Production of Green Gas through Biomass Gasification in the Netherlands

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GGROS2015
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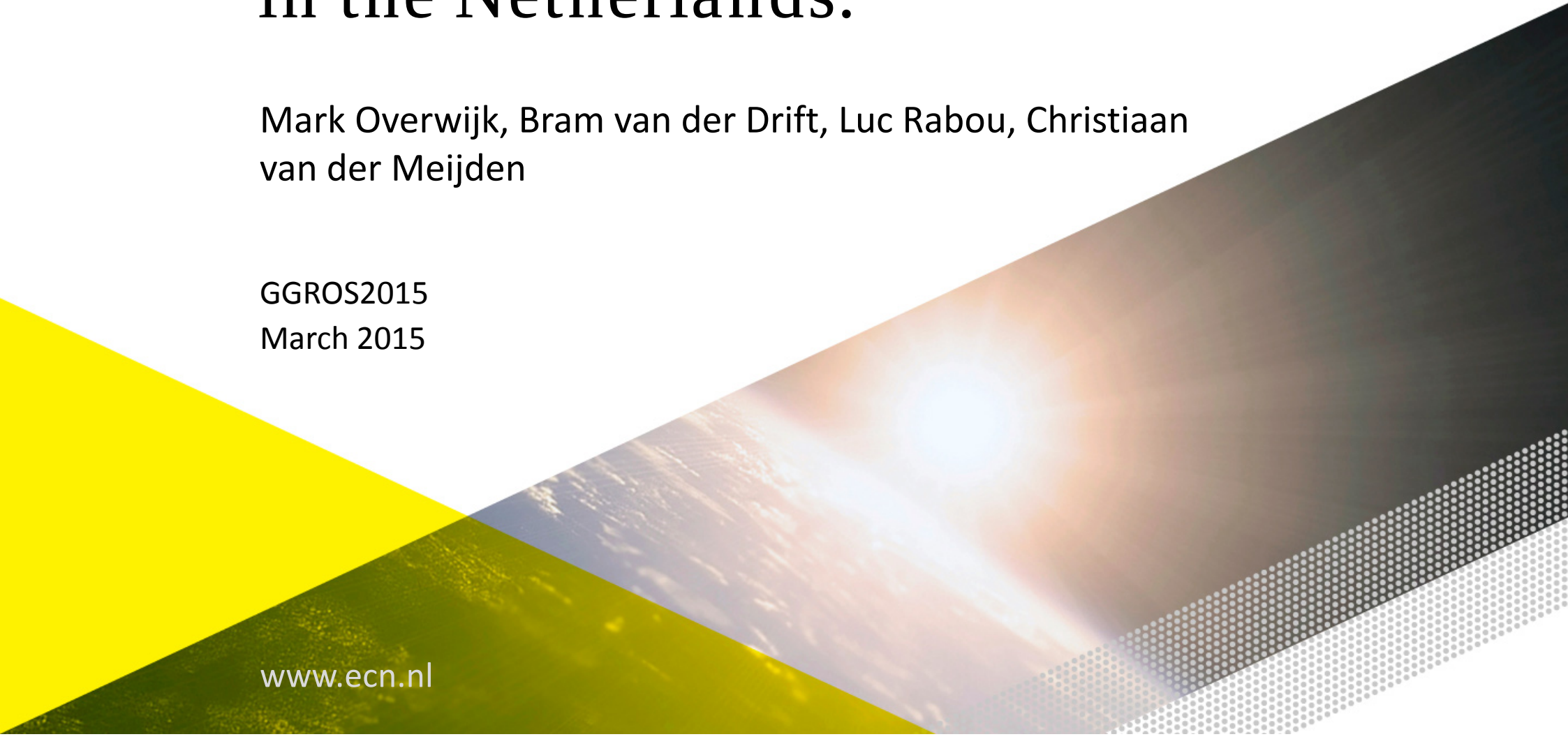


Energy research Centre of the Netherlands (ECN)

- Independent largest Energy R&D centre of the NL (500 FTE)
- Dedicated to Sustainable Energy Innovation

  With and for the market, ECN develops knowledge and technology that enable a transition to a sustainable energy system

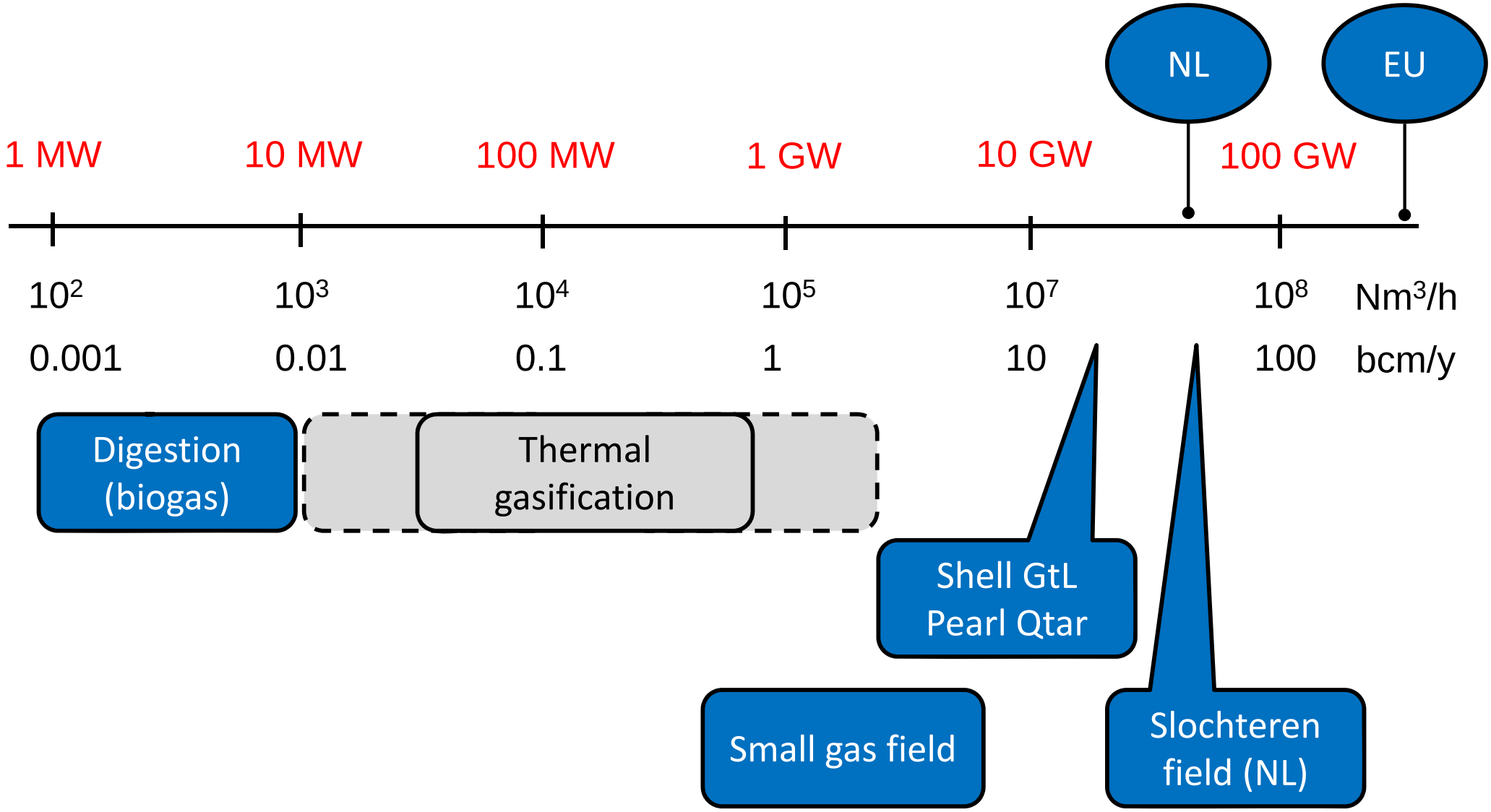
2 Ways to produce Green Gas

Digestion
of wet biomass

Gasification
of dry biomass

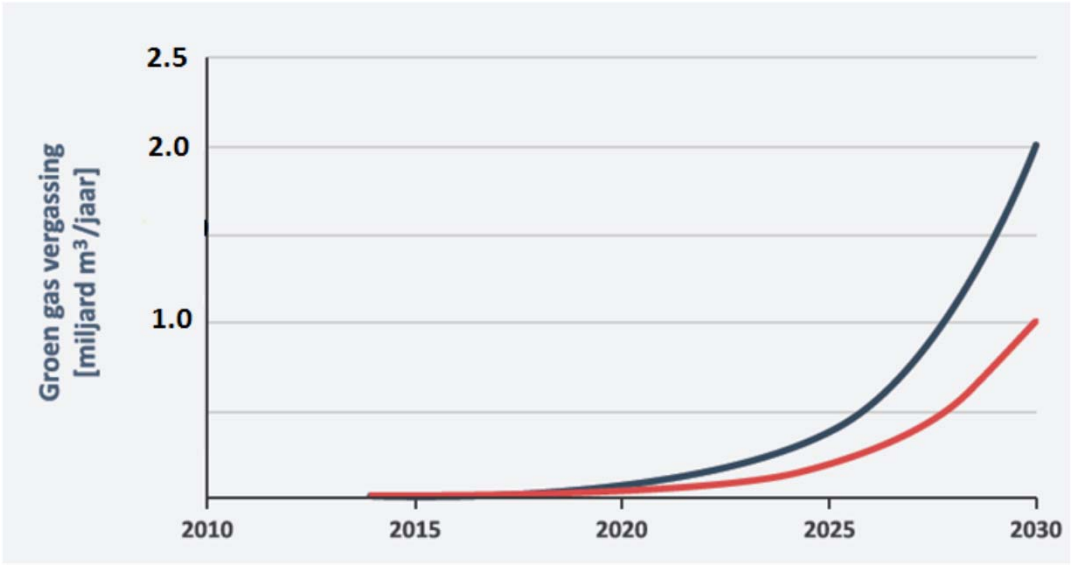
Comparing production potentials

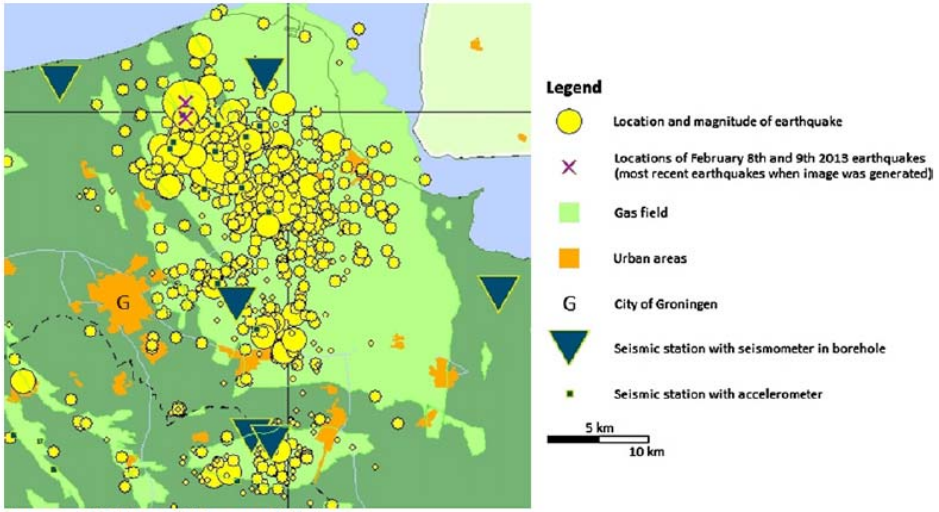
Large scale green gas production will employ gasification



Green Gas ambition in the Netherlands

- Netherlands is a gas country with extensive gas infrastructure
  - High production subsidies on green gas possible: prices up to 104 ¢/Nm3
- Potential digestion in the Netherlands is 2-3 BCM green gas p.a.
- Estimated green gas production in BCM p.a. from biomass gasification in the Netherlands:





Source: KNMI (2013c, modified).

- Number of initatives running to make this happen

Initiatives in the Netherlands
ECN/Dahlman

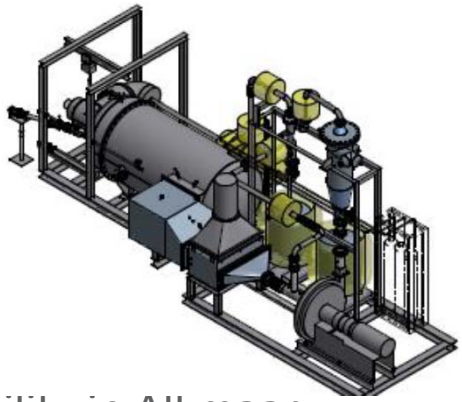
- Project: 4 MW_{th} demo plant on woodchips to inject SNG in the gas grid
- Technology:
  - MILENA biomass gasification
  - OLGA gas cleaning
  - ESME methanation
- Locations:
  - Alkmaar and/or Delfzijl
- Status:
  - Production subsidy granted for the Alkmaar location
  - Lab and pilot plants at ECN in Petten
  - For more: See update in this presentation

Initiatives in the Netherlands

torrgas

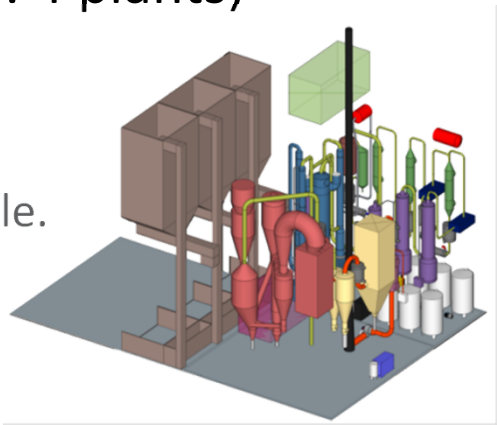
ECN

- Project: 25 MW commercial plant to produce syngas for industry from torrefied biomass
- Technology:
  - Special design to prevent slagging and tar cleaning
  - Stable operation by feeding of homogeneous, pulverisable, moisture-free torrefied biomass.
  - Probably integrated with a 12 MW P2G facility
- Locations:
  - Delfzijl
- Status:
  - Building a 0.7 MW pilot facility in Alkmaar



Initiatives in the Netherlands
i-*RES/BMC Zutphen*

- Project: 14 MW commercial plant to produce SNG (ambition: 4 plants)



- Technology:
  - Conceptual design available.
- Locations:
  - 4 potential locations
  - Environmental permits available for all 4 locations
  - Sofar production subsidy granted for the Zutphen location
- Status:
  - Looking for technology partners.
  - Repotec anticipated as gasification partner

Gasification to produce green gas

3 step process

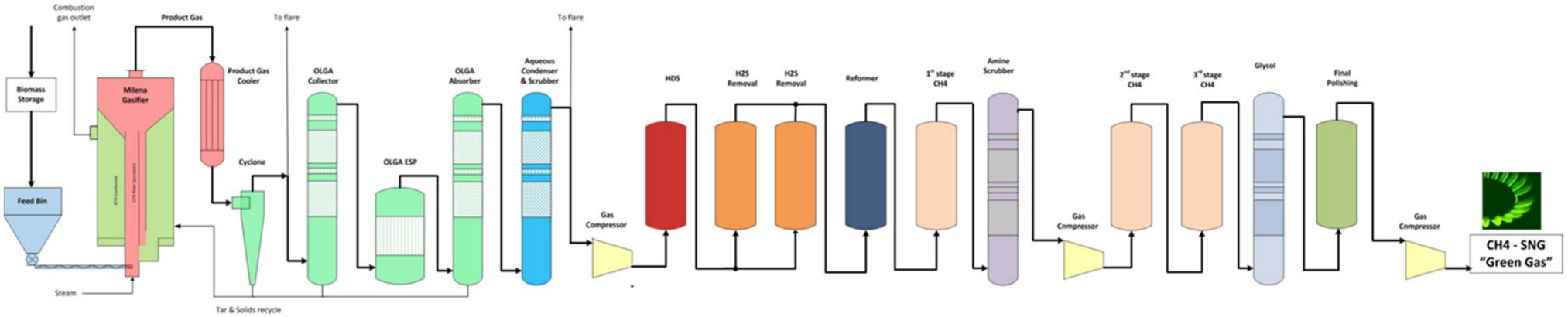
Solid becomes gas

Removal of tars, particles, sulphur, …

Make methane, compress, dry, …

MILENA/OLGA/ESME SNG system

70% efficiency from biomass to SNG

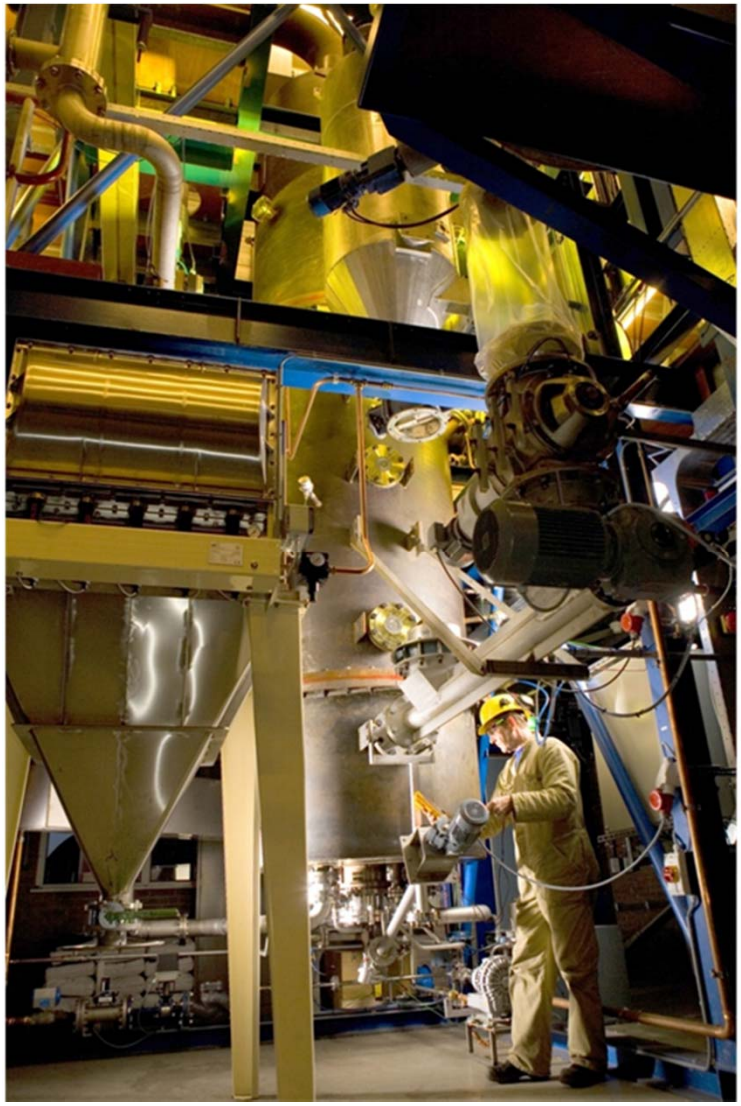


MILENA Gasifier OLGA tar-removal ESME gas-cleaning and methanation

Because the ECN MILENA/OLGA/ESME system makes optimal use of biomass gasification characteristics, record high SNG efficiencies can be achieved: 6% or more compared with competition.

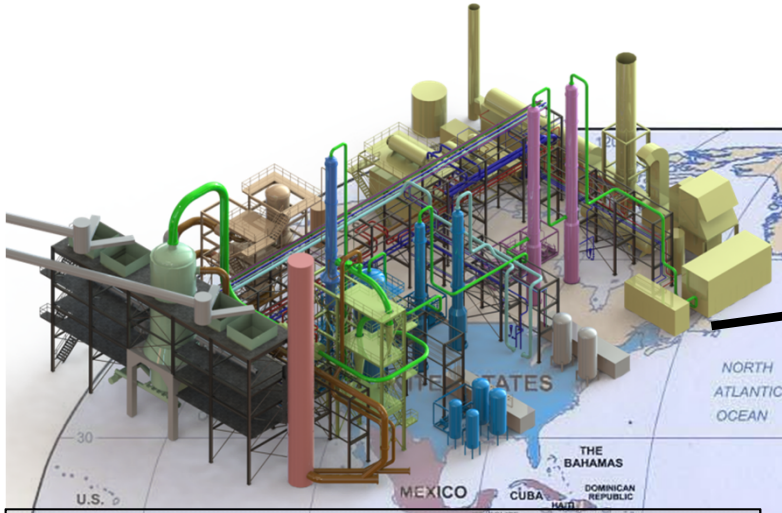
Status of the technology

- MILENA gasification proven on a scale up to 0.8 MW_{th} for a range of feedstocks (operational since 2008)
- OLGA gascleaning is commercially available at Royal Dahlman
- ESME methanation operational on lab-scale @ ECN
  - All components of ESME have been proven on commercial scale



Some of the running MILENA/OLGA developments worldwide

ECN



7 MWe MILENA/OLGA in Grimsby (UK) on RDF, SRF and local wood

0.8MW$_{th}$ MILENA OLGA pilot plant @ ECN

China: Signing ceremony for 18MW$_{th}$ MILENA

OLGA at the Tondela facility in Portugal

1 MWe CHP project in Washim (India) on soy residue - Thermax

Middle East
N. Africa
Africa
Near East
Asia
S. East Asia
N. America
Lat.America
E. Europe
W. Europe
Australia

Lab-facilities for SNG production @ ECN

- Successfully used to demonstrate system reliability for SNG production during a recent 500 h test

MILENA gasifier
1 bar

OLGA tar removal
1 bar

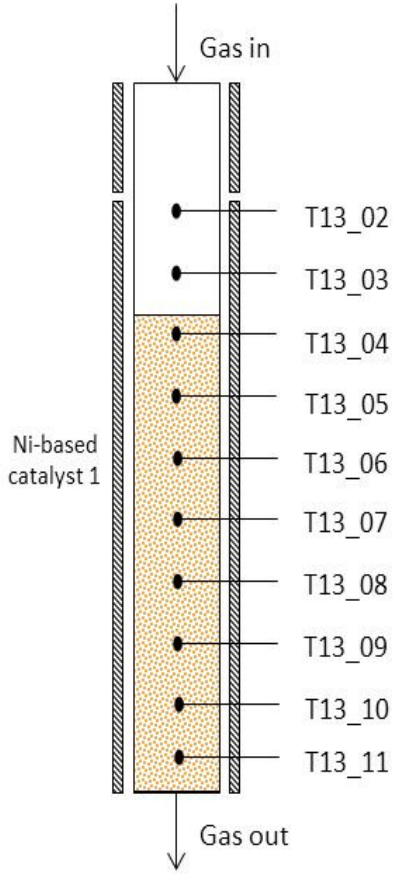
HDSreactor
6 bar

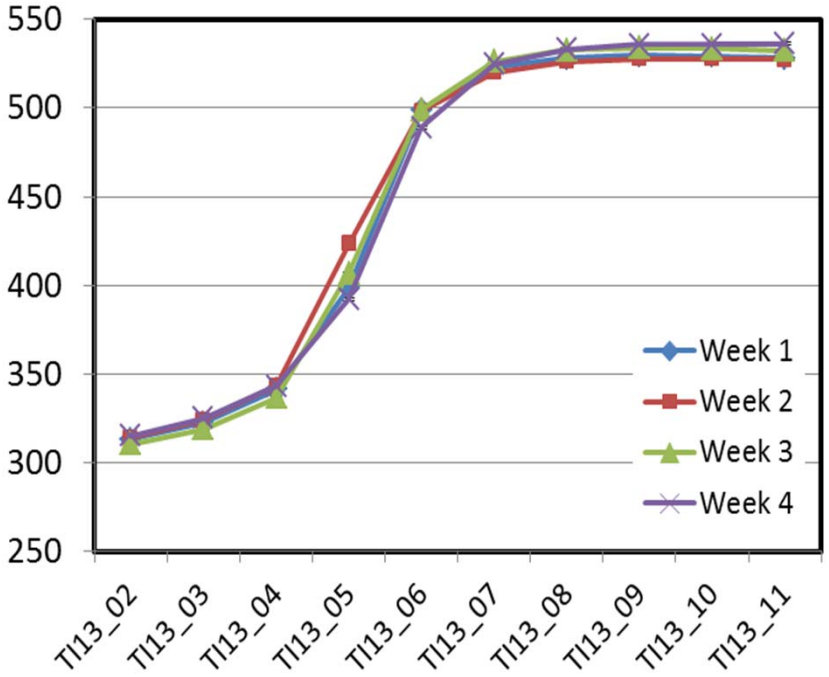
Further gas cleaning
6 bar

Methanation reactors
6 bar

500 hr performance ESME (SNG)

No degradation of catalysts during operation

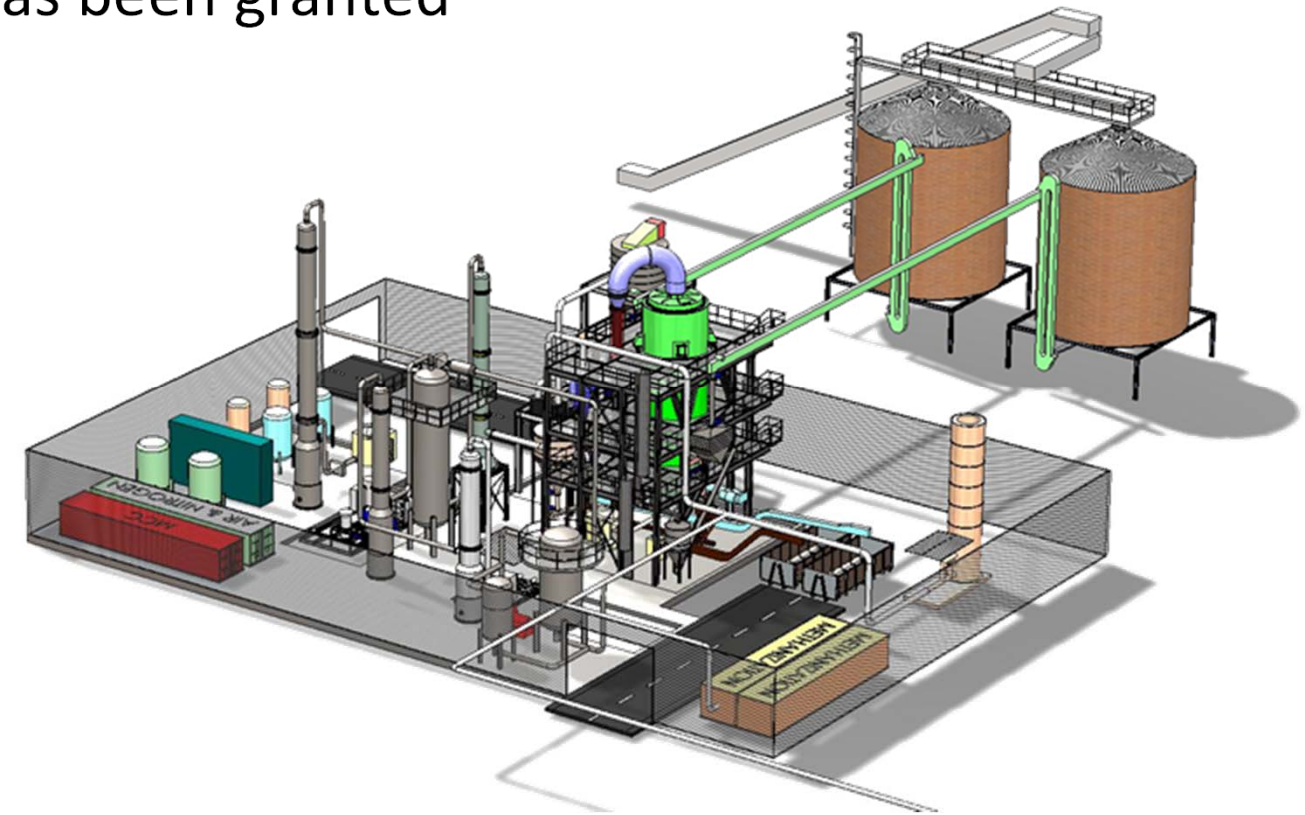




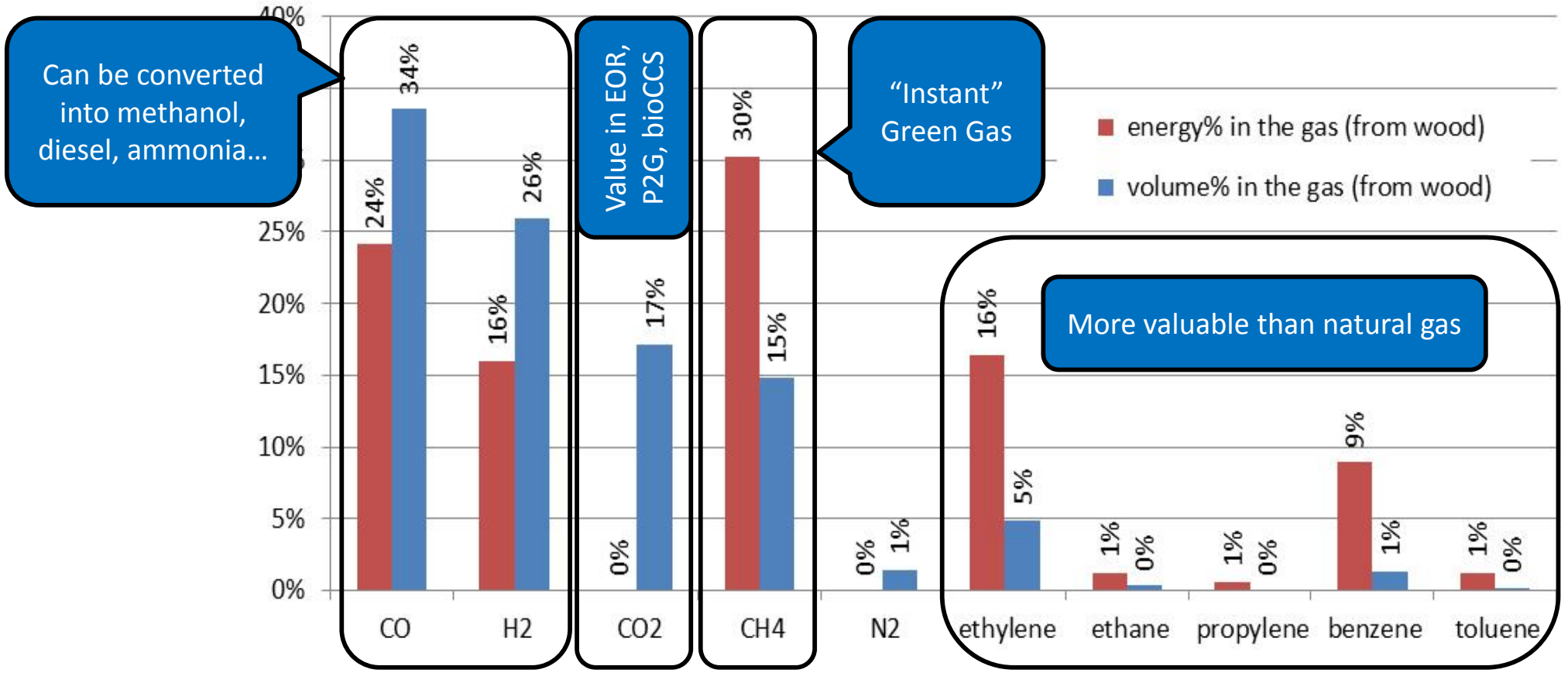
- Temperature distribution in the reactors did not change during 500h
- ESME is ready for scale up

Next step is the 4 MW_{th} demo

- Consortium of Gasunie, Dahlman and ECN
- 300 Nm3/h bioSNG production
- Aim is to be operational in the course of 2017
- Production subsidy has been granted

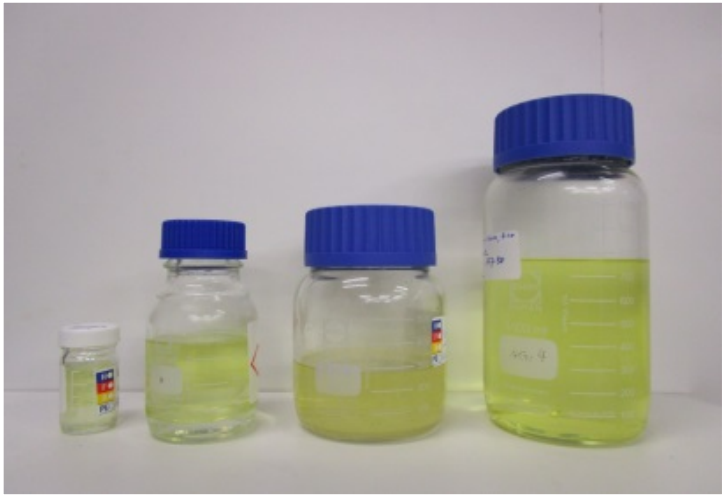


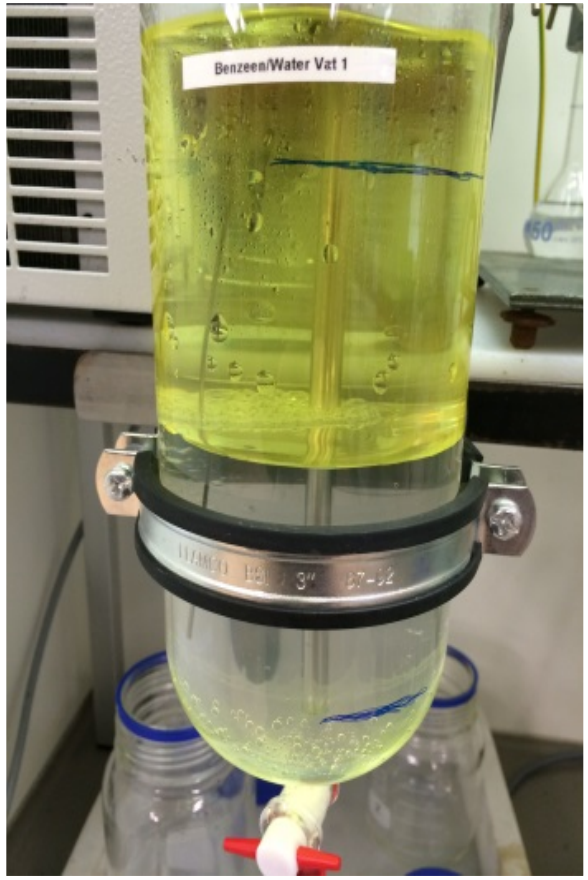
Further ahead:
Gas-composition for MILENA gasification



Further ahead: BTX separation
benzene, toluene, xylenes

- First step after OLGA tar removal
- Liquid BTX product: first liter in 2014
- >95% separation
- BTX = 90/9/1
- Simplifies downstream process to green gas
- Improves the business case for green gas





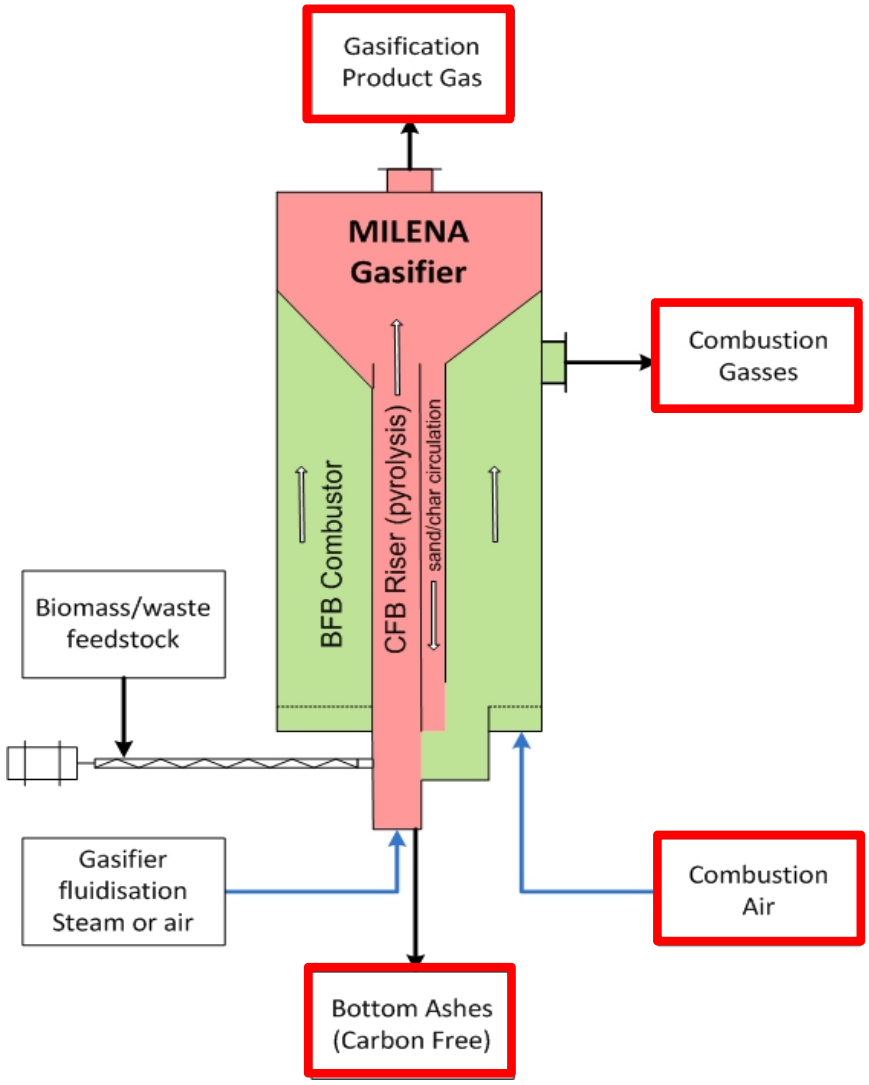
Conclusions

- Biomass gasification is essential for future large scale green gas production.
- Attractive production subsidies for green gas in the Netherlands have raised interest to develop biomass gasification (and digestion) projects.
- MILENA/OLGA/ESME technology is ready for scale up
  - 4 MWth SNG plant planned in The Netherlands by Gasunie/Dahman/ECN consortium
- Co-production of green chemicals and SNG offer much improved business models.
  - ECN co-produced BTX and SNG for the first time

The MILENA gasifier

MILENA an indirect gasifier

- Both reactors in one refractory lined reactor vessel
- 100% carbon to gas ratio
  - Resulting in carbon free ash, less waste, cleaner waste & safer waste
  - Resulting in a higher cold gas efficiency (5 to 15% higher on LHV basis)
- Separate flue gas exhaust, no or minimized nitrogen dilution of the product gas
  - Compared to air blown gasification 3 to 4 times higher heating value.
  - Compared to oxygen/steam blown gasification a much higher efficiency (no ASU parasitic), while still having 60% more heating value
  - Very suitable for SNG and gas turbines



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