Opportunities for BioSNG production with CCS

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Presented at the 1st International Workshop on Biomass & CCS, Orléans, France, 14-15 October 2010

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ECN

Energy research Centre of the Netherlands

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ECN

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 Dutch energy research institute
- 84 M€/a turnover (2008)
- Private sector investments ECN-technology approx. 33 M€ (2008)
- 690 employees (~630 fte)
- 500 scientific publications/reports each year
- 10-15 international patents each year

R&D units

Solar energy

Biomass

Wind energy

Efficiency & Infrastructure

Policy Studies

H_2 & Clean Fossil Fuels

Bio Energy with CCS (BECCS)

- Conversion of biomass to electricity/heat/fuels/ products combined with CO_2 capture and storage
- BECCS potentially leads to negative CO_2 emissions, i.e. CO_2 uptake from the atmosphere through natural sequestration of CO_2 in biomass
- Offset of both historical and distributed CO_2 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 CO_2 emissions

BECCS research at ECN (1)

- 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

BECCS research at ECN (2)

Technological routes under investigation:

- Power plants:
  - Biomass co-combustion
  - Biomass co-gasification
- Biofuels:
  - Lignocellulosic ethanol
  - BioSNG
  - Fischer-Tropsch liquids
  - Hydrogen

Not only clean wood:

- **Demolition wood**
- **Sewage sludge**
- **Grass/straw**
- **Agricultural waste**
- **Manure**

BioSNG

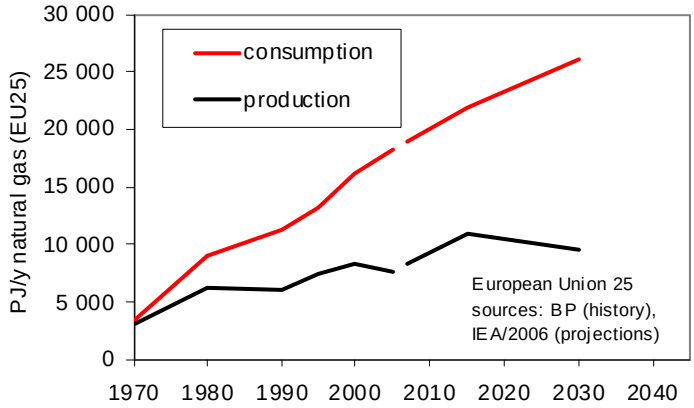
Natural gas in the Netherlands:

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

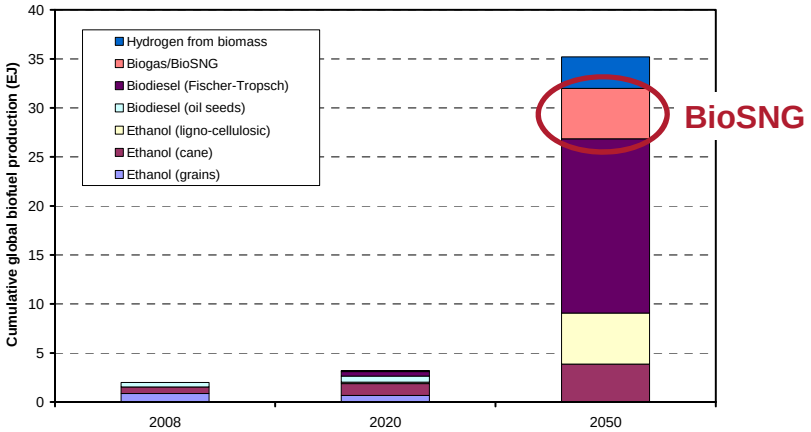
BioSNG:

- Ease of making distributed conversion more sustainable
- Possibility to decouple production and consumption
- Net CO_2 uptake from atmosphere possible through CCS

Natural gas production/consumption

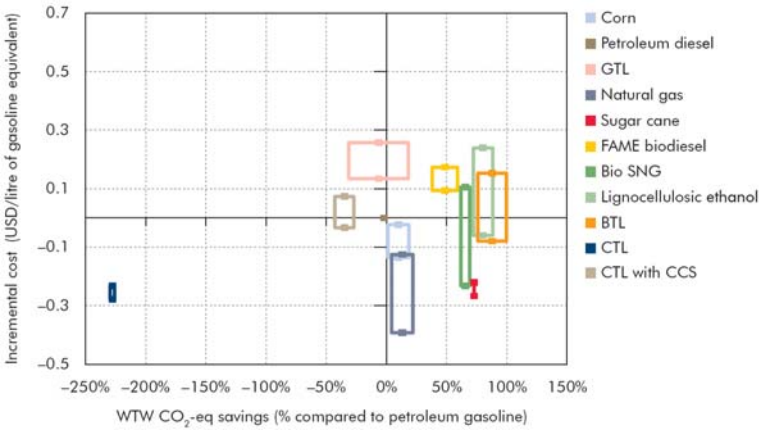


Projected biofuel production



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

Incremental cost vs. CO_2 em. reduction



Source: IEA ETP (2010)

Current status BioSNG

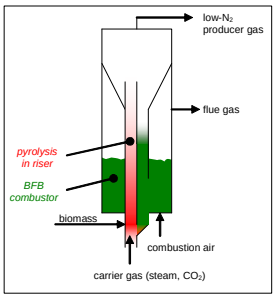
- Güssing (Austria): 1 MW_{SNG} pilot plant (existing)
- GoBiGas (Götenburg, Sweden) commercial plant: 20 MW_{SNG} (2012) & 80 MW_{SNG} (2016)
- HVC & ECN (The Netherlands) commercial plant: 4 MW_{CHP} (2012) & 35 MW_{SNG} (2015)

All based on indirect biomass gasification:

- Carbon conversion 100%
- N_2-lean product gas
- High initial CH_4 content

MILENA Indirect Gasifier

- Two integrated reactors for gasification and combustion
- Essentially N_2-free producer gas
- Complete conversion
- High methane yield, tailored for SNG-production



MILENA principle

MILENA, 5 kg/h, 2004

MILENA, 160 kg/h, 2008

Biomass gasification → tar formation

OLGA Tar Removal

- Commercially available, suited for different gasifiers
- Able to reduce tar dew point temperature below 0°C
- Operation above water dew point (no condensation)
- Absorber/stripper principle

OLGA at ECN, 2 nm3/h

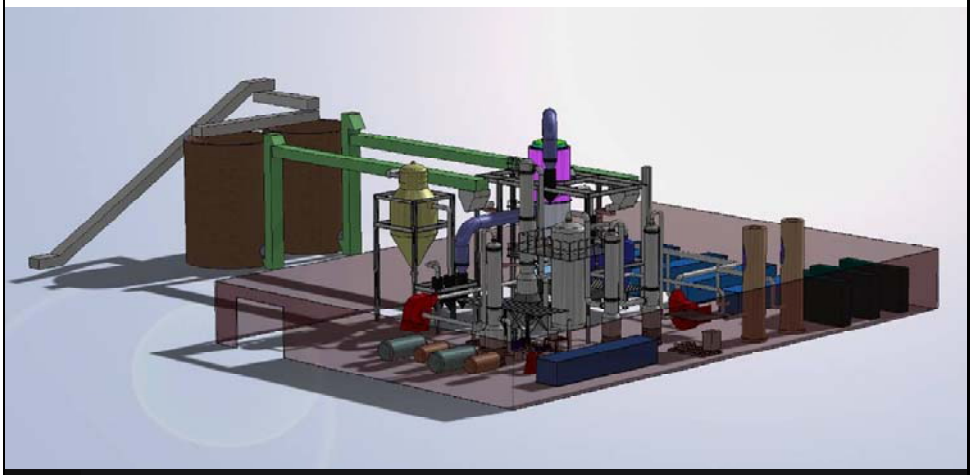
OLGA at ECN, 200 nm3/h

OLGA in France, 2000 nm3/h

OLGA in Portugal, 2000 nm3/h

OLGA in US, 25 000 nm3/h

Engineering for 10 MW_{th} Bio CHP plant



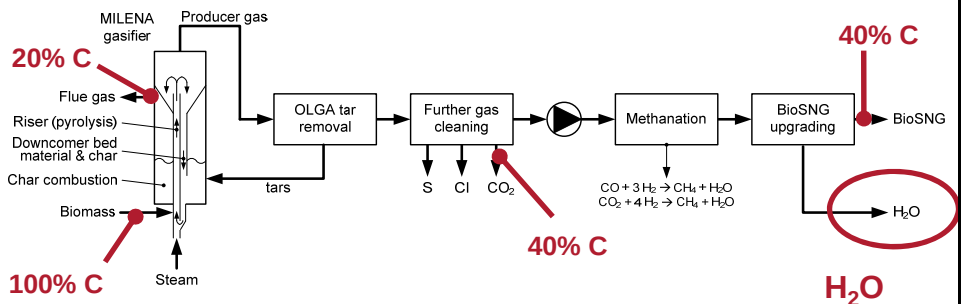
Plans at Dutch waste incineration plant

50 MW_{th} Milena SNG Plant in 2015

10 MW_{th} Milena CHP Plant in 2012

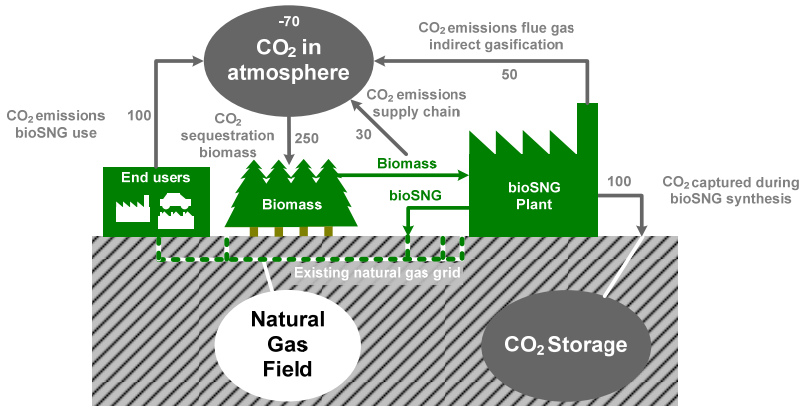
Photos courtesy of the HVC

BioSNG plant layout



H_2O production

CO_2 uptake during BioSNG production



Assumptions (1)

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

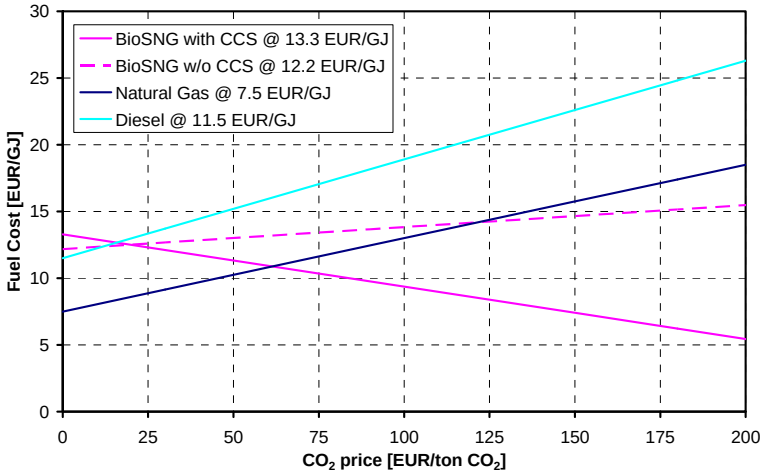
Assumptions (2)

- Gasification pressure: 7 bara
- TCI: 1,100 €/kW_{SNG}
- O&M: 5% of TCI
- Other ficed cost: 2% of TCI
- Return on Investment: 12%
- Interest: 5%
- Biomass price (dry): 4 €/GJ
- Electricity price: 0.05 €/kWh (14 €/GJ)
- CO_2 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 CO_2 capture and storage is low for biofuel production; CO_2 separation equipment implemented regardless of application CCS
- CCS retrofitting is straightforward
- CO_2 avoidance costs for BioSNG competitive with CCS in fossil fired power plants; net water production
- Accounting for net CO_2 uptake from atmosphere lowers avoidance costs and accelerates deployment
- Scale-up indirect gasification technology needed

Questions

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Milena indirect gasifier: www.milenatechnology.com
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