Trondheim, May the 25th 2016

Presentation of GAFT for Aviation Biofuels through Biomass Gasification GAFT/IEA workshop

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Brief overview of the project

- GAFT is a competence building project (KPN)

- Financed by:
  - The Research council of Norway (80 %)
  - Industry partners (20 %)

- Project duration: 4 years (2015 – 2018)

- Total Budget: 20 MNOK

GAFT industry and R&D partners

Partners:	
SINTEF Energi AS	Project leader
NTNU	R&D partner
Stiftelsen SINTEF	R&D partner
SP Energy Technology Center AB	R&D partner
Johnson Matthey	R&D partner
Avinor	Industry partner
Silva Green Fuel AS	Industry partner
Viken Skog	Industry partner
CAMBI ASA	Industry partner
ECOPRO AS	Industry partner
The Research Council of Norway	Financing organ

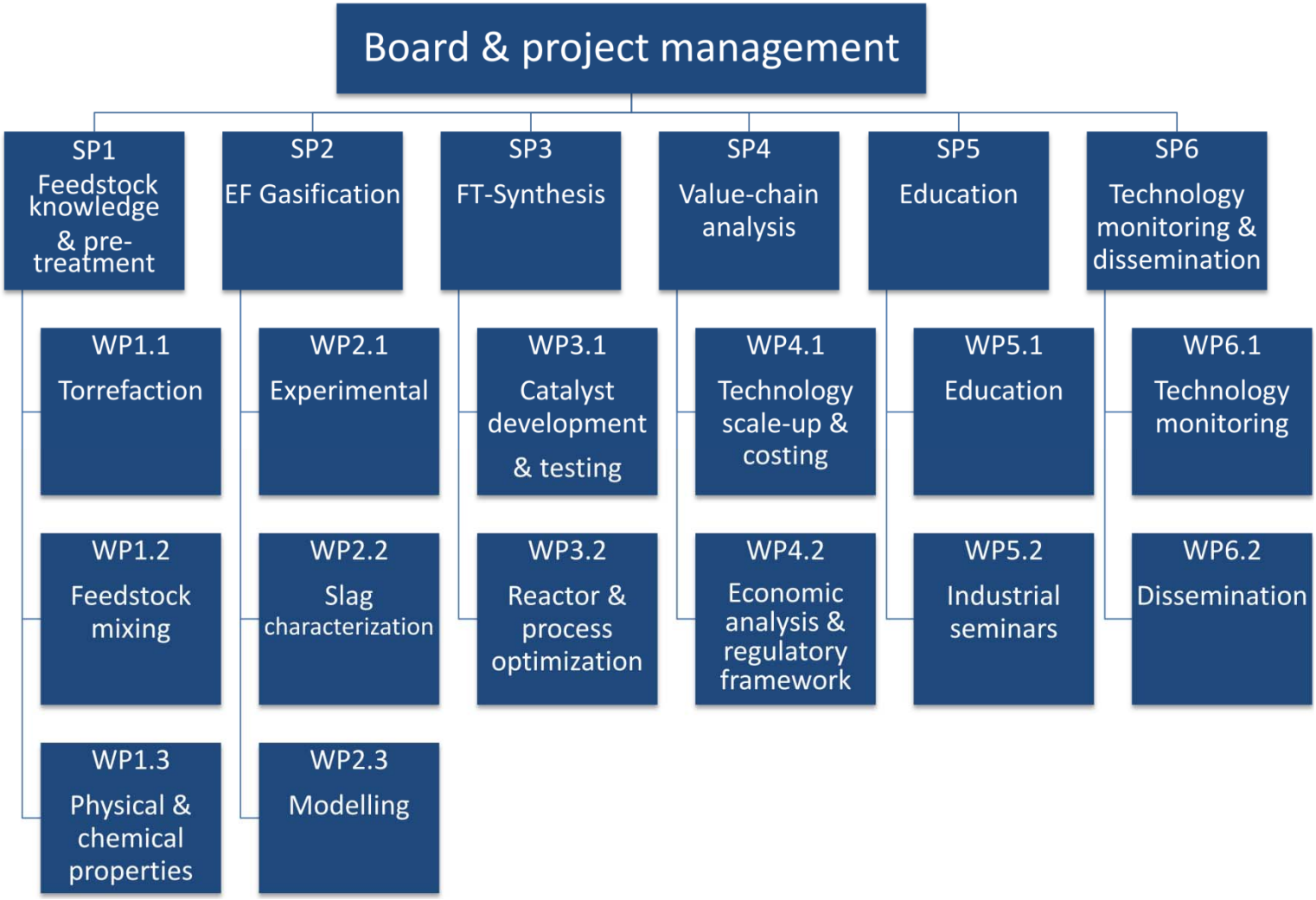
Brief overview of the project

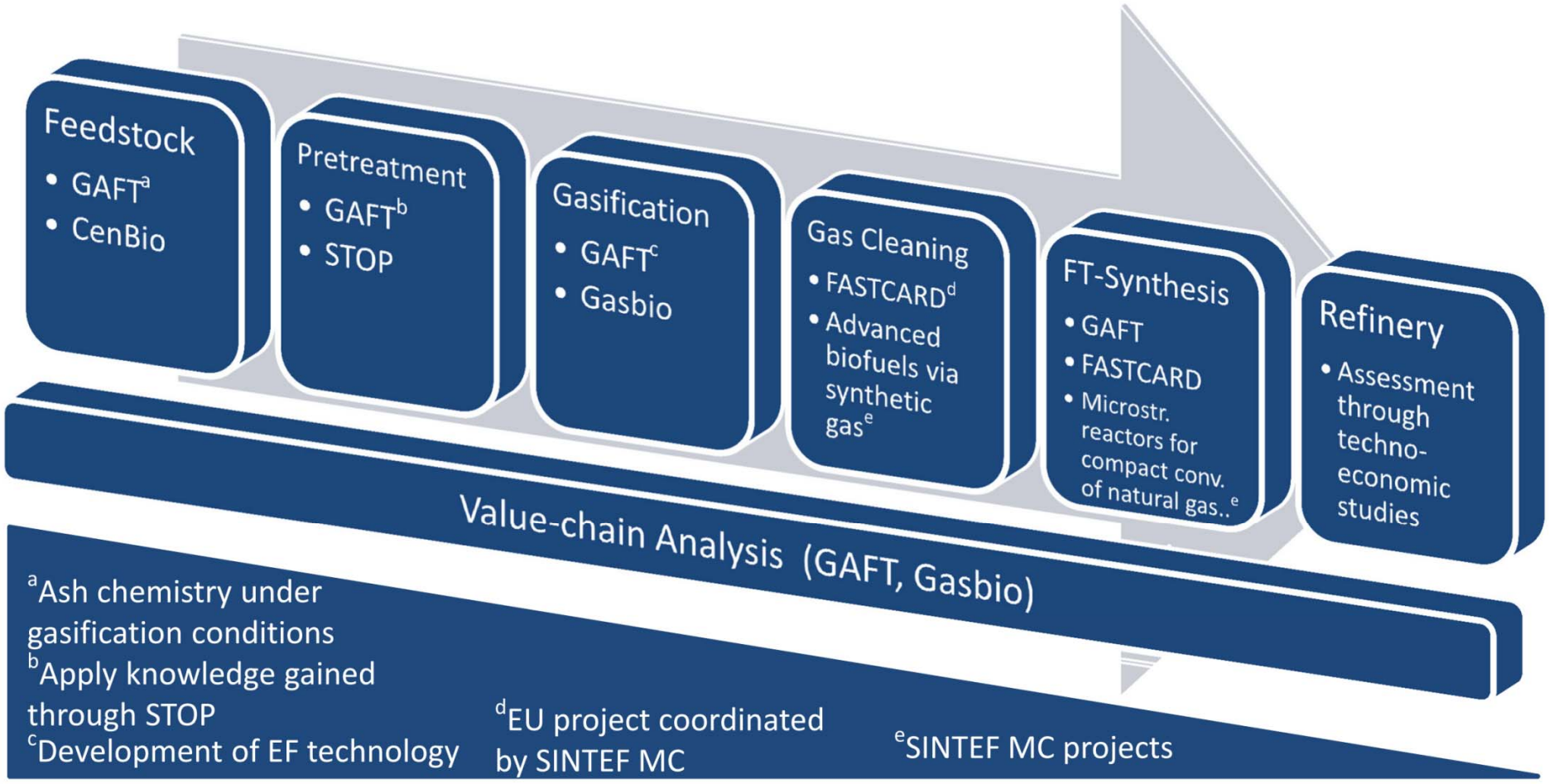
Objectives

To contribute to accelerated implementation of liquid biofuels production in Norway

Sub-objectives:

- Support implementation of pre-treatment methods, with particular attention to feedstock mixing and torrefaction that allow the use of challenging biomass in entrained flow (EF) gasification
- EF gasification technology improvement through lab experiments and modelling
- Fischer-Tropsch synthesis development for medium scale (150 – 500 MW thermal input)
- Techno-economic assessment of the overall biofuels production process with integration of heat recovery for relevant Norwegian business cases (Follum and Tofte sites)
- Education of highly skilled candidates within this area and training of industry partners


Board & project management
SP1
Feedstock knowledge & pre-treatment
SP2
EF Gasification
SP3
FT-Synthesis
SP4
Value-chain analysis
SP5
Education
SP6
Technology monitoring & dissemination
WP1.1
Torrefaction
WP1.2
Feedstock mixing
WP1.3
Physical & chemical properties
WP2.1
Experimental
WP2.2
Slag characterization
WP2.3
Modelling
WP3.1
Catalyst development & testing
WP3.2
Reactor & process optimization
WP4.1
Technology scale-up & costing
WP4.2
Economic analysis & regulatory framework
WP5.1
Education
WP5.2
Industrial seminars
WP6.1
Technology monitoring
WP6.2
Dissemination


Feedstock
• GAFT[a]
• CenBio
Pretreatment
• GAFT[b]
• STOP
Gasification
• GAFT[c]
• Gasbio
Gas Cleaning
• FASTCARD[d]
• Advanced biofuels via synthetic gas[e]
FT-Synthesis
• GAFT
• FASTCARD
• Microstr. reactors for compact conv. of natural gas..[e]
Refinery
• Assessment through techno-economic studies
Value-chain Analysis (GAFT, Gasbio)
[a]Ash chemistry under gasification conditions
[b]Apply knowledge gained through STOP
[c]Development of EF technology
[d]EU project coordinated by SINTEF MC
[e]SINTEF MC projects

Gantt diagram for GAFT SPs and tasks	Executive partner	Year 2015 Q2 Q3 Q4 2016 Q2 Q3 Q4 2017 Q2 Q3 Q4 2018 Q2 Q3 Q4	Budget kNOK
SP0 – Project management	SINTEF ER		2200
SP1 – Feedstock knowledge & pre-treatment	SINTEF ER		1772
Task 1.1.1 Pre-treatmen via torrefaction for …	SINTEF ER		467
Task 1.2.1 Production of feedstock mixtures …	SINTEF ER		600
Task 1.3.1 Optimal particle size distribution for …	SINTEF ER		255
Task 1.3.2 Optimal ash composition through …	SINTEF ER		450
SP2 – EF-Gasification	SINTEF ER		3550
Task 2.1.1 EF gasification study for syngas …	SINTEF ER		900
Task 2.1.2 Influence of gasification condition …	SINTEF ER		900
Task 2.1.3 Reactivity of products of incomplete …	SINTEF ER		700
Task 2.1.4 Scalability experiments, tests …	ETC		750
Task 2.2.1 Simulation (PhD Work)	NTNU		0
Task 2.2.2 Comparative study (PhD Work)	NTNU		0
Task 2.2.3 PhD student follow-up and guidance	SINTEF ER		300
SP3 – Fischer-Tropsch Synthesis	SINTEF MC		3500
Task 3.1.1 Catalyst screening	SINTEF MC		1000
Task 3.1.2 Effect of process conditions	SINTEF MC		1200
Task 3.2.1 Reactor and process optimization for …	SINTEF MC		1300
SP4 – Value-chain analysis	SINTEF ER		2950
Task 4.1.1 Scale-up analysis of FT biocrude …	SINTEF ER		900
Task 4.1.2 FT biocrude upgrading at refinery: …	SINTEF ER		500
Task 4.2.1 Regulatory framework and incentives strategy	SINTEF ER		500
Task 4.2.2 Risks and mitigation analysis	SINTEF ER		450
Task 4.2.3 Economic viability assessment	SINTEF TS		600
SP5 – Education	NTNU		4198
Task 5.1.1 Education of PhD candidate	NTNU		3073
Task 5.1.2 Education of Master candidates	SINTEF ER		200
Task 5.1.3 Summer student programme	SINTEF ER		200
Task 5.2.1 Training of the industry	SINTEF ER		725
SP6 – Technology monitoring and dissemination	SINTEF ER		1830
Task 6.1.1 Technology monitoring	SINTEF ER		400
Task 6.1.2 IEA Task participation	SINTEF ER		920
Task 6.2.1 Website	SINTEF ER		190
Task 6.2.2 Newsletters	SINTEF ER		200
Task 6.2.3 Publishing	SINTEF ER		0
Task 6.2.4 eRoom	SINTEF ER		120

◆ = JP, ▲ = Presentation, ◆ = PhD thesis, ▲ = Presentation for IEA Task members, ★ = Milestone

Torrefaction

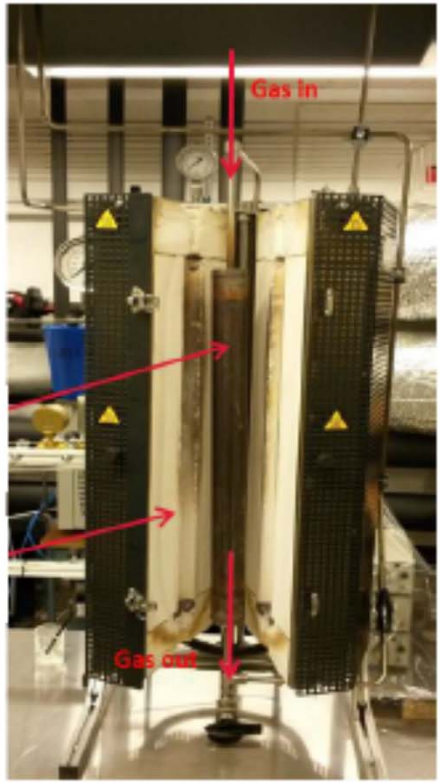
Feedstocks:

- Stem wood (debarked): 1 x 1 cm cubes
- Bark: chipped into pieces (~5-7 cm)
- Stump: shredded into pieces (~3-5 cm)

Torrefaction conditions:

- Temperature: 225 °C, 275 °C and 300 °C
- Residence time: 30 min and 60 min

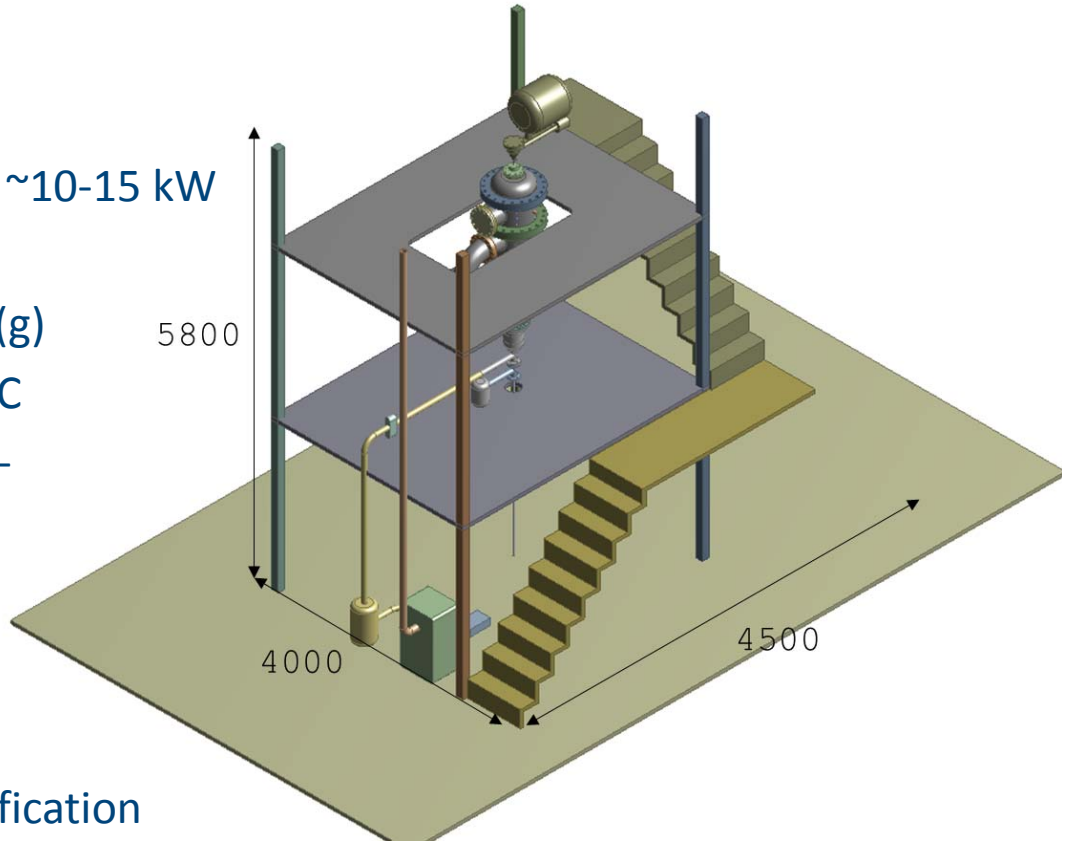
The raw and torrefied samples were ground by a cutting mill to <1 mm particle size.



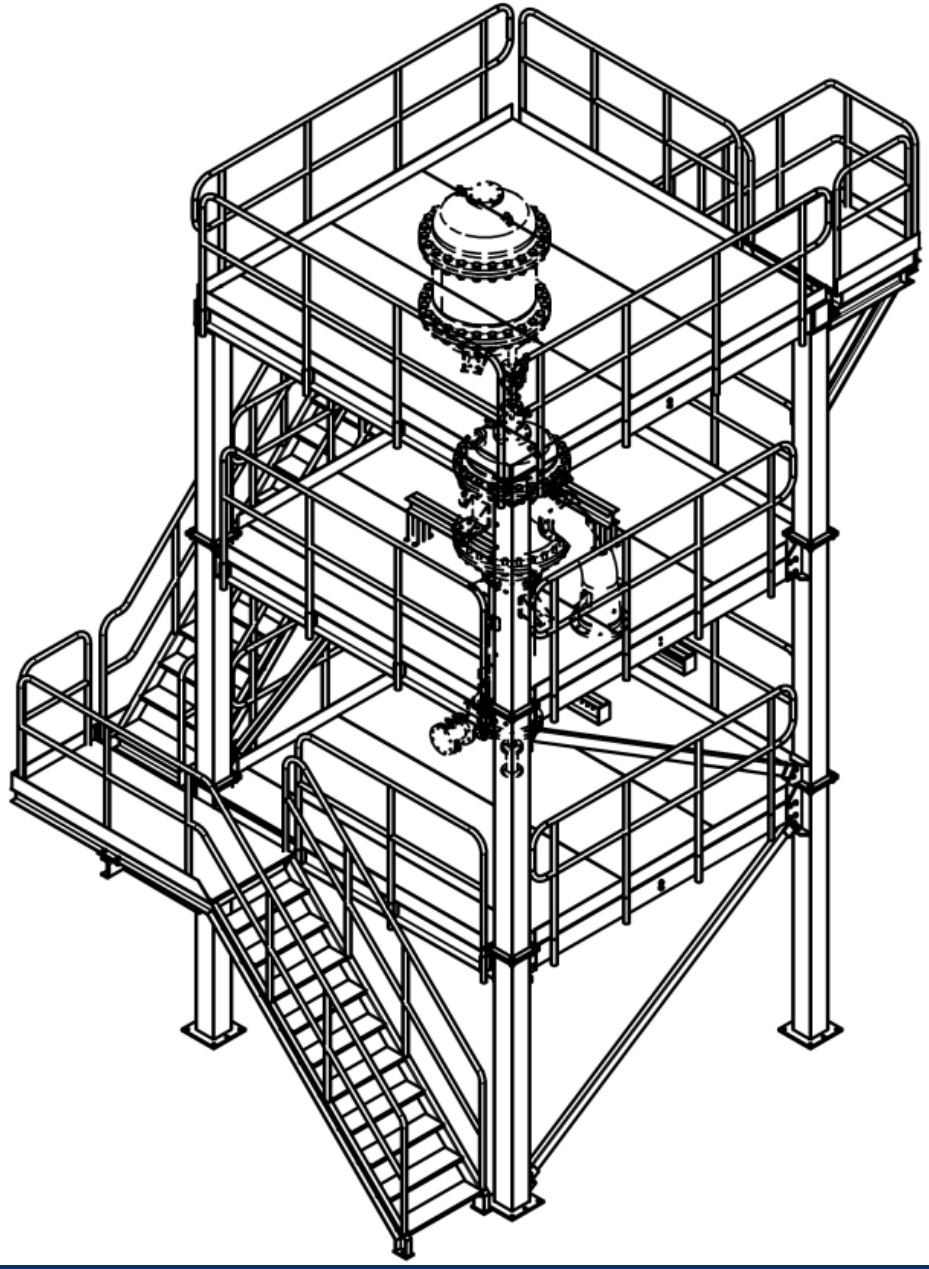
- Sample amount: ~ 80 g
- Heating rate: 10 °C/min
- Atmosphere: Nitrogen

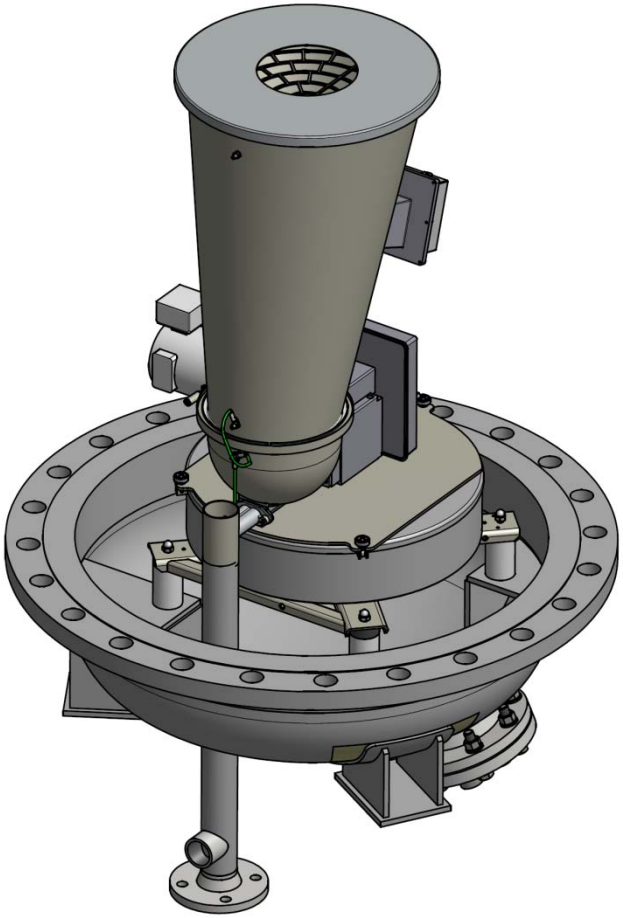
Specification and purpose

- Fuel flow rate: 2 kg/h ~10-15 kW
- Number of operators : 2
- Pressure: 10 bar(g)
- Wall heater temperature: 1500 °C
- Fuel particle size distribution: 50 µm-
- Continues operating time: 6 h

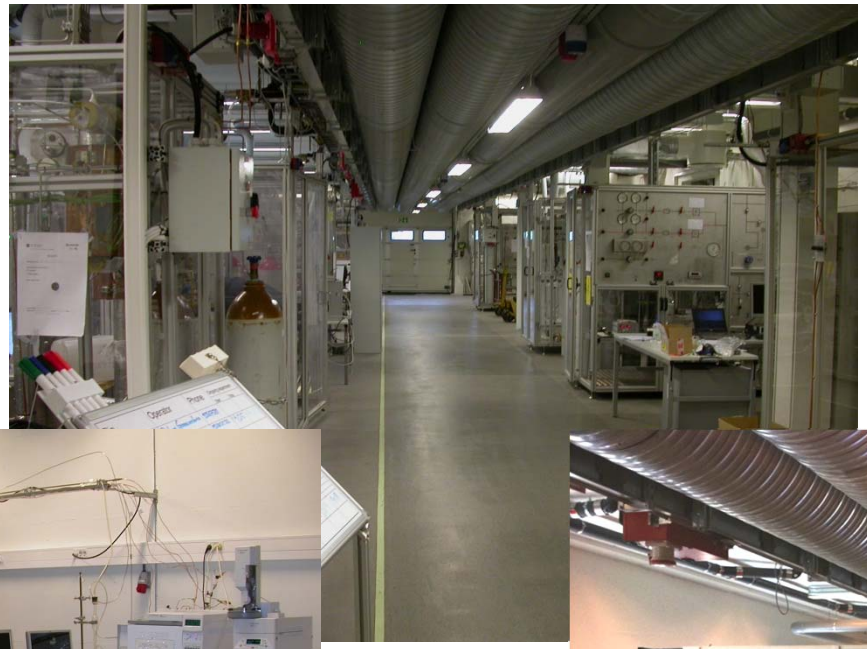


- The reactor will primarily be use to;
  - Study if a fuel is suitable for gasification
  - Study soot and tar formation from gasified biomass
  - Provide validation data to numerical models

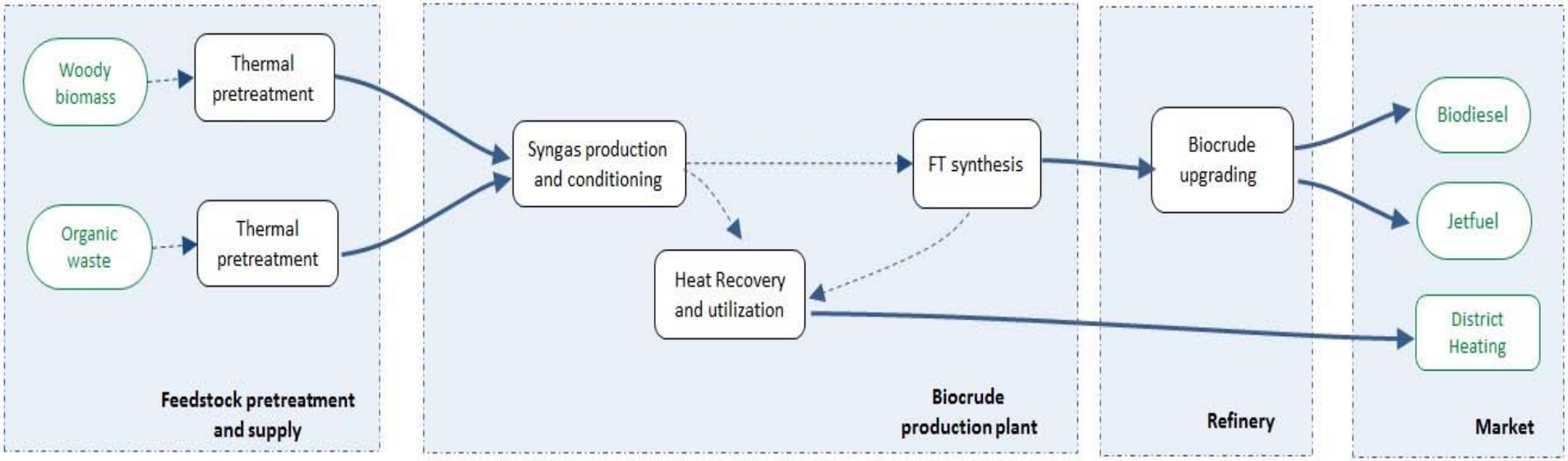




Advanced testing facilities:
From micro-scale to industrial pilot



GAFT: Value chain model for production of liquid biofuels from co-processing low grade woody biomass and organic waste



Thank you for your time