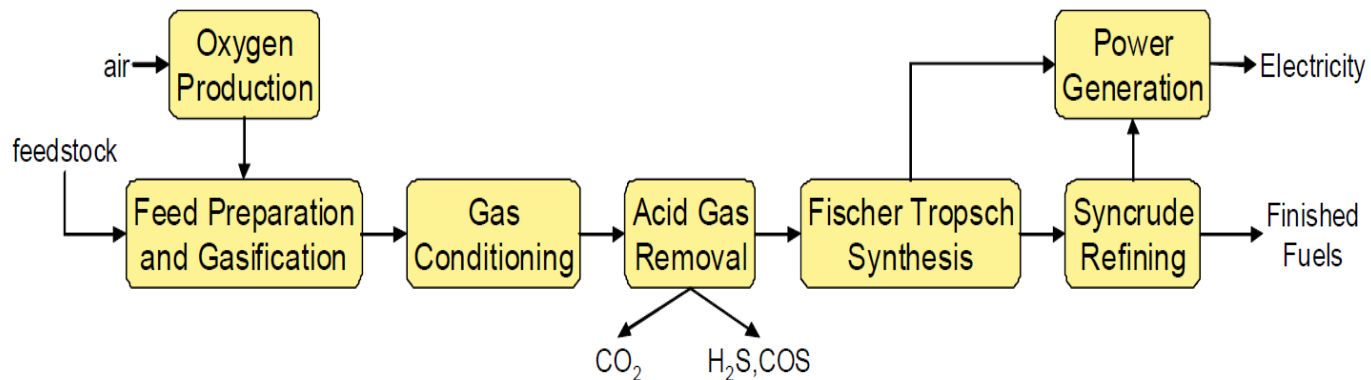
Rambøll

Results of the technology assessment

- SINTEF Energy Research has carried out a **technology assessment** for bio jetfuel production
- There are a **great number** of thinkable **technologies** and methods
- Only a **few technologies** (3) were considered in **details**
- Only **two technologies** considered suitable for **Norway**

Synthetic Fisher-Tropsch (FT) fuels

- Fuel derived from wood energy crops, agricultural and forestry residues, algal biomass, waste
- Large feedstock flexibility → gasification process → similar syngas quality
- Certified since 2009 by ASTM to be blended with conventional Jet A-1 up to 50%
- Strengths:
 - Large feedstock flexibility
 - Use of low-value feedstocks
- Challenges:
 - Investment cost of the plant is high



Sustainable Bio Jetfuel for Norwegian Aviation –results

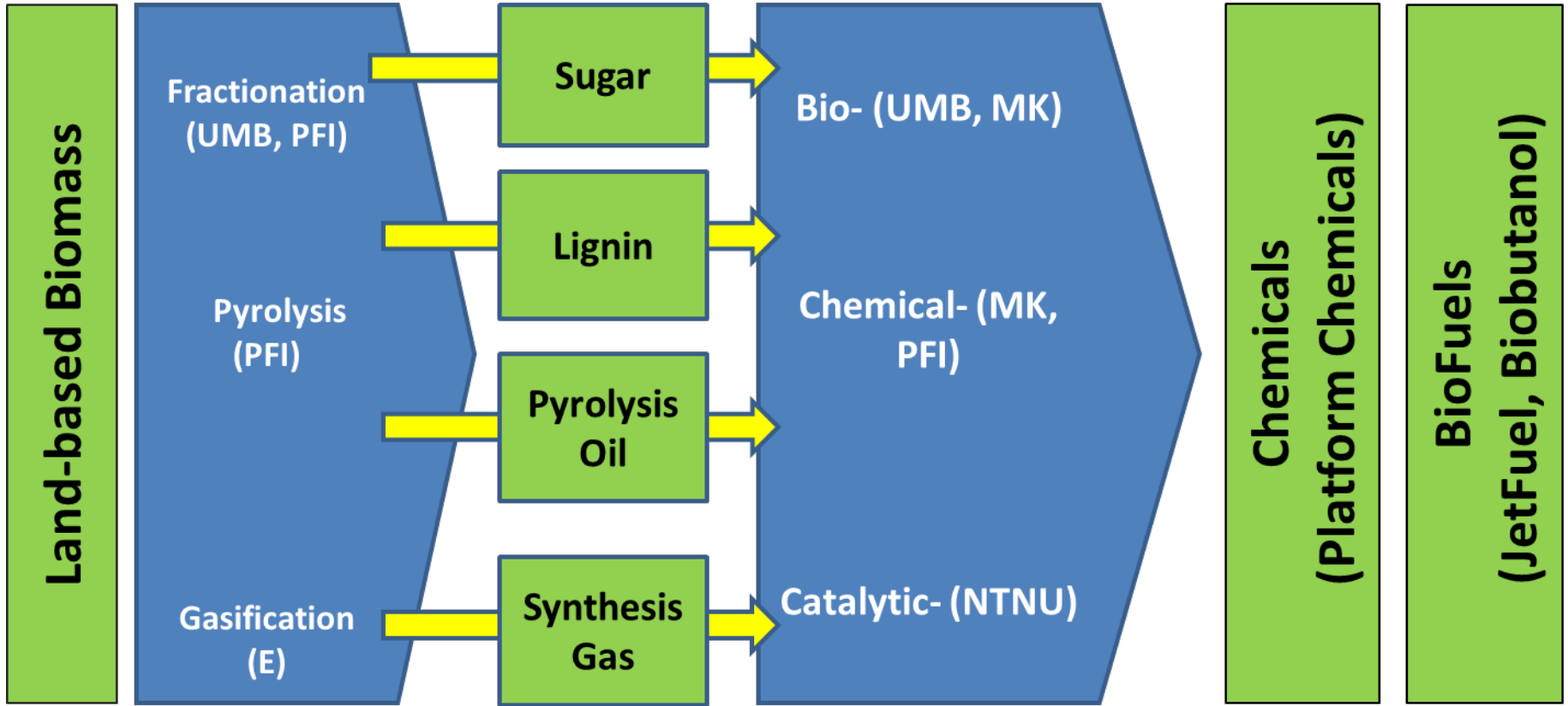
- Two alternatives:
 - Gasification → Fischer-tropsch:
 - Price: 11 NOK/L (2012), 7 NOK/L (2025), 5 NOK/L (price for by-products, included)
 - GHG reduction: 81%
 - Bio alcohols to jet
 - Price: 27 NOK/L (huge – 50% - uncertainty, no information obtained about by-products)
 - GHG reduction: 65%
- The report concludes that **it is possible to produce sustainable and cost efficient bio Jet-A1** in Norway by 2025.

Summary

- Until now, there are only **small scale waste/biomass-to-heat gasification** plants in Norway
- Norway has good competence and strong position within petrochemistry
- Medium/large scale **biomass gasification to BioJet** is a new opportunity for Norway
- **SINTEF Energy Research** has relevant **competence and tools** to help pave the way for **biojetfuel**
- A solid, **tight dialogue** with the most central national industrial partners has been established, as well as the **coordination of the research effort**

Pretreatment

Cost efficient Processing



Technical and Economical Evaluation (E, MK, PFI, UMB, NTNU)

A yellow biplane is parked on a wide, flat, snow-covered field. In the background, there is a dense line of evergreen trees under a clear blue sky. The foreground shows long, dark shadows cast across the snow.

***Thank you
for your attention!***