

GoBiGas

Technical successes



Göteborg Energi in numbers

	2014
No of employees	1 060
Profit, mio €	29
Revenue, mio €	603
Production of electricity, GWh	363
Electric grid (distribution), GWh	4 299
Sales of district heating, GWh	3 258
Sales of gas, GWh	1 420

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.

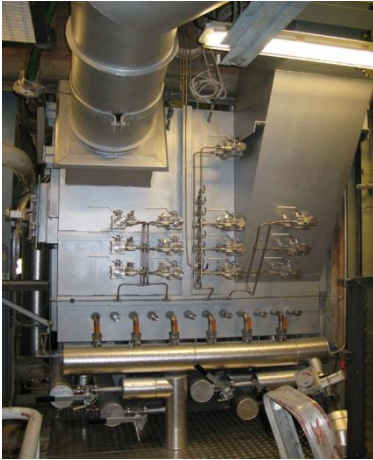


GoBiGas – Pioneering New Technology

- The world's first plant for bio-methane from biomass through gasification
- Injects bio-methane into the transmission grid, potentially reaching all of Europe

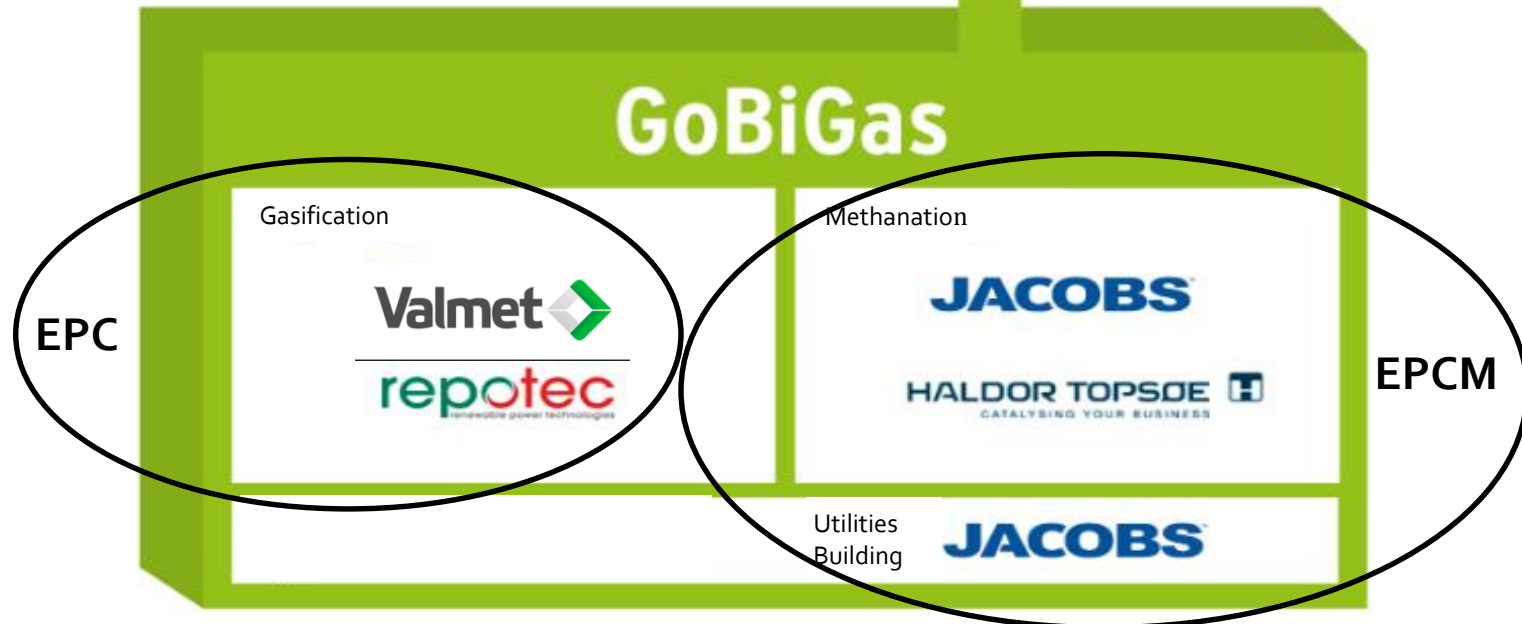


GoBiGas - Partners

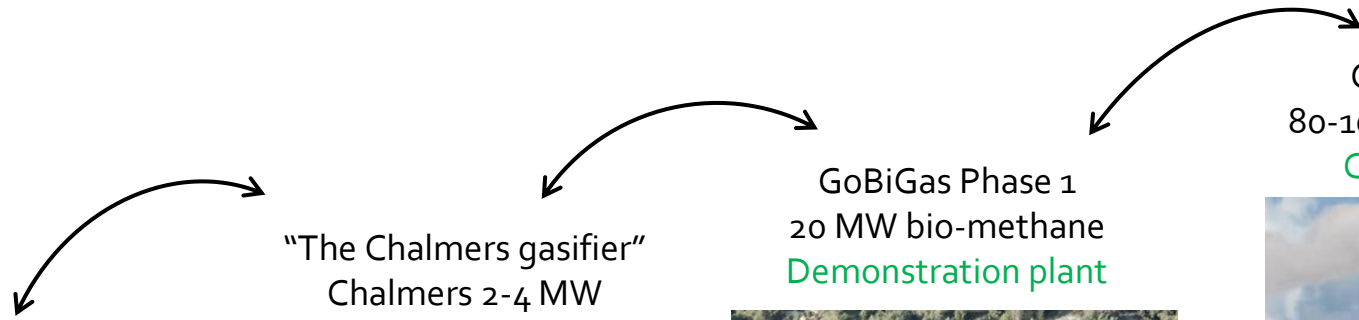


CHALMERS
UNIVERSITY OF TECHNOLOGY

Swedish Centre for Biomass Gasification (SFC)
R&D gasifier 2 MW
Prof. Henrik Thunman
~ 20 PhD students



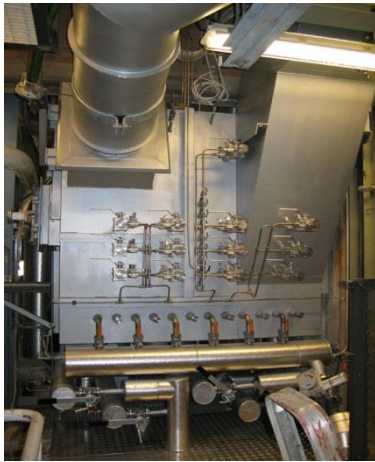
GoBiGas – a step-by-step development



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



2008

2012

2016

The GoBiGas project

- The first plant in the world to produce bio-methane from biomass continuously through gasification
 - Using forest residues as feed stock
 - Polygeneration – producing fuel and heat
- Injects bio-methane into the transmission grid for:
 - Vehicle fuel
 - Fuel to CHP or heat production
 - Feedstock to process industry
- Commercializing the technology in two phases:
 - Phase 1 - 20 MW demo plant, partly financed by Swedish Energy Agency
 - Phase 2 - 80 – 100 MW commercial plant, when the technology is proven in phase 1 and the market conditions are sufficient
 - Phase 2, a selected project by the EU Commission in NER300 but is currently not being developed.

The GoBiGas sites for Phase 1 & 2

Overall performance goals

- Biomass to bio-methane > 65 %
- Energy efficiency > 90%
- Planned operation 8000 h/year

Phase 1

Phase 2



Production in Phase 1

Bio-methane 20 MW
160 GWh/yr ⇔ 2200 Nm³/hr

District Heating 50 GWh/yr

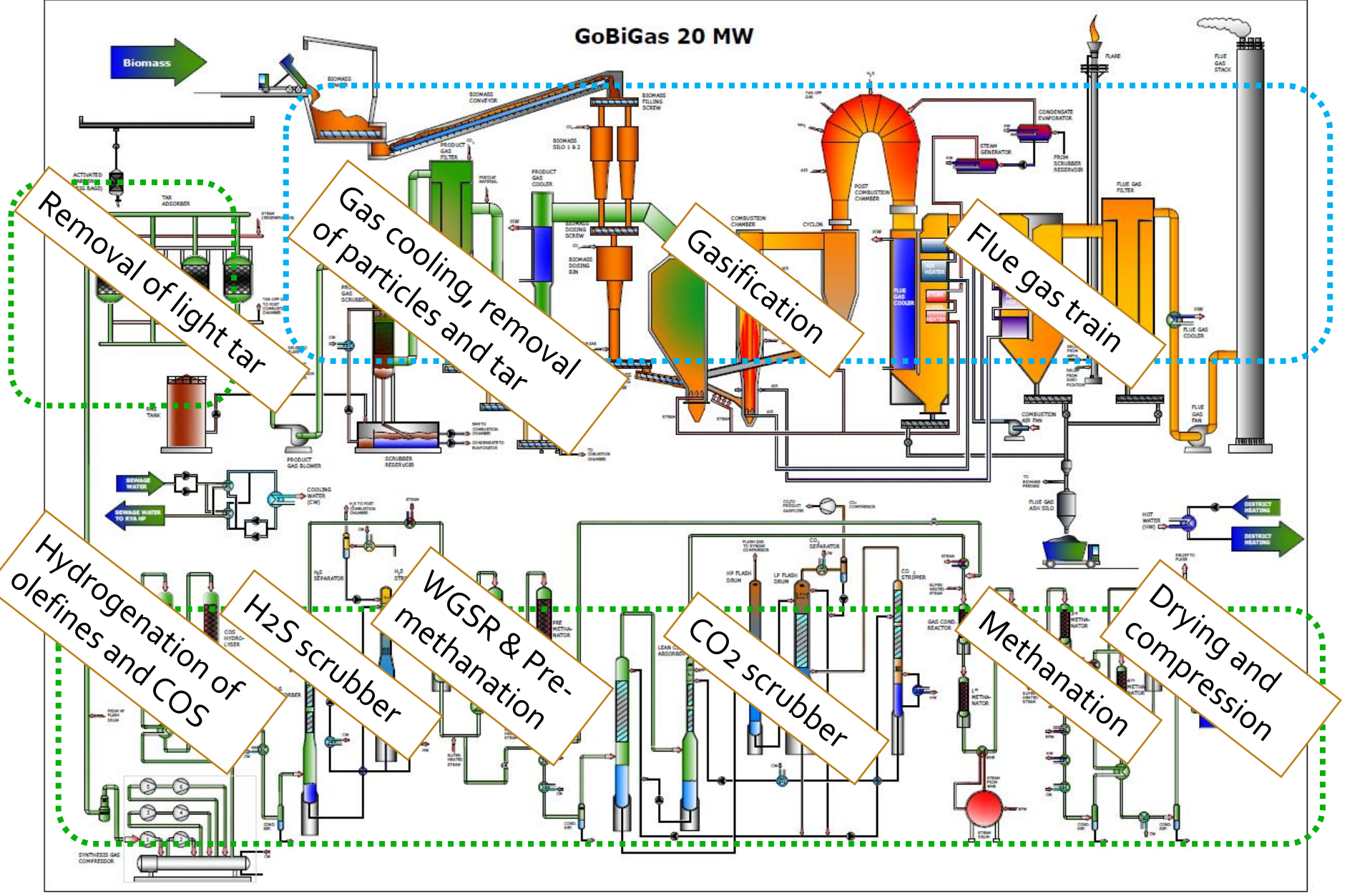
Consumption

Fuel 32 MW

Electricity 3 MW

RME (bio-oil) 0,5 MW

GoBiGas 20 MW



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

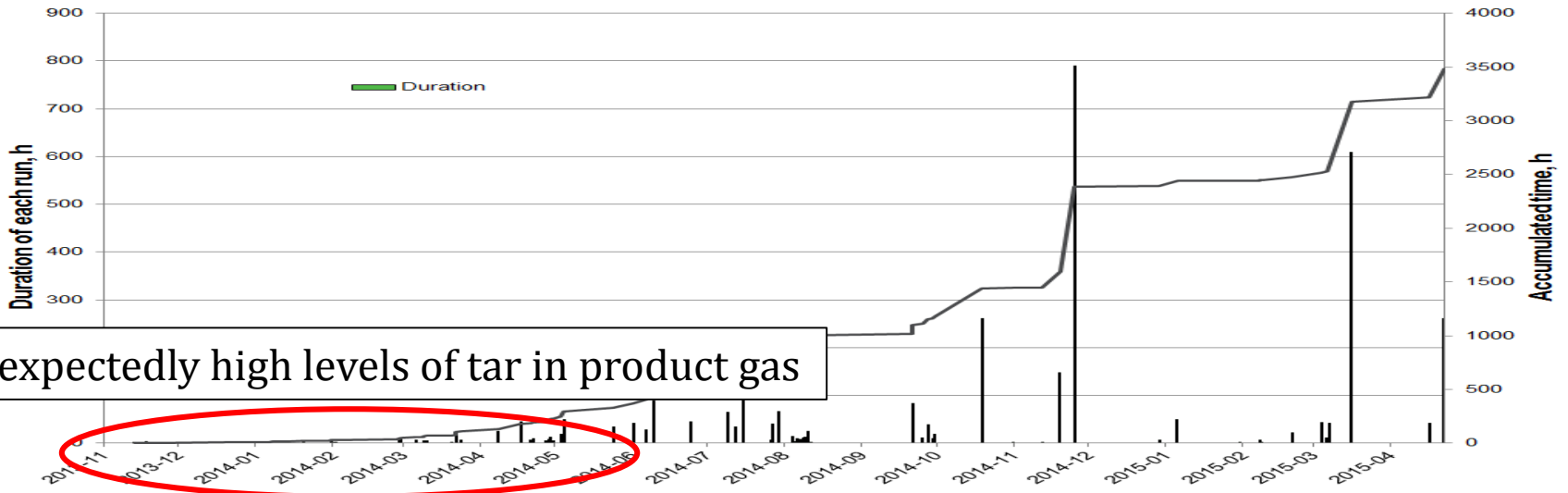
CO2 scrubber

Methanation

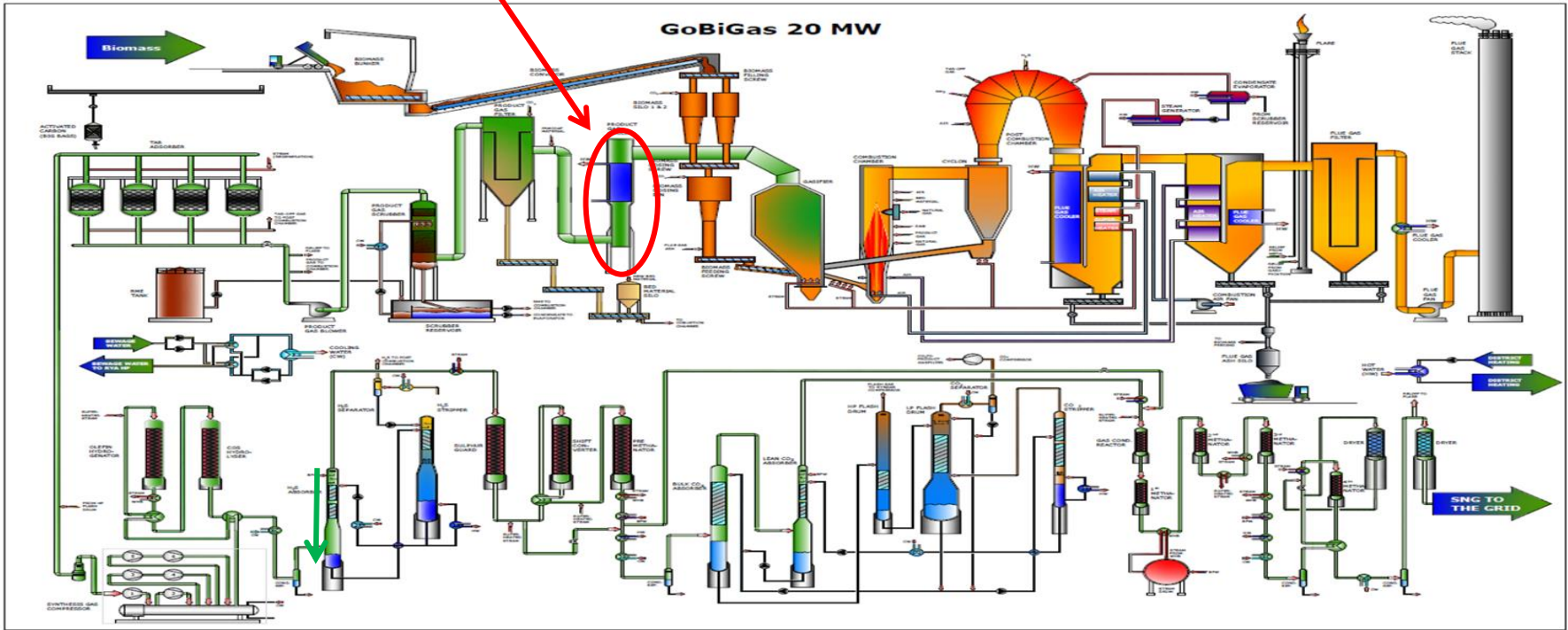
Drying and compression



Technical successes



Unexpectedly high levels of tar in product gas

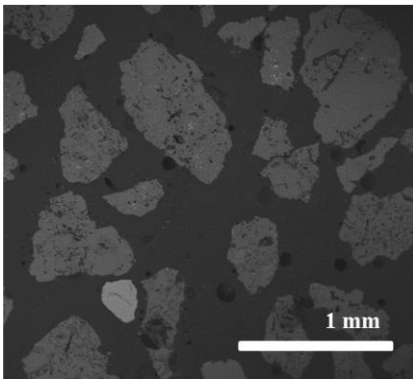


How did we reduce tars?

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

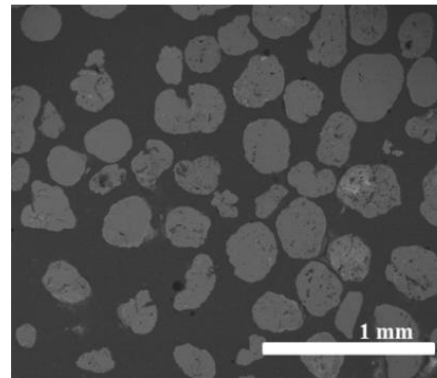
	Before K_2CO_3	After K_2CO_3
Total tar* (g/m ³)	43,1	13,1
Total tar, excl. BTX** (g/m ³)	21,8	4,4

Fresh olivine



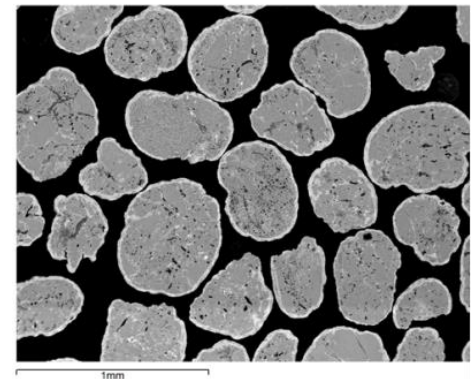
Analysis: Dr. Pavleta Knutsson

Used olivine

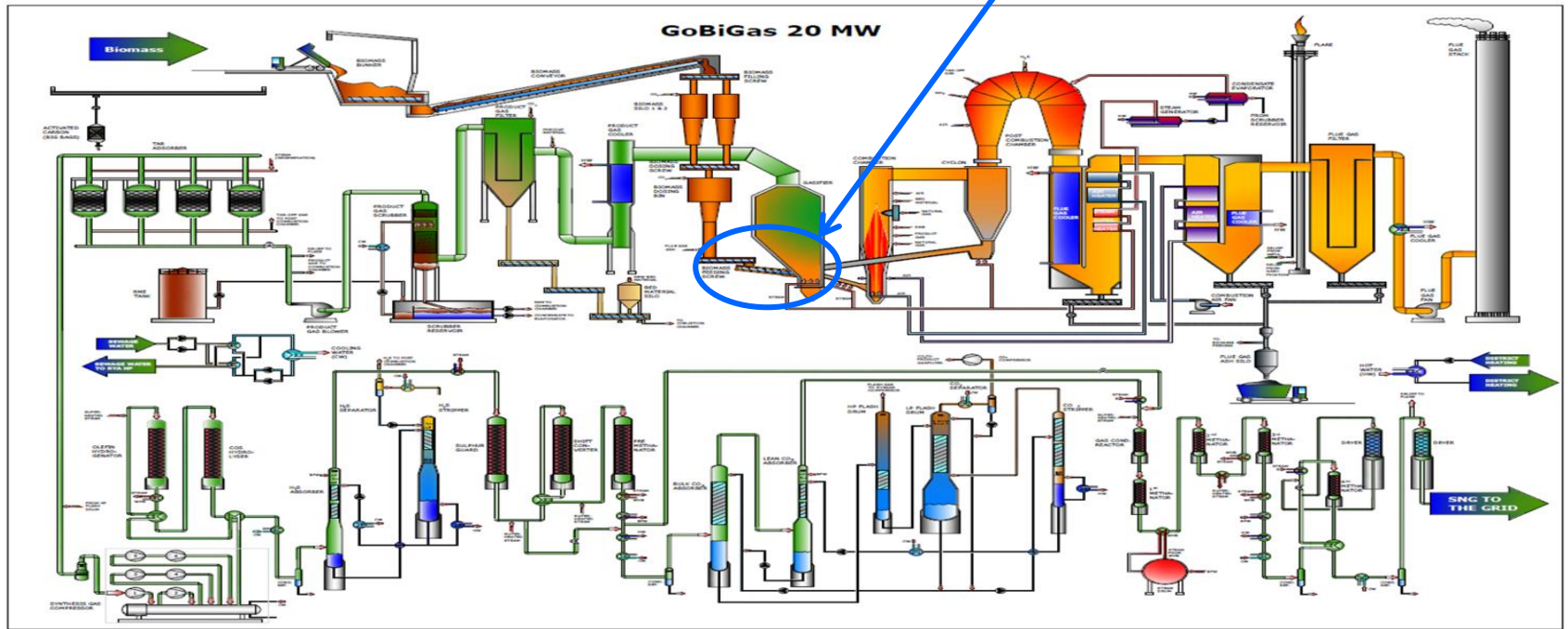
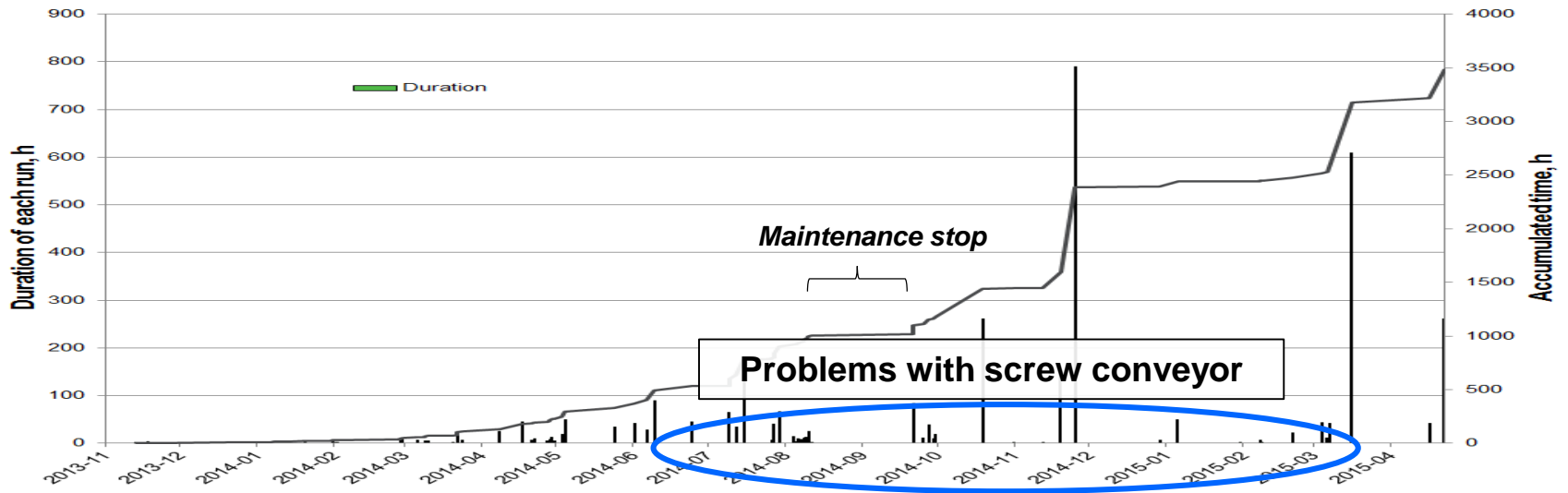


Analysis: Dr. Pavleta Knutsson

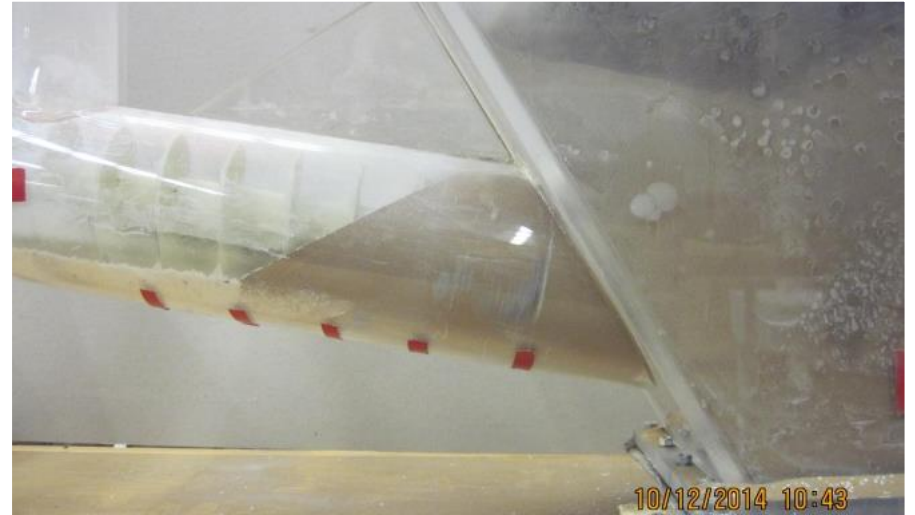
Used olivine after K_2CO_3



Analysis: TOP ANALYTIC, BSE-image



Improving the screw conveyor technique



Pictures: Dr. Claes Breitholtz, Valmet Power AB

GoBiGas - status

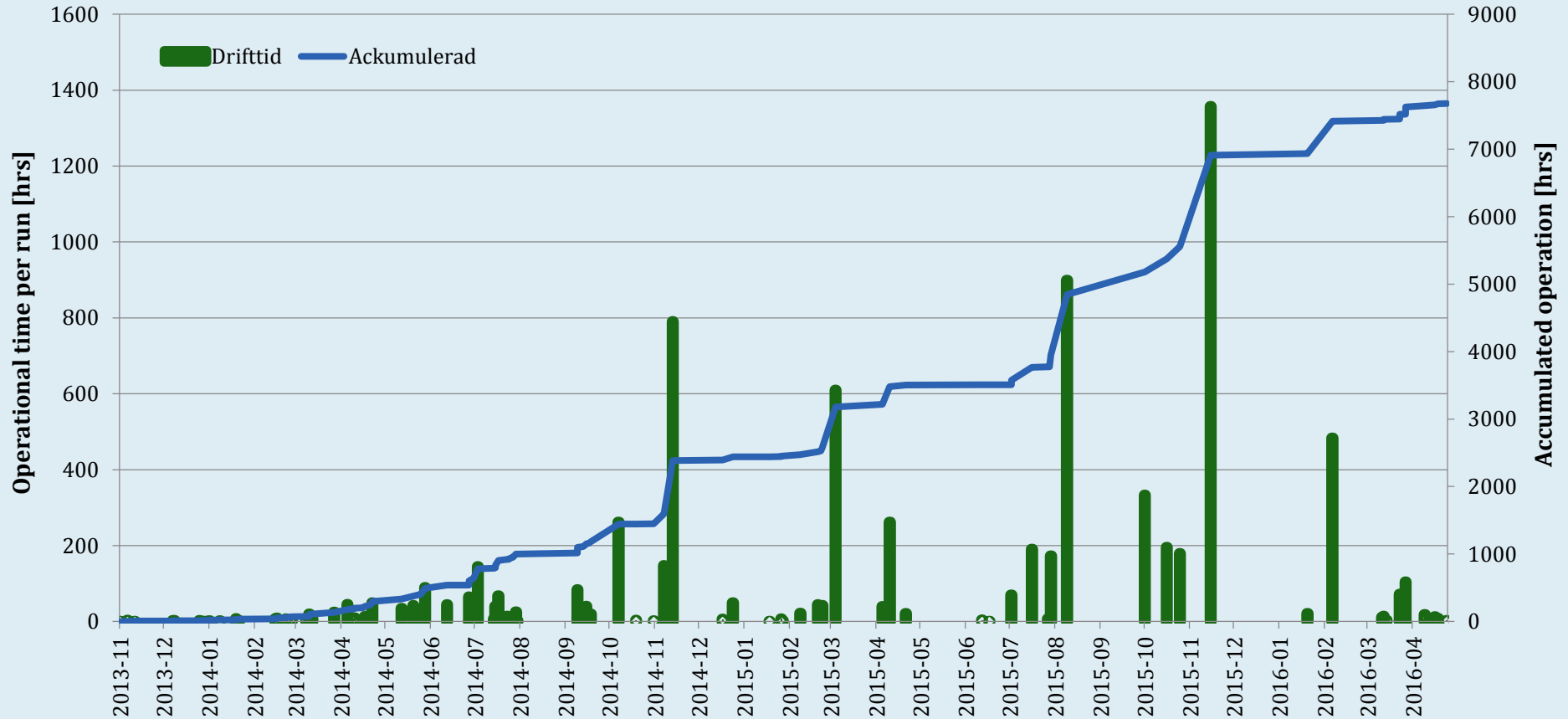
- 29 GWh biogas delivered in total in 2015.
- 26,5 GWh delivered to transportation, 74 % CO2 reduction (RED).
- Record of two months of continuous delivery of bio-SNG.
- 100 % capacity in gasification.
- 80 % capacity in methanation due to high levels of benzene.
- Currently changing feedstock to wood chips.



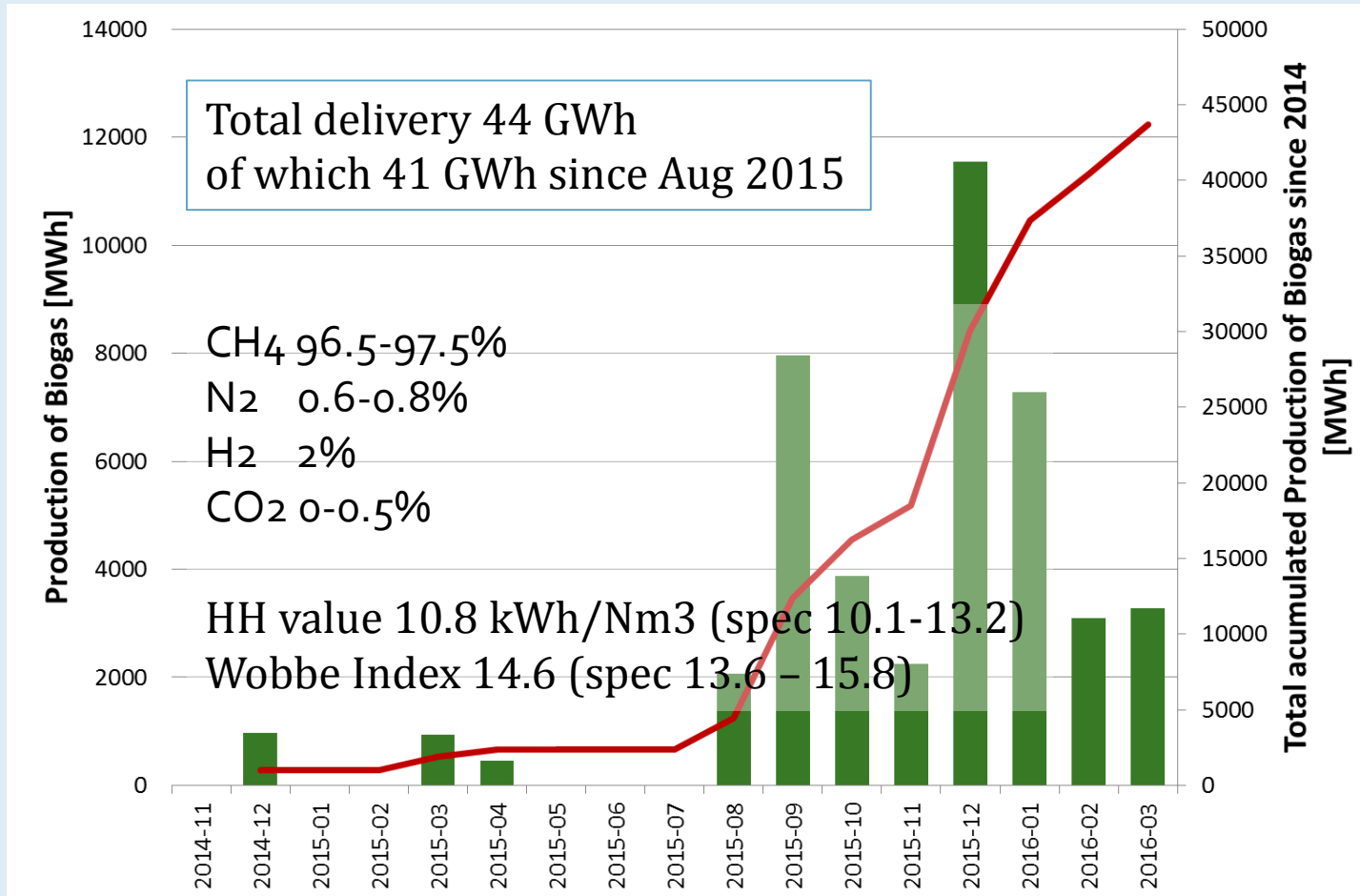
GoBiGas - status

Gasification in operation >7500 hours

Availability, gasification process

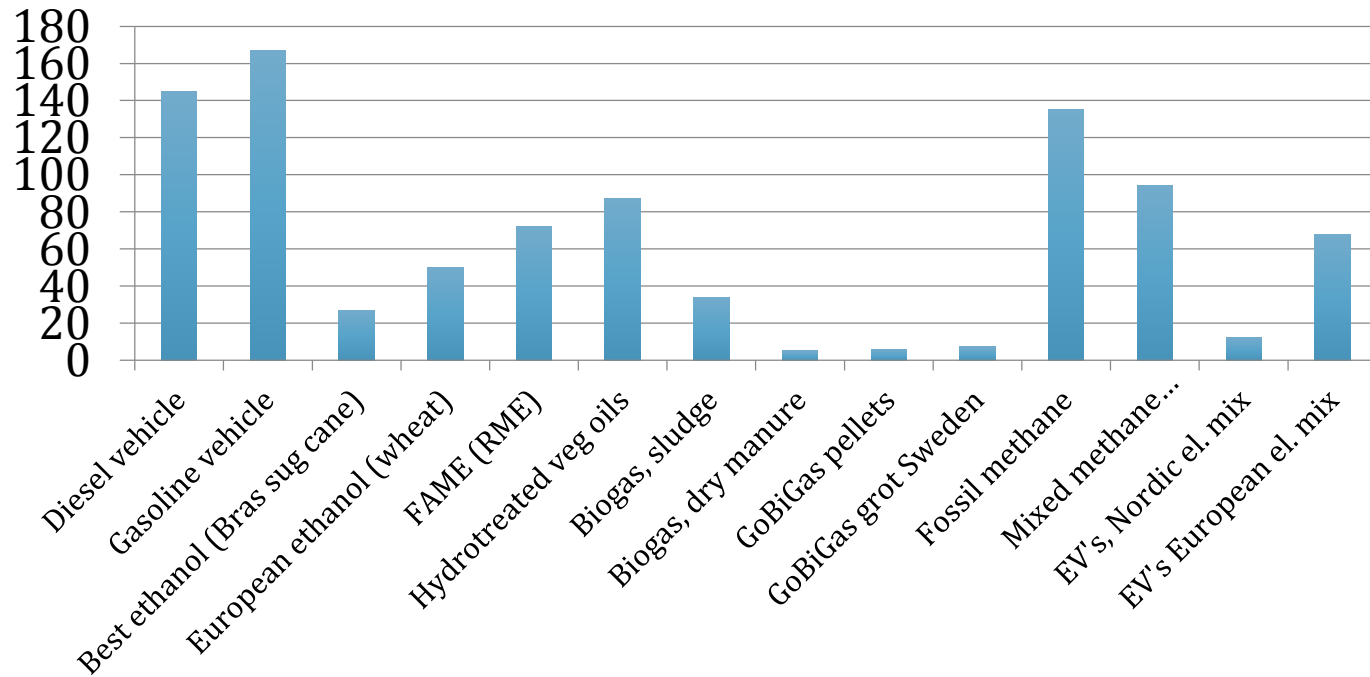


GoBiGas - status



Biogas has impressively low GHG-emissions

Well to Wheels climate impact (g CO_{2eq}/km)



Source: Well-to-Wheels rapport 2011, APPENDIX 1, Summary of WTW Energy and GHG balances, and Renewable electricity consumption (CSI 031/ENER 030) - Assessment published Apr 2012. European Environment Agency

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
 - Condensation and heat recovery
- Expecting challenges with chips
 - Moisture, impurities, etc.



Thank you for your attention!



www.goteborgenergi.se
www.gobigas.se