Güssing: Small scale gasification-FT

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Vienna, University of Technology
Bioenergy 2020+

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Technology for People

Institute of Chemical Engineering

166_3 Chemical Process Engineering & Energy Technology

Future Energy Technology

- Biomass gasification and gas cleaning
- Synthetic biofuels – BioFiT, BioSNG
- CO_2 separation processes – Chemical Looping Combustion

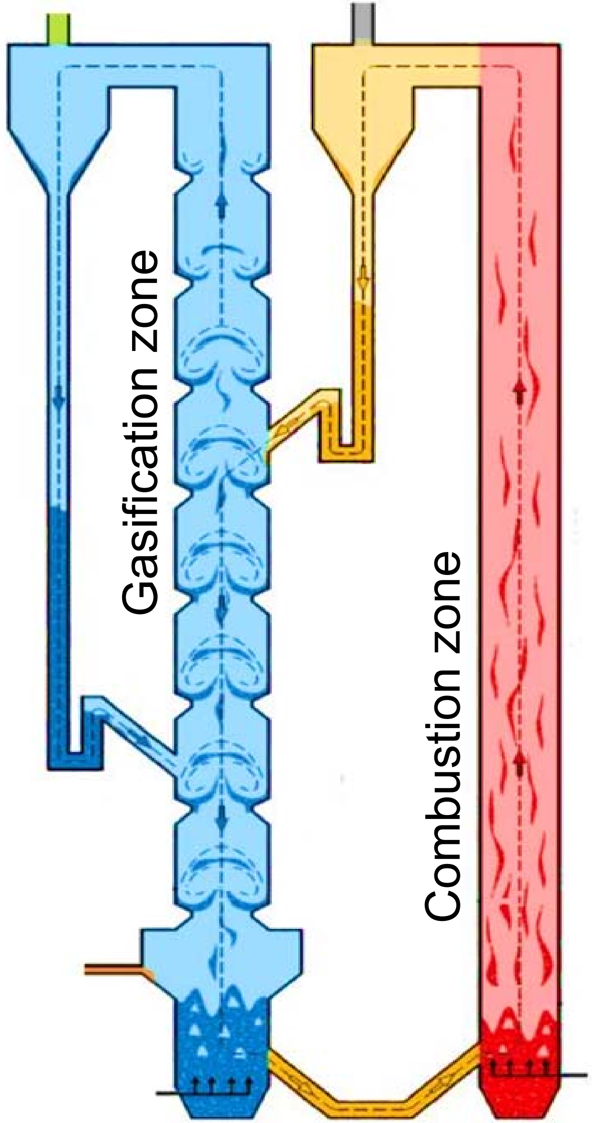
Reaction Engineerińg & Combustion

- Recovery of minerals, metals and plant nutrients from incineration residues
- High temperature process engineering
- Fluidized bed conversion - IEA

Fluidized Bed Systems and Refinery Technology

- Operation of FCC pilot plant
- Catalyst testing
- Bio fuels from cracking of bio oils
- Adsorber optimization of vapour recovery units

New design of gasifier: G-Volution



- no more limit in scaling-up, as there is no stationary fluidized bed anymore
- excellent gas-solids contact between catalytic bed material and product gas, so lower tar content
- increases of residence times for fuel particles as well as gases with regard to gas-solids interaction
- solids residence time distribution resembles a cascade of stirred vessels (dispersed downward movement of solids)
- 100 kW pilot plant at Vienna, University of Technology is in operation

BIOENERGY2020+

Competence Centers for
Excellent Technologies

BE2020: 3 locations + *2 research sites*
15 years of experience

Field of competences

Scientific Coord.: H. Hofbauer
CEO: W. Haslinger, R. Schmid

Area 1: Biomass combustion systems
AM: A Weissinger
KR: C Hochenauer
SA: C Schmidl

Area 2: Biomass gasification systems
AM: R Rauch
KR: H Hofbauer

Area 3: Bio-conversion and biogas systems
AM: G Drosg
KR: W Fuchs

Area 4: Cross-cutting topics

Sub-Area 4.1: Sustainable supply and value chains
AM: C Strasser, KR: P Schwarzbauer

Sub-Area 4.2: Automation and control
AM: M Gölles, KR: C Hochenauer, SA: M Horn

Sub-Area 4.3: Modeling and simulation
AM: R. Mehrabian Bardar, KR: C Hochenauer, SA: R Scharler

Infrastructure: Lab services: Head: N Kienzl

AM.. Area Manager
KR.. Key Researcher
SA.. Scientific Advisor

Area 2
Biomass Gasification Systems

- Increase of resource basis including biogeneous residues
- Biomass for industrial applications, e.g. substitution of natural gas
- Syngas-platform for bio-refineries
- Plants with poly-generation (heat, electricity, fuel)
- Hybrid systems with other RE

The basic concept – "Green Chemistry"

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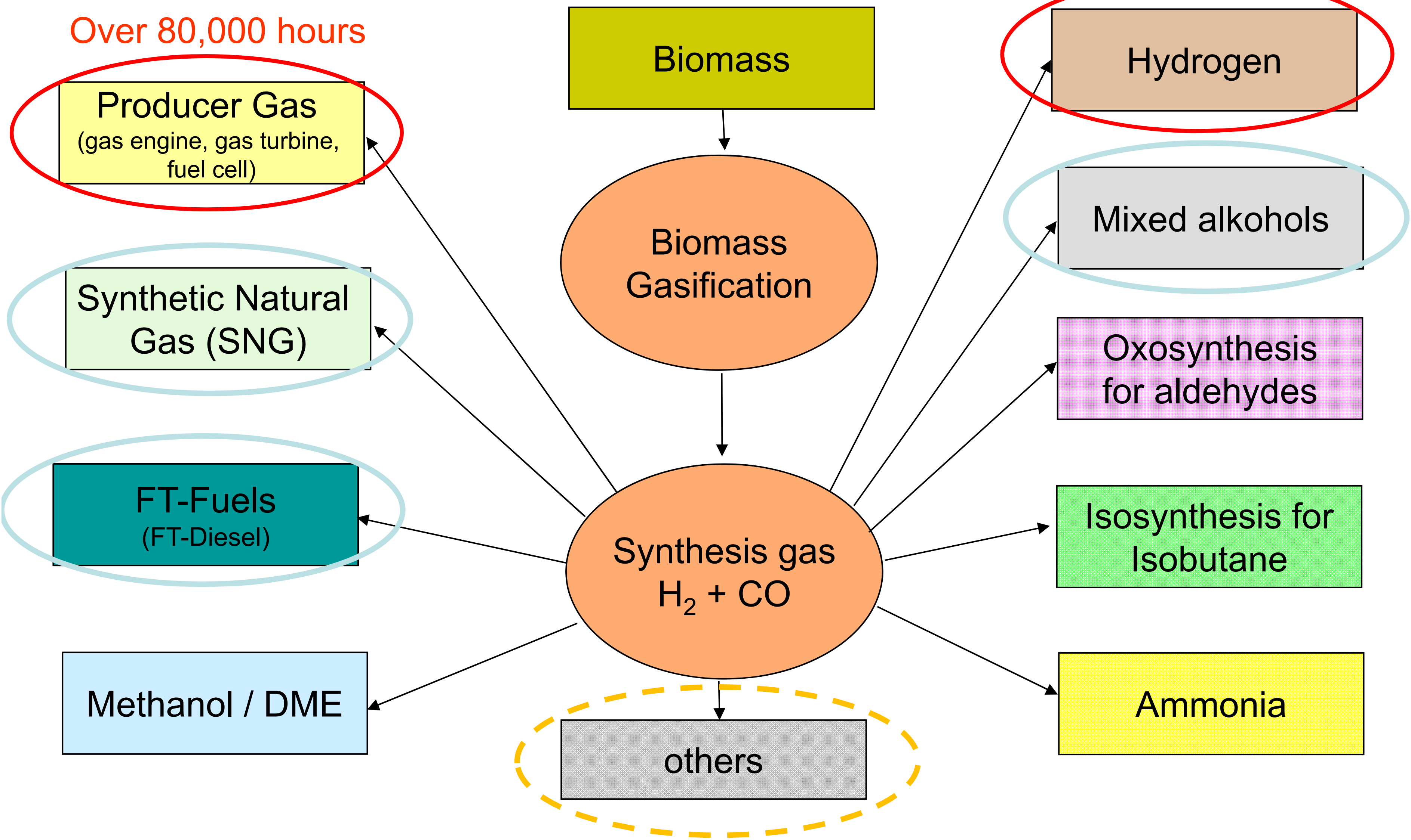
Over 80,000 hours



Aviation fuels

According to ASTM D7566 − 16 “Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons the following hydrocarbons can be blended into kerosene:

- A1. FISCHER-TROPSCH HYDROPROCESSED SYNTHESIZED PARAFFINIC KEROSINE
- A2. SYNTHESIZED PARAFFINIC KEROSINE FROM HYDROPROCESSED ESTERS AND FATTY ACIDS
- A3. SYNTHESIZED ISO-PARAFFINS FROM HYDROPROCESSED FERMENTED SUGARS
- A4. SYNTHESIZED KEROSINE WITH AROMATICS DERIVED BY ALKYLATION OF LIGHT AROMATICS FROM NONPETROLEUM
- SOURCES
- A5. ALCOHOL-TO-JET SYNTHETIC PARAFFINIC KEROSENE (ATJ-SPK)

GreenFly

R&D project on kerosene from biomass, with focus on usage in Wankel engine

Institut für Fahrzeugantriebe & Automobiltechnik

Institute of Chemical Engineering

renewable power technologies

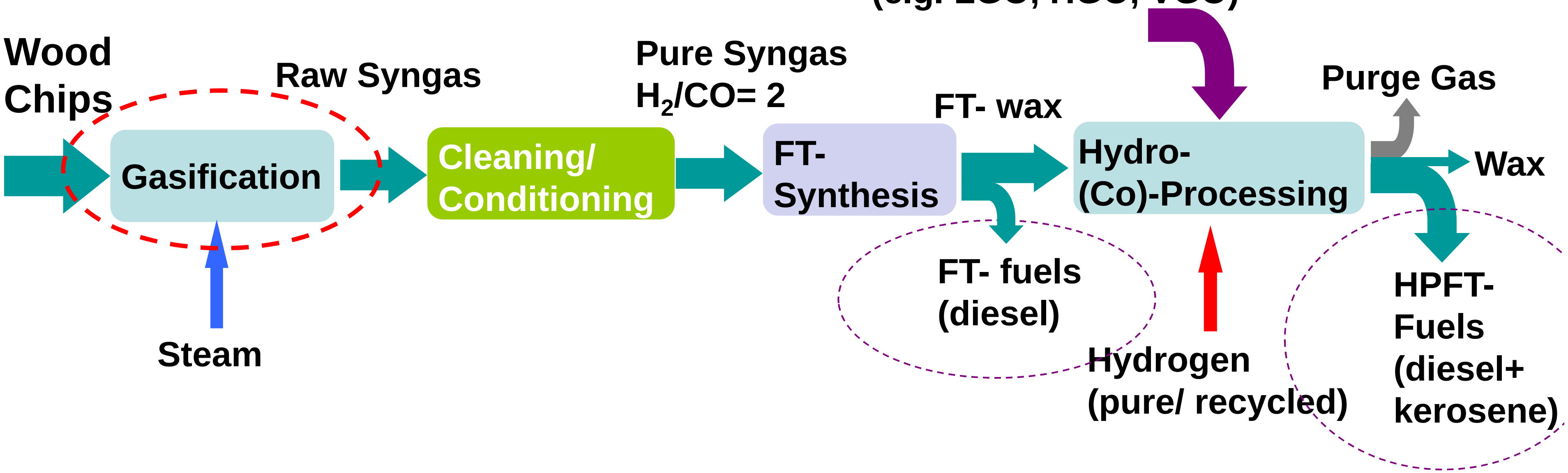
Funded by:

TAKE OFF Call, 2012

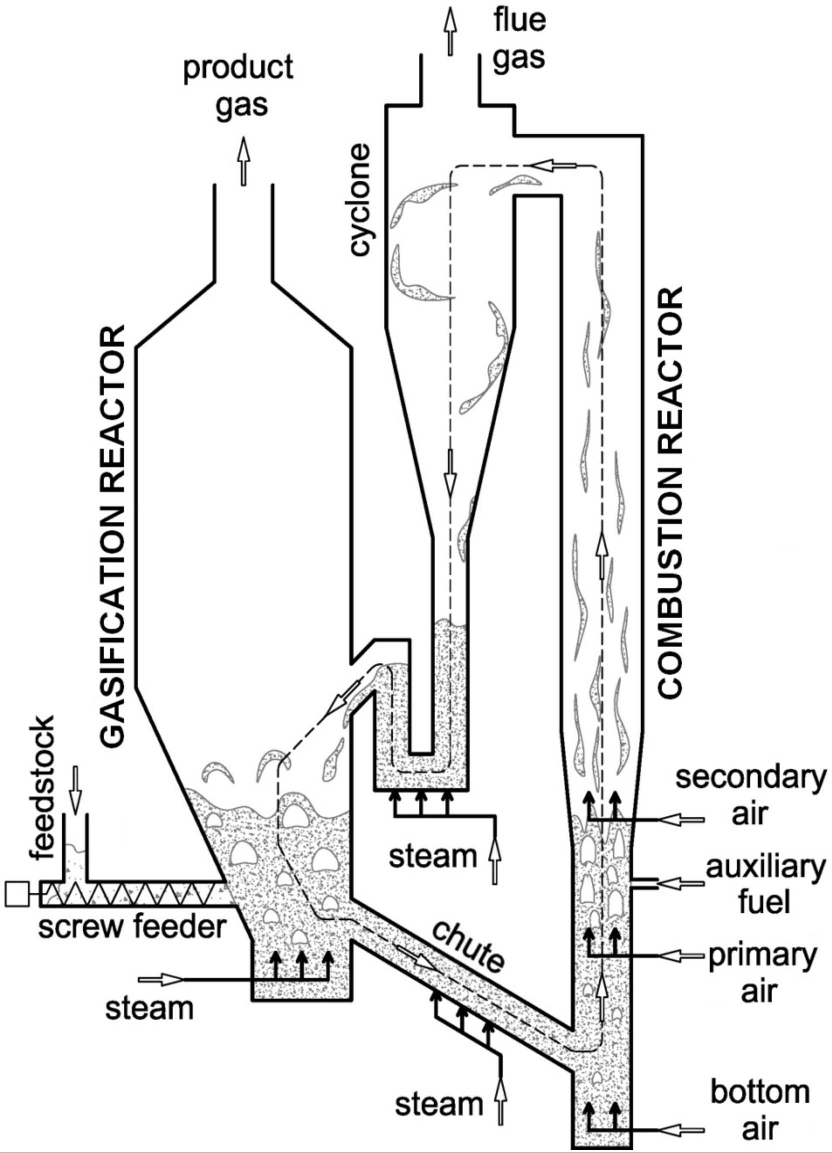
Synthetic Biofuels (FT- Route)

Cellulose
Hemicellulose
Lignin

i/n- paraffins
(hydrocarbons)



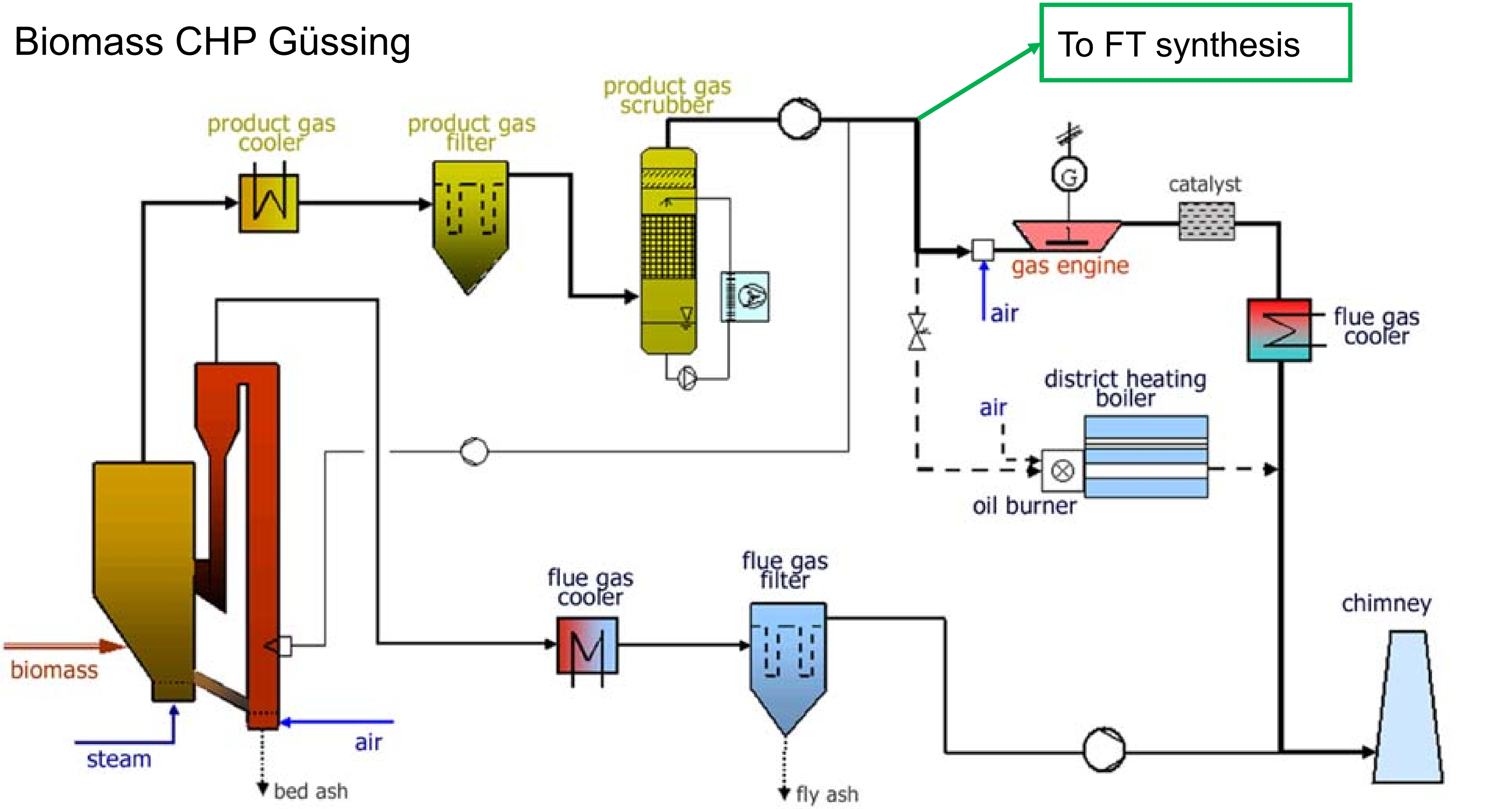
DFB gasifier



- Steam gasification, so product gas with high quality (low nitrogen, optimal H_2:CO ratio) can be produced, without need for pure oxygen
- Synthesis gas applications can be realised at smaller scale (10-100 MW_{fuel})

Experimental work

Biomass CHP Güssing



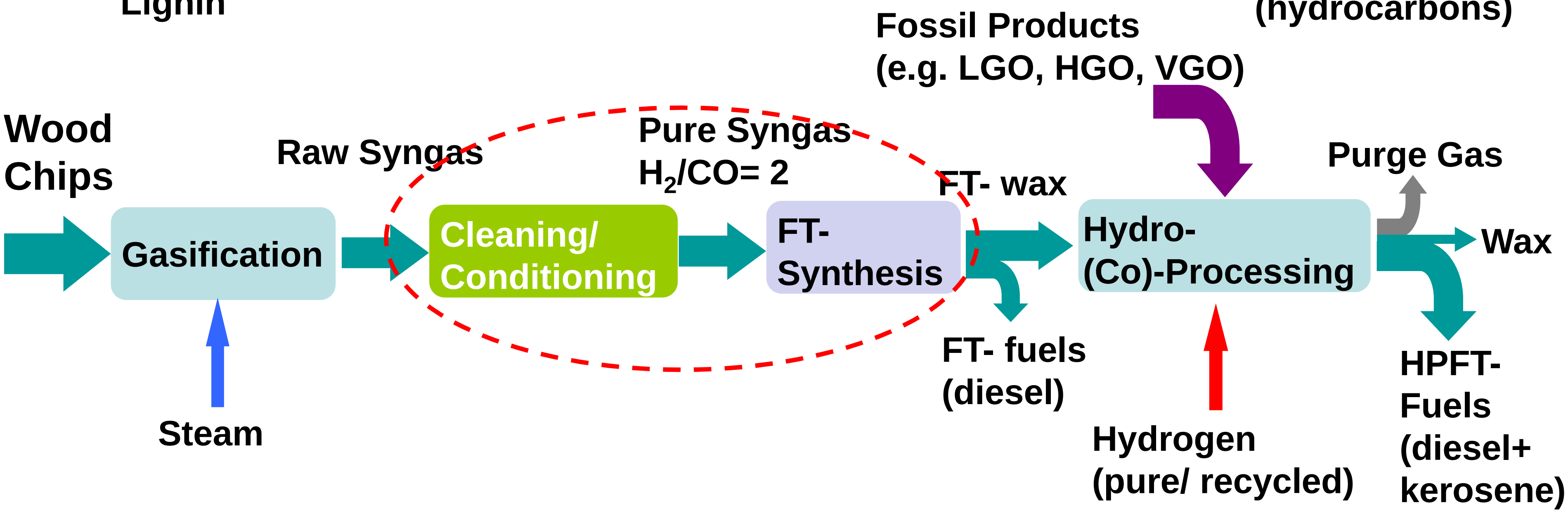
Dual Fluid Gasifiers

Location	Usage / Product	Fuel / Product MW, MW	Start up	Supplier	Status
Güssing, AT	Gas engine	8.0_{fuel} / 2.0_{el}	2002	AE&E, Repotec	Operational
Oberwart, AT	Gas engine / ORC / H_2	8.5_{fuel} / 2.8_{el}	2008	Ortner Anlagenbau	Maintenance
Villach, AT	Gas engine	15_{fuel} / 3.7_{el}	2010	Ortner Anlagenbau	On hold
Senden/Ulm, DE	Gas engine / ORC	14_{fuel} / 5_{el}	2011	Repotec	Operational
Burgeis, IT	Gas engine	2_{fuel} / 0.5_{el}	2012	Repotec, RevoGas	On hold
Göteborg, Sweden	BioSNG	32_{fuel}/20_{BioSNG}	2013	Repotec/ Metso	Operational
California	R&D	1 MW_{fuel}	2013	GREG	Operational
Gaya, France	BioSNG R&D	0,5 MW_{fuel}	2016	Repotec	Under construction
Thailand	Gas engine	4_{fuel} / 1_{el}	2016	GREG	Under construction

Synthetic Biofuels (FT- Route)

Cellulose
Hemicellulose
Lignin

i/n- paraffins
(hydrocarbons)



FT lab scale plant

In operation since 2005

5-10kg/day of FT raw product

Slurry reactor, because of excellent heat transfer and easy scaling up

Gas treatment removes Sulphur to below 10ppb

Cobalt and Iron- based catalyst were tested

Fully automatic

Results Kerosene

- Waxes can be converted to kerosene with a conversion efficiency of about 20-50% (boiling range 150-300°C)
- Cold flow behaviour in the range of -30 to -60°C freezing point (-40°C is the limit of ASTM)
- Most samples of kerosene fulfils ASTM D7566, Annex A1 for F-T SPK* (F-T SPK have been approved as maximum 50% blend stock in jet fuel)
- On Hydroprocessing more catalysts with different isomerisation behaviour should be tested

*Synthetic Paraffinic Kerosene

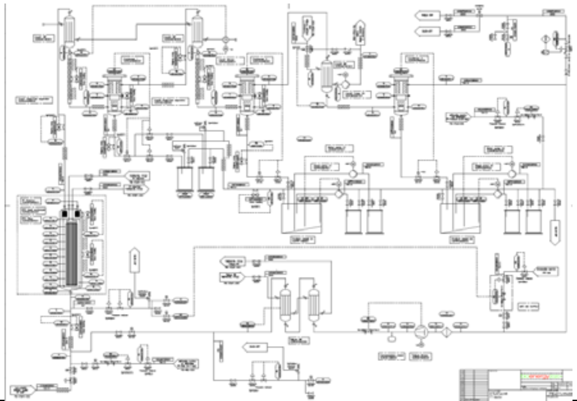
BioFiT

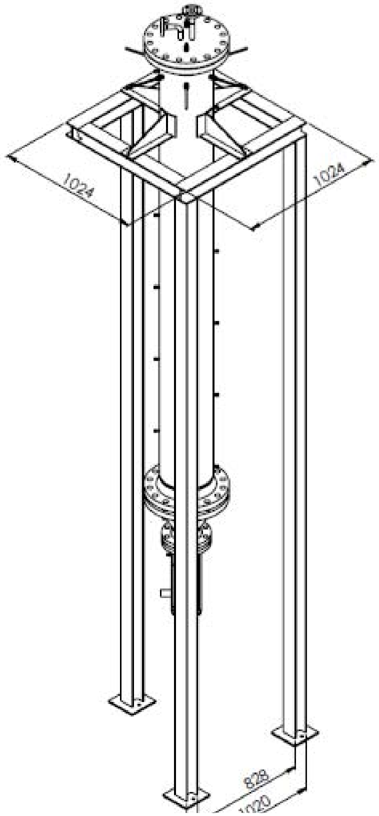
BIOMASS-TO-FISCHER-TROPSCH

$$nCO + 2nH_2 = nCH_2 + nH_2O$$

Work planed 1 barrel/day

- Economic optimisation of gas treatment
- Scaling up of Slurry FT reactor
- Long term tests fo FT synthesis with wood based synthesis gas
- Upgrading of the raw FT products
- Testing of FT products





Competence Centers for Excellent Technologies

COMET project 1bpd

Scientific partners

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Výzkumný ústav anorganické chemie, a.s.
ČLEN SKUPINY UNIPETROL

UNIVERSITY OF CHEMISTRY AND TECHNOLOGY PRAGUE

Industrial partners

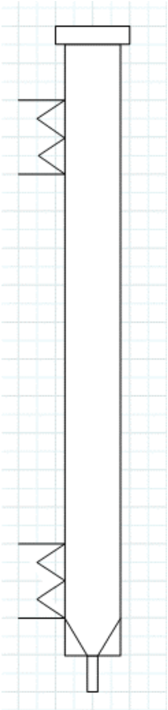
GÜSSING RENEWABLE ENERGY
GUSSINGRENEWABLE.COM

BILFINGER Bohr- und Rohrtechnik GmbH

Unipetrol ORLEN GROUP

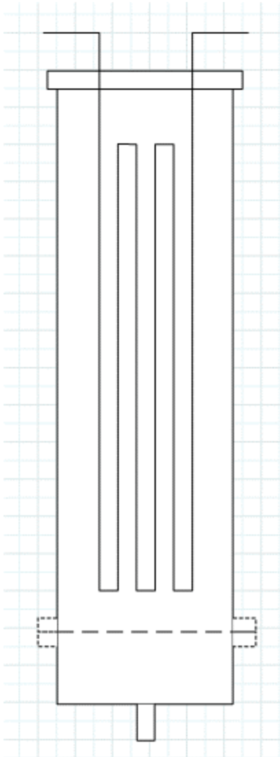
ORLEN

- **The actual reactor setup in the pilot plant**



  - *One through flow* without recycling of offgas.
  - Ratio height diameter H/D ≈ 20.
  - Coupled heating devices.
  - Conical gas distributor geometry.

- **What is our aim?**



  - Project of different flow configurations:
    - One Through Flow
    - With Recycling of Offgas
    - Recycling + Steam Reforming
  - Height/Diameter ≈ 7.
  - Integration of a heating exchanger system.
  - Flat gas distributor geometry.