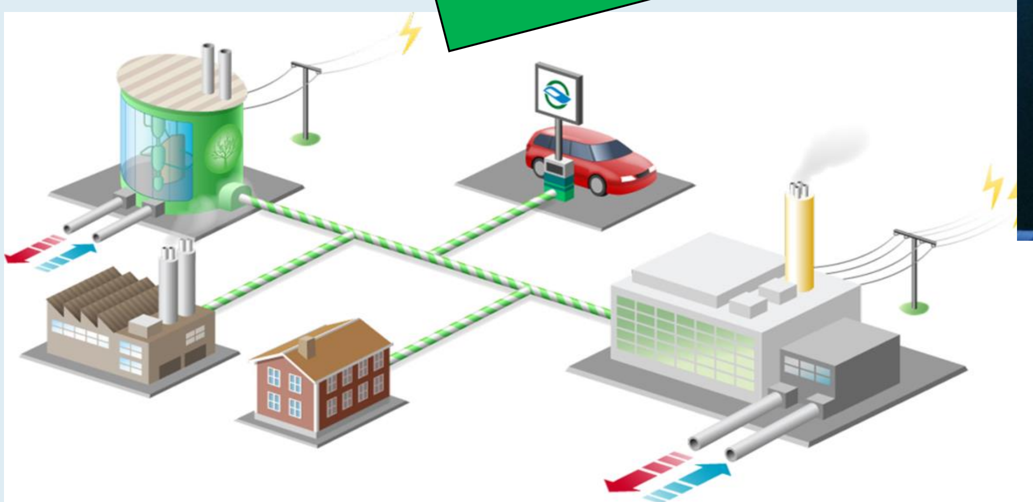
The Story of the GoBiGas Project
From Vision to Plant in Operation

Ingemar Gunnarsson Göteborg Energi



Our vision

Göteborg Energi actively contributes to the development of a sustainable society in Gothenburg.

We are an energy company which provides energy solutions for the second largest metropolitan area in Sweden. We have a diversified production portfolio with a strong environmental profile based on innovation.

GoBiGas – Pioneering New Technology

- The world's first plant for bio methane from biomass through gasification
- The first Swedish plant to inject bio-methane into the interregional grid

The GoBiGas Site – Phase 1 & 2

Phase 1 – Demonstration Plant
Partly financed by the Swedish Energy Agency

Phase 2 – Commercial Plant *after* proof of Phase 1 *and* secured financing
Selected project by the EU-commission in NER 300

Project Schedule

- Engineering – Early 2011
- Construction – Mid 2012
- Commissioning – Mid 2013
- Start-up – 2014-15

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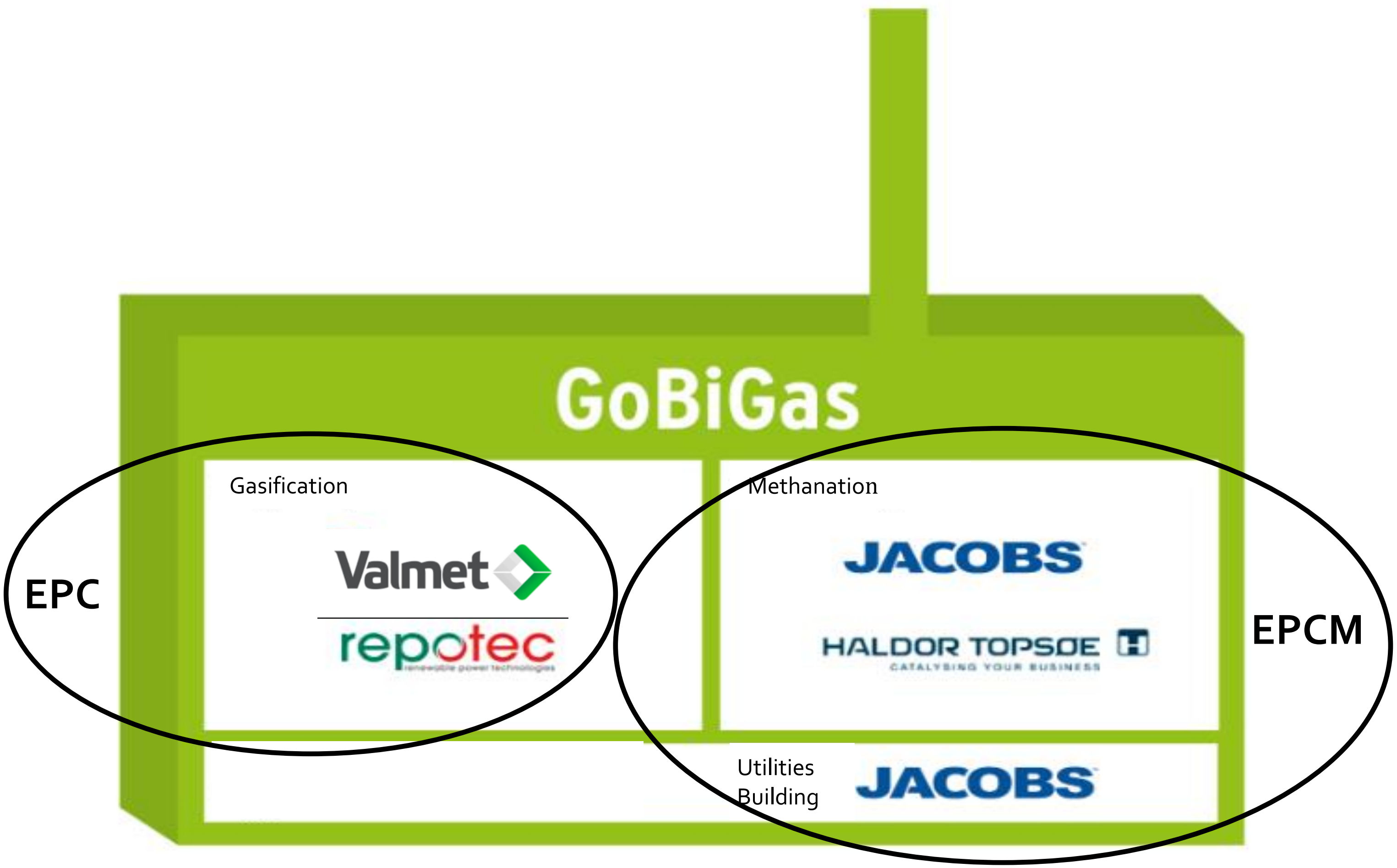
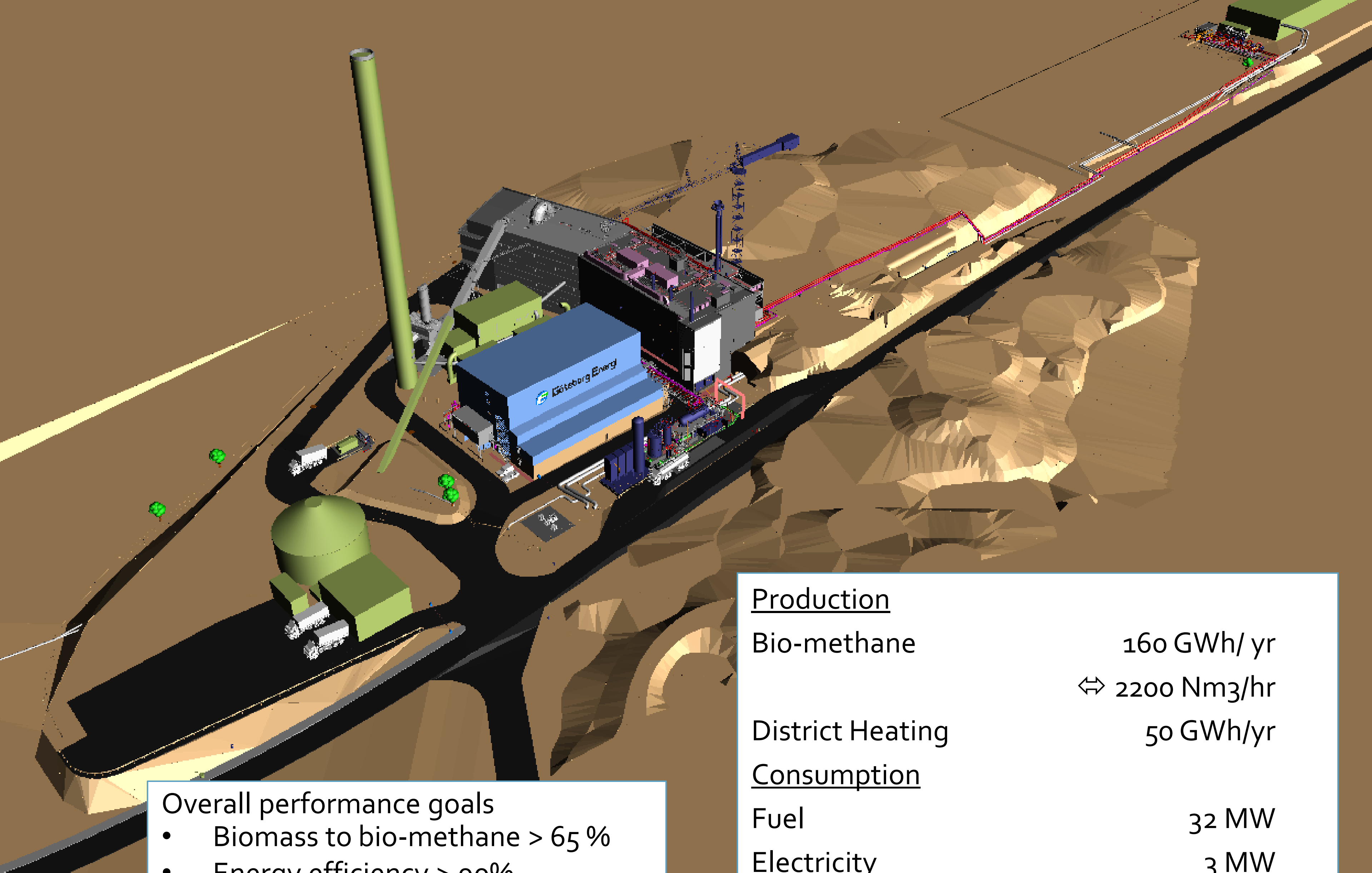
GoBiGas - The Private Sector Partners





Overall performance goals
- Biomass to bio-methane > 65 %
- Energy efficiency > 90%
- Operation 8000 h/year

<u>Production</u>	
Bio-methane	160 GWh/ yr
	⇔ 2200 Nm3/hr
District Heating	50 GWh/yr
<u>Consumption</u>	
Fuel	32 MW
Electricity	3 MW
RME (bio-oil)	0,5 MW

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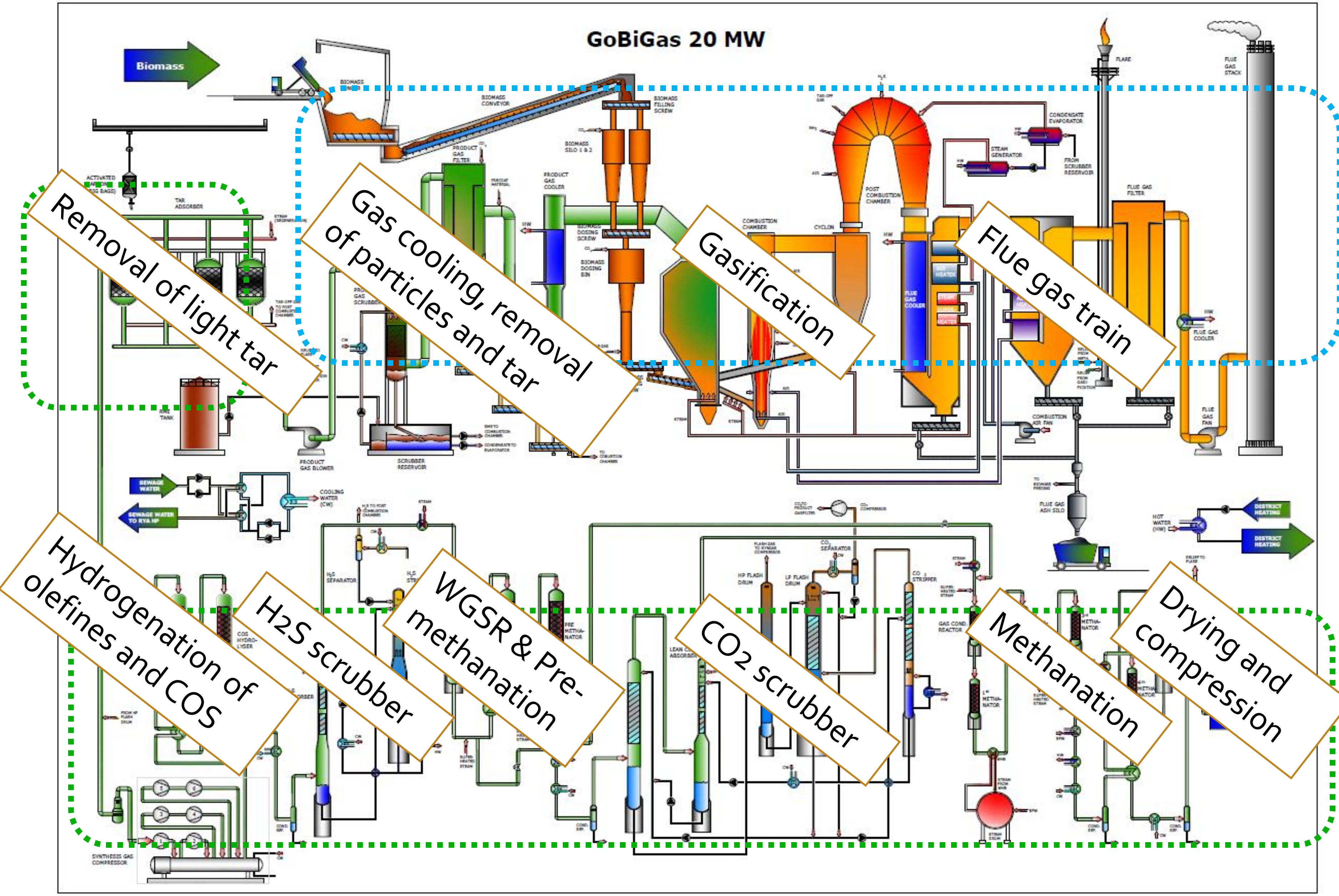
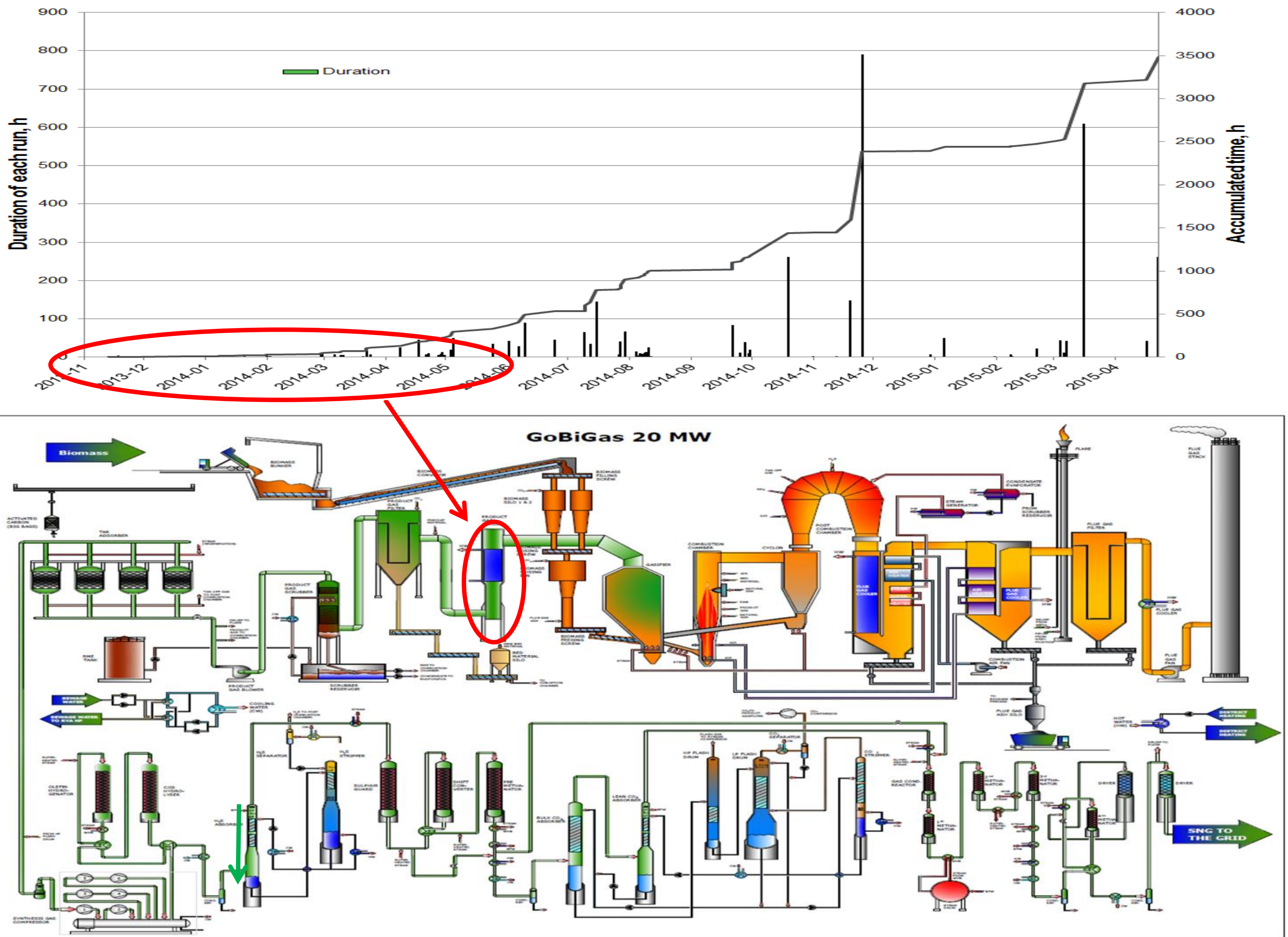

GoBiGas 20 MW
Biomass
Removal of light tar
Gas cooling, removal of particles and tar
Gasification
Flue gas train
Hydrogenation of olefines and COS
H2S scrubber
WGSR & Pre-methanation
CO2 scrubber
Methanation
Drying and compression



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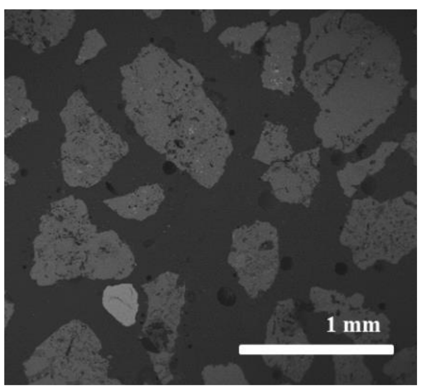
How We Handle Tars

- Activate the Olivine (Mg,Si,Fe)
- What makes the olivine ”active”? How is this activity achieved?
- Addition of K_2CO_3 activates olivine

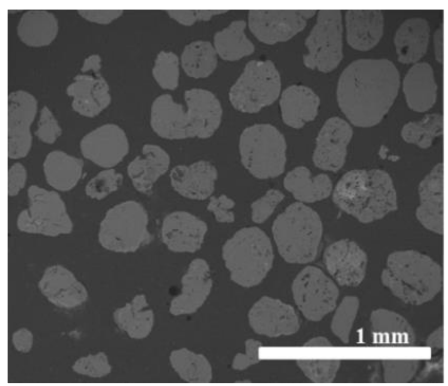
	Before K	After K
Total tar* (g/m3)	43,1	13,1
Total tar, excl. BTX** (g/m3)	21,8	4,4

Fresh olivine



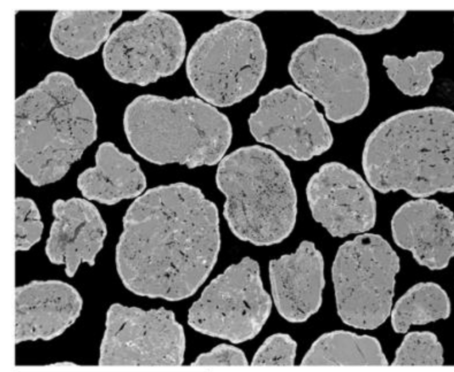
Analysis: Dr. Pavleta Knutsson

Used olivine



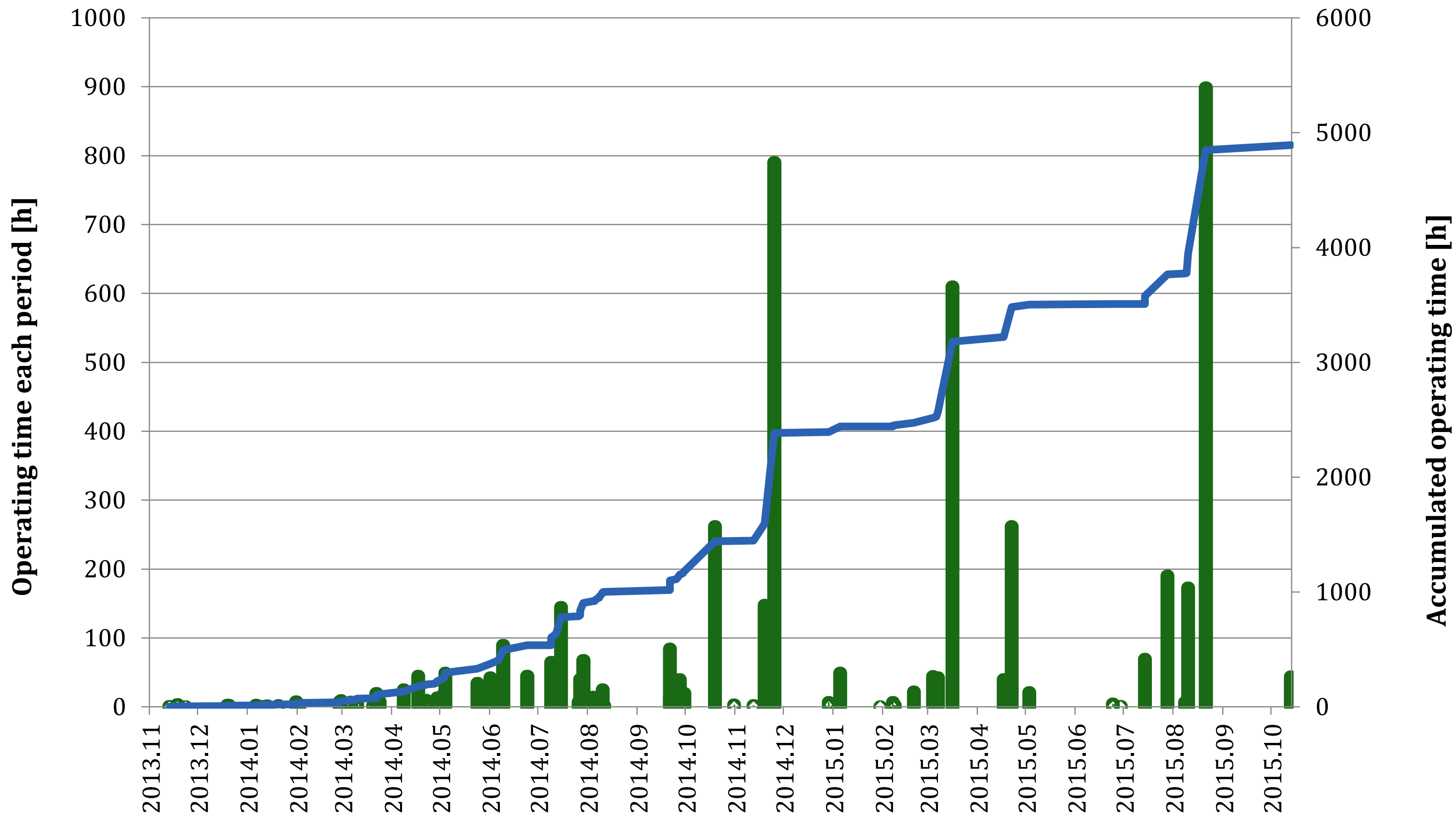
Analysis: Dr. Pavleta Knutsson

Used olivine after K_2CO_3



Analysis: TOP ANALYTIC, BSE-image

Gasification Sept 30 2015: 5000 hrs



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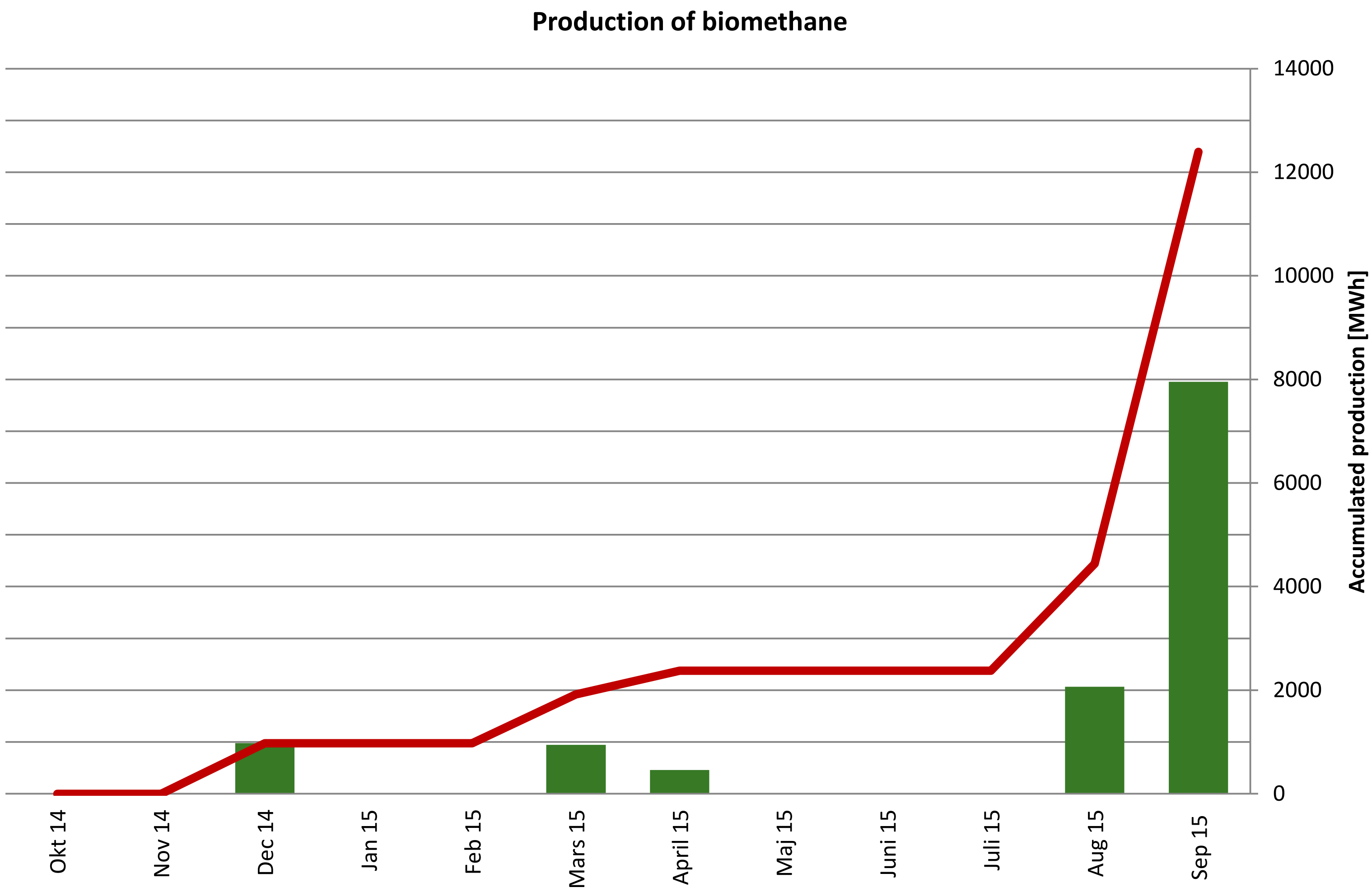
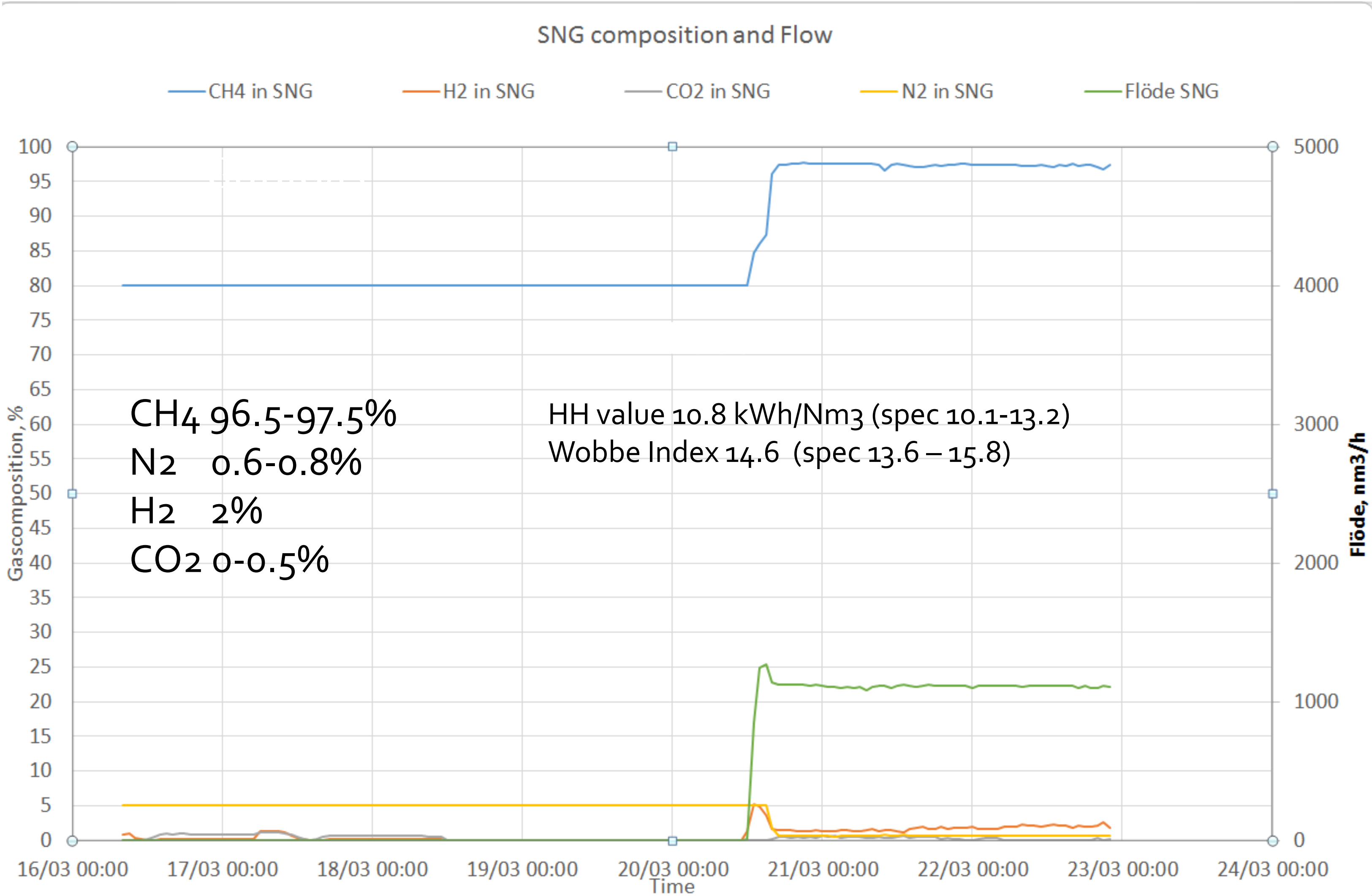
Bio-Methane Deliveries until September 2015



Bio-Methane to the Gas Grid



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Efficiency of Gasification Process

	Gasification Process	Max Biomethane
Cold Gas Efficiency Gasification reactor	84.2 %	69.0 %
Cold Gas Efficiency Gasification process	76.5 %	62.7 %
Total Efficiency (Cold Gas + District heating)	85.4 %	
Heat Losses	14.6 %	
Heat Loss to Flow Gas	2,0%	
Heat Loss to Cooling Water	9,6%	
Heat Loss to Surrounding	3,0%	

- The gasification process has been successfully demonstrated for syngas production of up to 6900m_n^3/h

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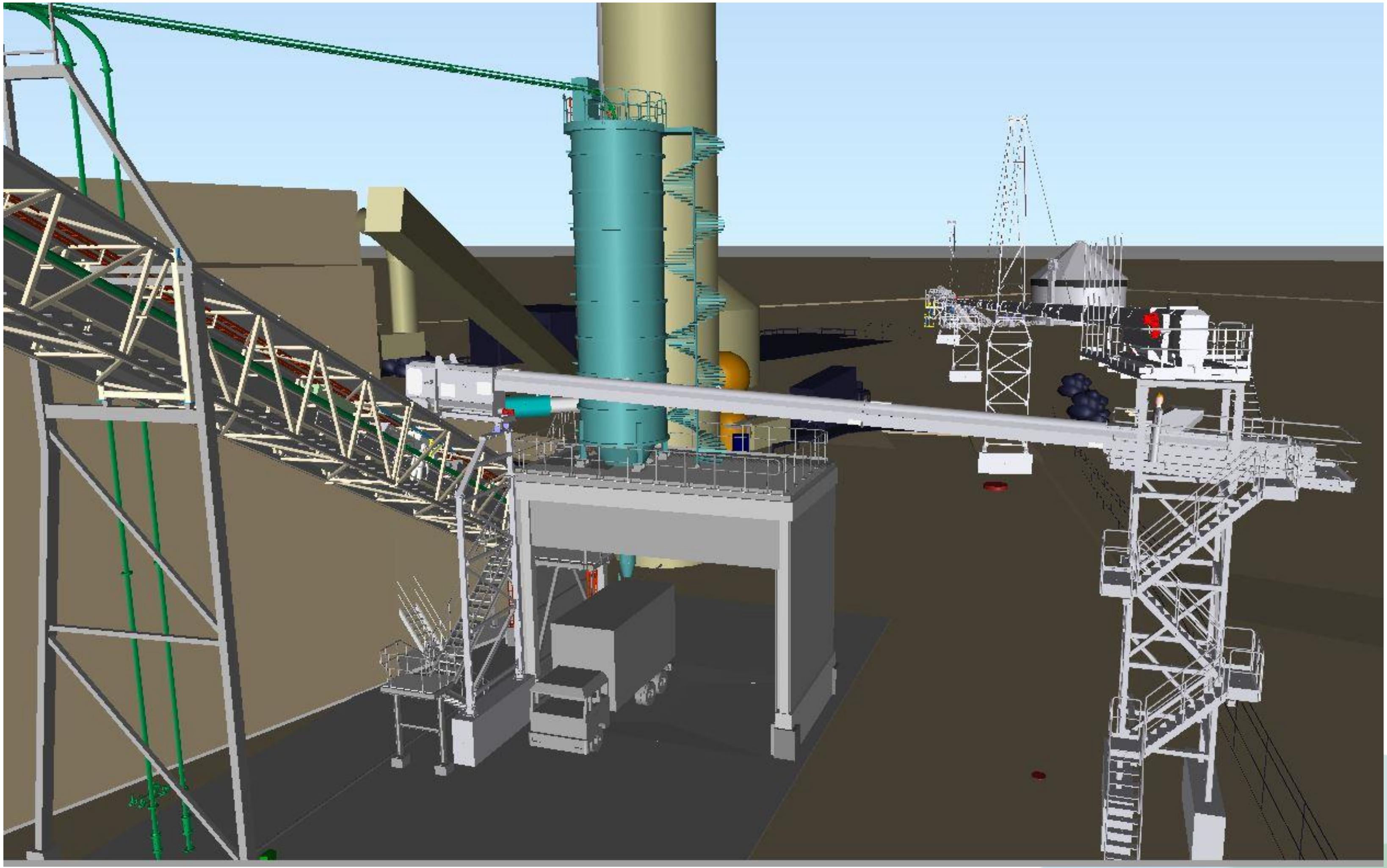
Conclusions

- GoBiGas is now online
- Major hurdles have been solved in the gasification stage and the gasifier now operates at full load.
  - Alkali needs to be in balance to achieve sufficient reduction and simplification of tars
  - Fuel feeding into the bed needs attention and reconstruction is probably required to enable 8000h/year operation

- Optimization of carbon beds for benzene removal now restricts the unit to go to full load

Forest residues reception & conveying – 2016



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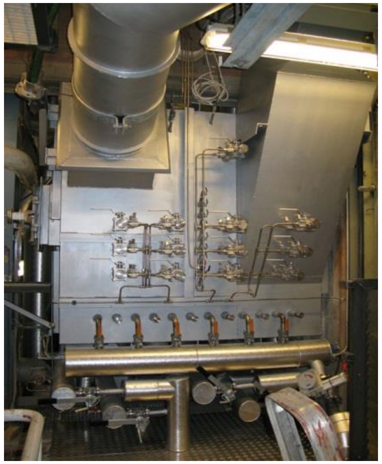
GoBiGas – Step-by-Step Development

Chalmers
Lab-Reactor

"The Chalmers Gasifier"
Chalmers 2-4 MW
Pilot Plant



GoBiGas Phase 1
20 MW bio-methane
Demonstration Plant

GoBiGas Phase 2
80-100 MW bio-methane
Commercial Plant

Commercial Success or not ?
Variable Oil Prices

Project Start **Pilot Study** **Investment Decision** **Construction of Plant** **Start Up and Operation**

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Thank you for your attention!

www.goteborgenergi.se
www.gobigas.se