TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

bioenergy2020+

Conversion of Biomass Over Steam Gasification to Biofuels and Chemicals - Actual Status of Work

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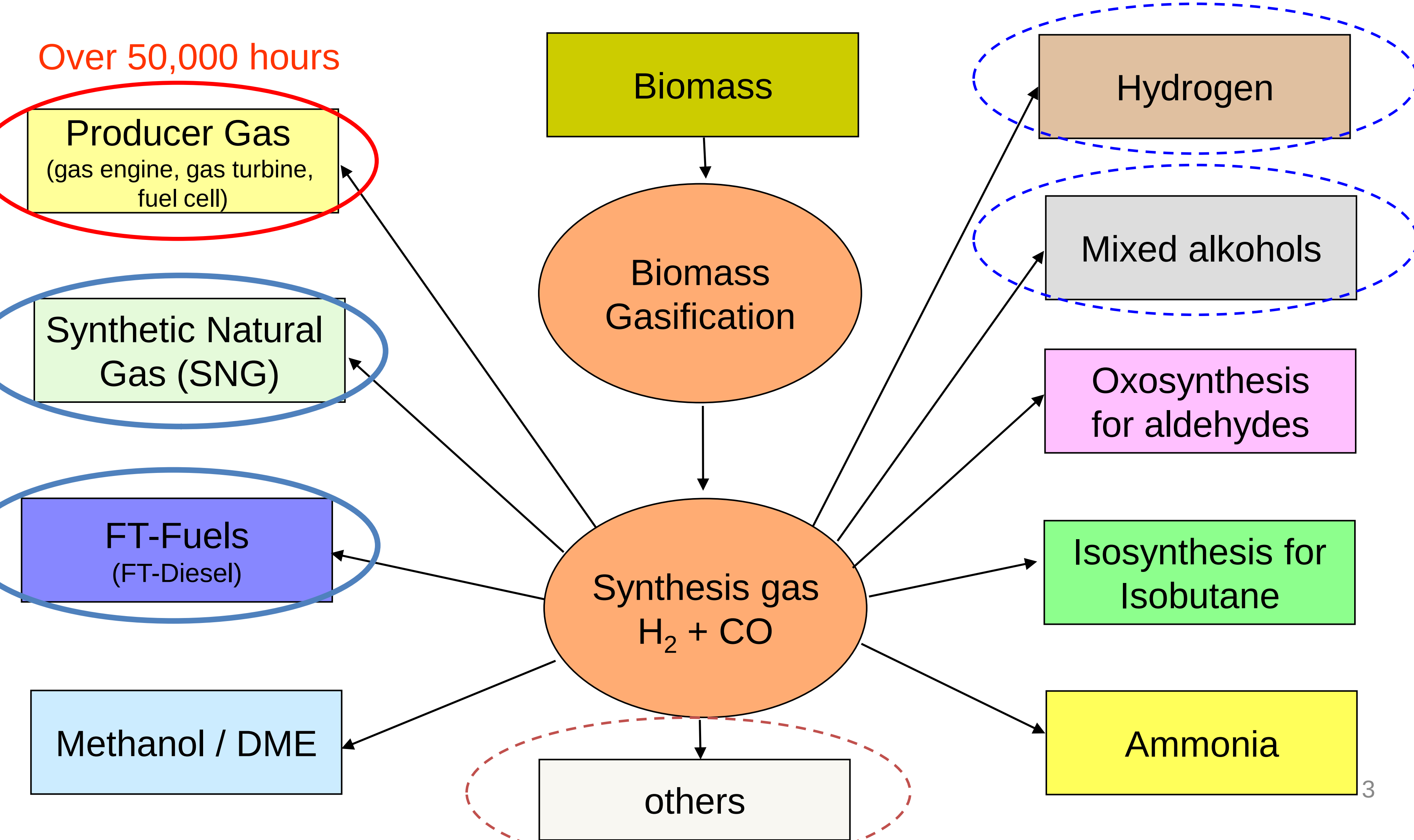
Team of R&D

- Scientific partners

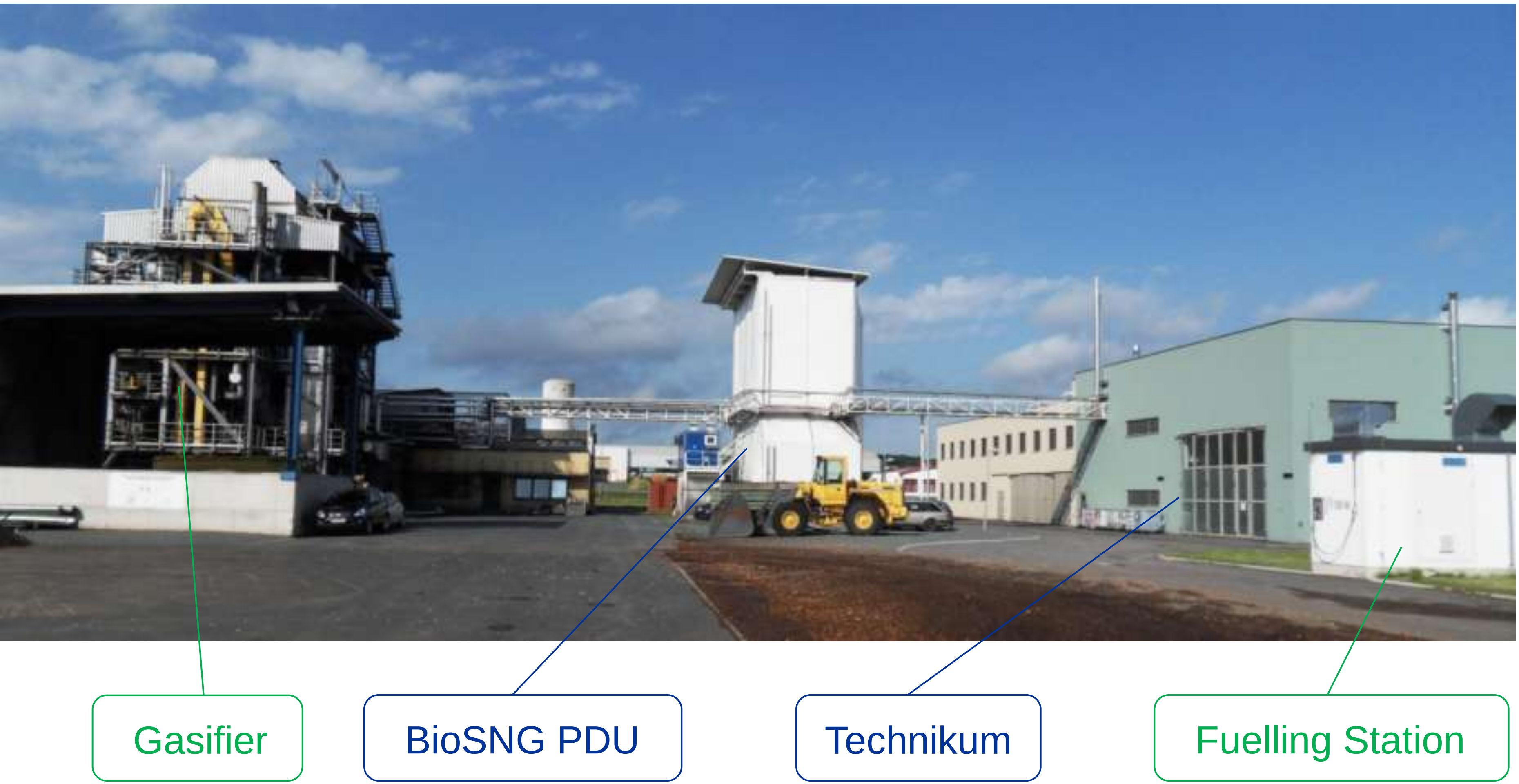
- Engineering (as example)

- Operators (as example)

The basic concept – “Green Chemistry”



Biomass CHP Güssing



Commercial FICFB gasifiers

Location	Product	Fuel / Product MW, MW	Start up	Status
Güssing, AT	Gas engine	8.0_{fuel} / 2.0_{el}	2002	Operational
Oberwart, AT	Gas engine / ORC	8.5_{fuel} / 2.8_{el}	2008	Operational
Villach, AT	Gas engine	15_{fuel} / 3.7_{el}	2010	Commissioning
Klagenfurt, AT	Gas engine	25_{fuel} / 5.5_{el}	2011	planing
Ulm, DE	Gas engine / ORC	14_{fuel} / 5_{el}	2011	Under construction
Göteborg, Sweden	BioSNG	32_{fuel}/20_{BioSNG}	2012	planing
Vienna, OMV	Hydrogen	50_{fuel}/$30_{hydrogen}$	2015	planing

Gas Composition (after gas cleaning)

Main Components		
H_2	%	35-45
CO	%	22-25
CH_4	%	~10
CO_2	%	20-25

Minor Components		
C_2H_4	%	2-3
C_2H_6	%	~0.5
C_3H_4	%	~0,4
O_2	%	< 0,1
N_2	%	1-3
C_6H_6	g/m³	~8
C_7H_8	g/m³	~0,5
$C_{10}H_8$	g/m³	~2
TARS	mg/m³	20-30

Possible poisons		
H_2S	mgS/Nm³	~200
COS	mgS/Nm³	~5
Mercaptans	mgS/Nm³	~30
Thiophens	mgS/Nm³	~7
HCl	ppm	~3
NH3	ppm	500-1000
HCN	ppm	~100
Dust	mg/Nm³	< 20

H_2:CO = from 1.7:1 to 2:1

BioSNG Demonstration Project

A 1 MW SNG Process Development Unit (PDU) is erected within the EU project BioSNG and allows the demonstration of the complete process chain from wood to SNG in half-commercial scale (2006-2009).

A consortium consisting of four partners is responsible for the PDU:

- CTU – Conzepte Technik Umwelt AG
- Repotec GmbH
- Paul Scherrer Institute
- Technical University Vienna

The project BioSNG is co-funded by

- the European Commission
- 6th Framework Programme PrNo TREN/05/FP6EN/ S07.56632/019895
- Swiss electric research
- Bundesförderung Österreich
- WIBAG

Institute of Chemical Process Fundamentals
Academy of Sciences of the Czech Republic

Results

- December 2008: First conversion of product gas into rawSNG
- June 2009: BioSNG at H-Gas quality produced

- June 24th : inauguration – CNG cars were fuelled using BioSNG from wood
- June 2009 CNG-car was successfully used for 1000km with BioSNG
- No more activities since end of 2009

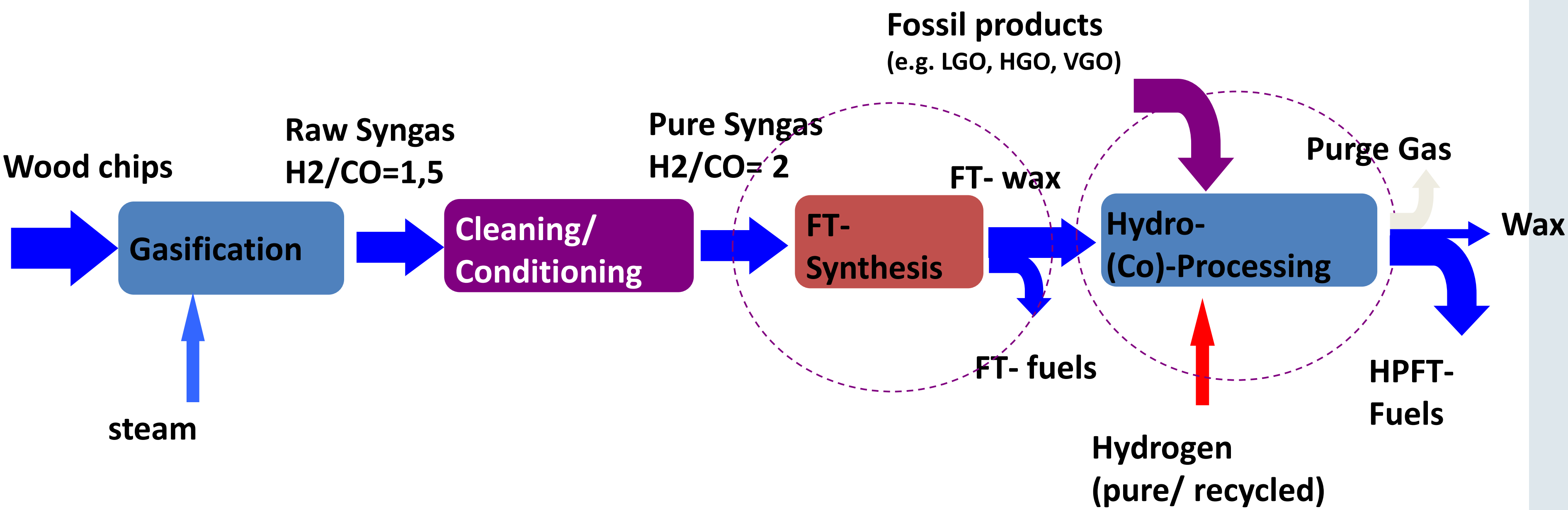
Quality BioSNG

	unit	Germany DVGW regulation G260	Austria ÖVGW regulation G31	BioSNG
Wobbe Index	[kWh/m³]	12,8-15,7	13,3-15,7	14,15
Relative density	[-]	0,55-0,75	0,55-0,65	0,56
Higher heating value	[kWh/m³]	8,4-13,1	10,7-12,8	10,7

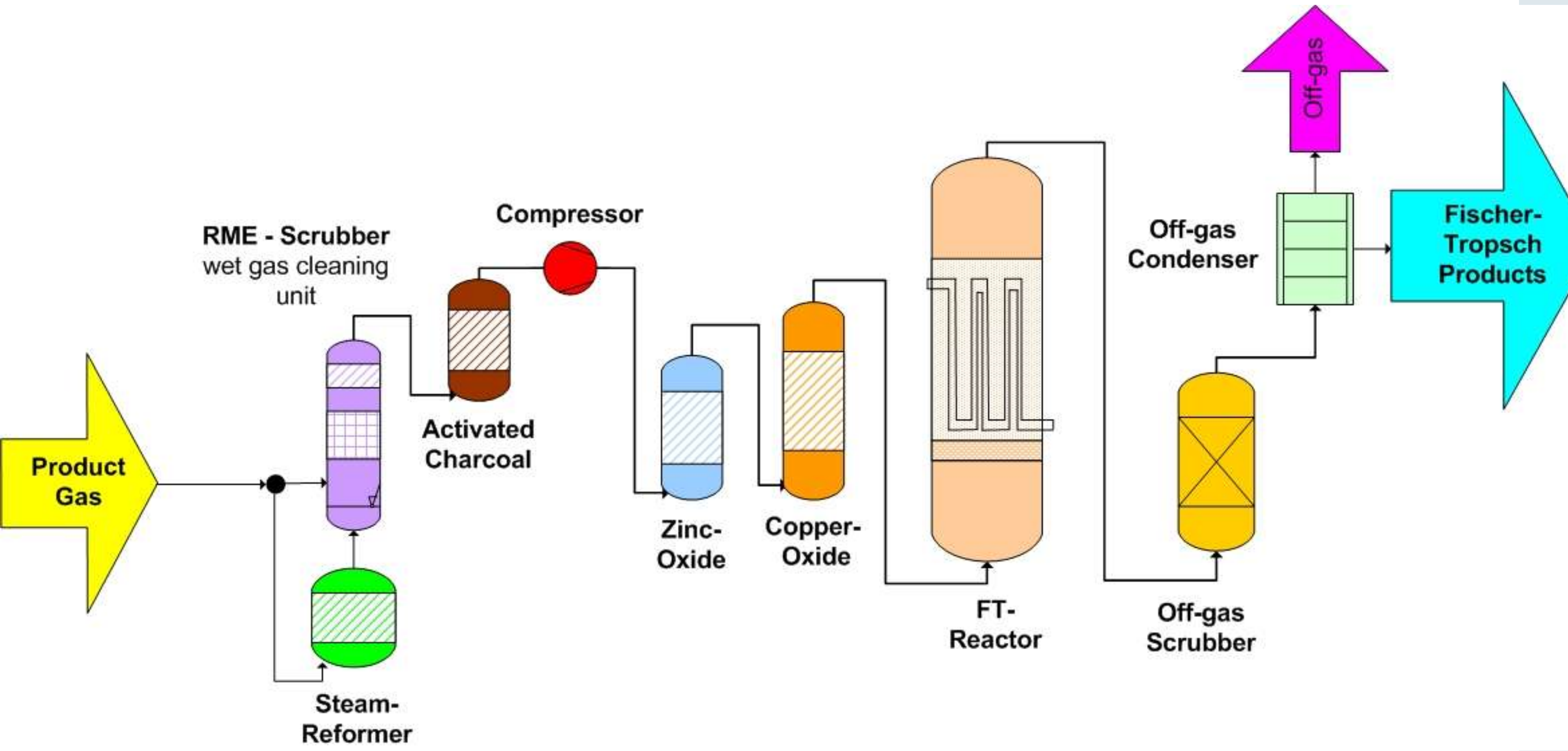
Synthetic biofuels (FT- Route)

Cellulose, Polyose (Hemicellulose)
Lignin

i/n- paraffins (hydrocarbons)



FT synthesis at biomass CHP Güssing



FT-Reactor and catalysts

A Slurry-Reactor is used. A slurry reactor is a 3-phase reactor, where the solid catalyst is suspended in the liquid product and the gas goes from the bottom to the top and keeps the catalyst in suspension.

The main advantages are:

- Simple and cheap construction
- Excellent heat transfer
- No hot spots and no temperature gradient along the reactor
- Easy to scale up

The following catalysts were used till now:

- Haber Bosch catalyst (mainly for start up)
- Research catalyst (based on cobalt ruthenium, produced from University of Strasbourg)
- Commercial cobalt catalyst
- Commercial iron catalyst

Actual 1300 hours of operation, without any change in activity

FT dependency on temperature

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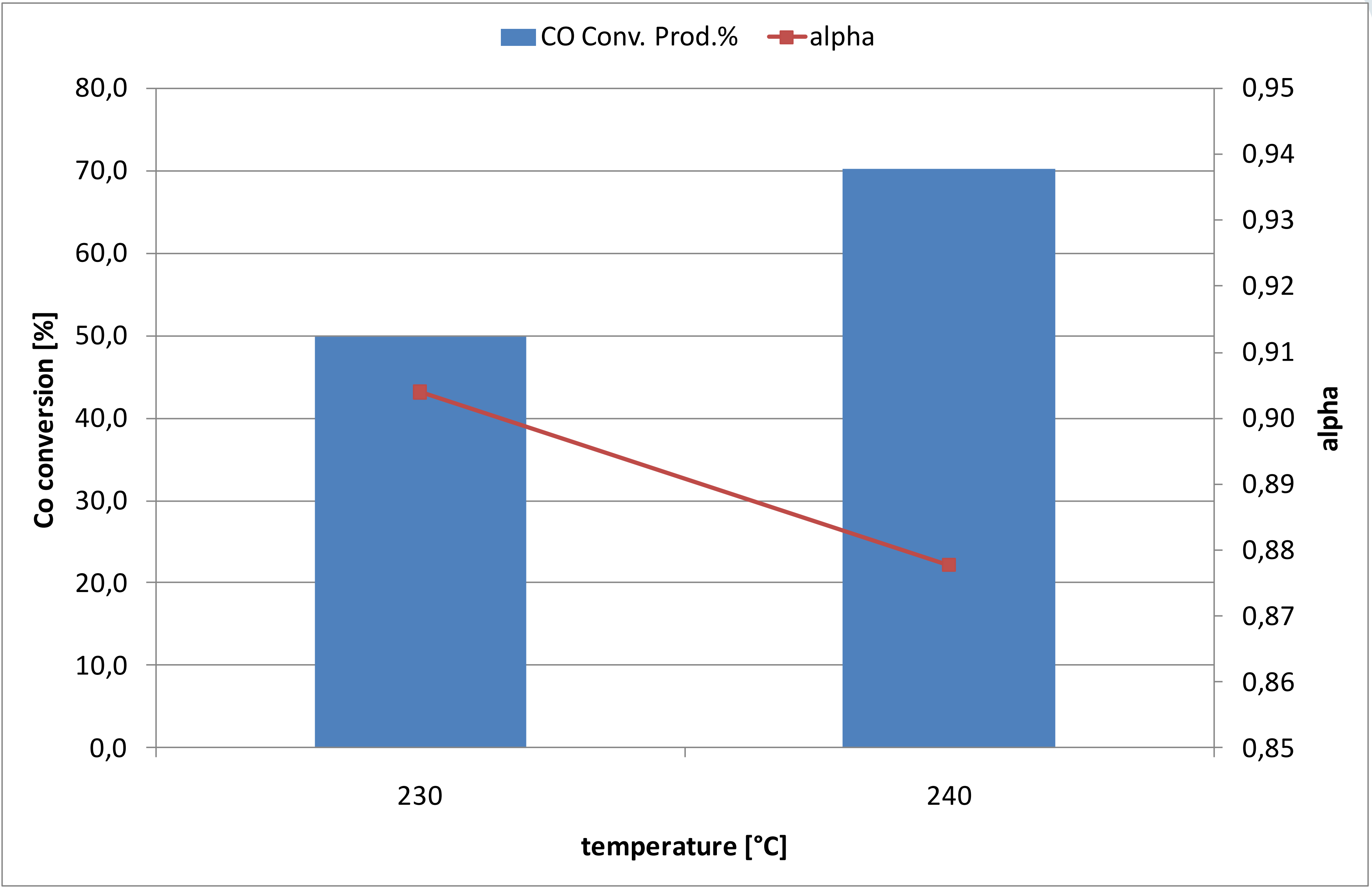

FT dependency on pressure

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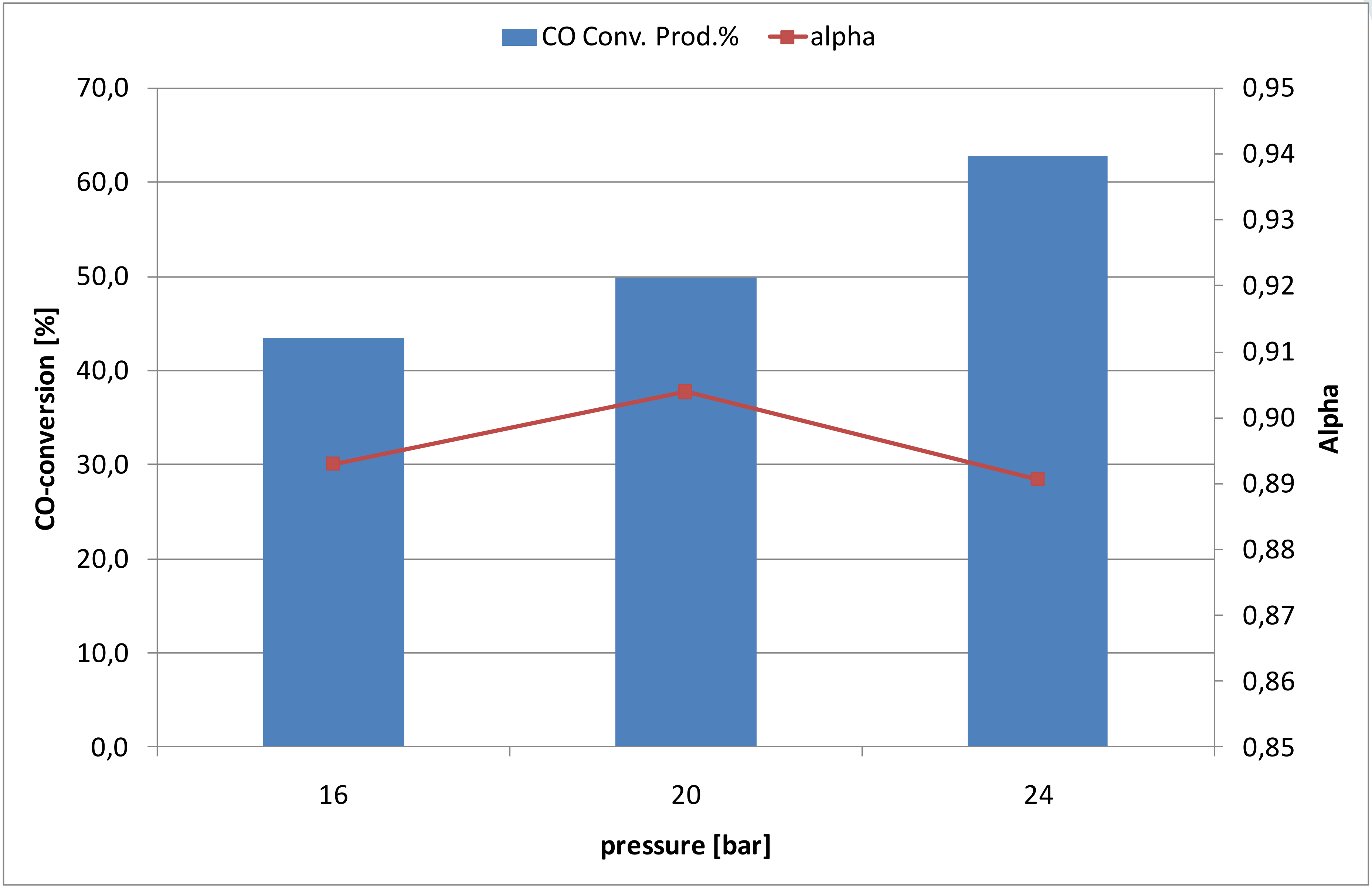

FT dependency on space velocity

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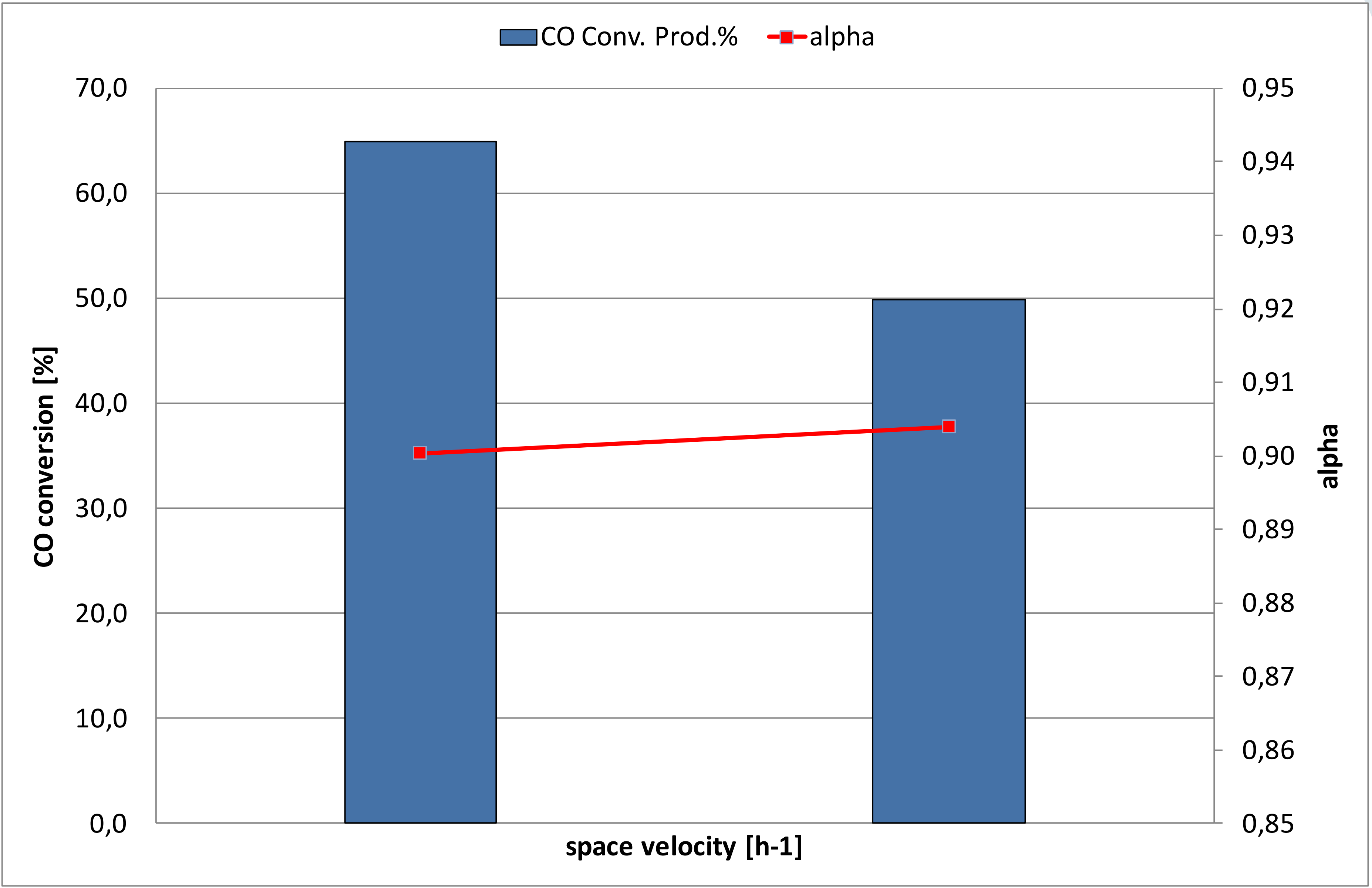
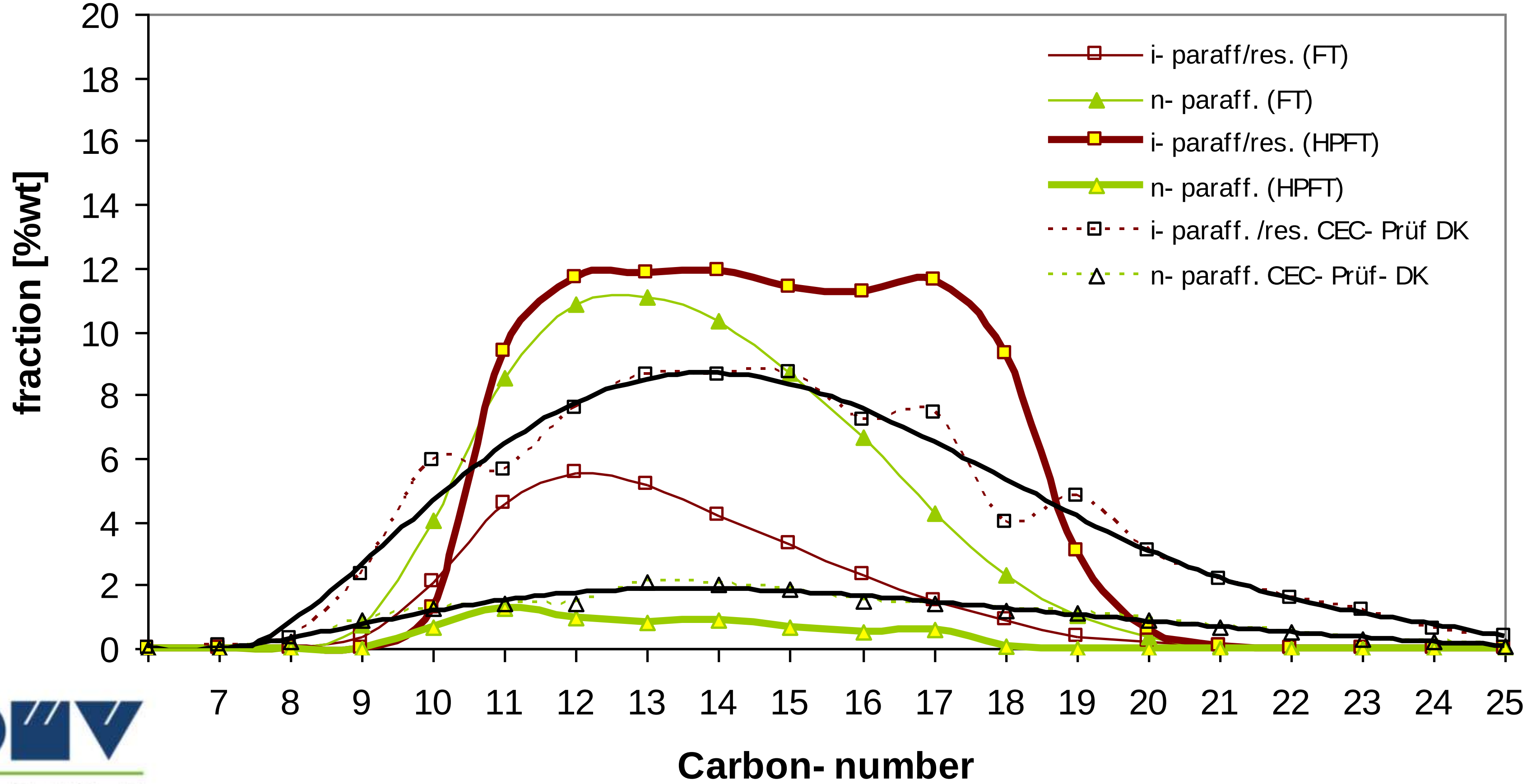
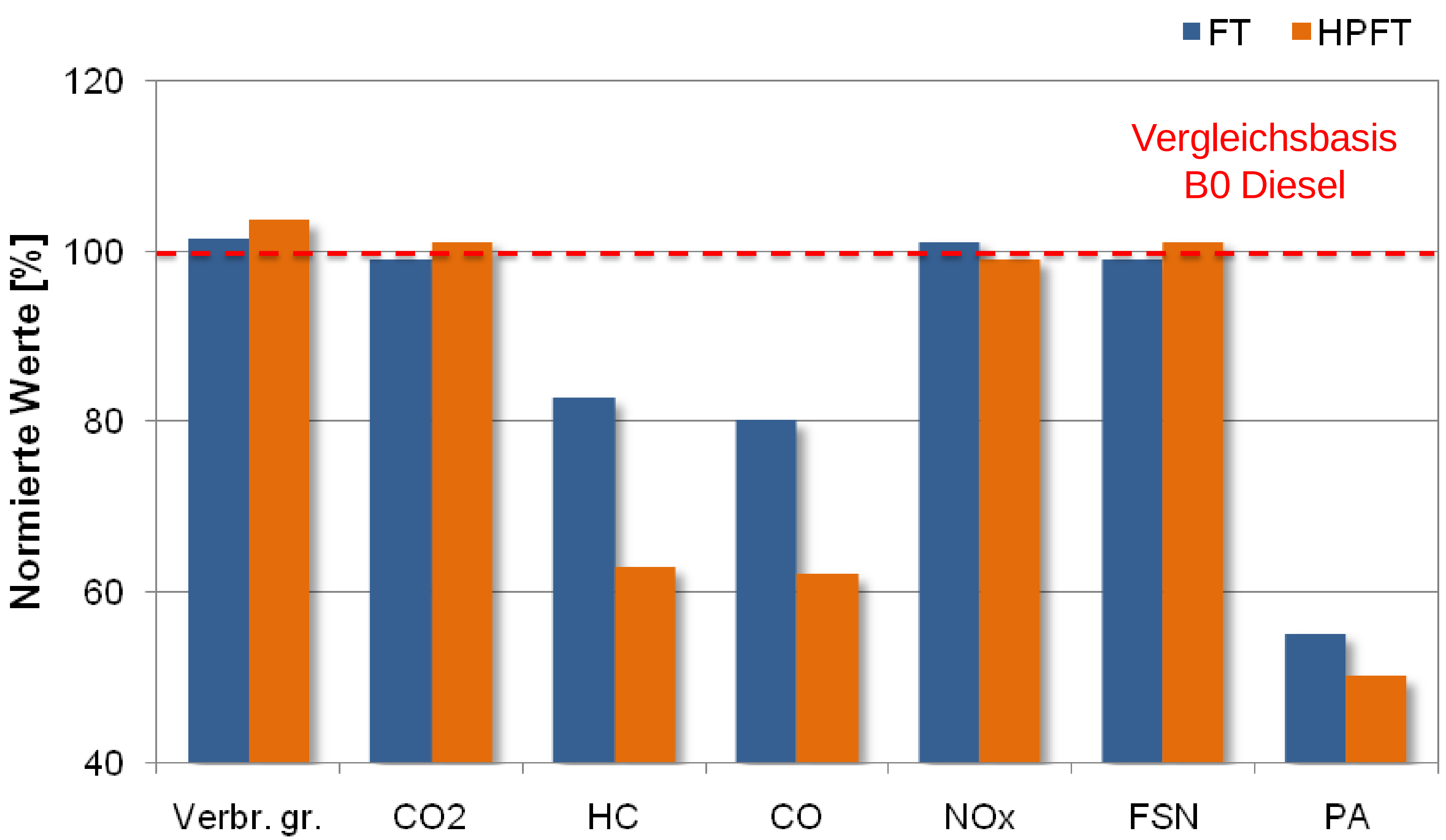


Comparison of produced FT Fuels

	FT- Diesel	HPFT- Diesel	CEC- Prüf.
ACN:	>72 t_d = 2,5 s	68,5 t_d = 2,91 s	>51,8 /
CFPP/CP/FP:	-12/ -9/ - °C	-62/ -60 / -98°C	-18/ -5 °C



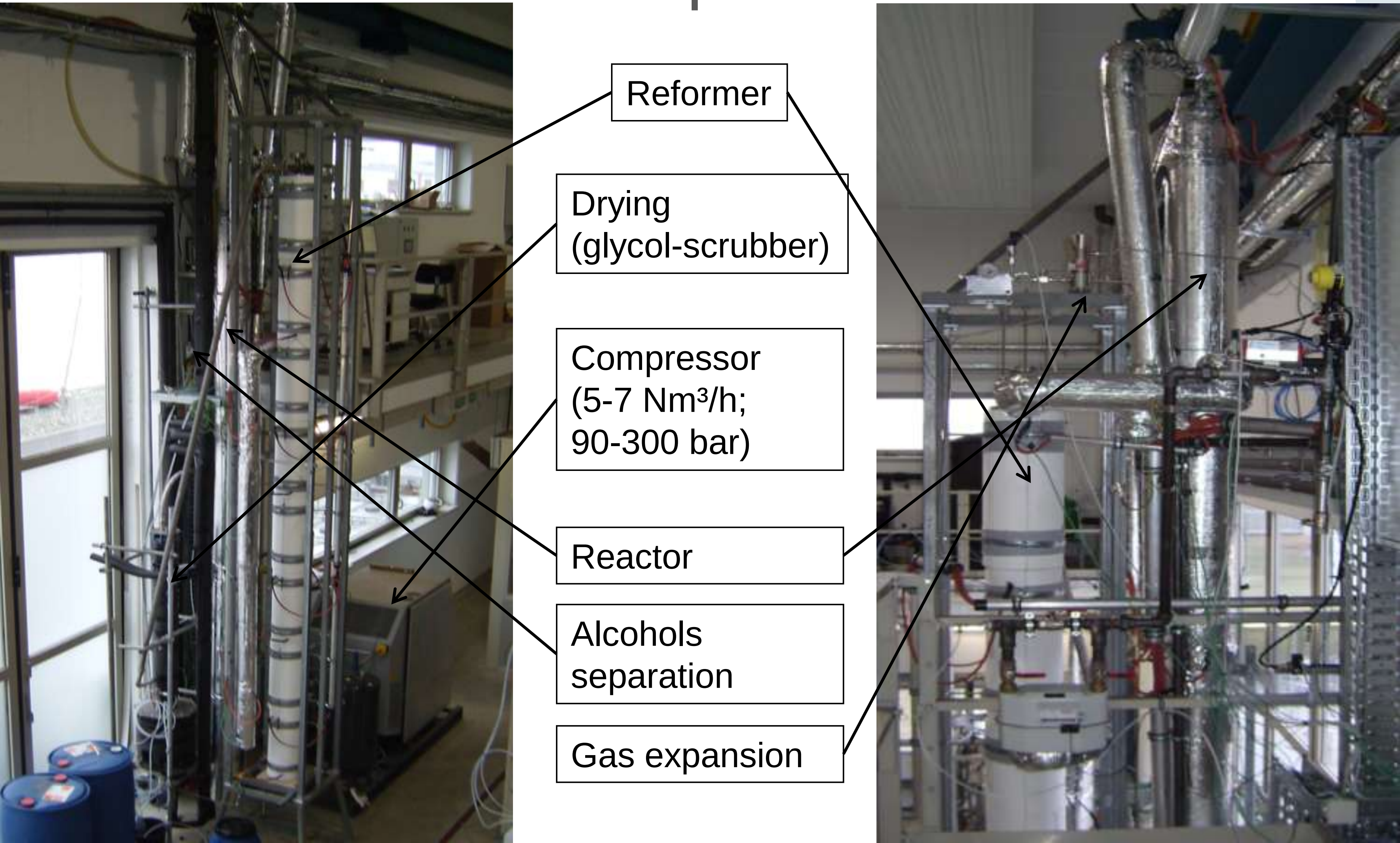
Results on engine tests with 20% blends



Mixed alcohols

- Funded by „Klima und Energiefonds" and Bioenergy 2020+
- Aim is to get fundamental know how in the synthesis of mixed alcohols from biomass
- Main advantage is very simple gas cleaning, due to sulphur resistant catalyst

Actual status: first experiments are done



Expected results (from literature and lab scale)

Alcohol	composition without methanolrecycle	composition with methanolrecycle
Methanol	28 %	-
Ethanol	50 %	75%
Propanol	16 %	11%
Butanol	4 %	8%
Pentanol	2%	6%

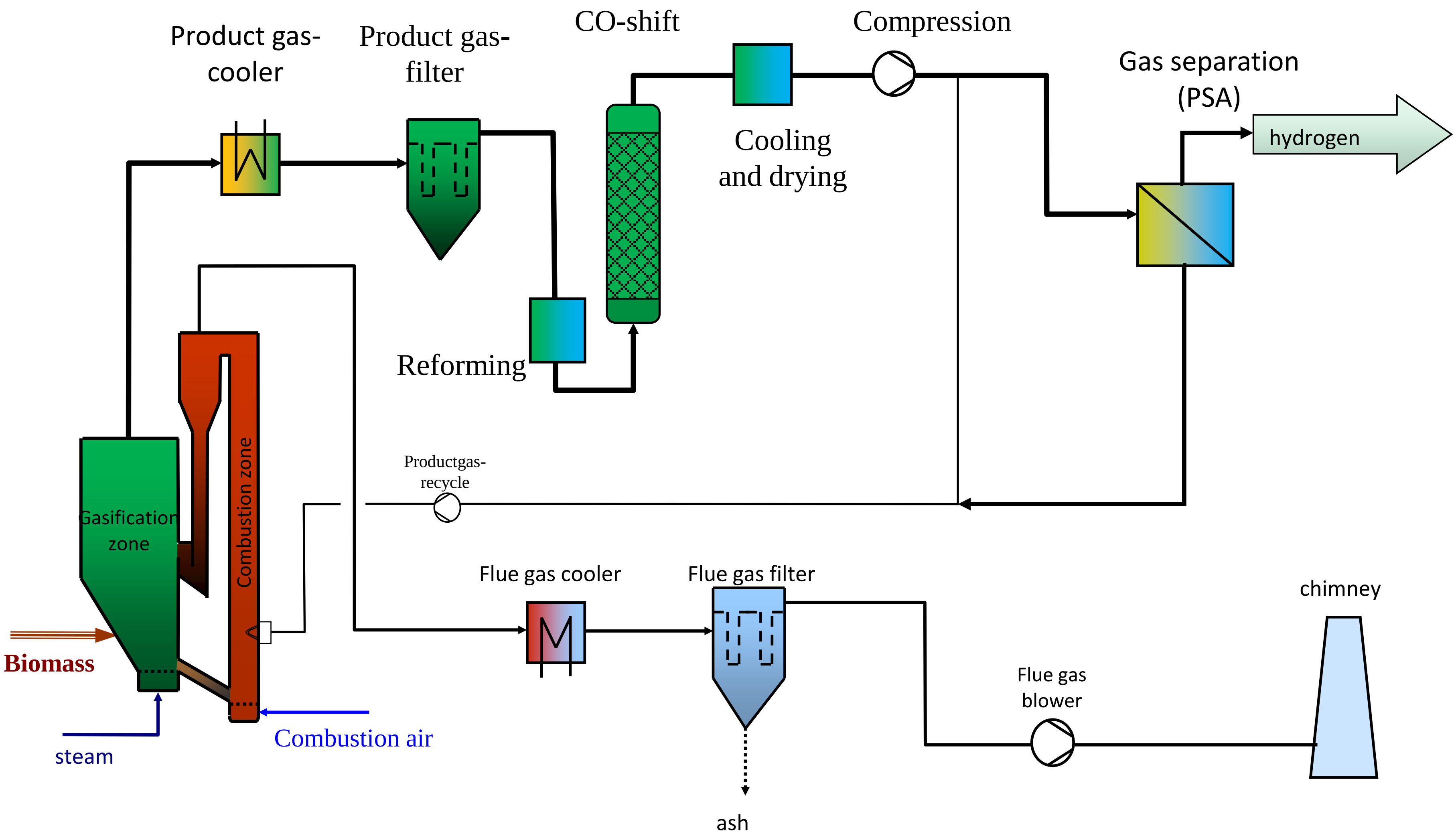
CO conversion should be about 20-30%

BioH2-4Refineries

Economic evaluation of production of hydrogen for a refinery

- Coordination by OMV
- 50 MW fuel plant to replace fossil hydrogen
- Evaluation of the biomass resources available for such a plant
- Basic - engineering of the gasifier as well as of all other sub units, including pipelines, utility systems, logistic needs
- Optimal use of by-products
- Economic evaluation

Simplified flow chart



Summary

- Biomass CHP Güssing has excellent frame conditions for R&D on synthesis gas applications
- Focus of R&D is on small CHP and on synthesis gas applications (BioSNG, Fischer Tropsch, Mixed Alcohols, Hydrogen)
- Gasification enables the conversion of biomass to many useful products

More info at
http://www.ficfb.at
http://www.vt.tuwien.ac.at
http://www.bioenergy2020.eu