GoBiGas – 10 000 Hours of Operation

Anton Larsson

IEA FBC and IEA Bioenergy Task 33 – joint workshop

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Göteborg Energi

Our owners say:

"Göteborg Energi shall actively contribute to the development of a sustainable Göteborg"

Our tools:

Infrastructure
Recycling of energy
Innovative technology
Innovative business models

Göteborg is mainly heated with recycled energy

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GoBiGas is:

The world's first large-scale plant for production of bio-methane from biomass through gasification.

Swedish Energy Agency invested 222 million SEK

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Estimated Production

Biogas	160 GWh/y
	20 MW
District heating	50 GWh/y
	5 MW
Heat to heat pumps	6 MW

Estimated Consumption

Biomass	32 MW
Electricity	3 MW
RME (bio-oil)	0,5 MW

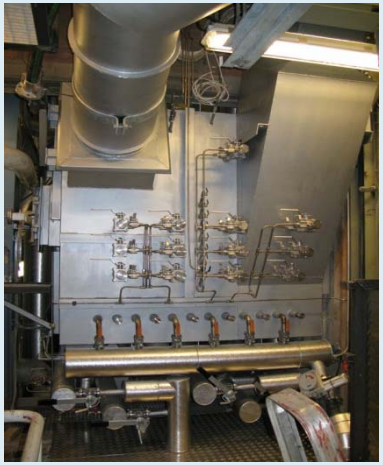
Performance Goals

Biomass to Biogas > 65 %
Total efficiency > 90%
Operation 8000 h/y

GoBiGas – step by step to commercialization

Chalmers
Lab reactors

"Chalmers gasifier"
Chalmers 2-4 MW
Pilot plant



GoBiGas Stage 1
20 MW biogas
Demonstration plant

GoBiGas Stage 2
80-100 MW biogas
Commercial plant

2008 2012 2016

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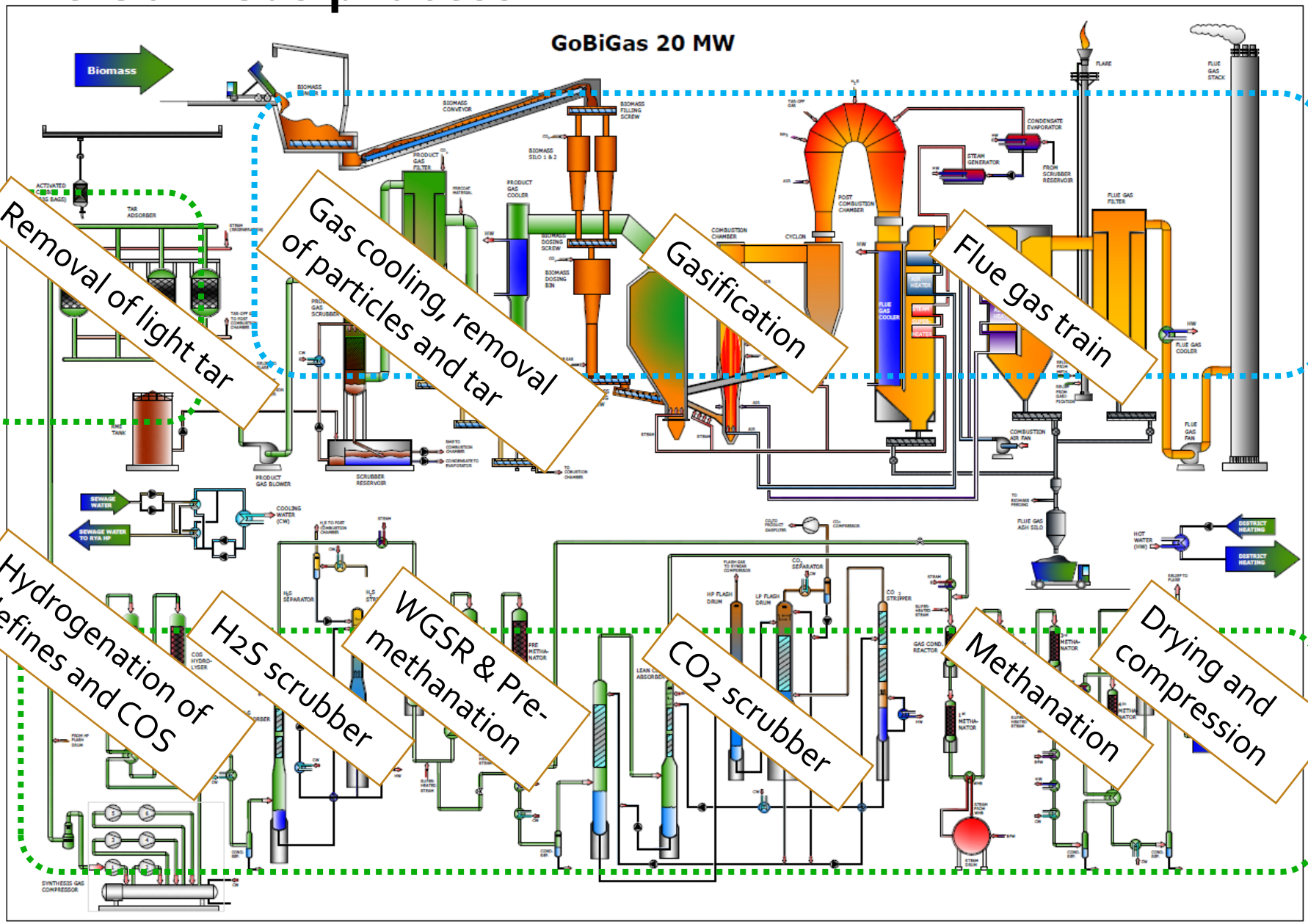
The GoBiGas process



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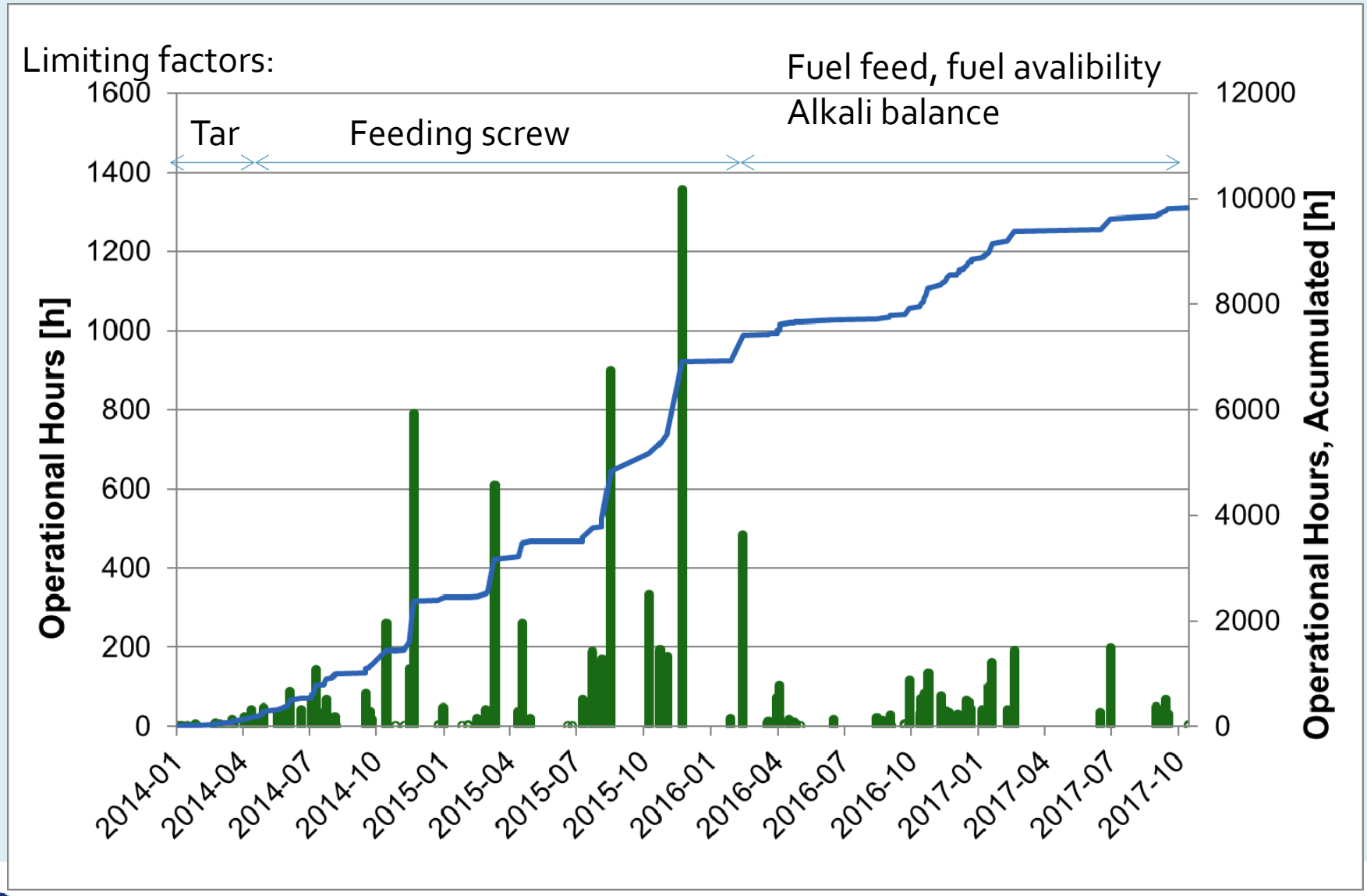
Operation of the GobiGas-Gasifier



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GoBiGas Performance with Different Fuels

Fuel	Pellets	Wood chips	Bark	Recovered Wood (A1)
Hours of operation (h)	>8000	900	750	~80
load	80-93%	55-70	40-70%	55-85%
Limiting factor	Carbon beds	Moisture, fuel feed -mechanical	Fuel feed - mechanical	Fuel feed - mechanical
Biomass to biogas efficiency	58-63%	40-55%	45-55%	45-55%
CO_{2eq} reduction compared to gasloien/diesel (wellt-to-wheel)	80-85%	-	-	-

Gas Quality with Different fuels

	Typical operation wood pellets	Typical operation wood chips	Typical operation bark	Typical operation Return wood (A1)
Gasifier temp. (◦C)	870-830	790-830	850-820	830
H2 ($\%_{vol\ dry}$)	39-42	39-41	39-43	39-43
CO ($\%_{vol\ dry}$)	21-24	22-23	17-21	17-21
CO2 ($\%_{vol\ dry}$)	20-27	21-23	23-25	23-25
CH4 ($\%_{vol\ dry}$)	8.0-9.0	7.9-8.6	7.1-8.7	7.1-8.7
Tar (excluding BTX), (g/m_n^3 dry gas)	3.0-8.7	8.9-12.7	7.9-15.0	8.5-14
Tar (Including BTX), (g/m_n^3 dry gas)	9.7-23.3	22.1-29.5	21.7-33.4	22-26

- The GoBiGas Gasifier can be operated with a wide variety of fuels with a stable gas quality
- The temperature can be varied in the range of 790-870 °C with retained gas quality

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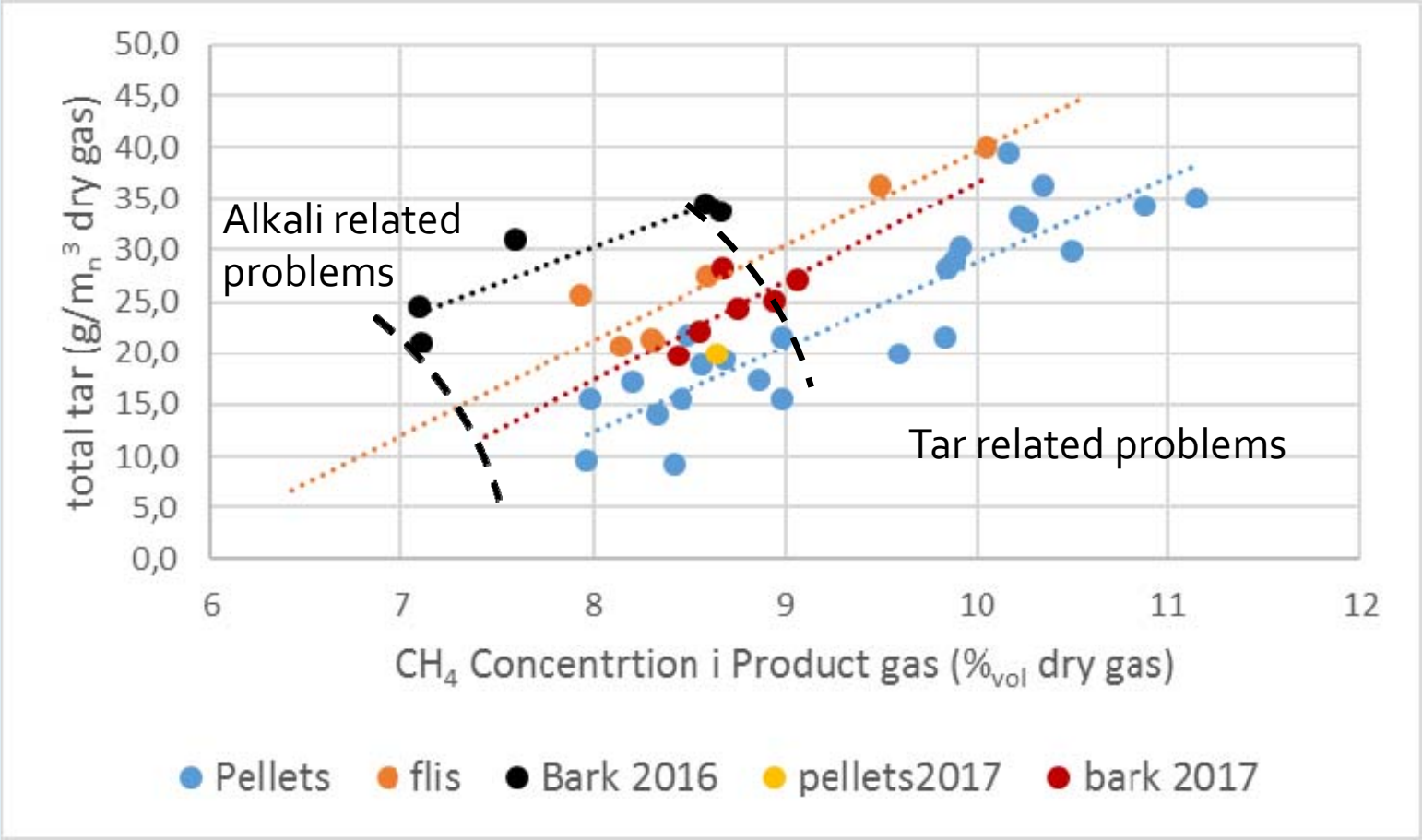
Monitoring and Controlling the Gas Quality



The gas quality (tar level) are controlled by adding potassium to the process. Specifically K_2CO_3 solved in water (40%) are added to the combustion side

J. Marinkovic et.al, Characteristics of olivine as a bed material in an indirect biomass, Chemical Engineering Journal.
A. Larsson et.al, Monitoring the Bed Material Activation in the GoBiGas Gasifier. Conference paper IFRF 2015.

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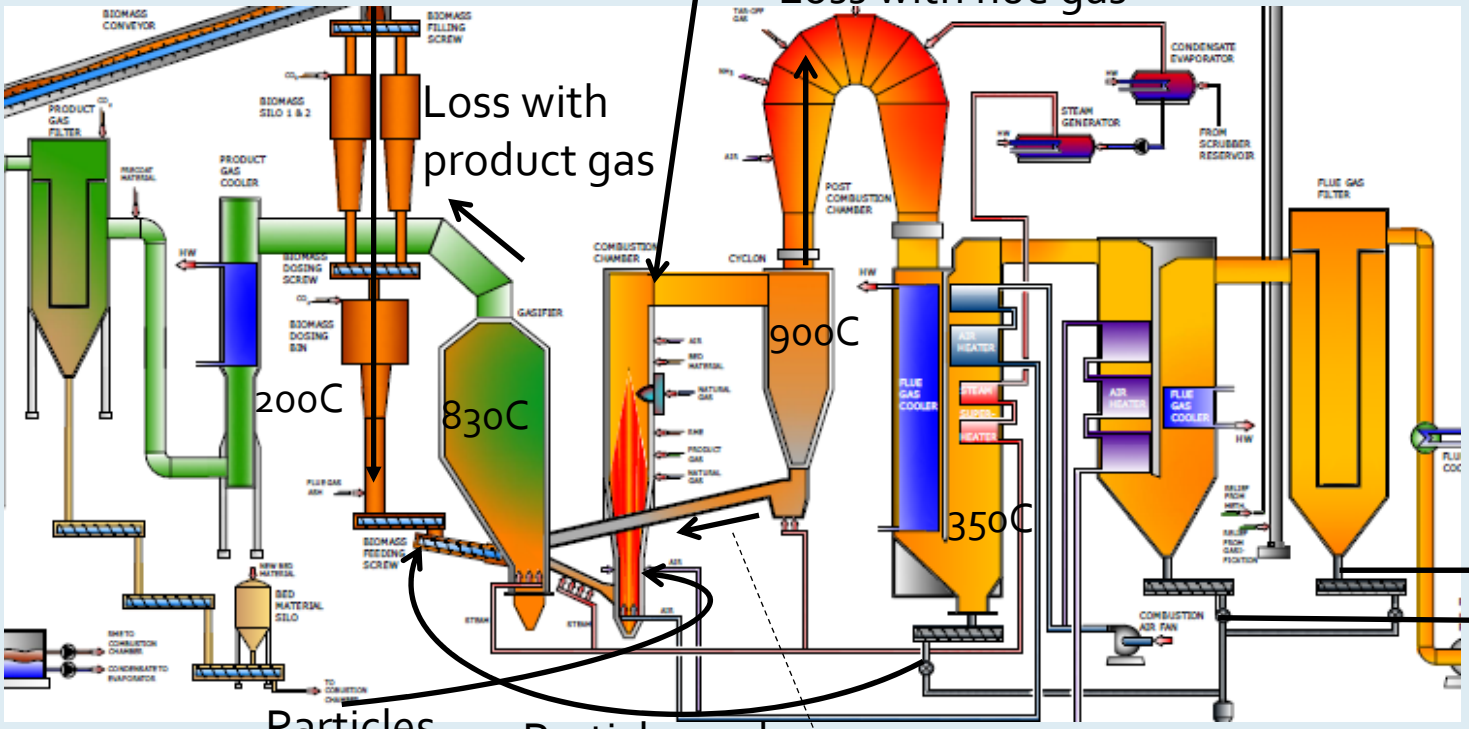
Alkaline Balance of the GoBiGas-Gasifier



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Clogging of the Fuel Feeding

Feeding the fuel with a screw directly to the bubbling bed of the gasifier cause warm sand to enter the screw and start pyrolysis the fuel, which eventually clogs.

By Claes Breitholtz, Valmet AB

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Film by Dr. Erik Sette och Rustan Hvitt, Chalmers Gasifier from above operating with wood pellets

Energiforsk Report: D. Pallares et.al. Char conversion in fluidized bed indirect gasification: https://energiforskmedia.blob.core.windows.net/media/22600/char-conversion-in-fluidized-bed-indirect-gasification-energiforskrapport-2017-393.pdf

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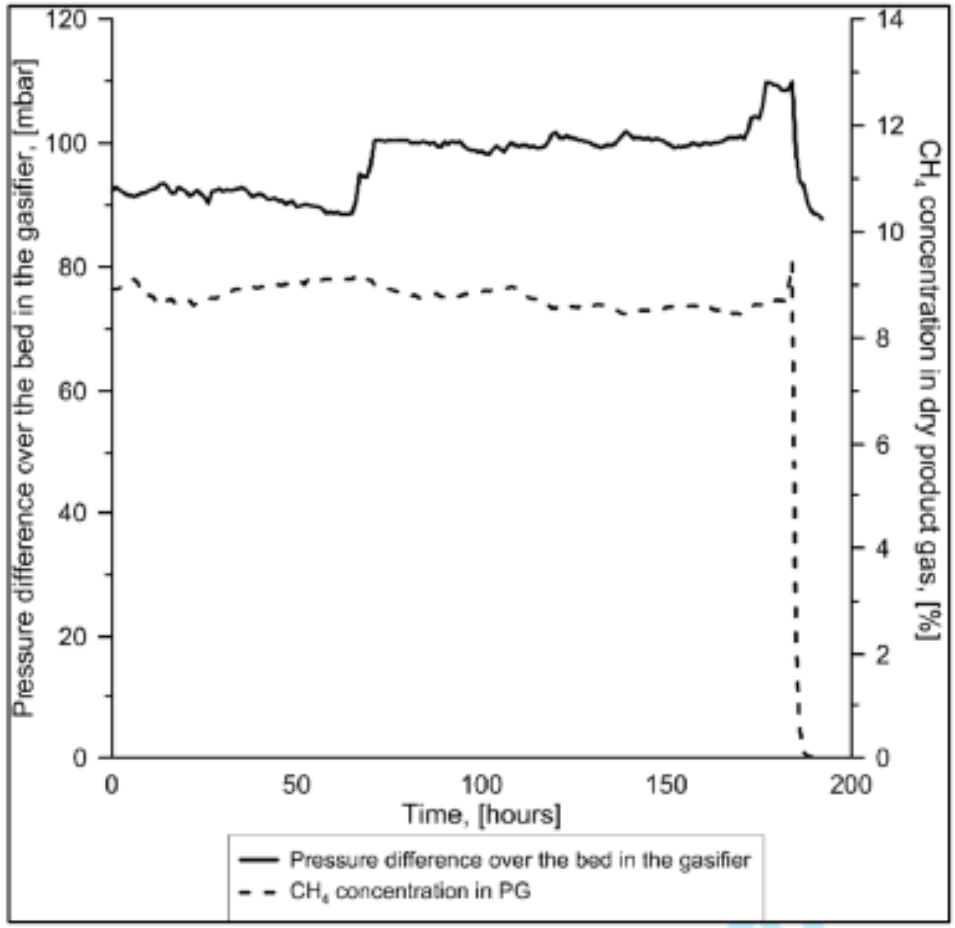
Clogging of the Fuel Feeding

With sufficient ”activation” of the bed material the bed height are of minor importance for gas quality.

By lowering the bed height the problems with the fuel feeding screw has bed reduced but not diminished.



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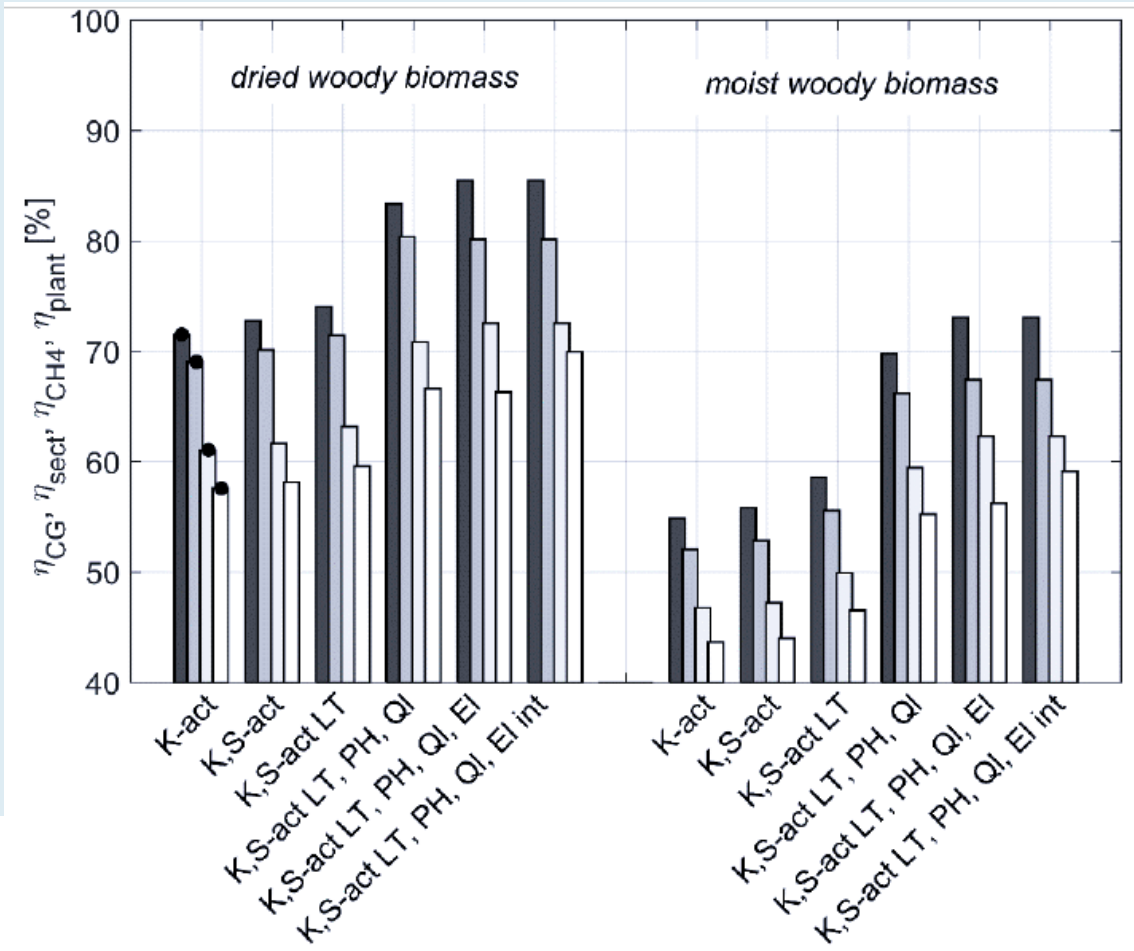
Performance of the GoBiGas Gasifier and Extrapolation to a 100MW Commercial-Scale

Case studie: A. Alamia, et.al. Performance of large-scale biomass gasifiers in a biorefinery, a state-of-the art-refrence. International Journal of Energy Research

- Efficiency can be increased with larger scale.
- Biomass to biogas efficiency >70% is possible
- Biomass to Syngas efficiency > 80 is possible
- Drying of the fuel is crucial



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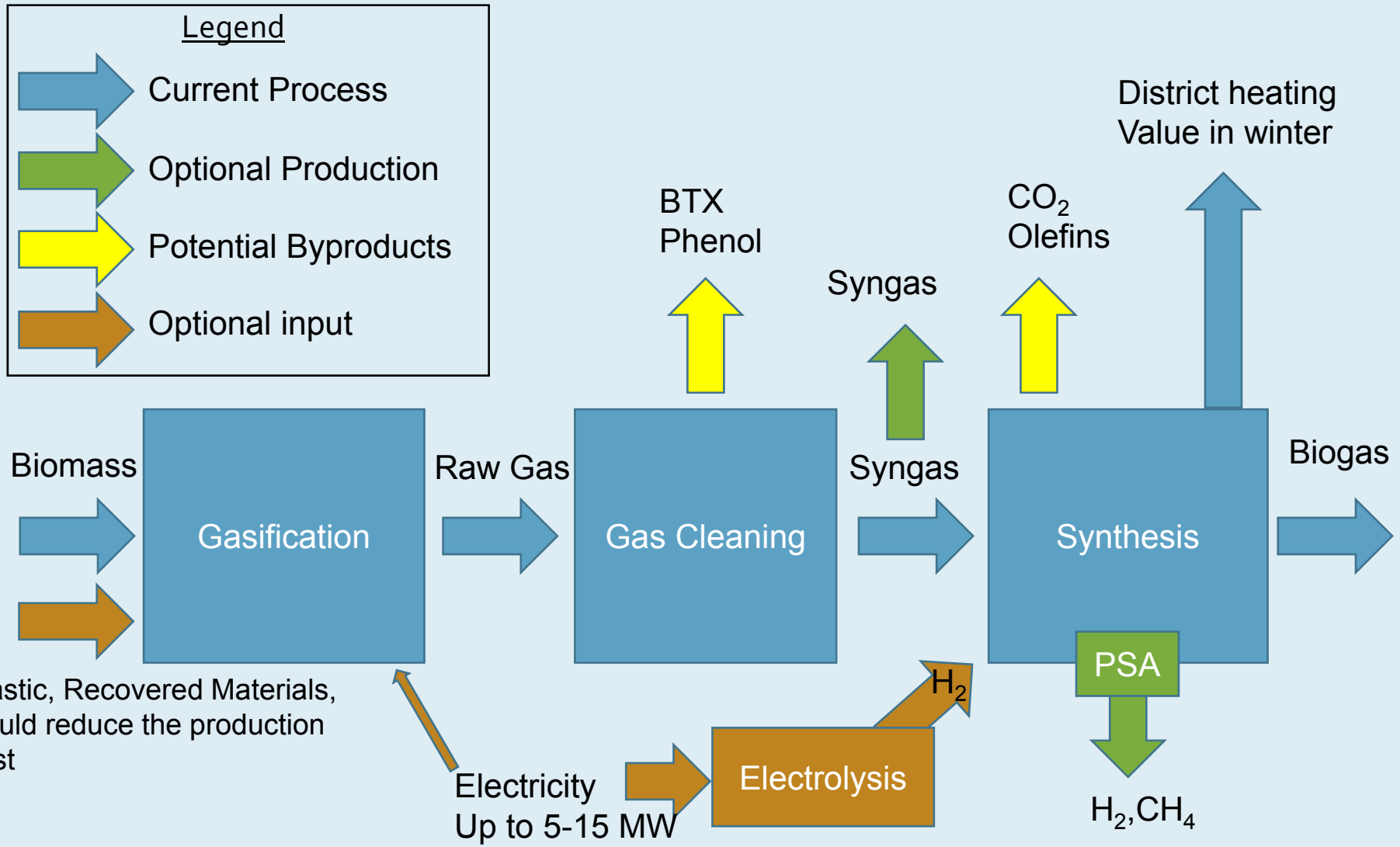
Overview of the GoBiGas Plant Potential



Conclusions

- Good fuel-flexibility has been demonstrated.
- High efficiency (up to about 70% biomass to biogas) can be reach with dry fuels.
- With some modification on the fuel feed and product gas cooling the process is technically ready for commercialization.
- Increased understanding of the function of potassium as well as the tar chemistry are required to optimize the gasifcation process and gas cleaning.

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