Alkmaar 4 MW bio-SNG demo

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M.H.F. Overwijk

May 2016
ECN-L--16-023

Alkmaar 4 MW bio-SNG demo

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Department of **B**iomass & **E**nergy **E**fficiency (BEE)

Malmö
May 11, 2016

Outline

- History
- Consortium
- Technology
- Budget & time schedule

ECN's early SNG interest

ECN-RX--99-016

HYDROGEN CONVERSION IN SUBSTITUTE NATURAL GAS BY BIOMASS HYDROGASIFICATION

M. Mozaffarian, M. Bracht, H. den Uil, and R.v.d. Woude
Netherlands Energy Research Foundation (ECN)
Business Unit Fuels, Conversion & Environment
System Assessment Group
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4th International Conference on New Energy Systems & Conversions (NESC '99)
27-30 June 1999, Osaka, Japan

ECN-C--04-081

"GREEN GAS" (SNG) PRODUCTION BY SUPERCRITICAL GASIFICATION OF BIOMASS

M. Mozaffarian, E.P. Deurwaarder (ECN Biomass)
S.R.A. Kersten (Twente University)

ECN-RX--05-194

Methanation of Milena product gas for the production of bio-SNG

Ewout P. Deurwaarder
Harold Boerrigter
Hamid Mozaffarian
Luc P.L.M. Rabou
Bram van der Drift

14th European Biomass Conference & Exhibition
17-21 October 2005, Paris, France

SNG enters energy scenario

January, **2006**

Transitie naar een duurzame energiehuishouding

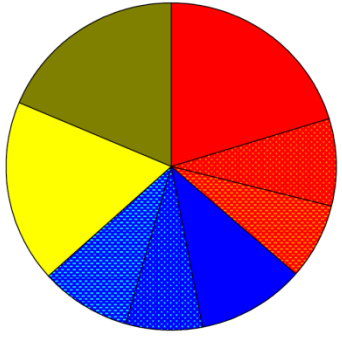
Platform
Groene Grondstoffen

Biomass in the Dutch Energy Infrastructure in 2030

L.P.L.M Rabou and E.P. Deurwaarder
ECN

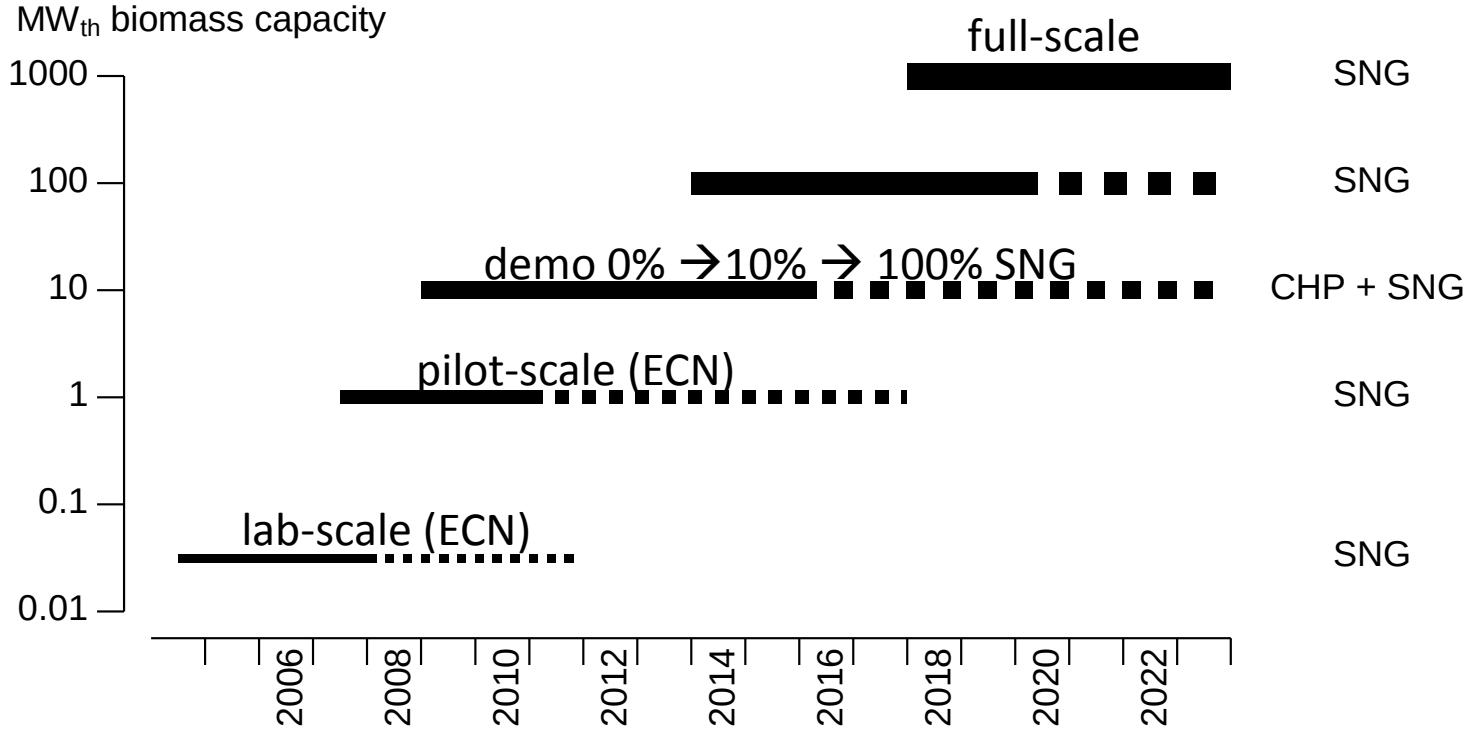
H.W. Elbersen and E.L. Scott
WUR, A&F

Can biomass supply 30% of energy demand in 2030 ? If so, how ?



	Energy demand [PJ]	Contribution biomass [%]	
Heat	1090	17	← 2/3rd SNG
Electricity	810	12	
Transportation	540	40*	
Raw materials Metal industry	65	50	
Chemistry natural gas	123	30	
Chemistry petroleum	315	25	
Others	57		
Total	3000		

2005 schedule for SNG development

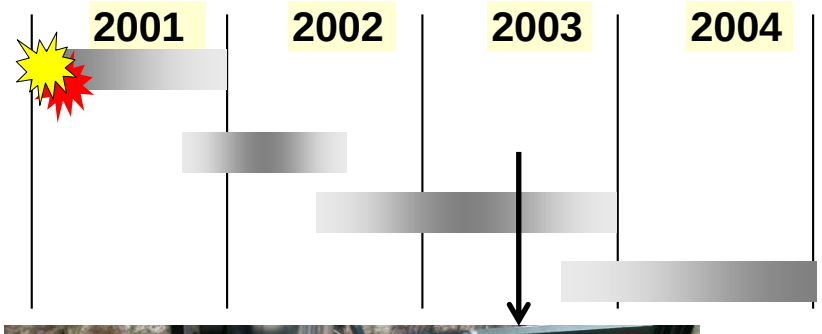


Foundation of the 1st consortium

May 11, 2016

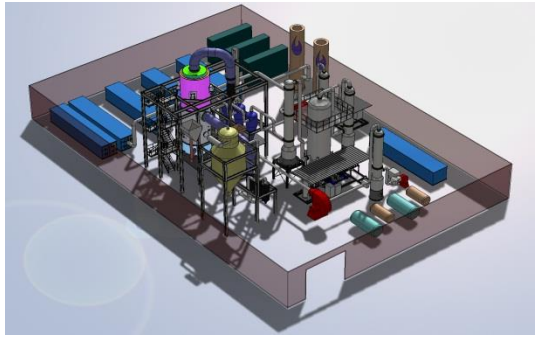
2003 Matchmaker OLGA

Conceptual Design
Proof-of-Principle (lab-scale)
Proof-of-Concept (bench-scale)
Full-scale Demonstration



Start of
ECN – Royal Dahlman
co-operation

2008 HVC towards Bio-SNG



TIME	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018

1	CHP 10 MWth	PILOT PHASE		DEMO	DEMO PHASE	COMMERCIAL OPERATION DEMO		
				design data				
2	SNG 50 MWth	LAB PHASE		PILOT PHASE		DEMO	DEMO PHASE	COMMERCIAL OPERATION DEMO

Shifting targets

ECN-M--**10**-057

Preparations for a 10 MW_{th} Bio-CHP Demonstration based on the MILENA Gasification Technology

C.M. van der Meijden
P.C.A. Bergman
A. van der Drift
B.J. Vreugdenhil

18th European Biomass Conference & Exhibition
3-7 May 2010, Lyon, France

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

A. van der Drift

October 2013
ECN-L--**13**-073

Foundation of the 2nd consortium

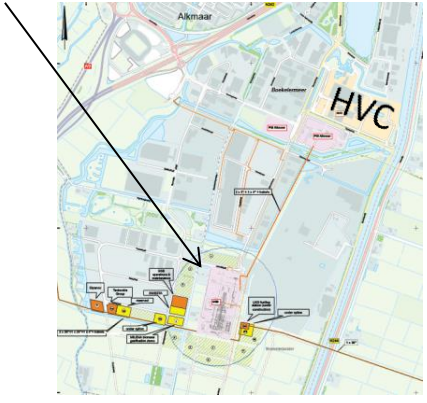
May 11, 2016

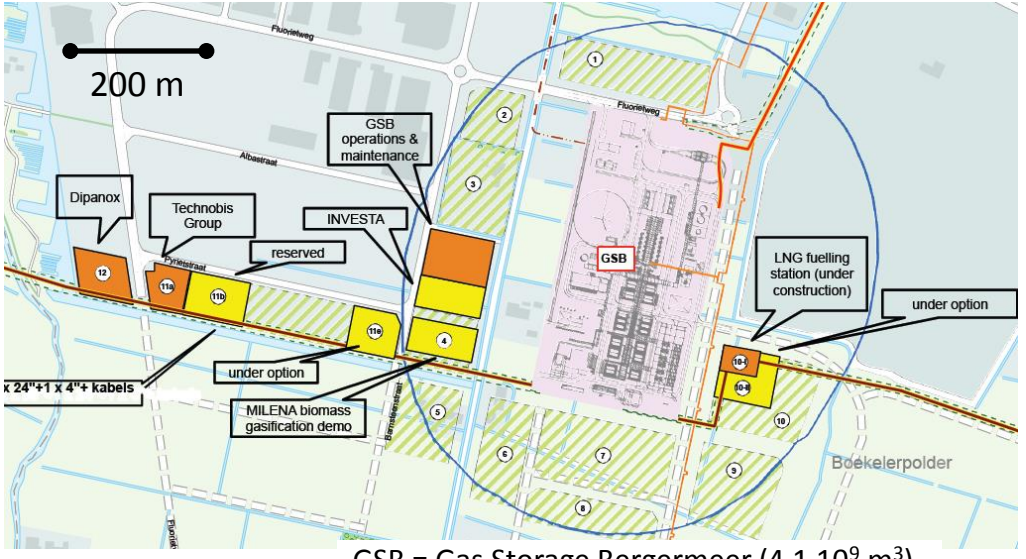
Some old, some new

- HVC withdraws from consortium, ECN and Royal Dahlman stay
- Gasunie becomes main partner
- North Holland Participation Fund for Sustainable Economy joins consortium

Location: near HVC, at

Energy Innovation Park Alkmaar





GSB = Gas Storage Bergermeer (4.1 10^9 m^3)

Co-operation with INVESTA

Expertise centre for biomass gasification

InVesta

Provincie Noord-Holland

TAQA

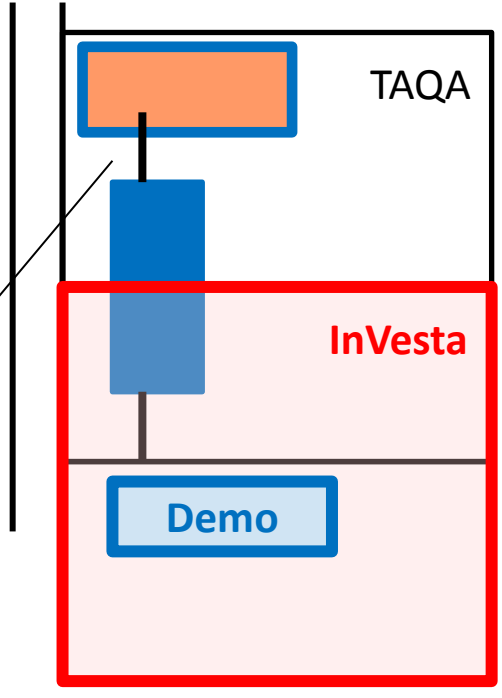
gemeente ALKMAAR

nhn Ontwikkelingsbedrijf Noord-Holland Noord

energy valley

ECN

nholland hogeschool



Demo technology

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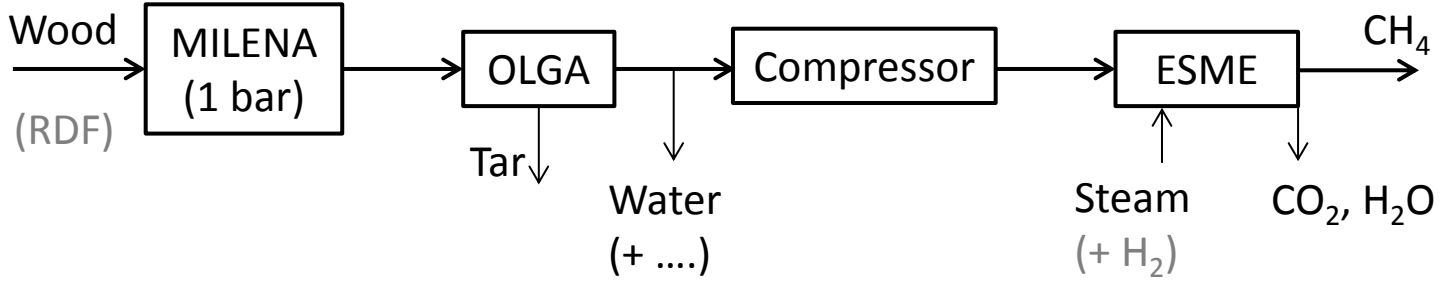
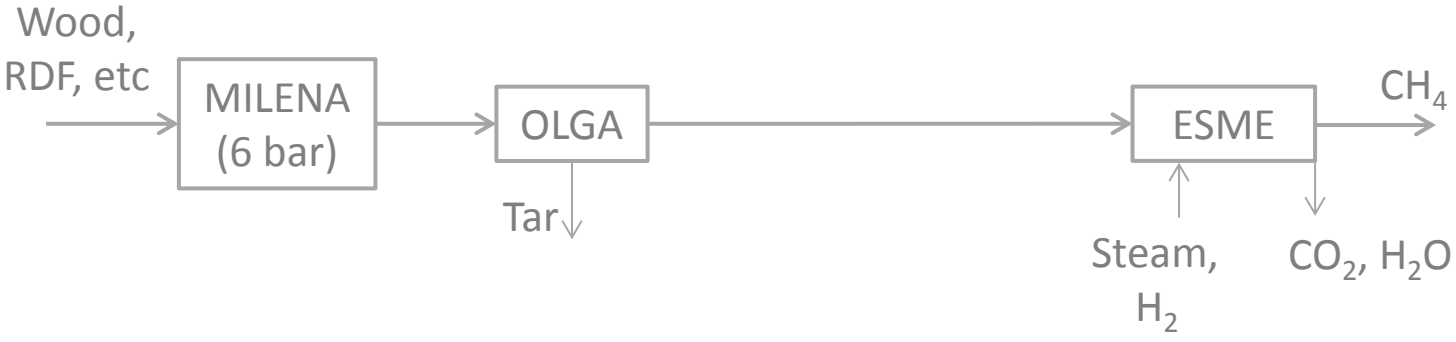
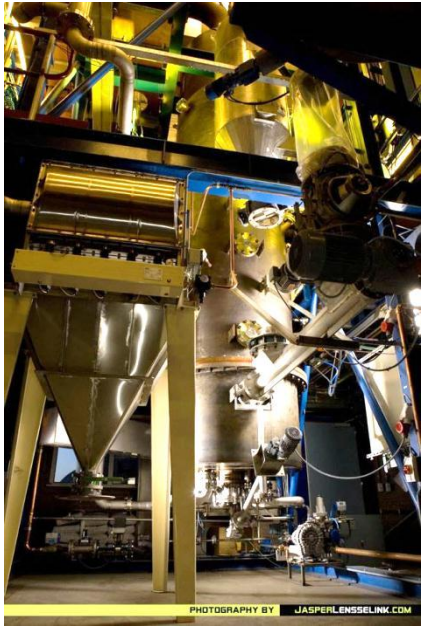
Demo (and future) lay-out





MILENA indirect gasifier

25 kW lab ECN



750 kW pilot ECN

4 MW India

DAHLMAN

THERMAX
Sustainable solutions
Energy & Environment

OLGA tar removal

1 m^3/h lab ECN

150 m^3/h pilot ECN

2000 m^3/h
France, Portugal, India

Producer gas composition (ds OLGA)

Component	Vol % (dry)	Energy %
$CO + H_2$	60	45
CH_4	13	29
C_2H_2	0.3	1
C_2H_4	4	15
C_2H_6	0.3	1
C_3H_6	0.1	0.6
C_6H_6	0.8	7
C_7H_8	0.1	1
C_{8+}	~0.01	
CO_2	19	
N_2	2	

Moisture content 35 - 40%

Gas also contains contaminants, such as

NH_3, HCN, C_5H_5N

H_2S, COS, C_4H_4S, CH_4S, C_2H_6S

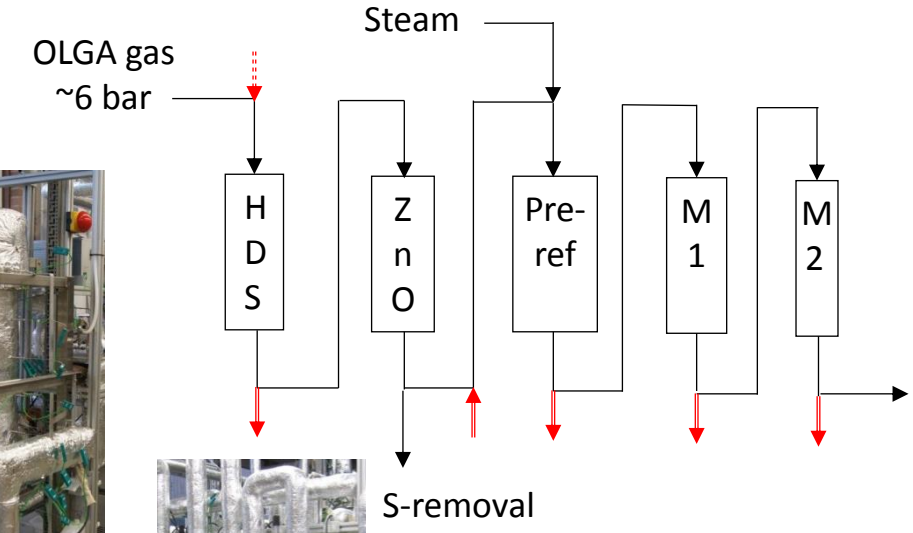
ESME considerations

- Use BTX (C_6H_6, C_7H_8, C_8H_{10}) for methane production
  => 5-10% more efficiency
- Convert organic S-components & unsaturated C_xH_y with HDS catalyst
  => protect methanation catalyst
- Two pressure stages: ~5 bar 1st stage => similar to future pressurised gasifier
  ~20 bar 2nd stage => low H_2 content, grid injection
- Remove most H_2O and CO_2 before compressor 2nd stage
  => low compression duty

ESME lab test (~5 kW)

HDS

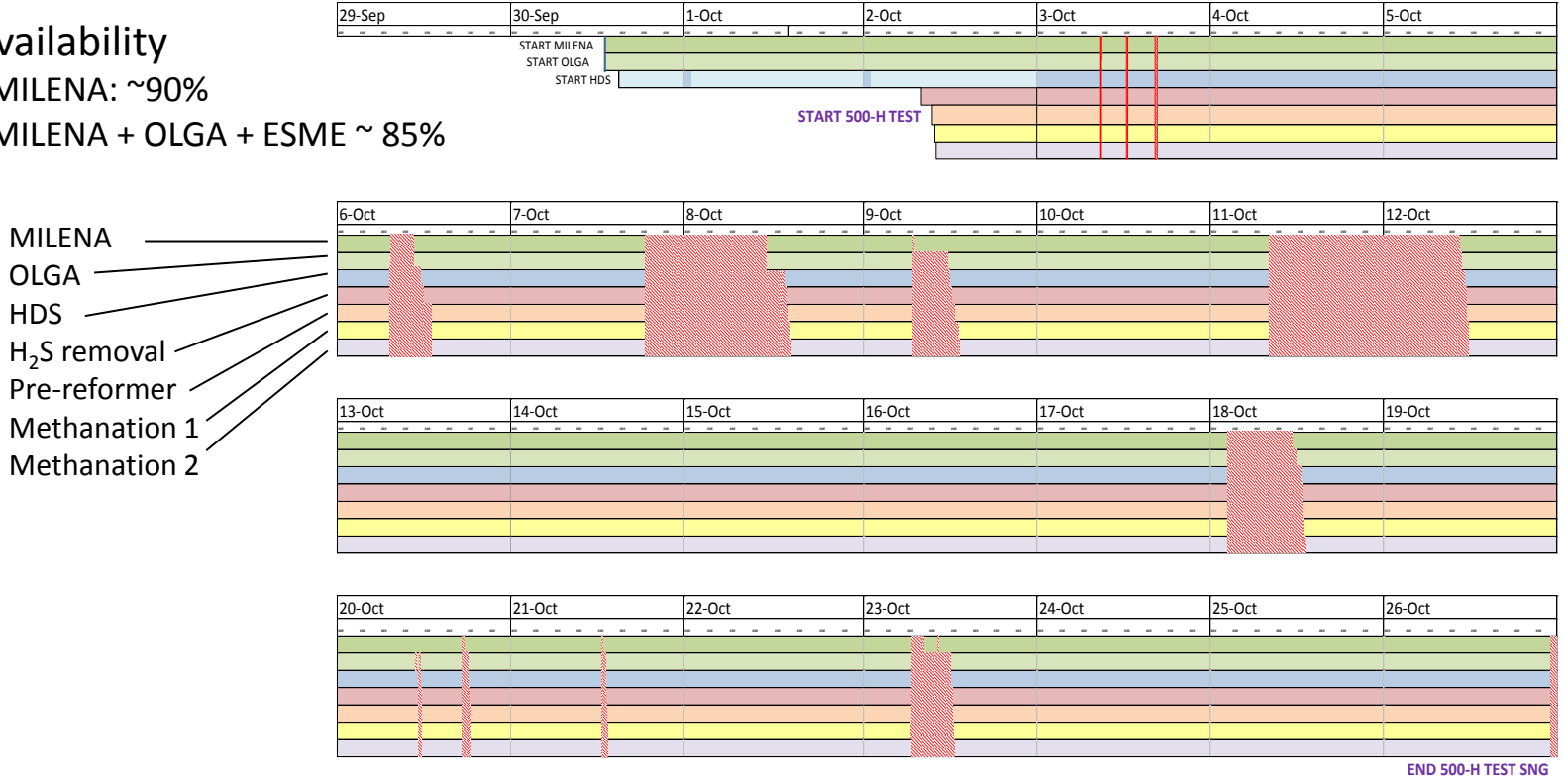
ZnO



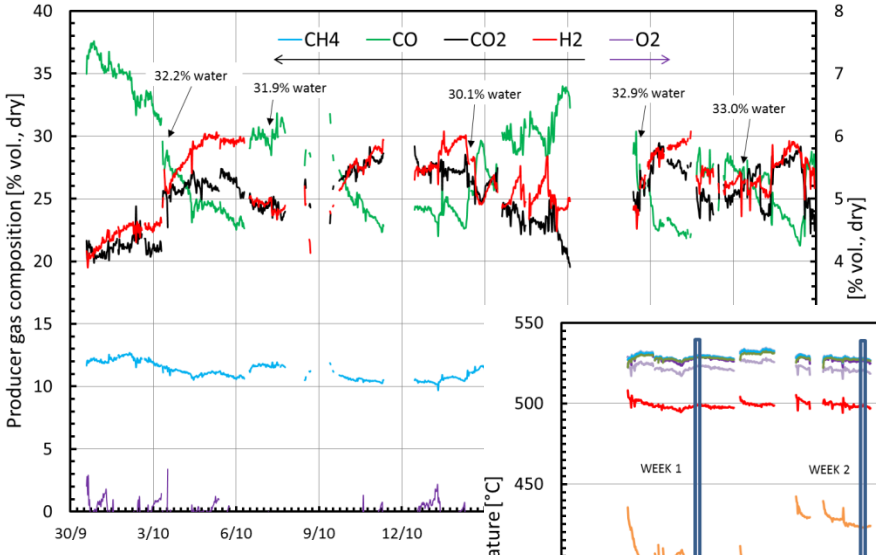
Pre-ref. M1 M2

Overview 500-hour bio-SNG test

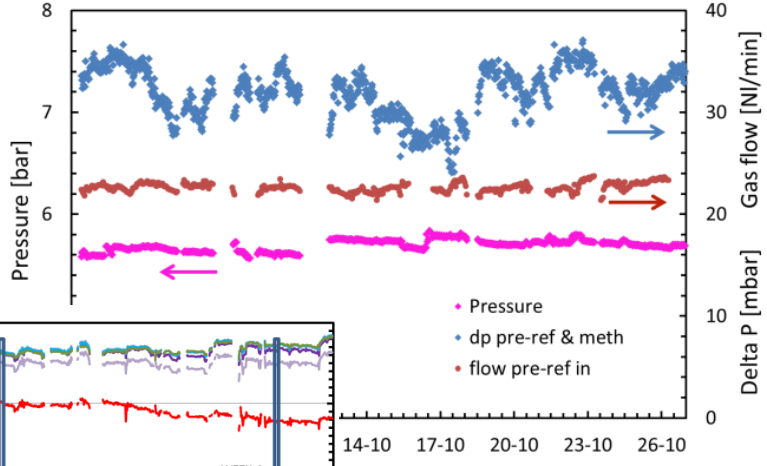
Availability
- MILENA: ~90%
- MILENA + OLGA + ESME ~ 85%



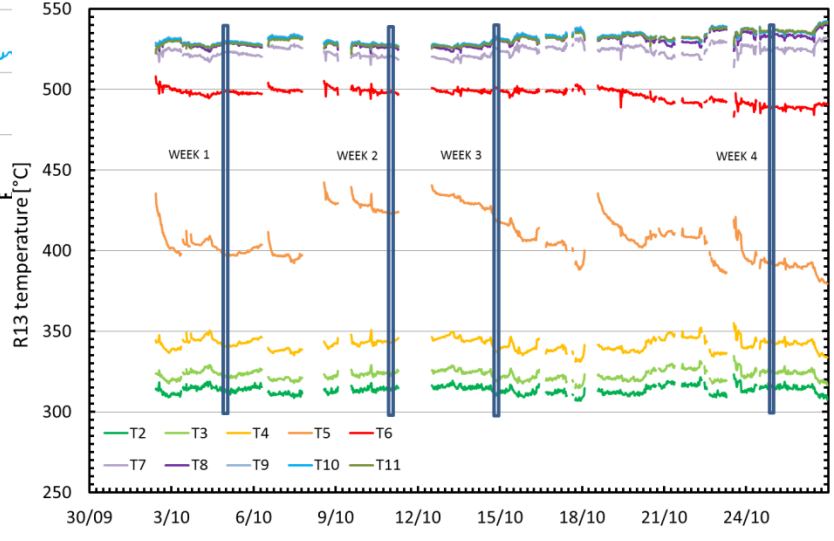
Some results of 500-hour test



MILENA gas



ESME **pressure**, **flow** and **pressure drop**



Pre-reformer temperatures

Where are we (going)?

Aim of Green Gas 2.0 Consortium

- SNG demo, based on MILENA + OLGA

  ~300 m^3/hr “green gas” for local gas grid
- Start of operation 2017
- Commercialization of technology at 50 - 100 MW scale,

  based on economic conditions in NL
- First commercial plant in 2020

Demo bio-SNG quality (NL specs)

	G-gas	Bio-SNG low CO_2	Bio-SNG high CO_2
CH_4	81.3	87.6	88.4
C_2H_6	2.9	0	0
C_3H_8	0.4	0	0
C_{4+}	0.2	0	0
CO_2	0.9	4.5	8
N_2	14.3	7.5	3.2
H_2	-	0.3	0.3
CO	-	0.1	0.1

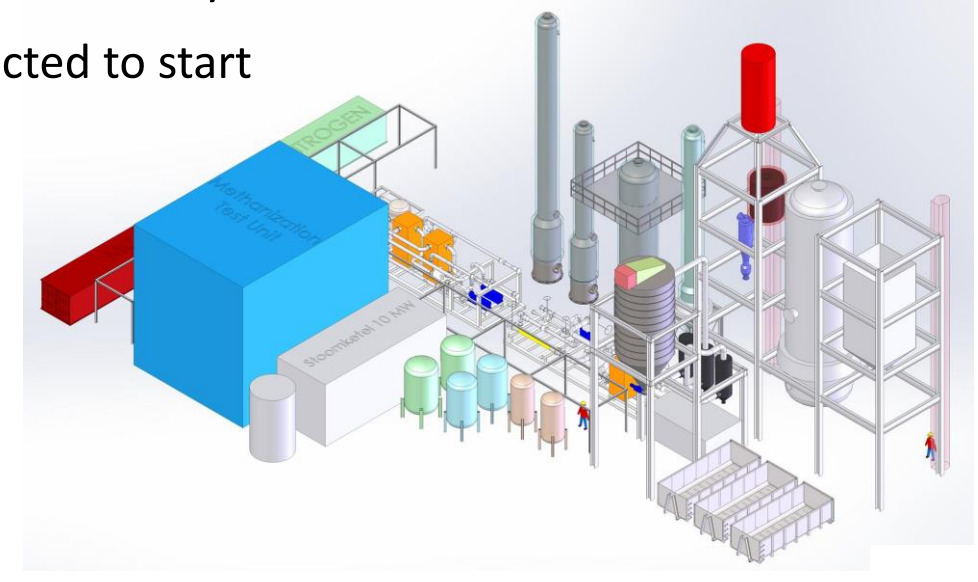
Heating value
100 ± 0.5% of G-gas

Wobbe index in centre of allowed band

H_2 and CO near 50% of allowed maximum

Budget & time schedule

- Budget 23 M€
- Basic engineering started in February 2016
- Detailed engineering expected to start in September 2016
- Start operation in 2017



Thank you

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SNG specifications (NL distribution)

- Wobbe index between 43.46 and 44.41 MJ/m_n^3
- H_2 < 0.5%
- CO < 0.23%
- CO_2 < 10.3% - 0.72 N_2 (≈ G-gas)
- Water dewpoint -32°C @ 8 bar

For H-gas, CO_2 will be < 2%, and some C_2H_6 and/or C_3H_8 may be needed

Acknowledgement

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Abstract

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Contents

CONTENT AND STRUCTURE:

- Does the title stimulate the reader to continue reading? Keep the report title short and concise and preferably avoid subtitles. Indication of title length (incl. subtitle): maximally 8 words. Advice on titles and sub headings: Informative, not business-like.
- Start each new chapter (and section) with the core message. Does this stimulate the reader to continue reading? The first sections (with core messages) of all chapters should together constitute the summary.
- Use lemmas to highlight the core message of a section. Avoid excessive use of lemmas, as this will make the text obscure. Indication: maximally 3 lemmas per page.
- Introduction: Always include objective, research question and reading instructions!
- You can also use text boxes. The text will be displayed against a light grey background with yellow lines above and below the text.
- Contents: Preferably use only two levels of headings. A third level is possible and a fourth level is not numbered, but printed in bold. The table of contents shows only 3 levels.
- Lists of tables and figures are no longer included in the template.

Summary

Informative summaries on technical or scientific research need to contain information on:

- the subject,
- the objective and scope,
- the methodology, experimental (on measuring or analysis methods) or theoretical (on models or approaches, calculation methods, for example analytical or computer-based)
- the results,
- the conclusions **that can be drawn about these results.**

The general guidelines for summaries:

- Emphasize what is new.
- Do not repeat the title of the document in the abstract.
- Length is limited to 6000 characters (900-1200 words, half an A4 page), including spaces and symbols.

"Type text here"

1

Title first chapter

IN ADVANCE:

- Who is my target group? **Who are my readers, what is their level?**
- How long will the text be? **What should be and what should not be included in the report?**
- What is the core message? **The content needs to be of use to the reader!**
- **Structure: Two options: An argumentative report starts with the conclusion/key message and substantiates them. A traditional/scientific report starts with the research question and guides the reader through methodology and results to the answers to the research questions, in other words: the conclusions.**

FORMULATION:

- Do you formulate the topic in a way that is comprehensible to all readers?
- Explain and clarify complex subjects and terminology.
- Use a clear style of writing:
  - Short sentences, indication: maximally 18 words.
  - Give the full meaning of abbreviations once and then use only the abbreviations.
  - Avoid use of old-fashioned/outdated words.
  - Avoid passive sentences as much as possible.
  - Avoid use of brackets in the texts ().

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