# The technical choices for the 12 MW Bio-SNG demonstration in the Netherlands

A. van der Drift

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# The technical choices for the 12 MW Bio-SNG demonstration in the Netherlands

Bram van der Drift

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Göteborg, Sweden

# ECN

- Independent R&D centre for renewable energy.
- Partly financed by the Dutch government and EU government grants, and partly by contract R&D.
- Main products: technology licenses and contract R&D
- 600 staff

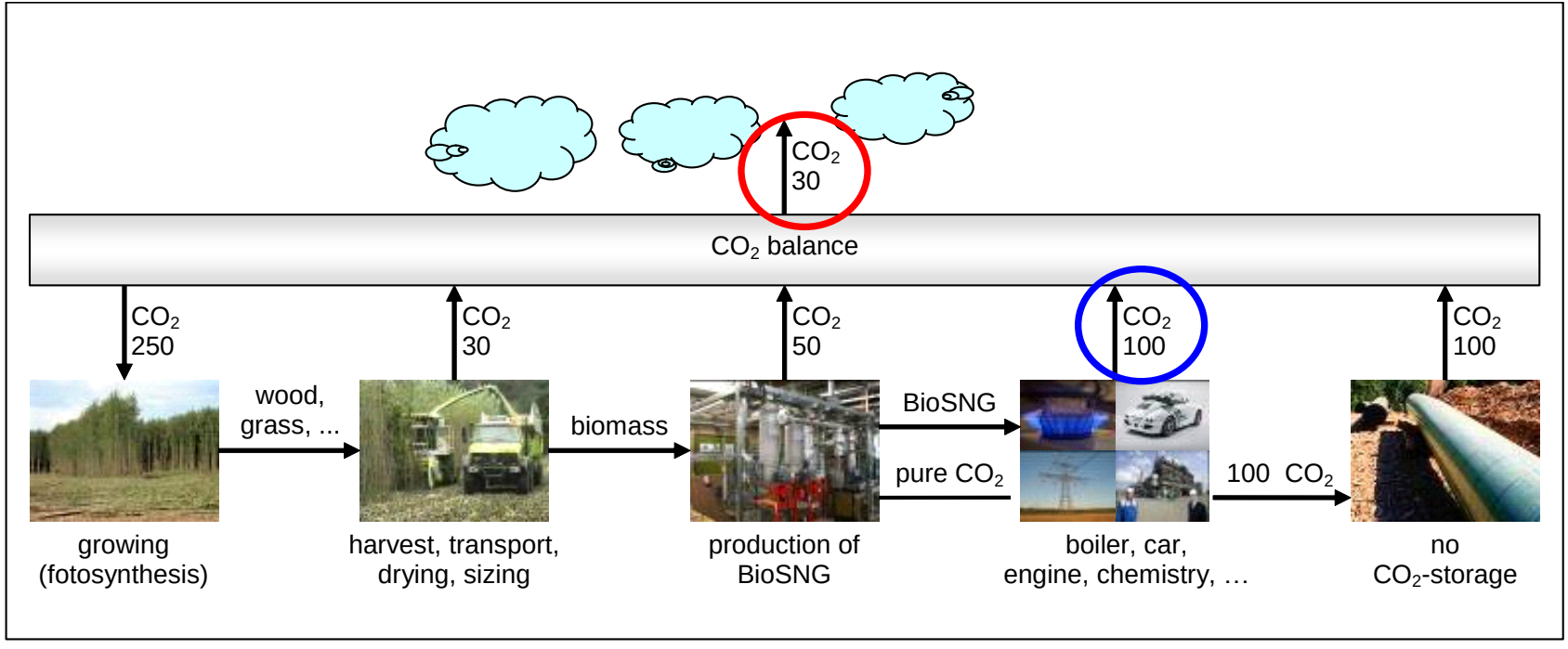
# ECN bioSNG VISION

- Biomass will become / is expensive:
  - High overall efficiency required
  - Co-production of bioSNG with benzene, ethylene, $CO_2$, …
  - Large scale production (>100 MW)

- Production of bioSNG will be near harbors or locations were biomass is widely available

- Compression of gas is preferred over compression of biomass

# $CO_2$ BALANCE
## *BioSNG*

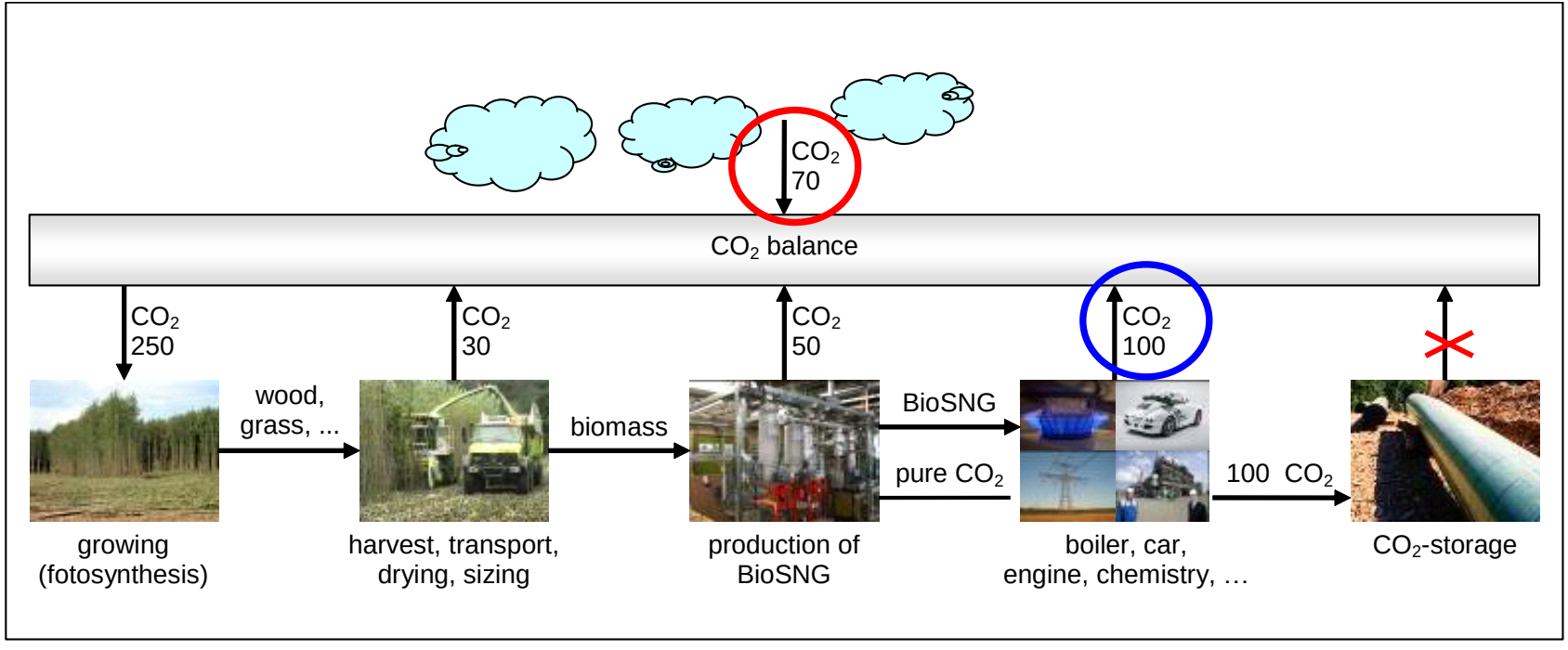



$CO_2$ emission: 100 → 30

70% $CO_2$ emission reduction

# $CO_2$ BALANCE: BEYOND NEUTRAL

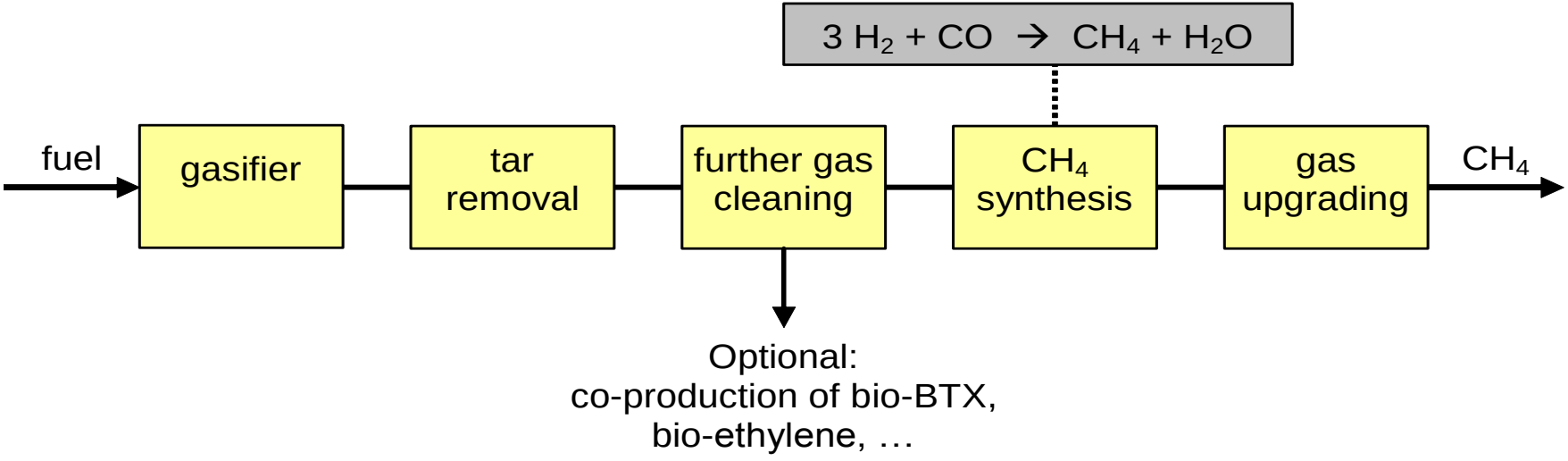
## *BioSNG with $CO_2$ storage*




$CO_2$ emission: 100 → -70

170% $CO_2$ emission reduction

# GASIFICATION PATHWAY

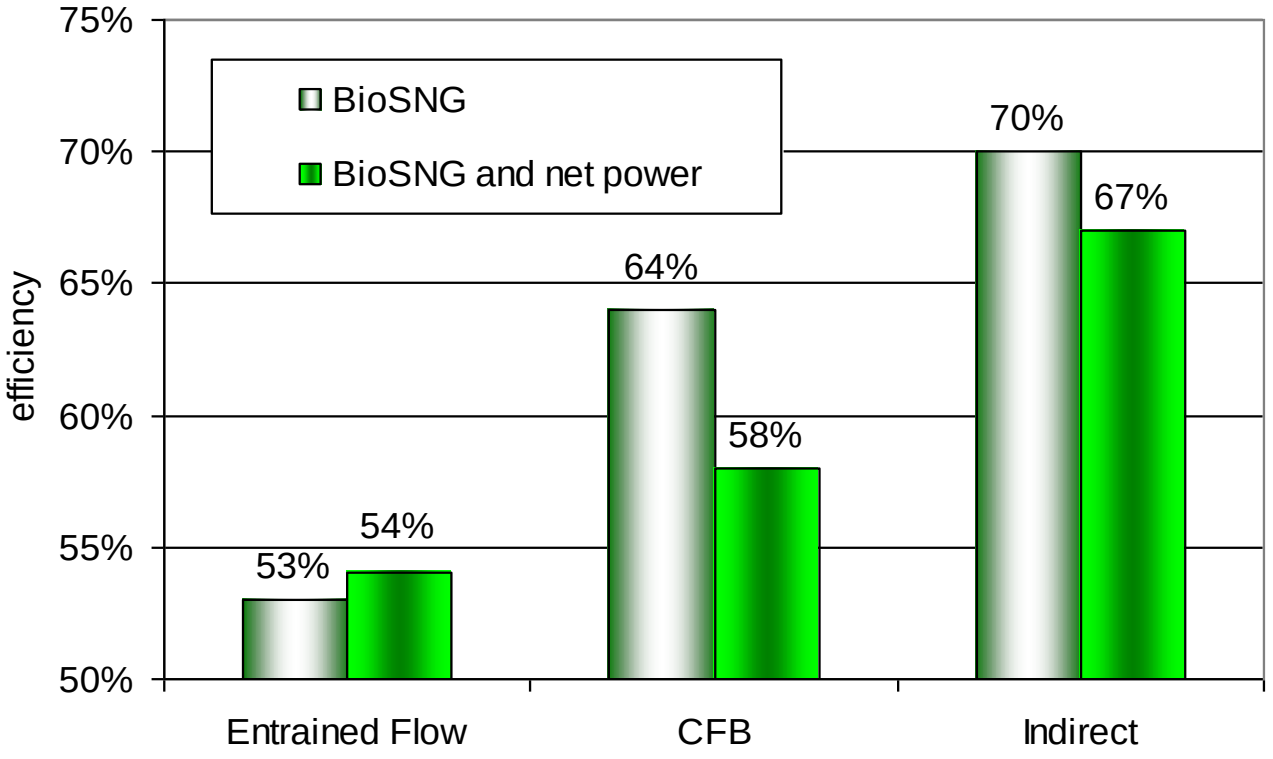


# COMPARING 3 GASIFIERS

- Boundary conditions:
  - Wood, 15 wt% moisture
  - SNG available for grid injection at 30 bar

- Technologies considered
  - Entrained Flow gasification at 30 bars using torrefaction to pre-treat the fuel
  - CFB gasification of wood chips at 10 bar, oxygen/steam mixture was used as gasification agent
  - Indirect gasification of wood chips at atmospheric pressure

# COMPARING 3 GASIFIERS



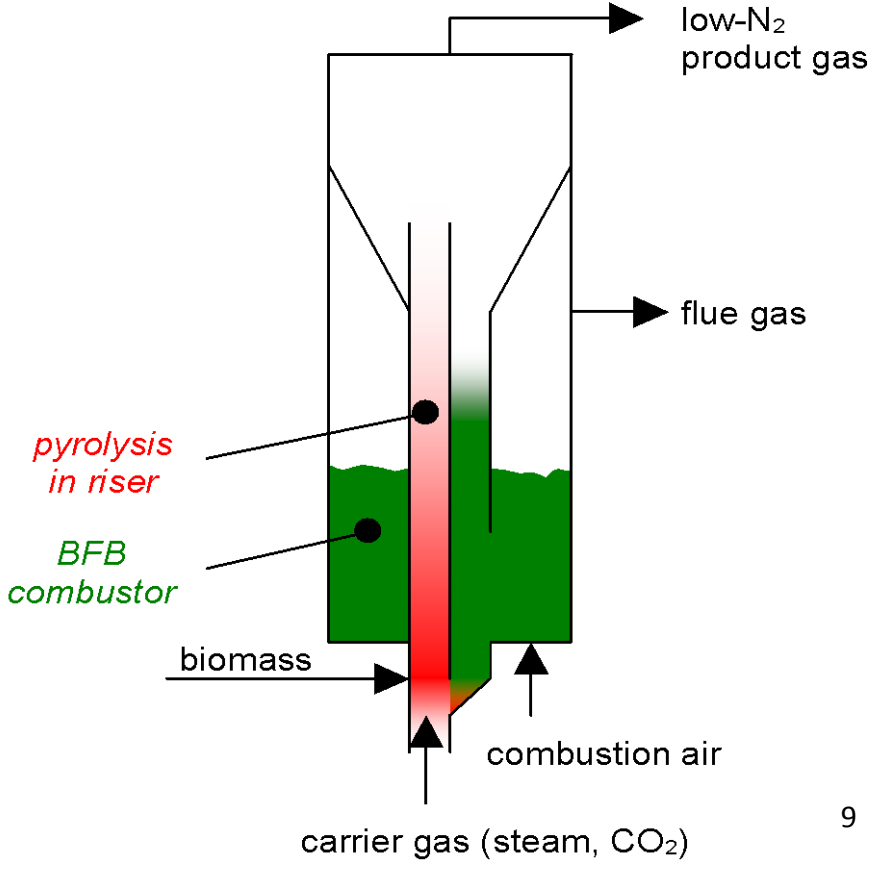

Meijden, C.M. van der; Veringa, H.J.; Rabou, L.P.L.M.;
The production of synthetic natural gas (SNG): A comparison of three wood gasification systems for energy balance and overall efficiency
Biomass & Bioenergy (Elsevier), 2009.

# MILENA INDIRECT GASIFICATION

*ECN-technology*

- Developed for high efficiency
- Medium calorific low-$N_2$ gas
- Complete conversion
- No carbon in ash
- High $CH_4$ content
- Suitable for scale-up and pressurized operation

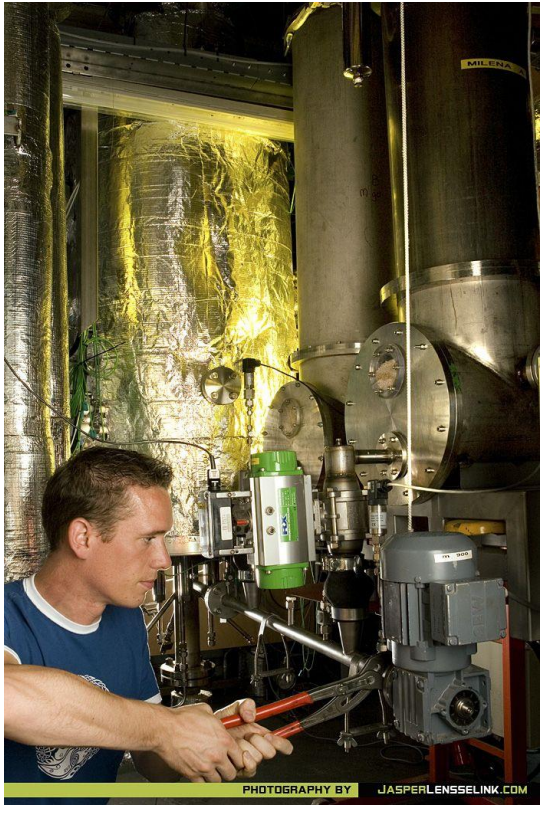
- High tar content



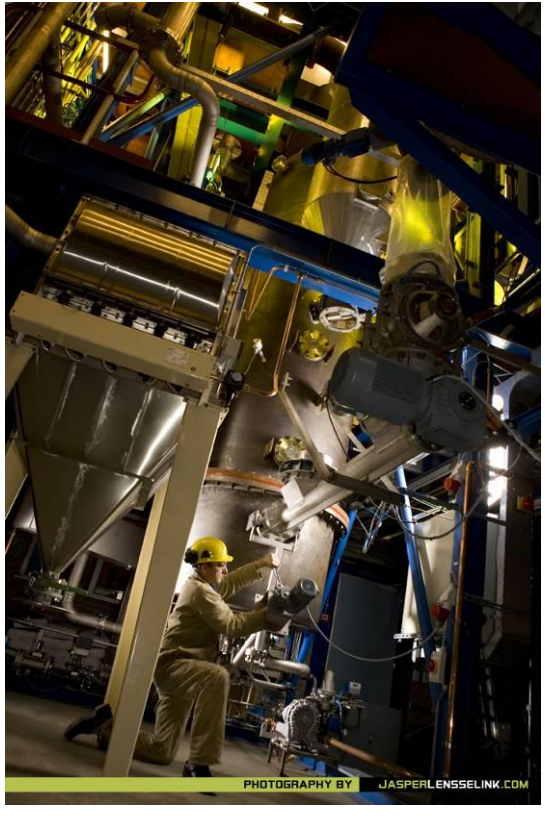
| | MILENA gasifier | CFB/BFB gasifier | Downdraft gasifier |
|---|---|---|---|
| Conversion | 100% / white ash | ~90% / black ash | ~90% / black ash |
| Cold Gas Efficiency | ~80% | ~70% | ~70% |
| Temperature control | Good temperature control, no char accumulation | Less temperature homogeneity due to char hold-up | Very non-uniform |
| | Lower temperature = higher efficiency | Lower temperature = lower conversion | Lower temperature = lower conversion |
| Fuel flexibility | Any size | Any size | Only large chunks |
| | Wastes and agricultural residues | Less freedom | Woody |
| Gas | 12-15 $MJ/Nm^3$ | 5-6 $MJ/Nm^3$ | 5-6 $MJ/Nm^3$ |
| | Essentially $N_2$-free | ~50% $N_2$ | ~50% $N_2$ |
| Scale | Scalable (>100 MW) | Scalable (>100 MW) | Max. 1 MW |

# MILENA INDIRECT GASIFICATION

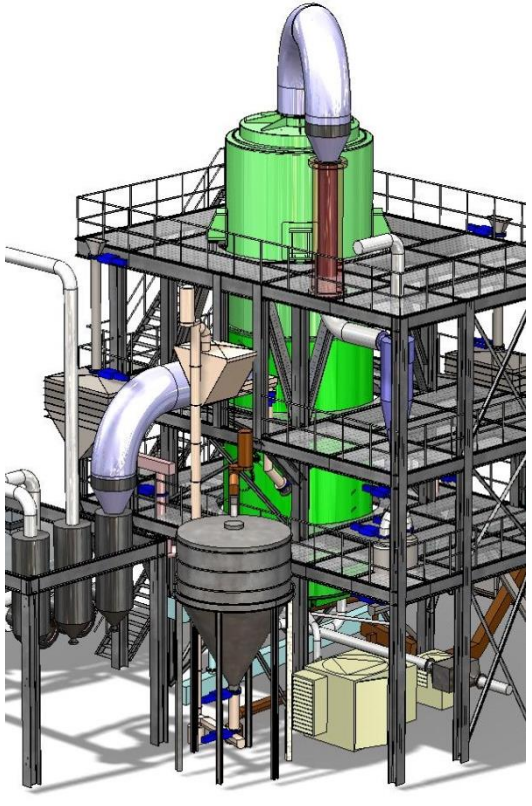
*ECN-technology*




*25 kW (2004)*




*800 kW (2008)*



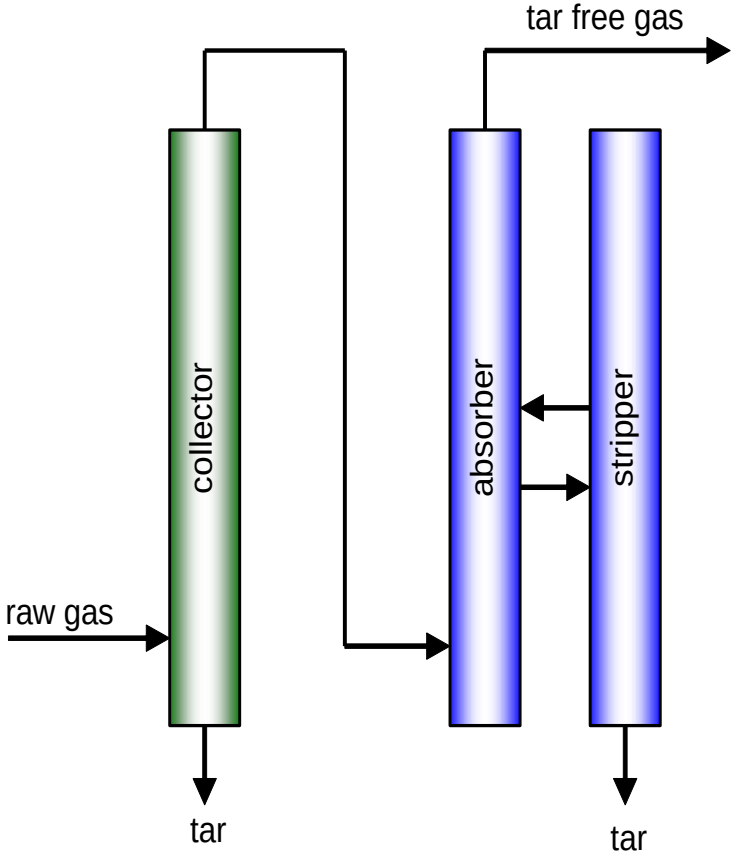
*12 MW (2014)*

# OLGA TAR REMOVAL

*ECN-technology*

- Complete tar removal
- Complete dust removal
- Up-scalable
- No methane reduction
- Tar recycle to gasifier
- No water condensation
- Fits many types of gasifiers

- *Supplied by Royal Dahlman*



# OLGA TAR REMOVAL

*ECN-technology*

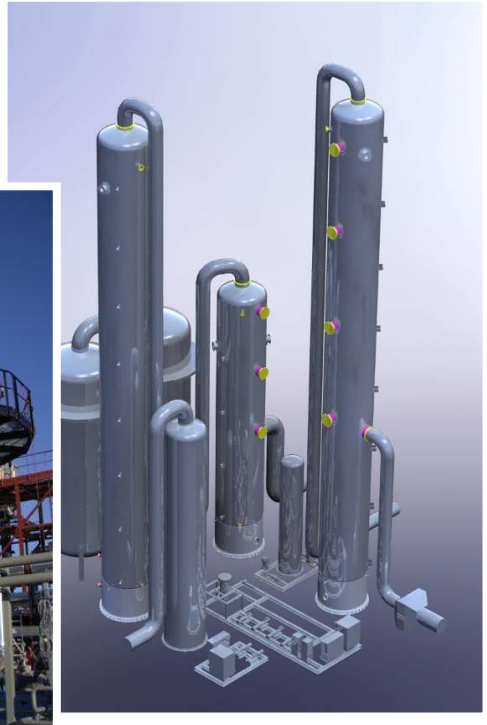
DAHLMAN

www.olgatechnology.com

*2 m³/h*

*200 m³/h*

*2000 m³/h*



*25000 m³/h*

# MILENA OLGA experience

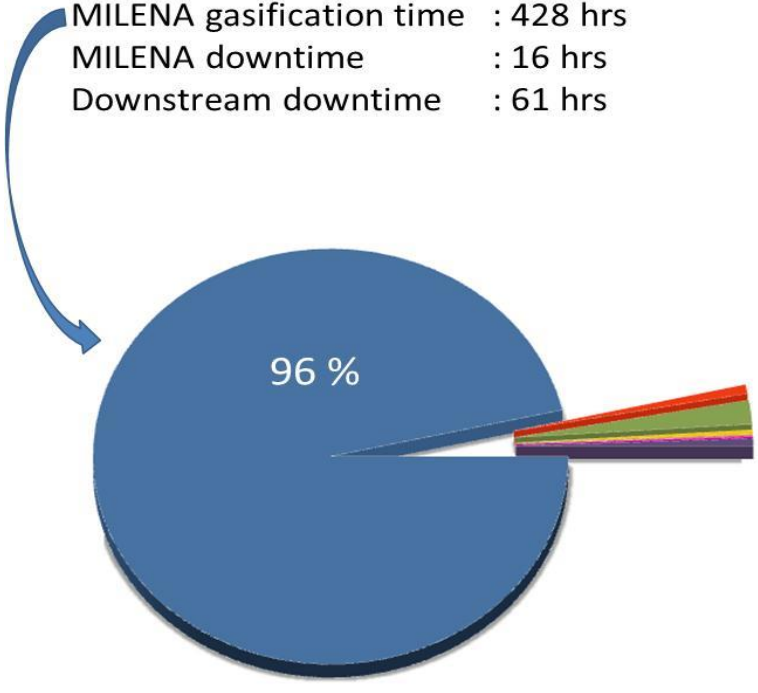
## *at ECN in Netherlands*

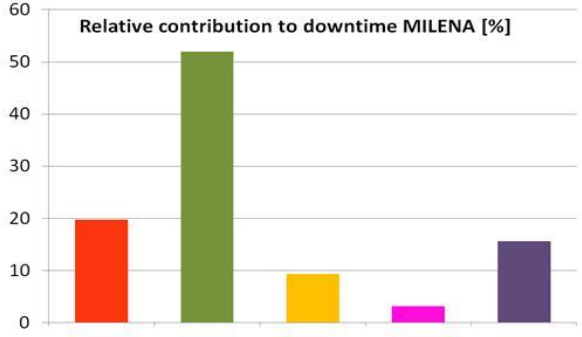
- Lab-scale
  - In operation since 2004
  - Connected to lab-scale gas cleaning and methanation
  - >3000 hours of operation
  - Fuels: beech wood, lignite, sunflower husk, soya stalk, high ash coal, RDF, etc.

- Pilot-scale
  - In operation since 2008
  - Connected to pilot scale  and lab-scale methanation
  - >1000 hours of operation
  - Fuels: demolition wood, wood chips, RDF

# Results recent 500 hour test of 1 MW Milena + OLGA tar removal system

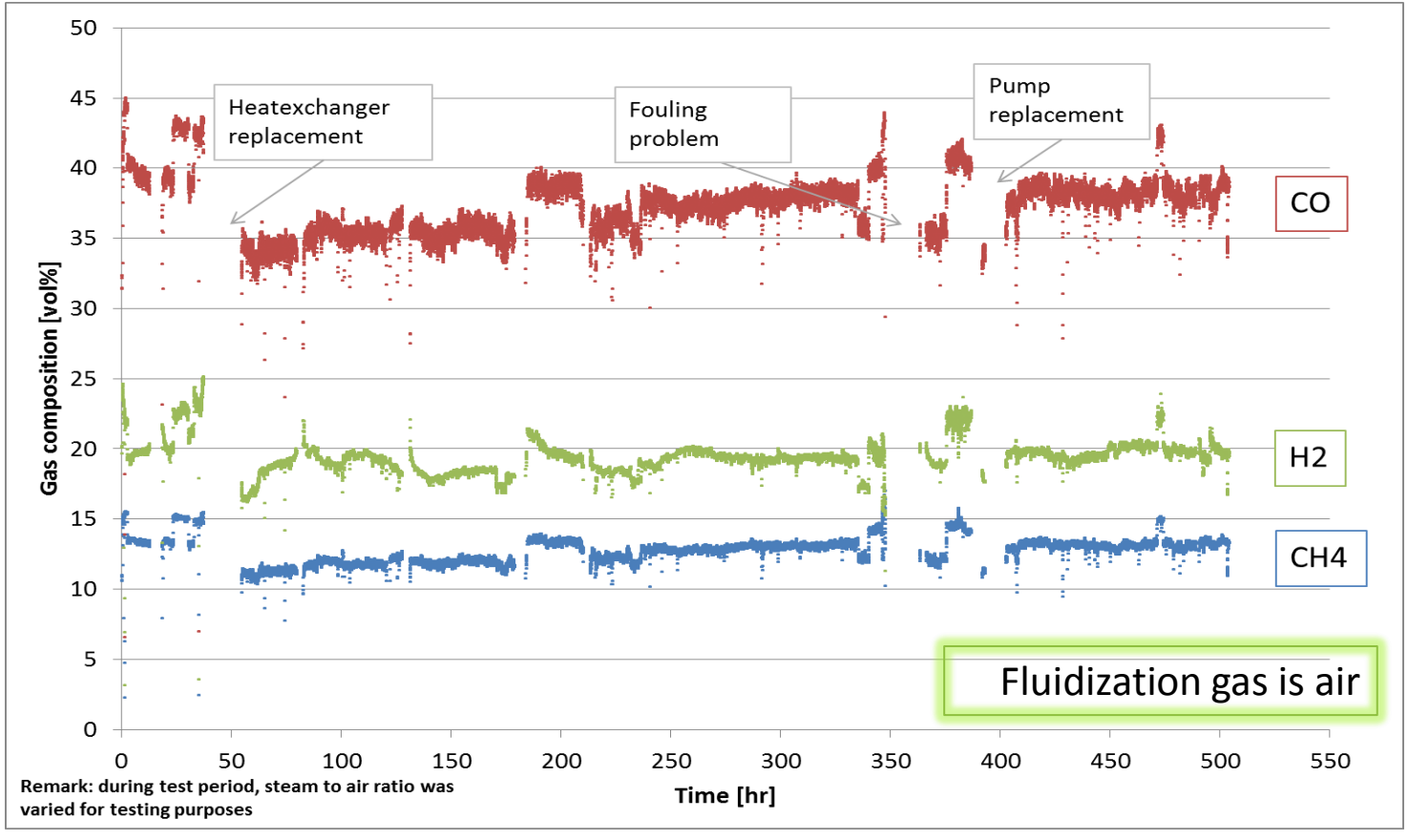
Duration experiment : 505 hrs
MILENA gasification time : 428 hrs
MILENA downtime : 16 hrs
Downstream downtime : 61 hrs




- Availability Milena 96%
- “Downstream downtime”: in OLGA tar removal system

# Gas composition 2012 duration test



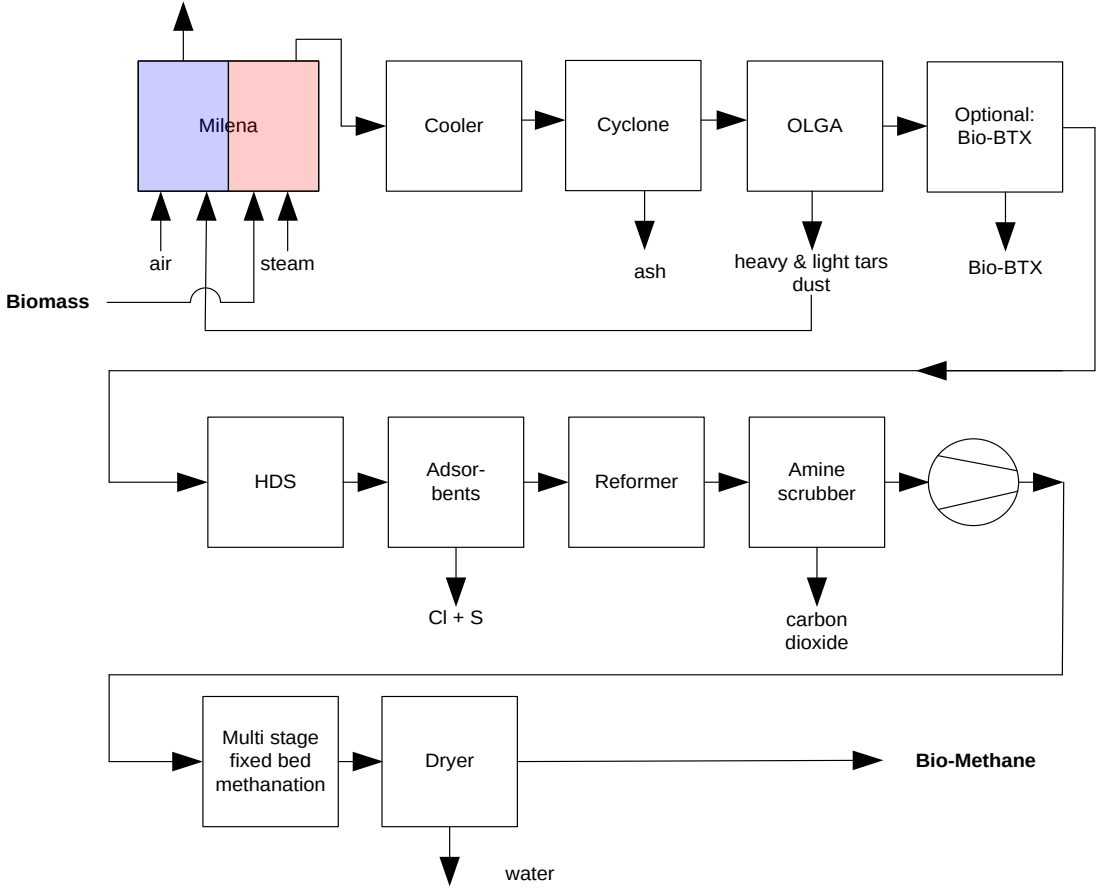
# Conclusions 2012 duration tests

- Used bed material (Norwegian olivine) resulted in (very) high tar concentrations, but OLGA was able to remove all tars
- Despite high tar load, fouling of piping between gasifier and gas cleaning was acceptable (scrapers in some parts of the piping were used)
- Gas composition was according expectations
- Tests showed a high availability of overall plant

# DIFFERENCES with FICFB

| MILENA | FICFB |
| --- | --- |
| Gasification in riser reactor | Gasification in bubbling bed |
| Low steam-to-biomass ratio | High steam-to-biomass ratio |
| High tar content | Low tar content |
| OLGA for complete tar removal | RME scrubber for tar removal |
| Only tar + char to combustor | Tar, char + gas to combustor |

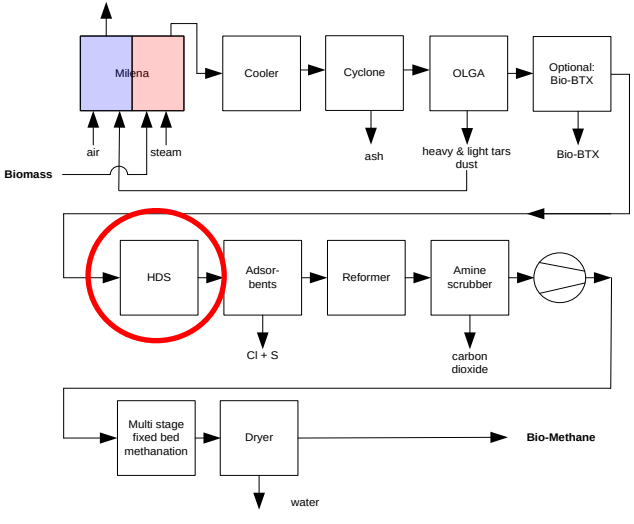
# BioMETHANE PROCESS



# DOWNSTREAM TESTING

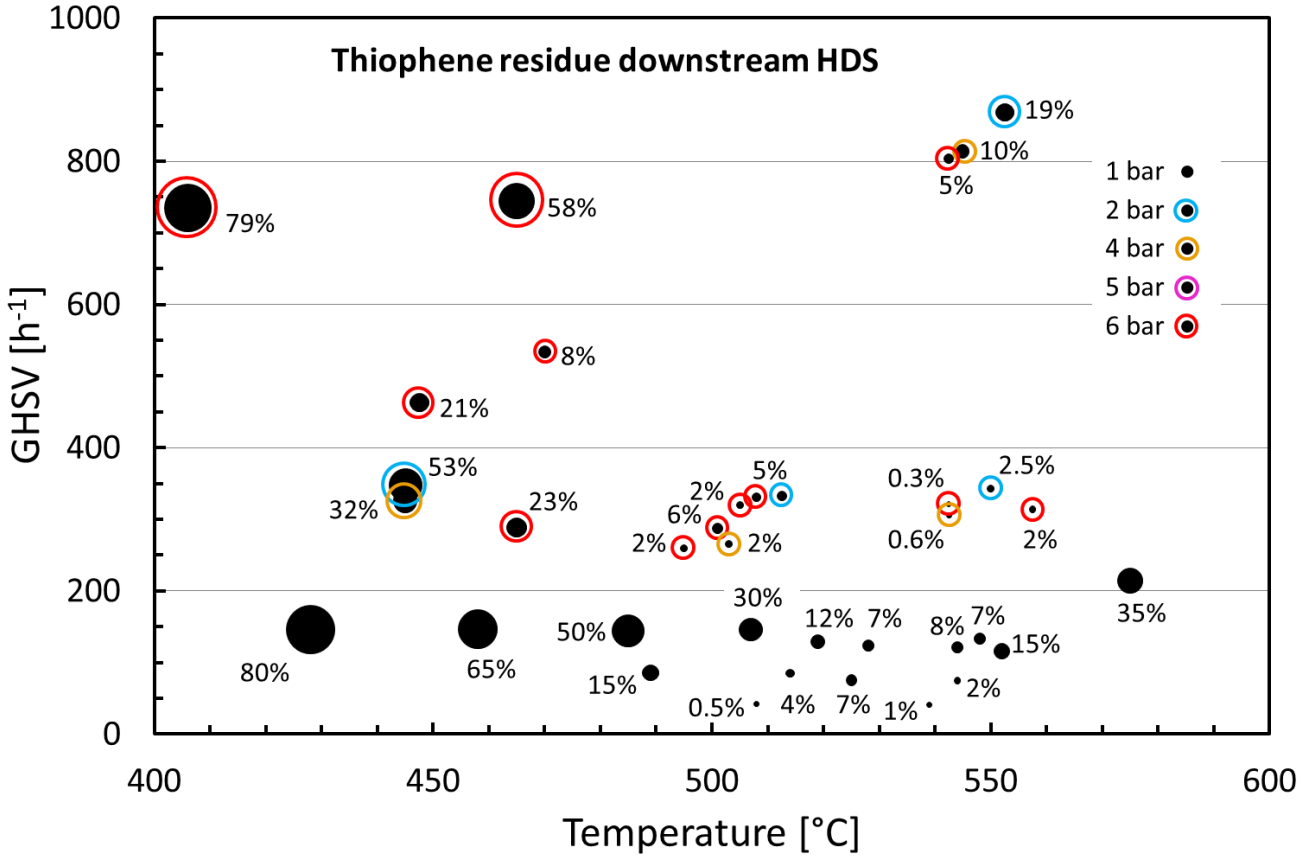
## *at ECN in the Netherlands, lab-scale*

- Several duration tests done to test different catalysts
- Focus on HDS
- Hydrogenation ($C_2H_2$, $C_2H_4$) and shift raise temperature by 100 – 200°C
- Thiophene residue <0.1 ppmv



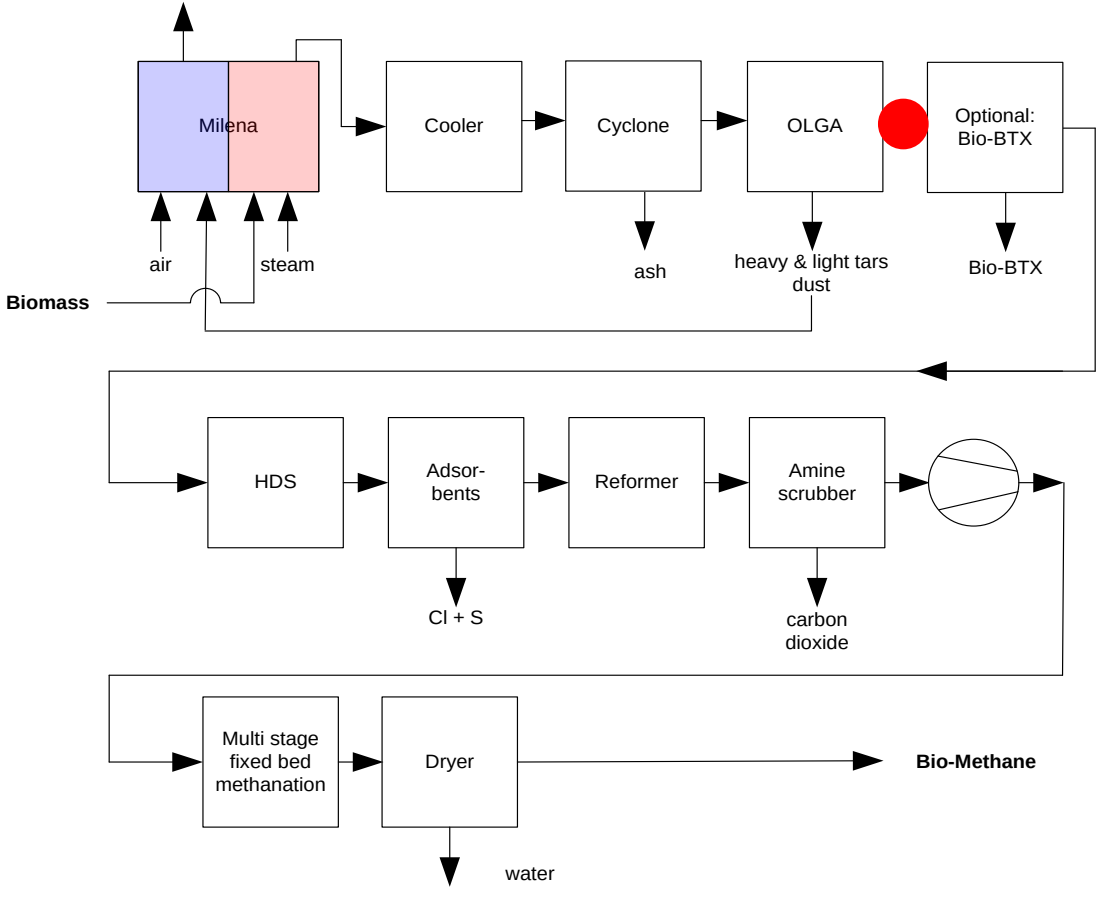

# HDS results

*<0.1 ppmv thiophene*



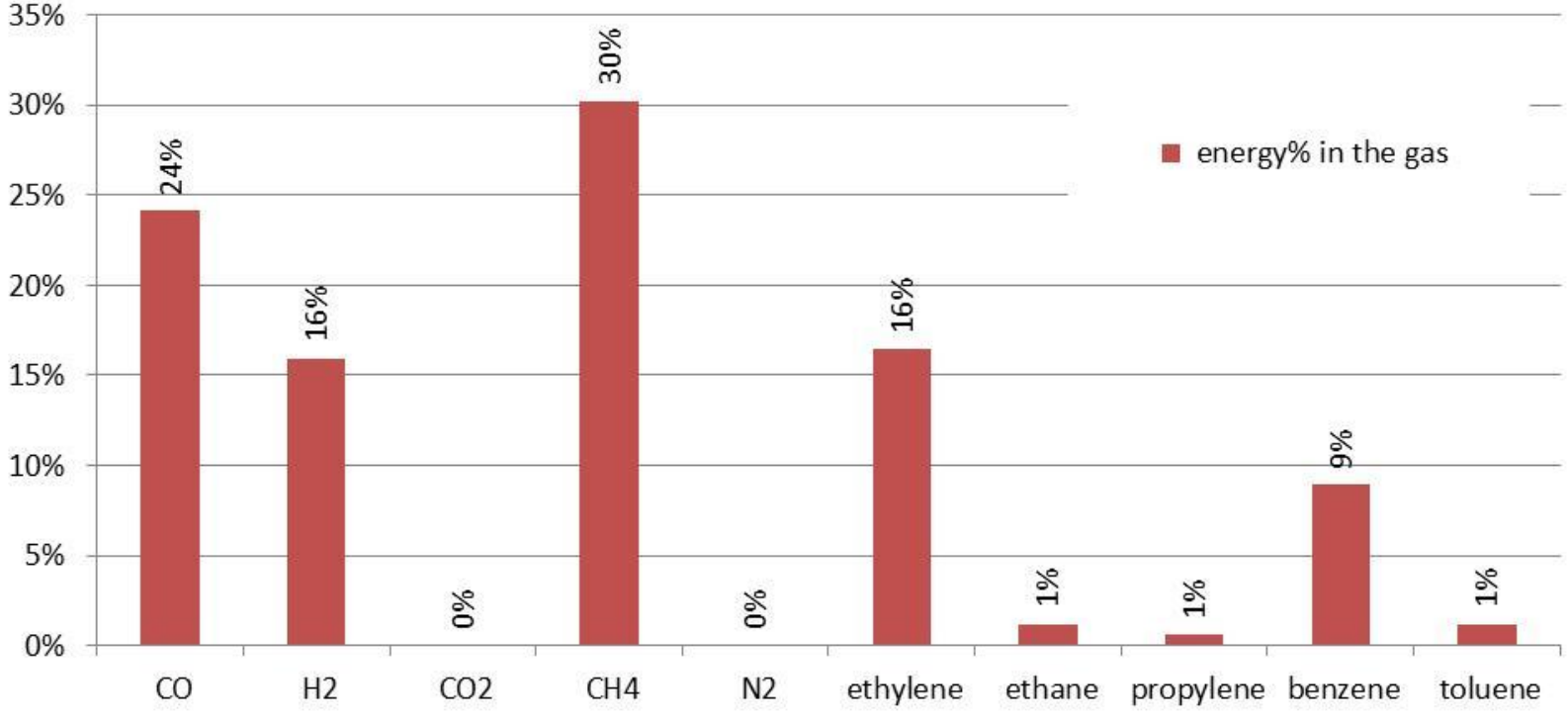
# GASIFICATION PATHWAY

## *gas composition exit OLGA*



# GAS COMPOSITION

*energy% in gas exit OLGA*



# CONCLUSION

- BioSNG can be produced with very high efficiency
- With indirect gasification up to 70% is possible
- Co-production makes much sense: bioSNG *plus* benzene, ethylene, …
  - Better value products
  - Even higher overall efficiency
  - Possibly even simpler process

# THANKS FOR THE ATTENTION


**Bram van der Drift**

**ECN**

Westerduinweg 3
1755 LE Petten
The Netherlands

P.O. Box 1
1755 ZG Petten
The Netherlands

T +31 224 56 45 15
M +31 61090 9927

vanderdrift@ecn.nl
www.ecn.nl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**ECN**
Westerduinweg 3
1755 LE Petten
The Netherlands

P.O. Box 1
1755 LG Petten
The Netherlands

T +31 88 515 4949
F +31 88 515 8338
info@ ecn.nl
www.ecn.nl