Bio4Fuels

Norwegian Centre for Sustainable Bio-Based Fuel and Energy

Sub Project 4 - Gasification processes

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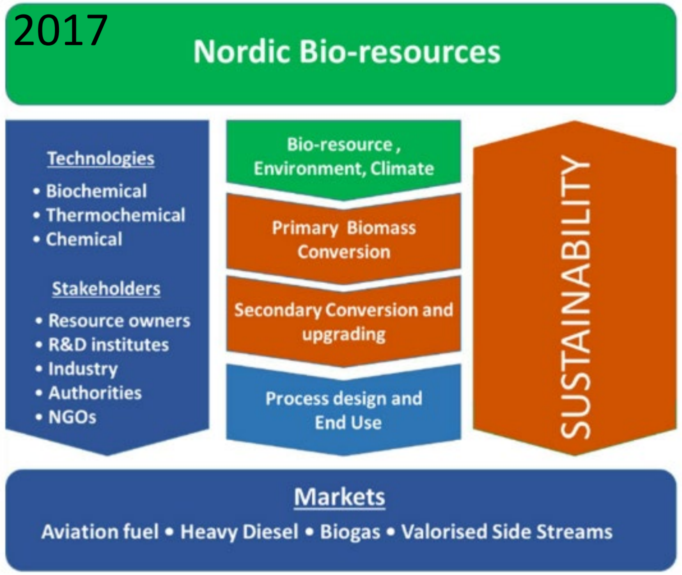
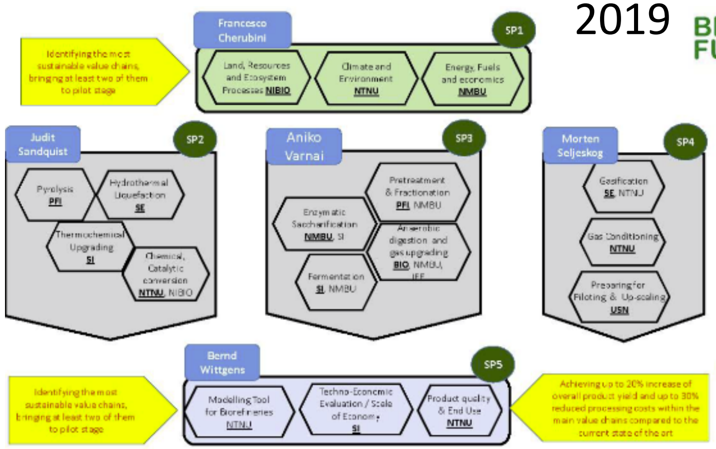
2017-2024

2017



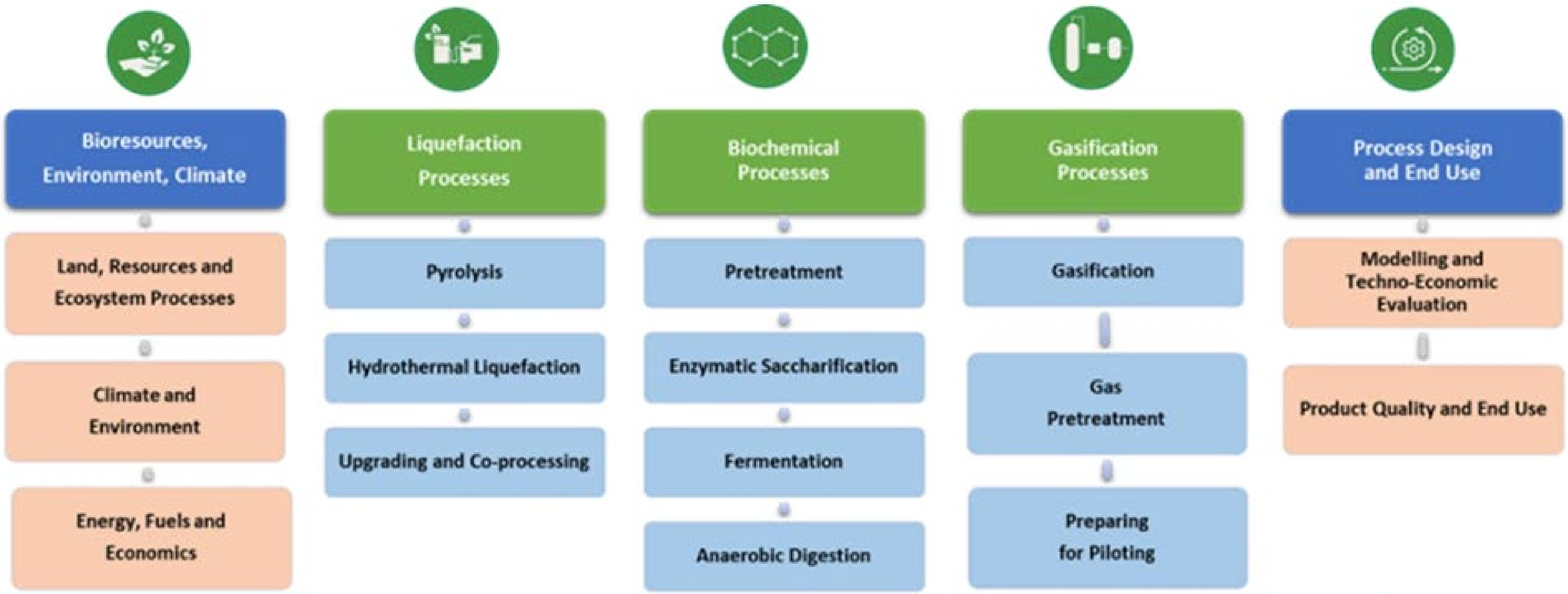
2019



2020

Going from conversion routes in 2019, to technological value chains resulted in a clearer perspective on the Centre goals

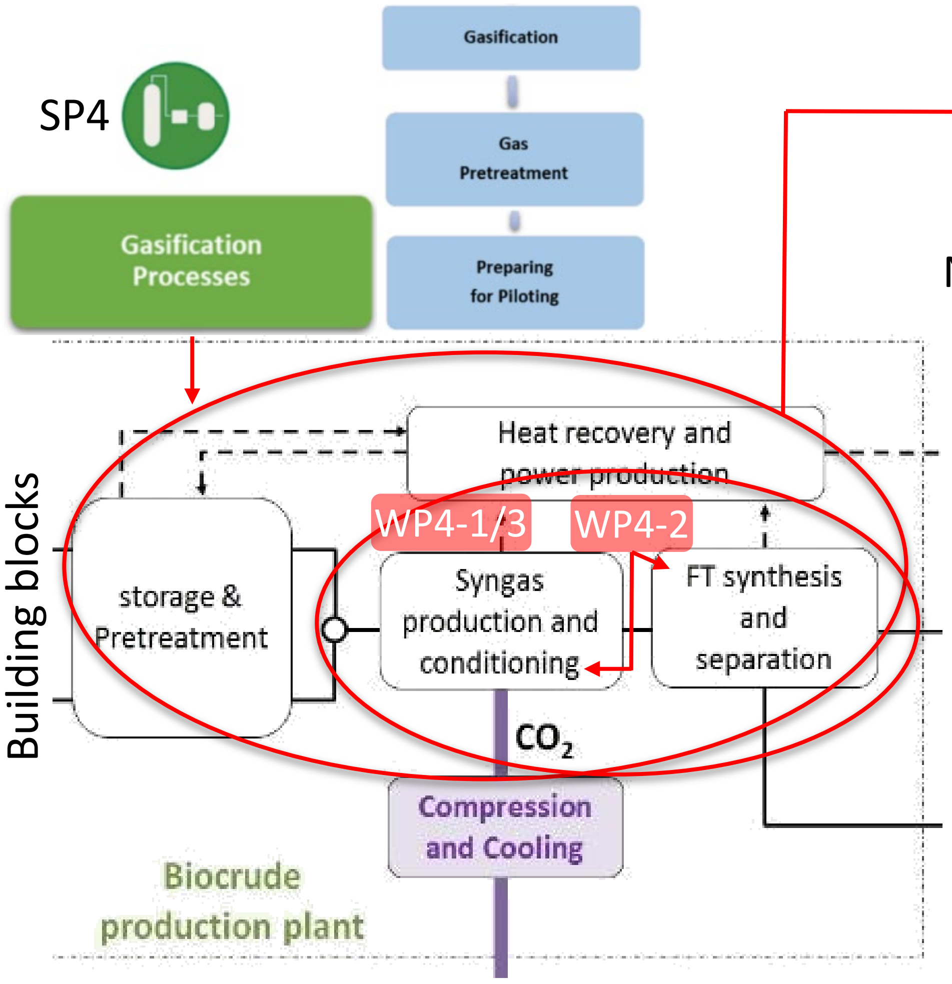
2024



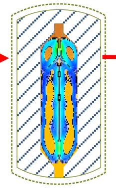
Objectives

Make this stuff work together for complex high-ash biogenic feedstocks, and mixtures of such with woody biomass

SP4



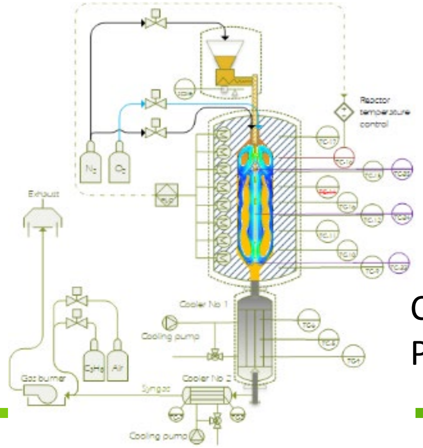
10-25 kW



New gasification tech.

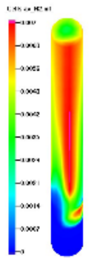
Fluidized bed, 20 kW

Entrained flow, 10-20 kW



Piloting and up-scale

WP4-3



Simulation Tools -> Aspen, Barracuda

Gasification

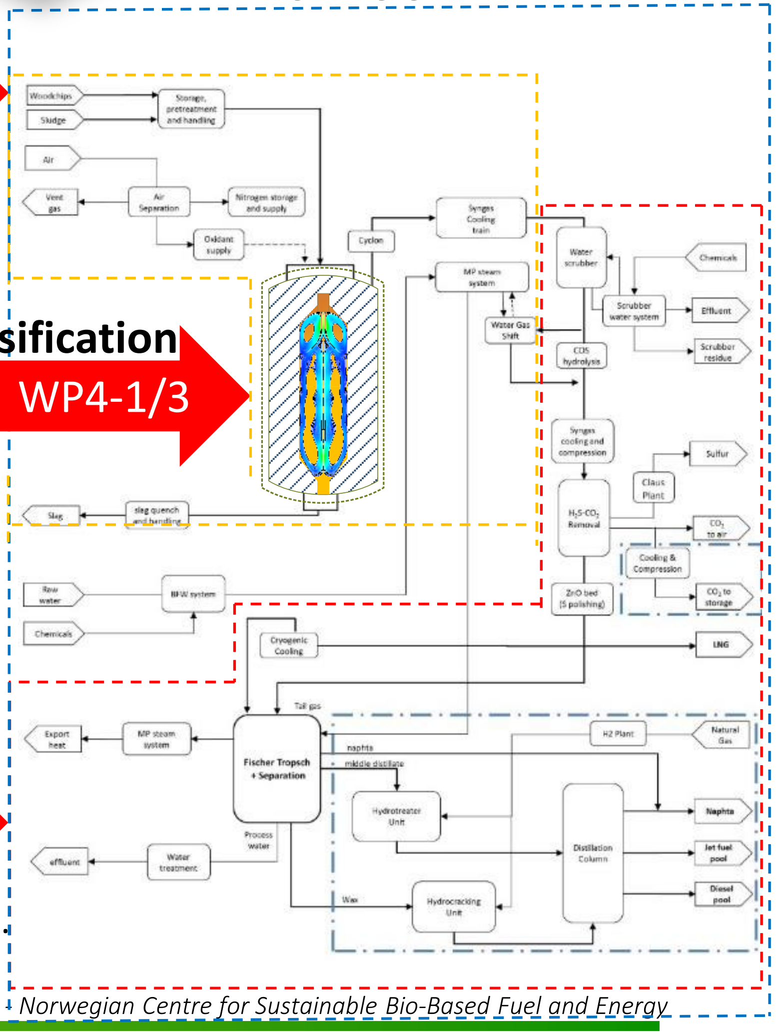
WP4-1/3

Gas cond. & Fischer Tropsch

WP4-2

Catalytic/sorbent tech.
Pilot/real gas

20-100 MW?



Highlights

WP 4.1 EF gasification, using O_2/steam as gasifying agents, p = 4-8 bars (SINTEF)

- Successful gasification of wood power from sawmill production, pulverized commercial lignin pellets, bio residues and mixtures of such with wood power (50/50 wt.%) as well as cultivated seaweed and mixtures of such with wood power (10/90, 20/80 and 30/70 wt.%)

WP 4.2 Gas pretreatment (NTNU)

- Improved understanding of manganese promotion and phosphorus poisoning on Co-based catalysts in BtL via Fischer-Tropsch Synthesis
- Steam reforming of HC impurities in syngas from biomass gasification with Ni-Co/Mg(Al)O catalysts, improved understanding of Ni-Co ratio effects, operating parameter effects and noble metal promotion effects

WP 4.3 Preparing for piloting (USN)

- Developed a multiscale Computational Particle Fluid Dynamics (CPFD) model for BFB and EFR
- BFB: Experiments with wood chips, wood-, grass- and biorefinery lignin pellets at varying reactor temperature, airflow- and biomass feed rates for validation of the CPFD model
- EFR: Parameter exploration; reactor temperature, steam-to-biomass ratio, equivalence ratio, and particle size.
- EFR: Simulation/validation, process optimization, sensitivity analysis of ST1 lignin

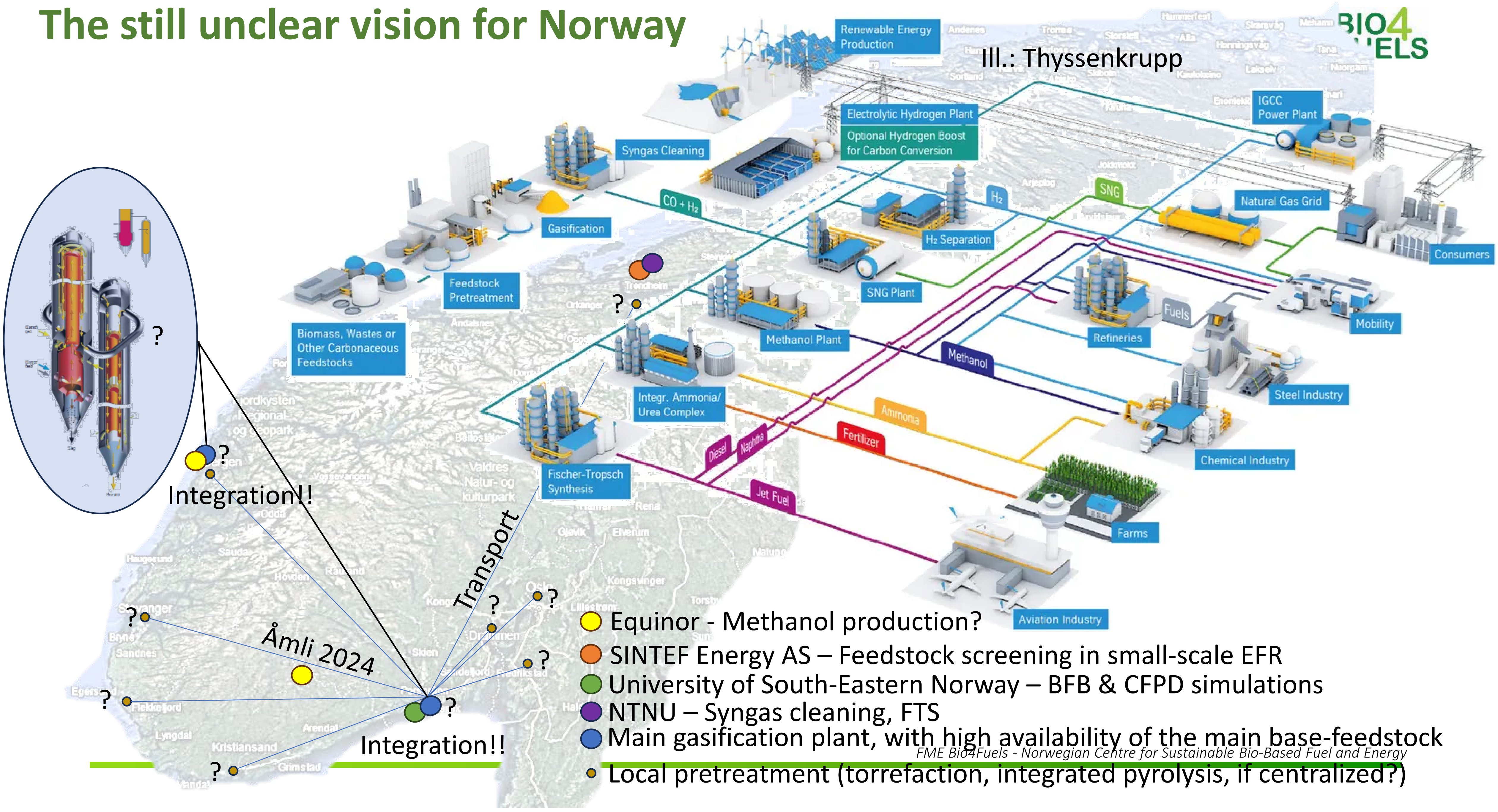
What do we know today?

- That bio residues and mixtures of such, with a suitable (e.g. residual forest waste) base feedstock can readily be gasified with 100% carbon conversion and varying degree of H2/CO ratio, depending on the given ratio of O2/steam gasification agents
- That integration of the gasification process into existing infrastructure is necessary to achieve competitive product costs
- That syngas in not only a valuable source for biofuel but also for higher valued products
  - Clean syngas could be used to enhance biogas production or to produce high value chemical and biofuels through various processes like fermentation and electro-chemical conversion
- FTIR and GC measurements has given us insight into what are the constituents of syngas
- That this gasification process can be modelled to a high degree of accuracy using Computational Fluid and Particle Dynamics (CFPD), for further use in process up-scaling and low-grade feedstocks
- Much, but not all, on how to condition the syngas and prepare it for FTS conversion, as well as the FTS process itself
  - Though, an EFR operated at ash-melting conditions inhibits the cleanest, pre-condition, syngas – compared to other types of gasification

Further research is needed?

- How to scale-up/down gasification reactors (TRL ≈ 6-9) process
  - However, technology exists in the marked (e.g. Thyssenkrupp, Shell…) that could be adapted to national feedstock streams, hence providing the size of the plant
- How to down-scale the FT process to suit a smaller plant (50-100 MW?) for Norwegian conditions
- Which type of gasification reactor that most suits Norwegian conditions
  - One large main reactor (type?) or two parallel ones (and of which type)
- Where the main gasification plant should be situated (Herøya, Mongstad…)
- Is Hydrothermal gasification (HTG, TRL ≈ 6) a viable parallel alternative
- How to optimize the pretreatment and the collection of various feedstock, and how these should be transported to the main gasification plant
- How to best compose optimum feedstocks from mixtures of locally available ones, with a base feedstock available at the plant site, for a robust gasification process
- Can MSW be used for syngas production and what is needed in terms of syngas conditioning?
- Can mixtures of Refuse Derived Fuel (RDF) or Solid Recovered Fuels (SRF) be gasified if mixed with a suitable amount base feedstock? What about conditioning?

The still unclear vision for Norway



- Equinor - Methanol production?
- SINTEF Energy AS – Feedstock screening in small-scale EFR
- University of South-Eastern Norway – BFB & CFPD simulations
- NTNU – Syngas cleaning, FTS
- Main gasification plant, with high availability of the main base-feedstock
- Local pretreatment (torrefaction, integrated pyrolysis, if centralized?)

Let's hope for an SFI!

CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
The Research Council of Norway