GoBiGas and other gasification activities at Chalmers

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GoBiGas

Gothenburg Biomass Gasification Project

A collaboration between Göteborg Energi and e.on

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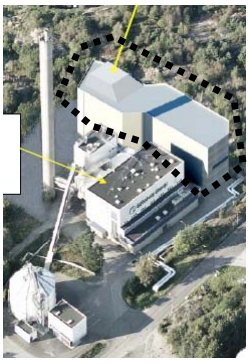
GoBiGas project

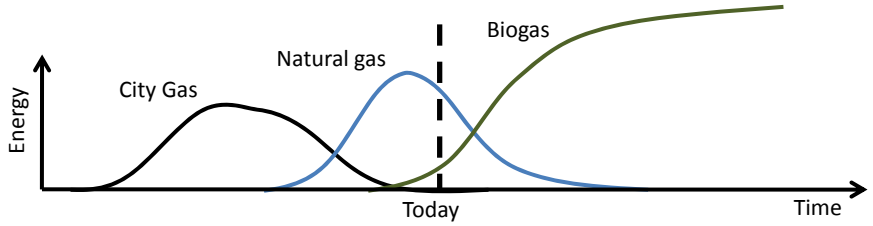
- Production of gas from biomass of the same quality as natural gas
- Commercial scale of production (>100 MW)
- Location, harbor in Gothenburg
- Step 1, 20 MW in operation in 2012
- Step 2, 80 MW in operation 2015
- Performance target
  - Gas yield >65% (based on energy)
  - Overall energy efficiency >90%
  - Operation of plant 8000 h/year

Step 1

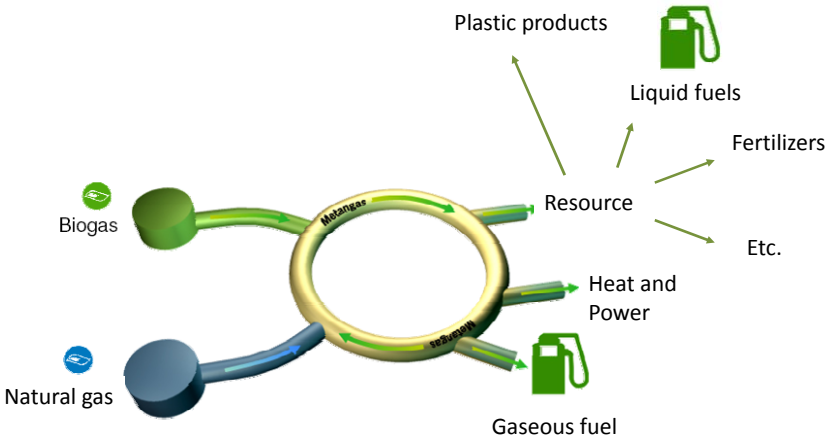


Long term goal

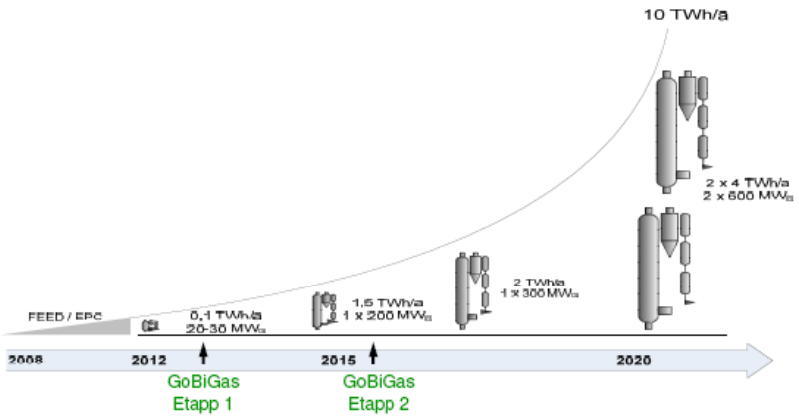
- Replace natural gas with gas produced from biomass
- Make Sweden a net exporter of gas
- Target for 2020, production of 20 TWh gas from biomass (biogas)
  - 10 TWh via thermal gasification
  - 10 TWh via anaerobic digestion



Use existing infrastructure for natural gas



Commercial development plans

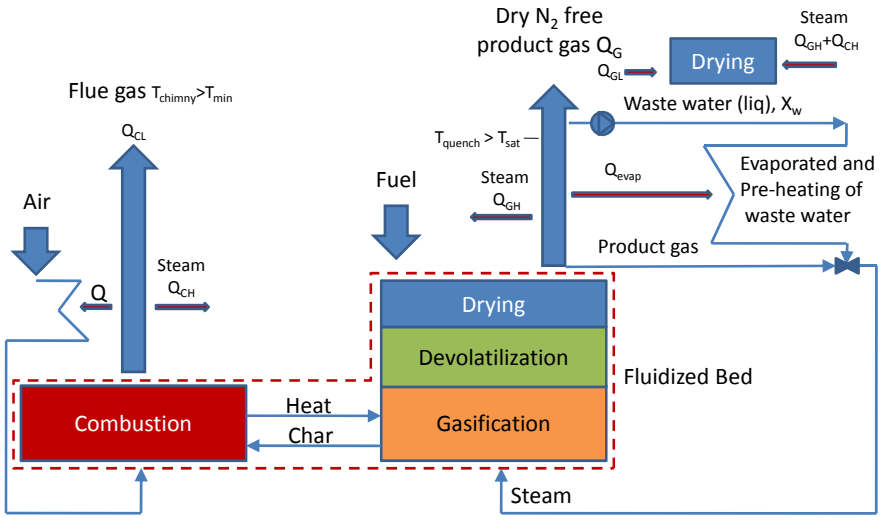


Gasification technology for initial steps

- Gasification - Indirect (allothermal) gasification
- Gas cleaning
  - Tars biooil scrubbing
  - CO2 Amin scrubbing
  - Particles low temperature filters
- Methanisation
  - Low pressure fixed bed methanisation

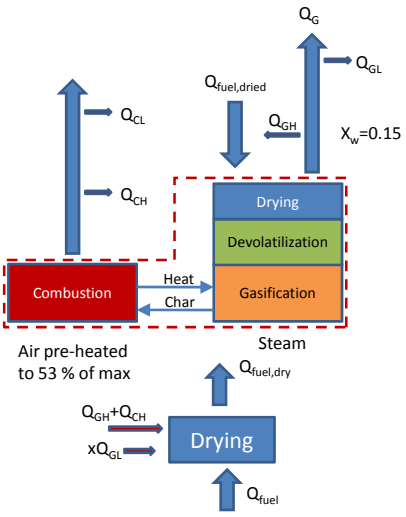
Indirect Gasification, 4-8 MW_{fuel}/m^2

(0.8-1.6 ton/h m^2)



Energy Balance Indirect Gasification

Optimized gasifier	Q (LHV)	Q(HHV)
Fuel 50% moist, Q_{fuel}	100.0	123.0
Fuel 20% moist, $Q_{fuel,dried}$	111.2	123.0
Product gas, Q_G	97.9	109.7
Steam prod. gasi., Q_{GH}	6.4	6.4
Steam prod. comb., Q_{CH}	2.9	2.9
Low temp heat, gasi., Q_{GL}	3.7	3.7
Low temp heat, comb., Q_{CL}	0.3	0.3
	111.2	123.0
Heat demand drying	11.2	11.2
$Q_{GH}+Q_{CH}$	9.3	9.3
$Q_{GH}+Q_{CH}+0.5Q_{GL}$	11.2	11.2



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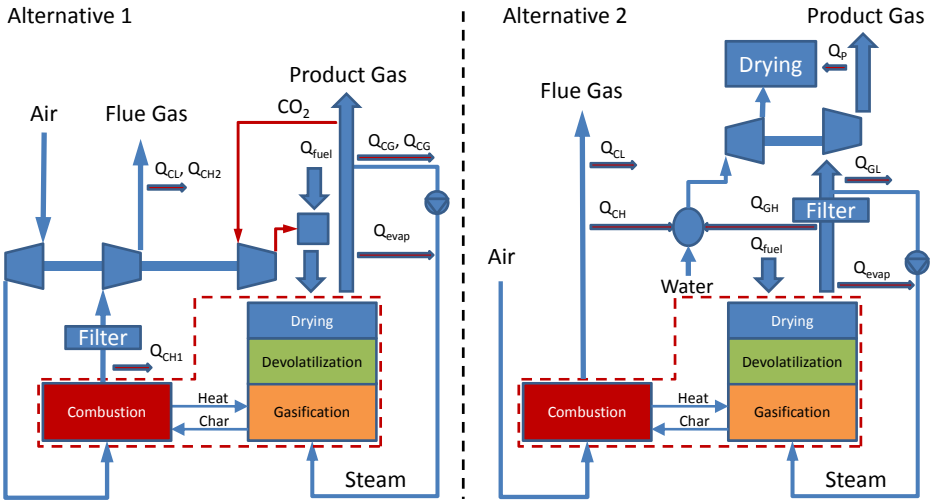
Pressurizing of Product Gas



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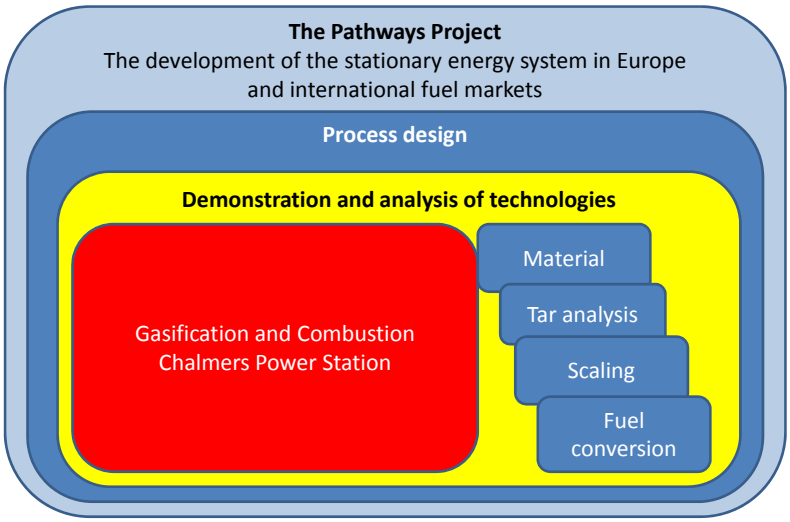
Research Activity at Chalmers



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Division of Energy Technology

Major Research Areas

- Biomass and Waste combustion in fluidized beds
- Biomass Gasification
- Chemical Looping Combustion/Reforming (CLC/CLR)
- Oxyfuel Combustion
- Energy System analysis

Short Facts

- Personnel
  - Professors 3
  - Professor emeritus 1
  - Associate Professors 3
  - Assistant Professors 5+1
  - PhD students 28+3
  - Research Engineers 5
  - Project Coordinator 1
  - Administrators 2
- Turn over ≈90 Mkr (≈10 M€)

Research Infrastructure

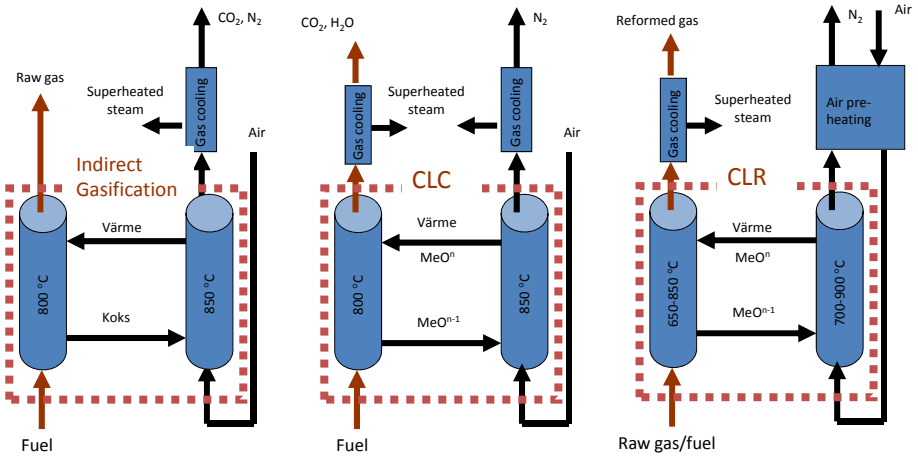
Major Experimental Facilities

- Chalmers 12 MW multi fuel circulating fluidized bed research boiler
- Chalmers 2-4 MW indirect (allothermal) biomass research Gasifier
- Chemical Looping Combustion/Reforming reactors for gaseous fuels (300 W, 1kW, 20 kW)
- Chemical Looping Combustion/Reforming reactors for solid fuels (10kW, 100 kW)
- Macro thermo gravimetric analyzer, for fuel particles up to a few centimeters
- Cold flow models for fluidization research, raiser heights between 0.4 – 8 m

Data bases

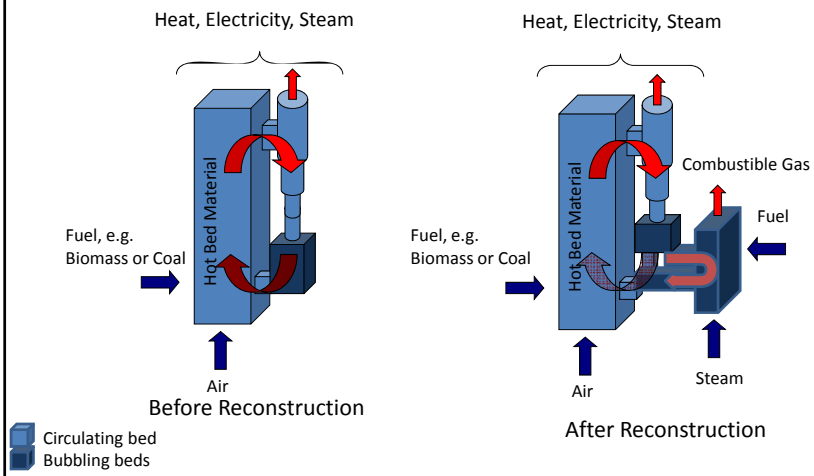
- Power plants, 98-99% of all European plants above 10 $MW_{electric}$, coal power plants under development in Asia and North America
- Fuel data bases, all major fuel infrastructures and recourses of gas, oil and coal, including long term SPAs (sales and purchase agreements) for gas
- All major European industrial CO_2 emitters
- All European potential CO_2 storage sites (coal basins, oil and gas fields and aquifers)

Indirect gasification ≈ CLC ≈ CLR



Chalmers gasification concept

Circulating fluidized bed (CFB)



Poly-Generation Concept for Production of Heat, Electricity and Biofuels

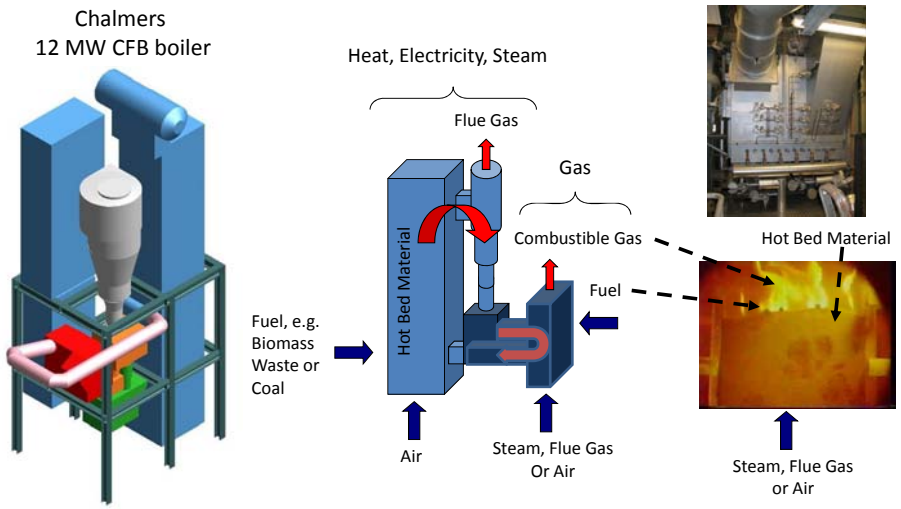
- Increased stability of the gasification process
- Less need of refractory walls
- Possibility to take full advantage of the low temperature heat demand connected to the drying
- Production unit can produce heat and power even if the biofuel production has low availability

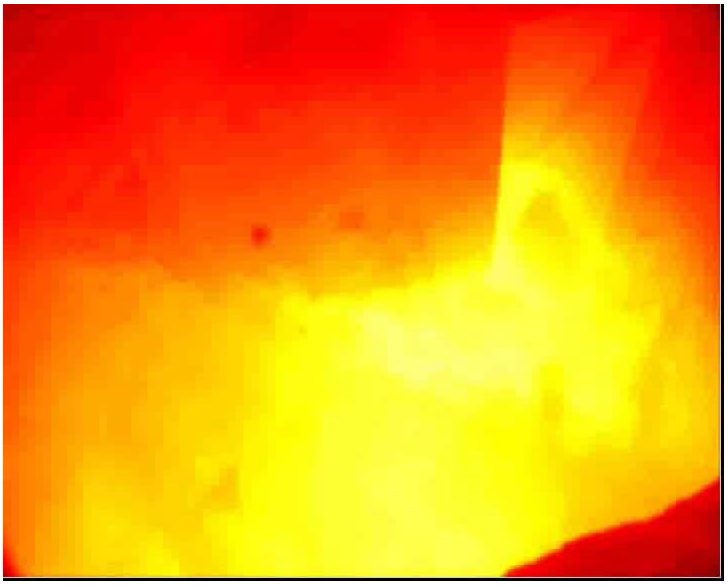
Market Introduction

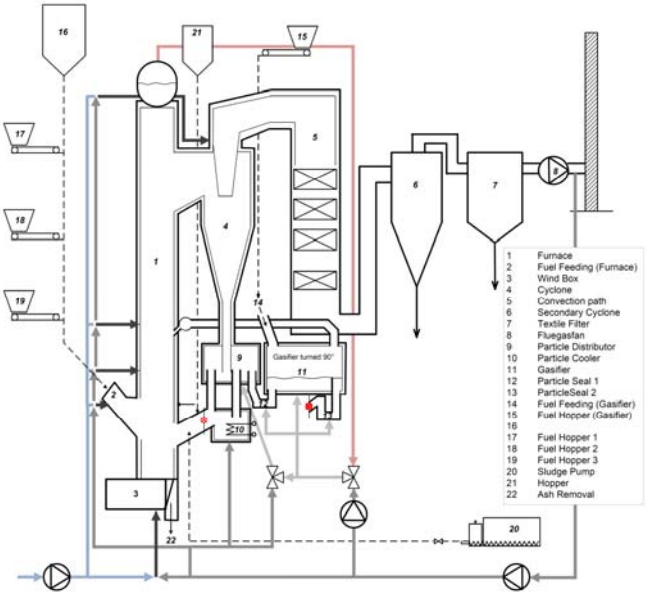
The gasification route has so far not been **Economically Feasible**, however present and expected requirements on the introduction of renewable fuels in large scale are slowly changing this

To use **Existing Boiler Infrastructure** for solid fuels - at present producing heat and power - **to also produce gas** is a low risk option for the introduction of biofuels via gasification

Chalmers Research-Gasifier







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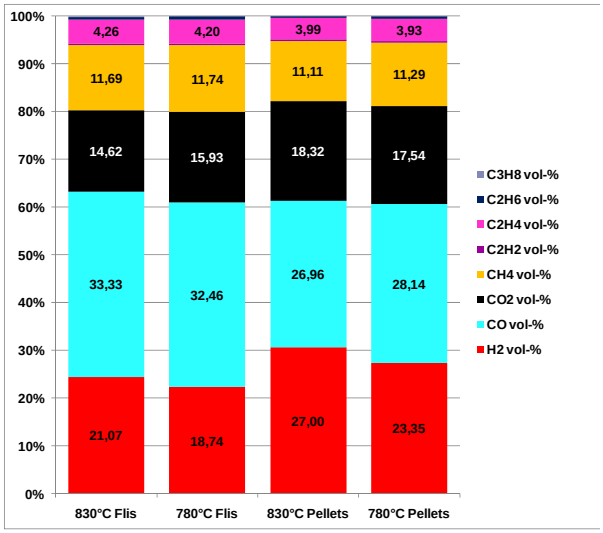
Wood Chips vs Pellets



Tars without any reduction measures

~20g/nm^3
~ 4-5% of energy in ingoing fuel

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Specification of Chalmers Gasifier

Variation possibilities

- Fuel load 0 – 4 MW (0 - 1 ton/h)
  - (tested: 0-2.3 MW)
- Optional fluidization media
  - Steam
  - Flue gases
  - Air (not yet tested)
- Temperature in Gasifier 550-950 °C (tested 725 - 860 °C)
- Residence time
  - Adjustable solid flux
  - Adjustable bed height (Not yet applied)
- Fuel
  - Dry pellets (tested: Wood and Bark)
  - Wet biomass (tested: Wood chips)
- Bed material (tested: silica sand)

Measurements

- Product gas composition
- Solid flux
- Fuel feed
- Temperatures
- Pressures
- In plant gas and bed sampling
- Extraction of gas slip flow

Accumulated Time of Operation

with fuel ~650 h without fuel ~4300 h

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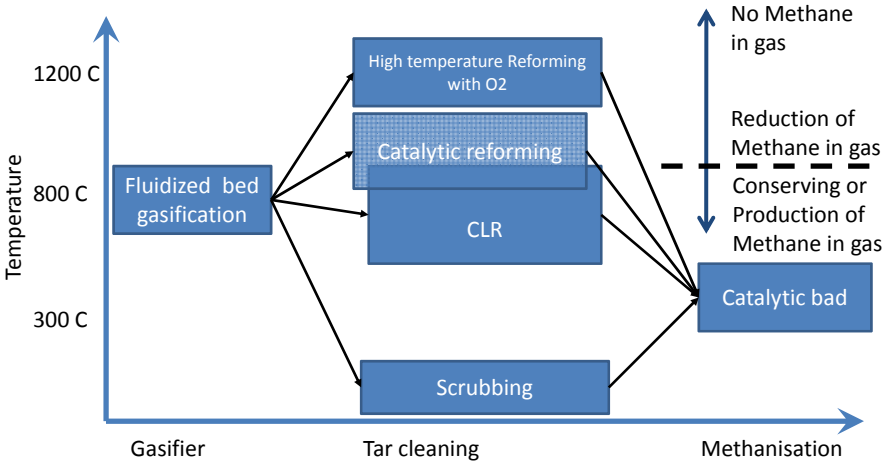
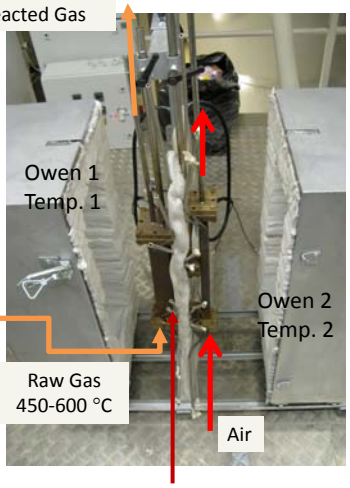
Medium Temperature Tar Cracking with CLR-Technology

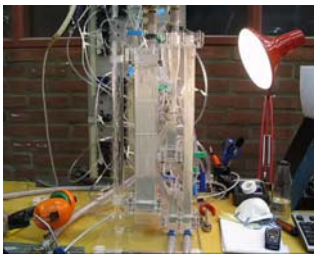


Second Indirect Gasifier for Gas Cleaning and Bed Material Tests

Primary Indirect Gasification



Air Cooling



Cold Model

Summary

- Production of gas from biomass to substitute natural gas (SNG) is a ready technology with a well established infrastructure and market for the product, which will be demonstrated within the GoBiGas project
- Indirect gasification is an energy efficient process to produce a suitable product gas for SNG from biomass in mid- and large scale, up to several hundreds of MW fuel input
- Poly-generation of gas with heat and power production from solid biomass simplify construction and operation. It also utilize the low temperature heat demand of the process and enable higher steam data from biomass.