Green Gas on the Road

Bram van der Drift

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6-7 October 2011, Malmö, Sweden

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GREEN GAS on the ROAD

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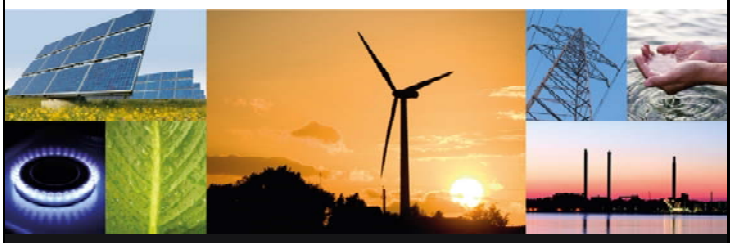

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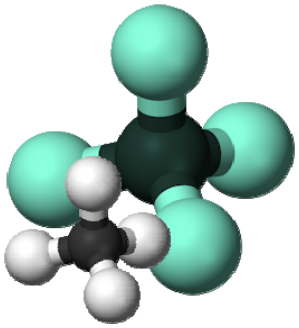
CONTENT

- What is Green Gas?
- What is the fun?
- The process
- What does it cost?
- Any fun left?
- The future



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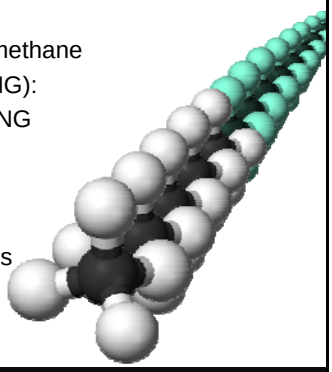
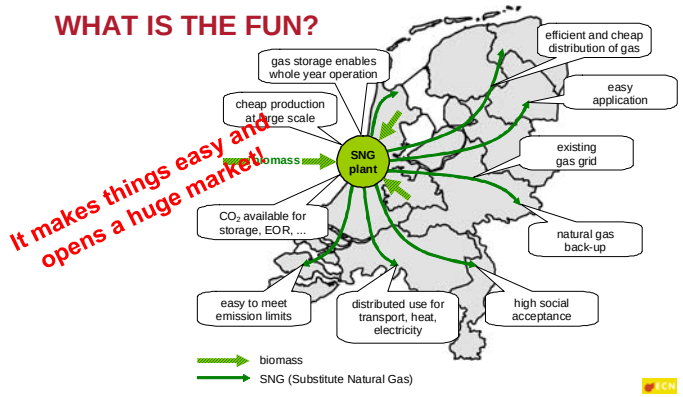
WHAT IS GREEN GAS?

- Other words: bioSNG, bio-methane
- It resembles Natural Gas (NG):
  - It can be transported as NG
  - It can be stored as NG
  - It can be used as NG
  - It is accepted as NG
- It only is made from biomass



WHAT IS THE FUN?



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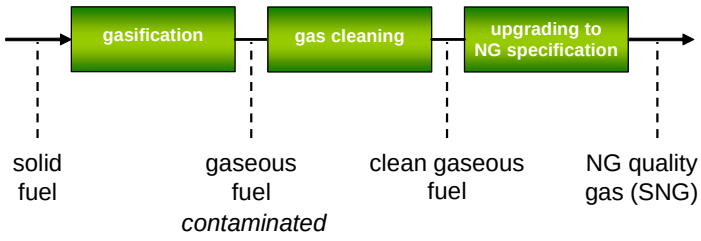
THE PROCESS



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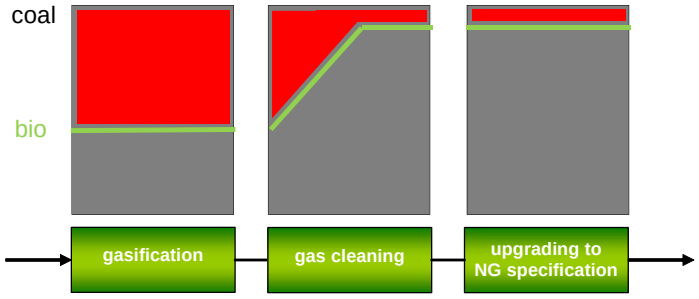
AVAILABLE TECHNOLOGY?
coal-to-SNG as reference



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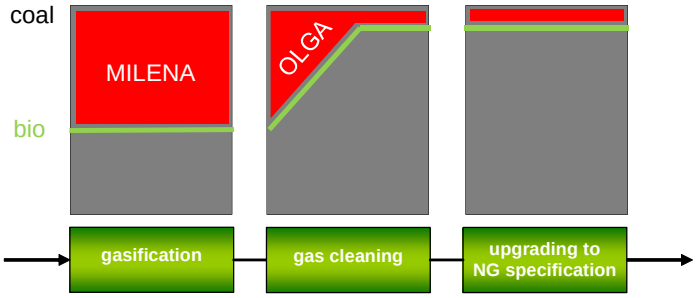
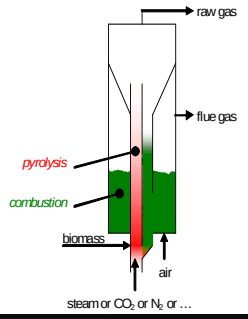
ECN CHOICES

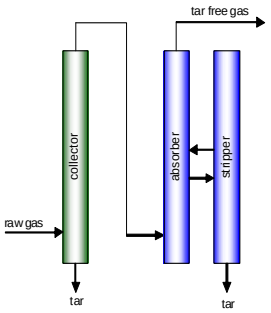


TECHNOLOGY
the key processes (ECN)

MILENA gasification



OLGA tar removal



TECHNOLOGY
the key processes (ECN)

MILENA gasification

- low N_2 in gas
- no air separation
- high methane yield
- complete conversion
- fuel flexible
- up to 5-10 bar, 100^+ MW

OLGA tar removal

- complete tar removal
- no methane reduction
- tar recycle to gasifier
- no water condensation
- fits many types of gasifiers

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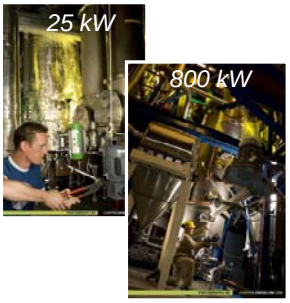
TECHNOLOGY
the key processes

MILENA gasification



OLGA tar removal

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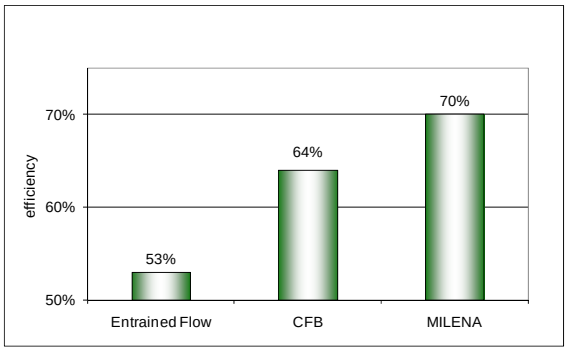
C. M. van der Meijden et.al., Biomass and Bioenergy 34, pp 302-311, 2010.

SNG PRODUCTION from BIOMASS



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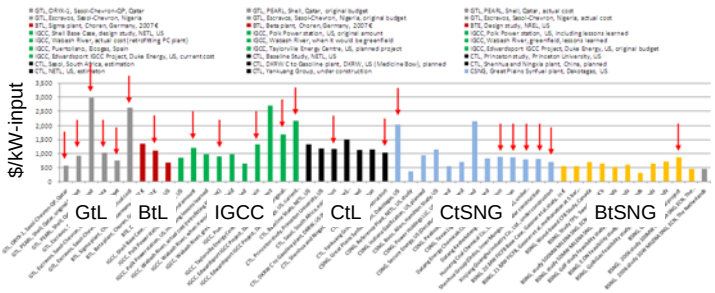
SNG DEMONSTRATION PLANT
ECN technologies MILENA and OLGA

- First phase 12 MW (waste wood)
- Second phase 50-100 MW
- HVC main partner

WHAT DOES bioSNG COST?
total capital investment

- Total Capital Investment (TCI) of the 10th bioSNG plant with 1 $GW_{th\_biomass}$ capacity
  (1 $GW_{th\_biomass}$ = 20 PJ_{SNG}/y = 0.6 bcm/y)

- Investment is estimated by:
  - Assuming existing/planned GtL, IGCC, CtL, and CtSNG as references
  - Expressing investment per kW *input* capacity



You cannot read this, but it shows there is quite a number of references
arrows indicate actual plants or plants under construction

	Average TCI [$/$kW_{input}$]
GTL	1,500
IGCC	1,500
CTL	1,100
CSNG	1,000

NB: numbers follow directly from figure previous page, not taking into account differences in scale and year

WHAT DOES bioSNG COST?
total capital investment

- Next steps:
  - Accounting differences with BtSNG
  - Adapt for inflation (to 2011-US$)
  - Adapt to 1 GW input (scaling factor 0.7)

	Average TCI [$/kW$_{input}$]	Average TCI for a bioSNG plant, adjusted for technological differences [$/kW$_{input}$]
GTL	1,500	1,700
IGCC	1,500	1,400
CTL	1,100	1,300
CSNG	1,000	1,100

WHAT DOES bioSNG COST?
total capital investment

- Average: 1400 $/kW (thermal input)
- After learning: 1000 $/kW (thermal input)

- Translating to 15 $/GJ (bioSNG) production costs

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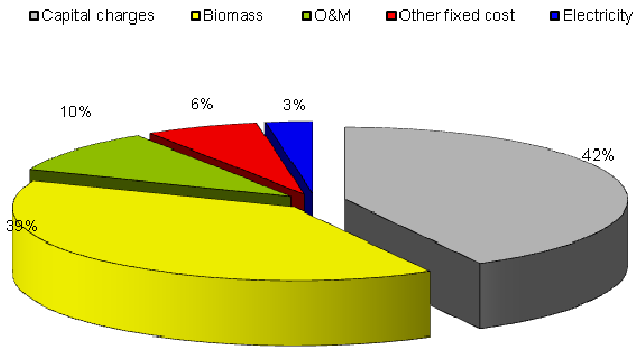
source: ECN-report ECN-X-10-140

BioSNG PRODUCTION COSTS: 15 $/GJ



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IS 15 $/GJ GOOD OR BAD?

- Present Natural Gas (NG) prices:
  - 6 €/GJ in Netherlands
  - 10-12 $/GJ in Canada/BC
  - 4 $/GJ in Canada and US
- Future natural gas price EU: 11-15 $/GJ (IEA WEO)
- Yes, BioSNG probably will be more expensive than NG

- But NG may not be the reference!
- The reference of BioSNG is what it actually replaces

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WHAT DOES bioSNG REPLACE?

bioSNG as biofuel
bioSNG as renewable syngas source
bioSNG as renewable high-T source
bioSNG as renewable flexible power source
bioSNG as renewable spatial heating source

WHAT DOES bioSNG REPLACE?
case: bioSNG as biofuel

- bioSNG (bioCNG) versus Biodiesel within the EU biofuels directive

  - Present biodiesel costs ~25 €/GJ
  - Biodiesel is 1st generation
  - BioCNG is 2nd generation, counting double
  - That would make bioCNG worth 35-40 €/GJ

  - *NB: this assumes an existing CNG market*

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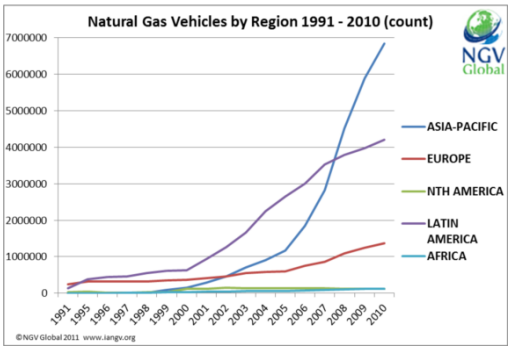
NATURAL GAS VERHICLES
13 million now (equals ~ 650 PJ/y CNG)



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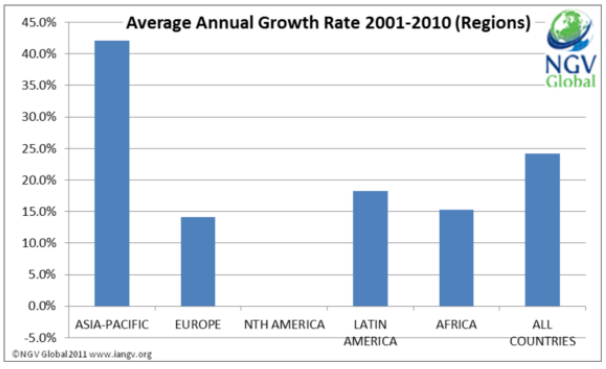
DOUBLE DIGIT GROWTH



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SO

- BioSNG will probably be more expensive than Natural Gas
- But the value of BioSNG will probably be higher

GREEN GAS POLICIES

- NL: 20-33 €/GJ (62-104 cent/m3) in SDE+ (2011)
- UK: ~28 €/GJ in Renewable Heat Directive
- EDGaR: 40 M€ PPP on gas research (NL)

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- National Renewable Energy Action Plan (NREAP-EU27): projected 535 PJ/y in 2020
- NL: 25 PJ/y in 2020 (1200 MW_{SNG}), 700 PJ/y in 2050
- S: 36 PJ/y in 2020
- D: 200 PJ/y in 2020, 360 PJ/y in 2030

FINAL REMARKS

- Renewable energy is unstoppable
- Natural gas is there to stay
- *BioSNG is fitting in perfectly*
- Production costs are higher than for NG
- The value however, is what it makes it worth
- Technology developments needed
- Biggest hurdle however, is two worlds having to meet: fossil and green:
  - Gas quality
  - Economics, scale, pressure
  - Reliability

MORE INFORMATION

Bram van der Drift

e: vanderdrift@ecn.nl
t: +31 224 56 4515
w: www.ecn.nl

PO Box 1
NL 1755 ZG Petten
the Netherlands

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