



Energy research Centre of the Netherlands

Bio Energy with CCS (BECCS): Large potential for BioSNG at low CO₂ avoidance cost

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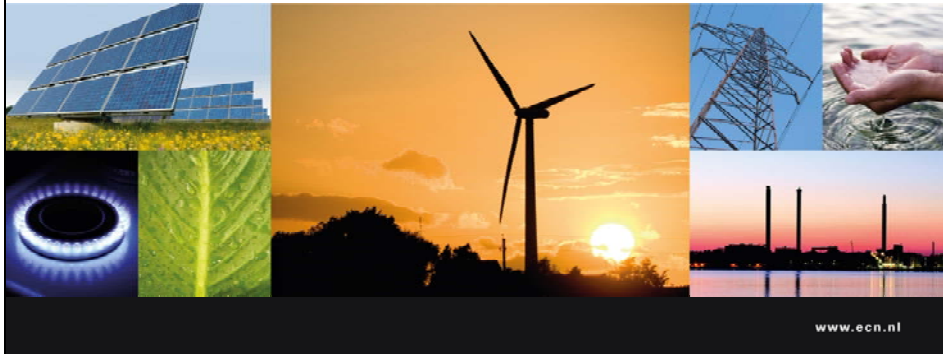
Bram van der Drift

Daniel Jansen

Presented at the 10th International Conference on Greenhouse Gas Technologies (GHGT-10), 19 – 23 September 2010, Amsterdam, The Netherlands

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ECN Energy research Centre of the Netherlands

“ECN develops high-level knowledge and technologies for a sustainable energy system and transfers those to the market”



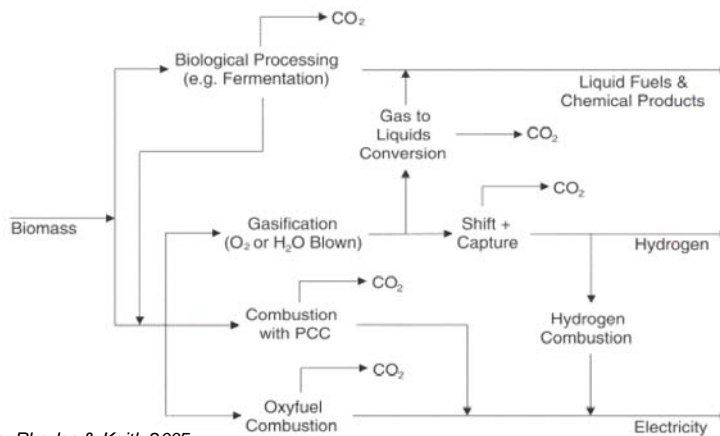
ECN in brief

- ECN is the largest, independent, market oriented and innovative Dutch energy research institute
- 84 M€/a turnover (2008)
- 690 employees (~630 fte)
- 500 scientific publications/reports each year; 10-15 international patents each year
- (Inter)national co-operation with companies, universities and research institutes

Bio Energy with CCS (BECCS)

- Conversion of biomass to electricity/heat/fuels/products combined with CO₂ capture and storage
- BECCS potentially leads to negative CO₂ emissions, i.e. CO₂ uptake from the atmosphere through natural sequestration of CO₂ in biomass
- Offset of both historical and distributed CO₂ emissions
- BECCS is indispensable to cost-effectively achieve most stringent global warming stabilisation scenarios
- Fossil fuel fired power plants with CCS ultimately only mitigate 80-90% of current CO₂ emissions

Bio Energy with CCS (BECCS)



Source: Rhodes & Keith 2005

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BECCS research at ECN

- BECCS research is multidisciplinary collaboration between different units:
 - Biomass, Coal & Environmental research
 - Hydrogen & Clean Fossil Fuels
 - Policy Studies
- Research topics:
 - Mapping sources & sinks, LCA, public perception
 - Policy measures & incentives
 - Assessment conversion routes

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BioSNG

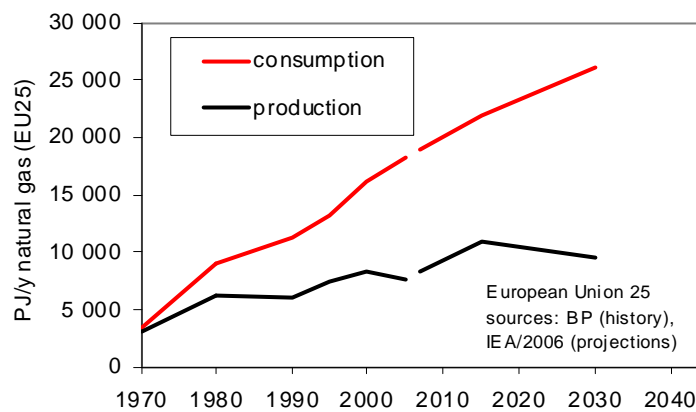
Natural gas in the Netherlands:

- 45% of primary energy consumption
- 135,000 km transportation grid
- 94% of all households connected

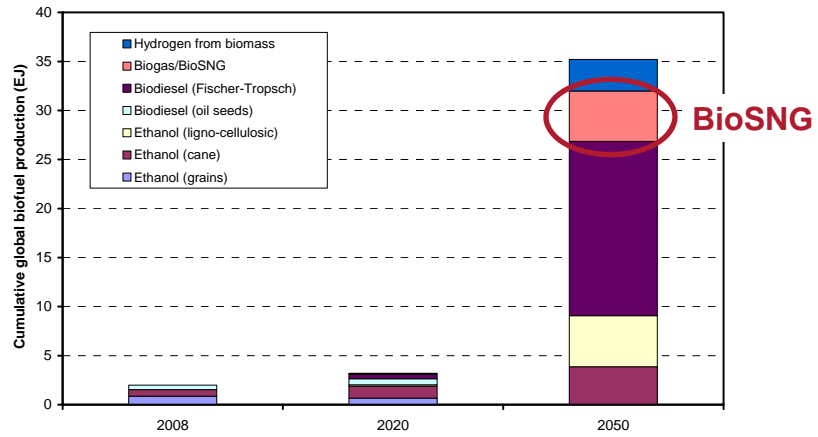
BioSNG:

- Ease of making distributed conversion more sustainable
- Possibility to decouple production and consumption
- Net CO₂ uptake from atmosphere possible through CCS

Natural gas production/consumption

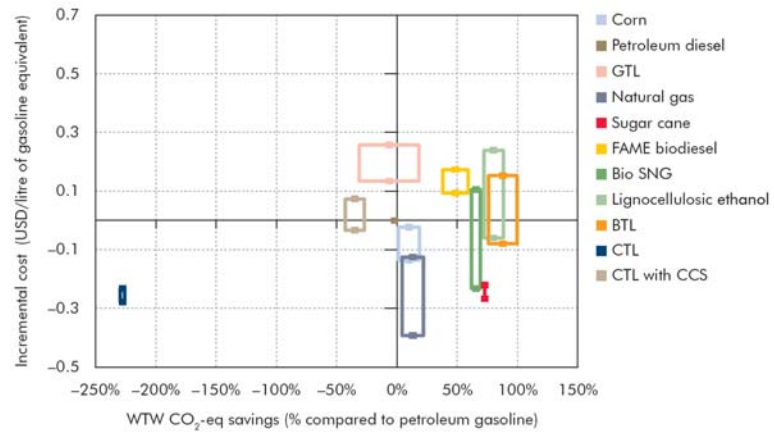


Projected biofuel production



Sources: REN21 (2009) and IEA ETP (2010, BLUE Map scenario)

Incremental cost vs. CO₂ em. reduction



Source: IEA ETP (2010)

Current status BioSNG

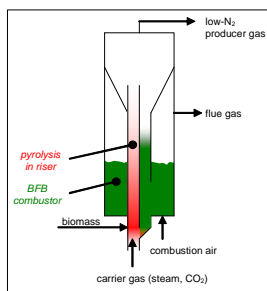
- Güssing (Austria): 1 MW_{SNG} pilot plant (existing)
- GoBiGas (Göteborg, Sweden) commercial plant: 20 MW_{SNG} (2012) & 80 MW_{SNG} (2016)
- HVC & ECN (The Netherlands) commercial plant: 4 MW_{CHP} (2012) & 35 MW_{SNG} (2015)

All based on indirect biomass gasification:

- Carbon conversion 100%
- N₂-lean product gas
- High initial CH₄ content

MILENA Indirect Gasifier

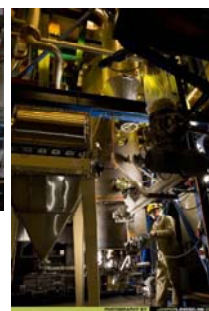
- Two integrated reactors for gasification and combustion
- Essentially N₂-free producer gas
- Complete conversion
- High methane yield, tailored for SNG-production



MILENA principle



MILENA, 5 kg/h,
2004



MILENA, 160 kg/h,
2008

OLGA Tar Removal

- Commercialised by Dahlman
- Modified to deal with tars from different gasifiers
- Able to reduce tar dew point temperature below 0°C
- Absorber/stripper principle



OLGA at ECN,
2 nm³/h



OLGA at ECN,
200 nm³/h



OLGA in France,
2000 nm³/h

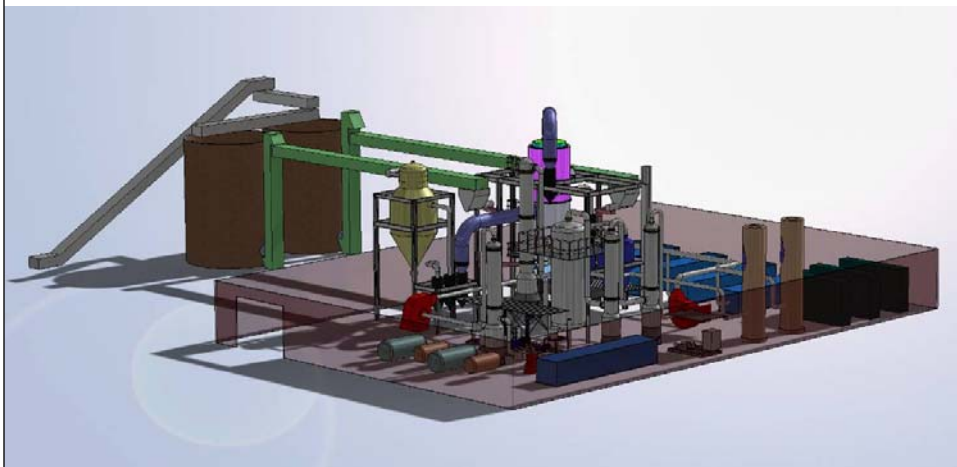


OLGA in Portugal,
2000 nm³/h

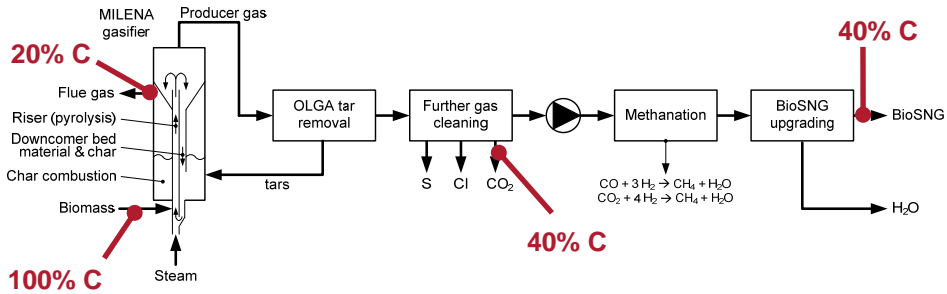


OLGA in US,
25 000 nm³/h

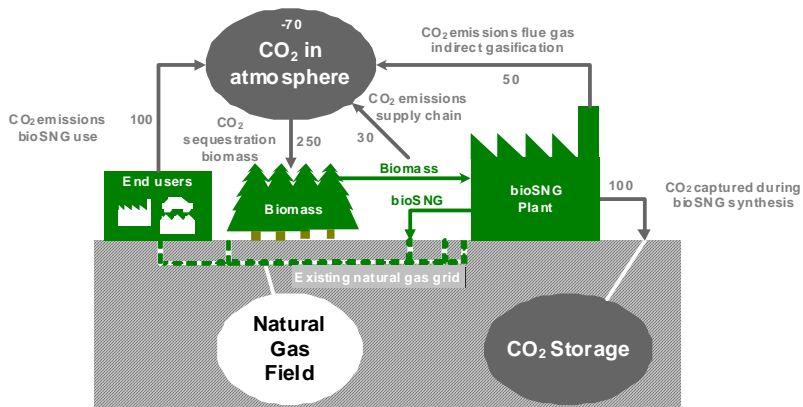
Preparations for 10 MW_{th} Bio CHP plant



BioSNG plant layout



CO₂ uptake during BioSNG production



Assumptions (1)

- Plant size ~500 MW_{th} input
- Plant simulated using AspenPlus V7.1
- Costing:
 - Early 2010
 - Greenfields, overnight
 - Nth plant, North-western Europe

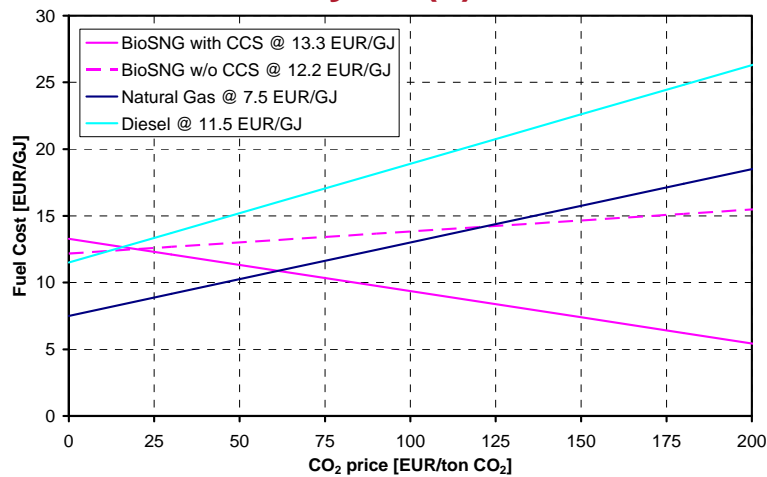
Assumptions (2)

- Gasification pressure: 7 bara
- TCI: 1,100 €/kW_{SNG}
- O&M: 5% of TCI
- Other fixed cost: 2% of TCI
- Return on Investment: 12%
- Interest: 5%
- Biomass price (dry): 4 €/GJ
- Electricity price: 0.05 €/kWh (14 €/GJ)
- CO₂ emission natural gas combustion: 55 kg/GJ

Economic analysis (1)

	Annual Cost (M€/yr)	Cost (€/GJ)
TCI	55.2	3.50
Biomass	89.7	5.69
Electricity	10.9	0.69
O&M	28.6	1.82
Other fixed cost	11.4	0.73
Total cost	195.8	12.42
Result	13.5	0.86
Revenues	209.4	13.28

Economic analysis (2)



Conclusions

- Incremental cost for CO₂ capture and storage is low; CO₂ separation equipment implemented regardless of application CCS
- Retrofit application of CCS is straightforward
- CO₂ avoidance costs for BioSNG competitive with CCS in fossil fired power plants
- Accounting for net CO₂ uptake from atmosphere lowers avoidance costs and accelerates deployment
- Scale-up indirect gasification technology needed

Questions

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Publications: www.ecn.nl/publications
Fuel composition database: www.phyllis.nl
Tar dew point calculator: www.thersites.nl
IEA bioenergy/gasification: www.ieatask33.org
Milena indirect gasifier: www.milenatechnology.com
OLGA tar removal: www.olgatechnology.com
SNG: www.bioSNG.com and www.bioCNG.com