

# Biomethane in the EDGaR program

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# Biomethane in the EDGaR program

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ECN

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<http://groengas.nl/wp-content/uploads/2012/05/BioNoF1.jpg>

## EDGaR Program

<http://www.edgar-program.com/>

EDGaR = Energy Delta Gas Research

Joint research effort by

5 Gas companies (trade, transport, distribution)

3 Universities & 3 Research institutes

Total budget for period 2010 – 2014      44 M€

**The role of gas**  
**in the transition to a sustainable energy supply**

## EDGaR themes

1. From monogas to multigas
2. Future energy systems
3. Changing gas markets

### 30 projects in 8 clusters

Sustainable gas production

Gas quality measurement

Gas quality and applications

Gas quality and infrastructure



Research leaders & Program steering committee

CO<sub>2</sub> infrastructure

Energy systems for the future

Legal aspects

Market aspects

## Focus on Gas Quality Issues

The Netherlands are used to gas of well-defined quality (“Groningen” gas)

Gas from small fields & import is mixed with N<sub>2</sub> to G-gas quality

Increasing import, especially LNG, forces wider quality band

Sustainable gas brings additional “threats”

- CO<sub>2</sub> content (biomethane)

- Contaminants (siloxanes, NH<sub>3</sub>, terpenes, pathogens, CO)

- H<sub>2</sub> (electrolysis or incomplete methanation)

# EDGaR Biomethane Research (1)

Effect of gas components & contaminants on infrastructure materials

Literature study & exposure testing

	S	H <sub>2</sub> S	Mer-cap.	Odor.	NH <sub>3</sub>	Cl comp.	F comp.	HCl	HCN	CO	CO <sub>2</sub>	BTX	Aro-mats	O <sub>2</sub>	H <sub>2</sub>
PVC	Orange		Light Green		Orange			Light Green		Orange	Dark Orange	Dark Green		Light Green	Orange
PE	Orange		Light Green		Orange			Light Green		Orange	Dark Orange	Dark Green		Dark Green	Light Green
NBR	Light Orange	Dark Orange	Light Green		Dark Green	Dark Orange			Light Green		Dark Green		Dark Green		
Steel	Dark Orange		Light Green						Dark Orange	Dark Orange		Light Green		Dark Orange	Dark Green
Cu	Dark Orange			Light Green	Dark Orange	Light Green			Light Orange		Dark Orange	Light Green		Dark Orange	Light Orange
Al	Light Orange			Light Green	Dark Green	Light Green			Light Orange		Dark Orange	Light Green		Dark Green	Light Orange

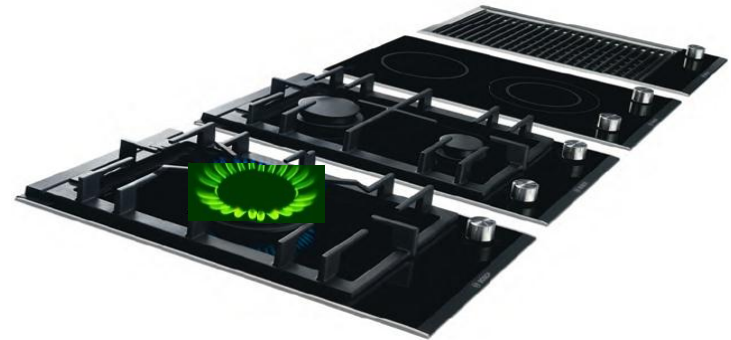
## EDGaR Biomethane Research (2)

Effect of wider gas quality band on household & industrial appliances

Theoretical evaluation & experimental testing

flame lift  
emissions  
unwanted ignition

flashback  
engine knock  
instability





## EDGaR Biomethane Research (3)

Gas composition measurement techniques

Development of gas sensors

Detection of trace components (siloxanes)

Specifications for silicon-containing  
compounds in biogas



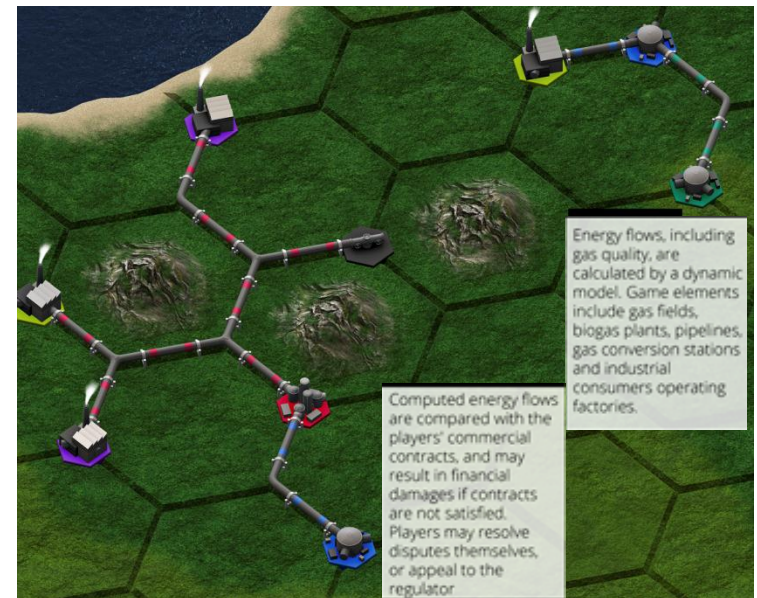
## EDGaR Biomethane Research (4)

### Decentralized (bio)gas storage

Techniques & economics of gas storage,  
heat management, safety,  
social & legal aspects

### Smart-grids, local gas grids

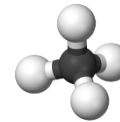
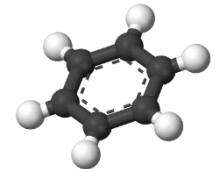
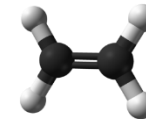
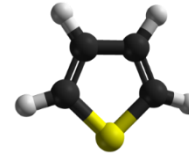
Gasboard: a serious game on  
tomorrow's gas infrastructure



# ECN Biomethane (SNG) Research

- MILENA biomass gasification
- OLGA tar removal
- Sulfur removal / HDS for thiophene
- Conversion or removal of  $C_xH_y$  (unsaturated / aromatic)
- Conversion of  $CO + H_2$  into  $CH_4$
- Power-to-Gas ( $CO_2$  / biogas / producer gas +  $H_2 \Rightarrow CH_4$ )

Groen Gas 2.0  
Milena-Olga-SNG



## Pressurised HDS & SNG test rig

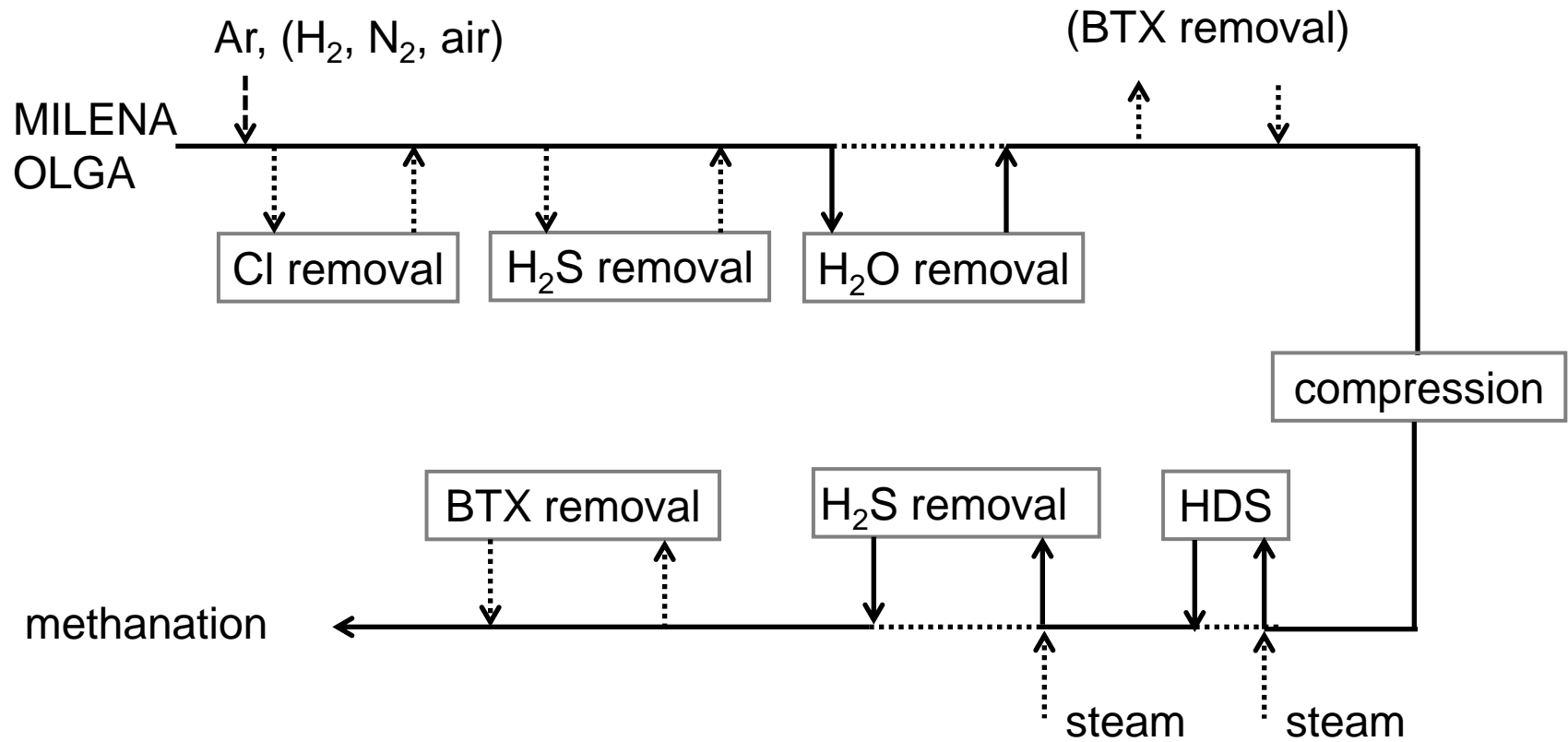


HDS

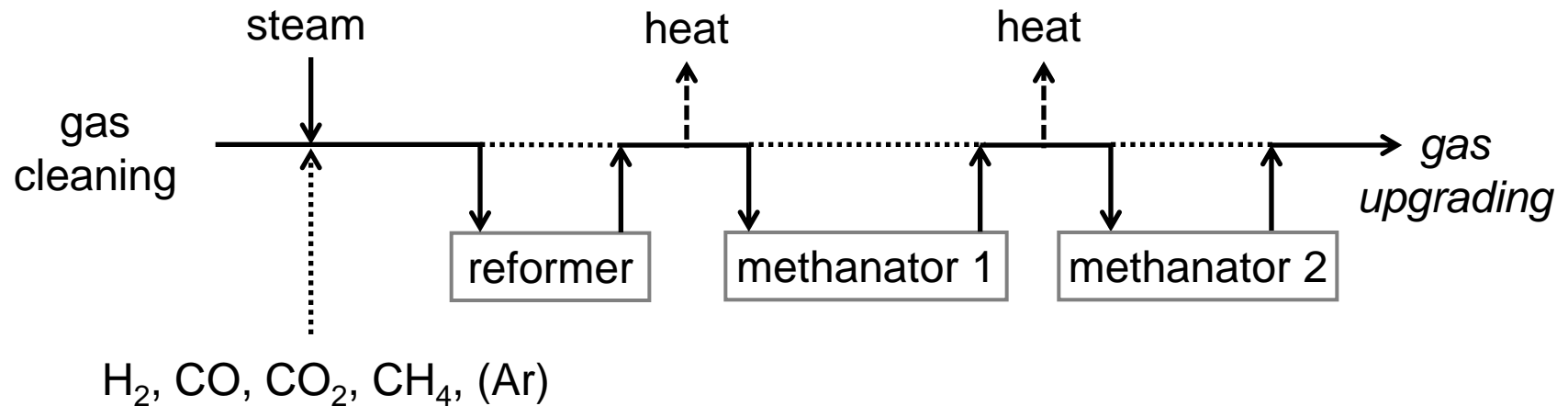


SNG: Lefthand and righthand view

# Gas cleaning flow scheme



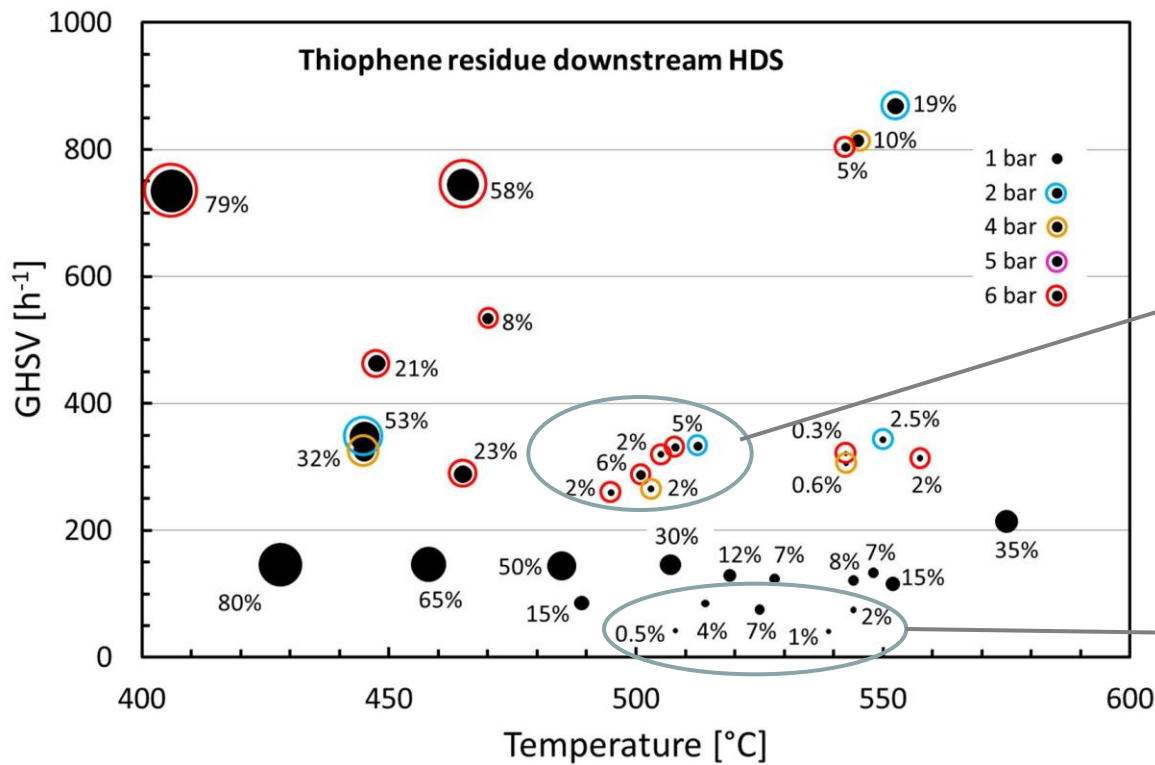
## Methanation flow scheme



### Simulation of

1. Gas recycling (temperature control)
2. Power-to-Gas (H<sub>2</sub> from electrolysis)
3. Power-to-Gas with biogas or pure CO<sub>2</sub>

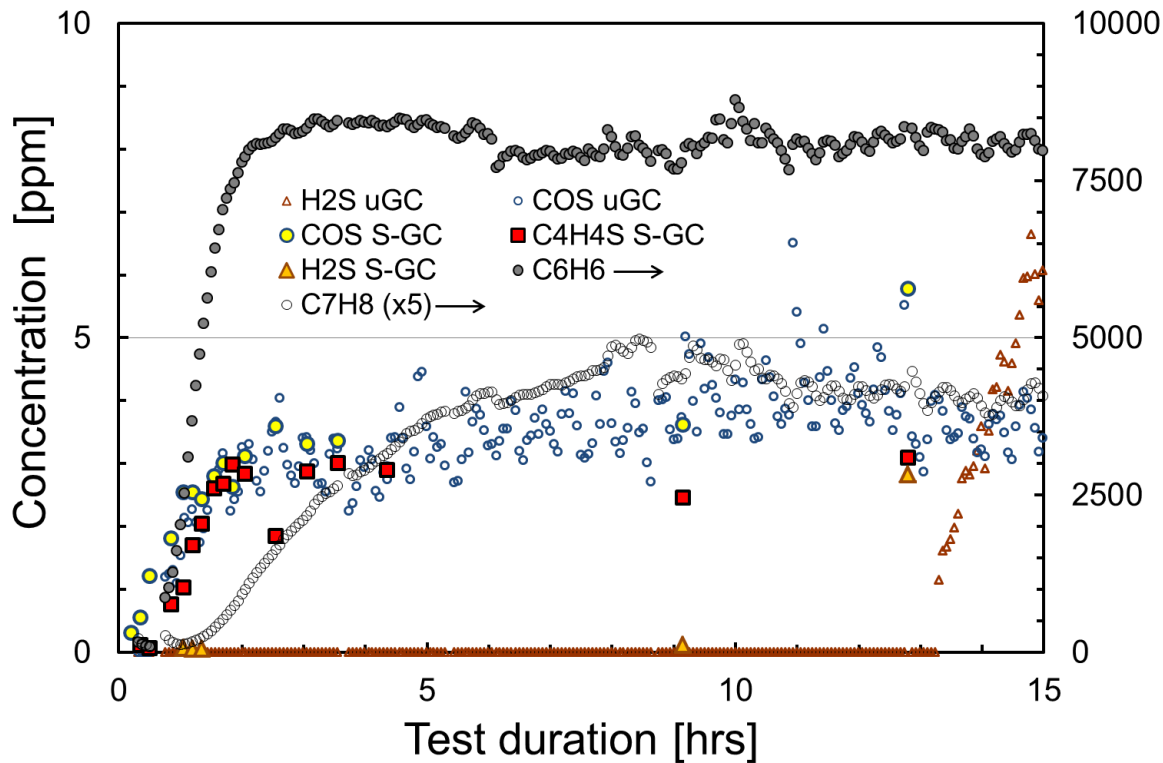
# HDS results for thiophene conversion



Lower temperature & higher gas velocity allowed for >95% conversion at 6 bar

High temperature & low gas velocity required for >95% conversion at 1 bar

# Thiophene adsorption by active carbon



Impregnated  
active carbon

Order of break-through:

COS

Benzene, thiophene

Toluene

H<sub>2</sub>S



# $^{14}\text{C}$ analysis for “green” credentials

$^{14}\text{C}$  => independent verification

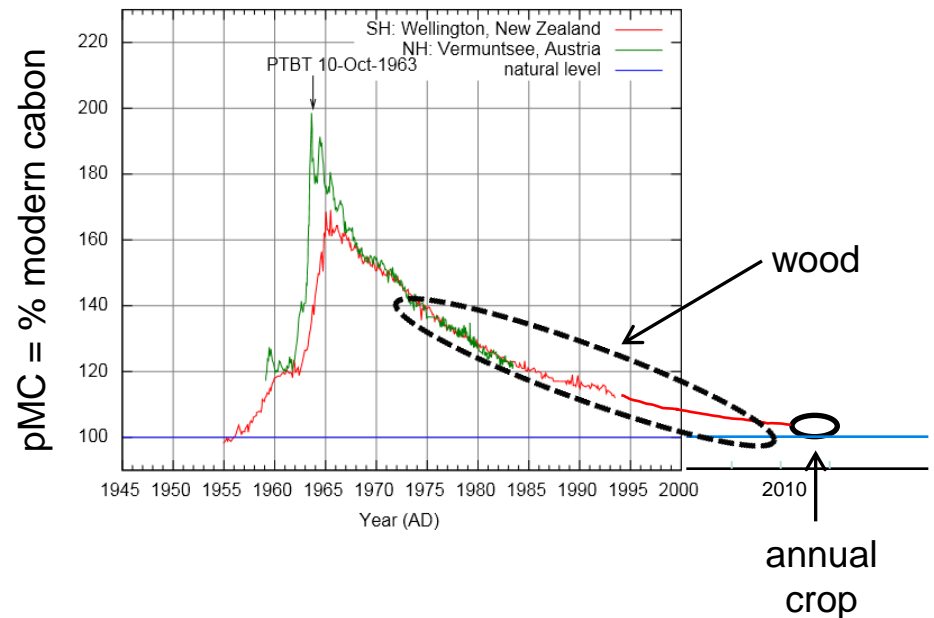
$^{14}\text{C}$  in biomass = 100% bioC

$^{14}\text{C}$  in fossil fuel = 0% bioC

Intermediate bioC values for  
biomass-fossil mixtures  
=> mixture ratio

Sanne W L Palstra, Harro A J Meijer;  
Radiocarbon, Vol 56, Nr 1, 2014, p 7–28

Inherent inaccuracy 2 to 4% due to  
varying  $^{14}\text{C}$  content atmosphere



# SNG composition & <sup>14</sup>C analysis

	Wood	Wood + lignite
<b>Pressure</b>	<b>5.8 bar</b>	<b>5.4 bar</b>
CO <sub>2</sub>	46.5%	47.2%
CH <sub>4</sub>	39.1%	38.3%
H <sub>2</sub>	2.8%	2.5%
Ar	5.7%	4.8%
N <sub>2</sub>	4.7%	6.1%

BioC in MILENA flue gas & SNG

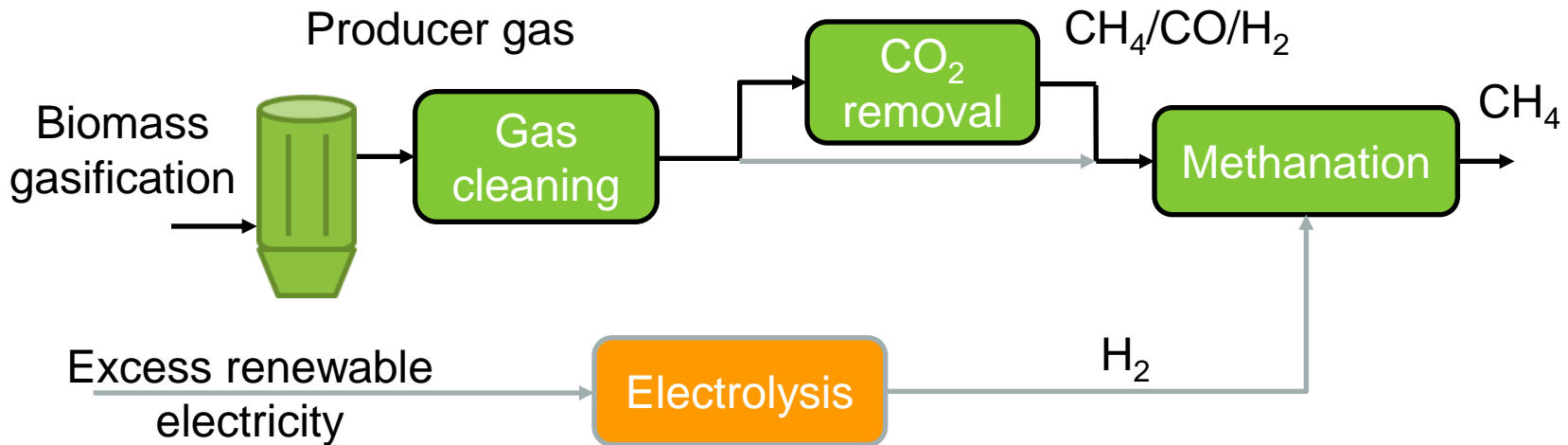
Wood + lignite	BioC [%]
Input	78
Flue gas CO <sub>2</sub>	38
SNG CO <sub>2</sub>	89
SNG CH <sub>4</sub>	89

Fossil enriched

More biogenic

Can be used to study carbon conversion to gas and char

# P2G, e.g. coupled to biomass gasification

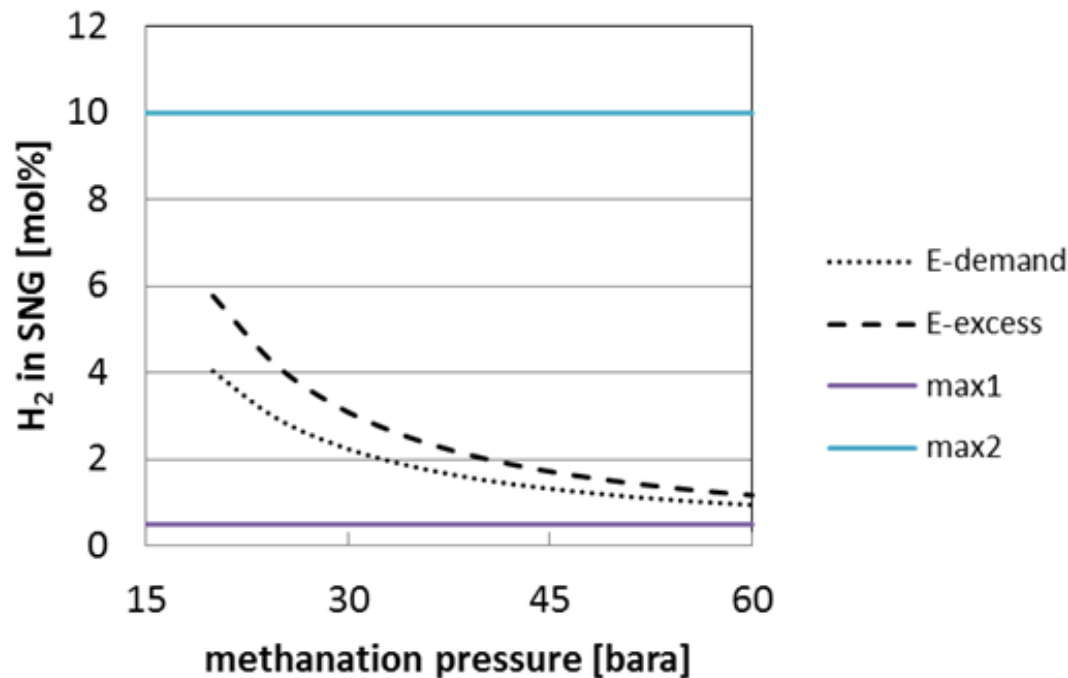


Switch between two modes:

E-demand => CO<sub>2</sub> removal

E-excess => H<sub>2</sub> addition

## Modelling result: 3 reactors + recycling



1. H<sub>2</sub> concentration similar for both cases
2. H<sub>2</sub> concentration above Dutch limit

## Conclusion

- The Dutch gas sector is preparing for a change
- Big money is involved => very careful & reluctant
- EDGaR 2010 – 2014, and beyond?

Meeting in Brussels 27 + 28 Nov, 2014 (EDGaR, DVGW, you?)

<http://www.edgar-program.com/agenda/from-monogas-to-multigas>

EDGaR Closing Conference in Amsterdam, 18 March, 2015

<http://www.edgar-program.com/agenda/closing-conference-2015>



Ministerie van Economische Zaken



### Nederlands

Hier wordt geïnvesteerd in uw toekomst. Het onderzoeksprogramma EDGaR is erkentelijk voor de bijdrage van de financieringsinstellingen: Samenwerkingsverband Noord Nederland. Dit project wordt medegefinancierd door het Europees Fonds voor Regionale Ontwikkeling en door het ministerie van Economische Zaken. Cofinanciering vindt eveneens plaats door de Provincie Groningen.

### English

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