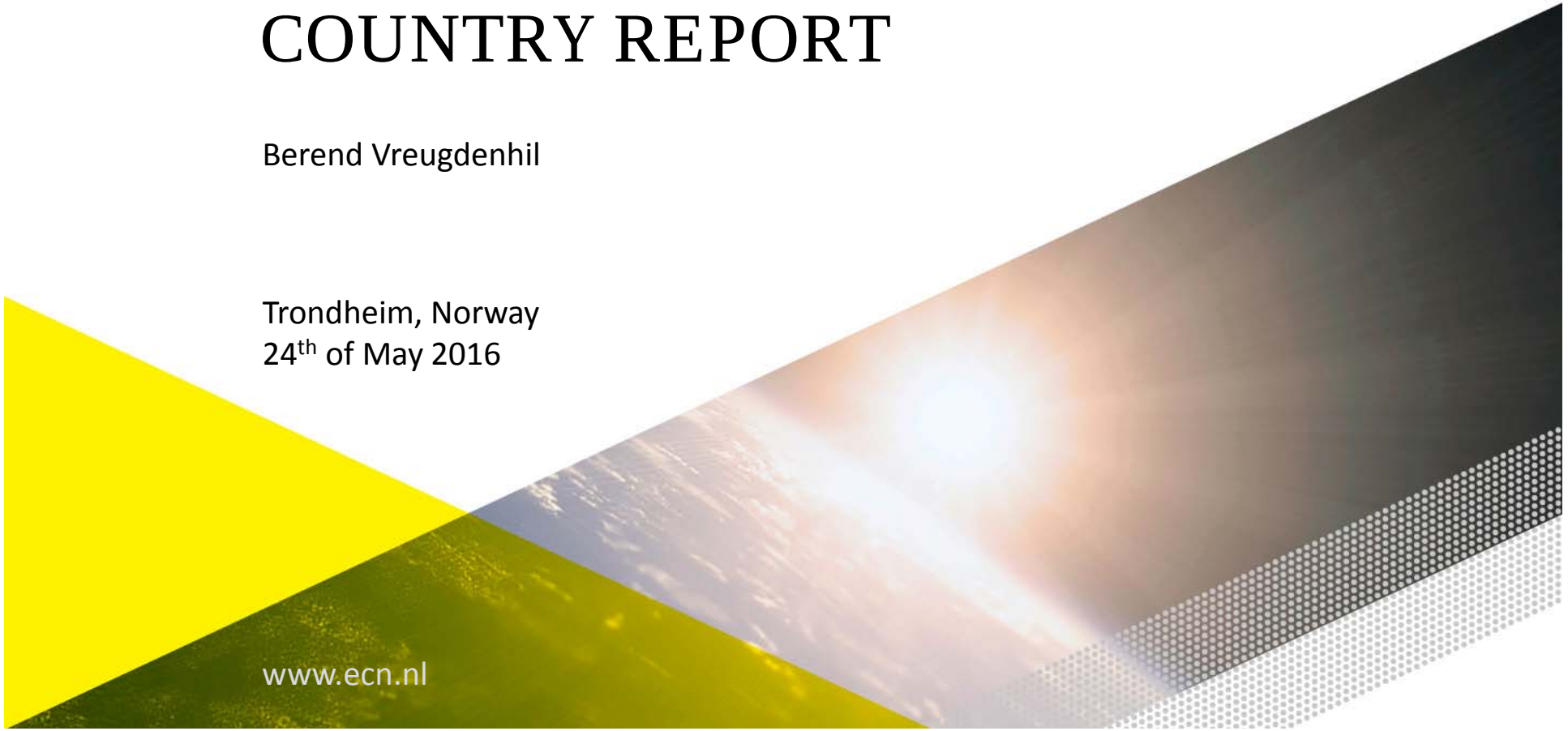
THE NETHERLANDS COUNTRY REPORT

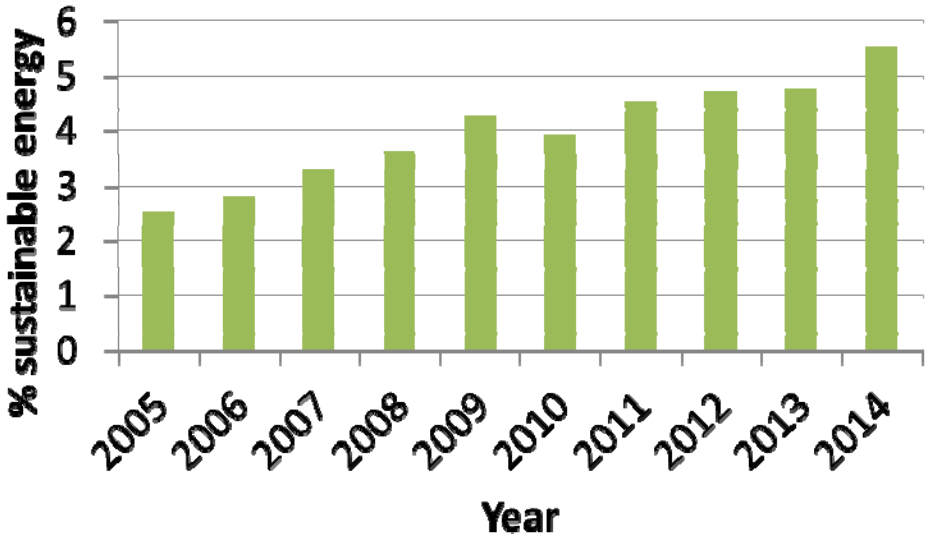
Berend Vreugdenhil

Trondheim, Norway
24th of May 2016



www.ecn.nl

STATUS RENEWABLE ENERGY



- ~5.5% sustainable energy (2014)
- Minister is considering shutting down 2 additional coal fired power plants
- Minister is considering no more subsidy on co-firing.
- This would reduce the amount of sustainable energy with ~1% point
- Off shore wind should fill the gap to 14%
- Current estimates are pointing towards ~12% sustainable energy in 2020.
- ISDE is focussing on wood pellets burners, heatpumps, solar and biomass boilers (70 M€)

Status update ESKA and Torrgas

Eska Graphic Board

torrgas

- Air blown CFB gasifier for paper rejects
- Pyrolysis reactor coupled with a high temperature zone for syngas production, operated on torrefied biomass

Key figures and Characteristics

- Fuel: 25 kton/y rejects (eural 030307)
- Airblown CFB gasifier coupled to a steam boiler
- Saturated steam production @ 16 bar
- Fuel load 12 MW
- Thermal efficiency ~ 85%
- Availability > 7500 hours
- Low emissions
- Simple and robust reject-pre treatment
- “Unmanned” operation
- Fuel and Load flexible
- Earthquake “proof”

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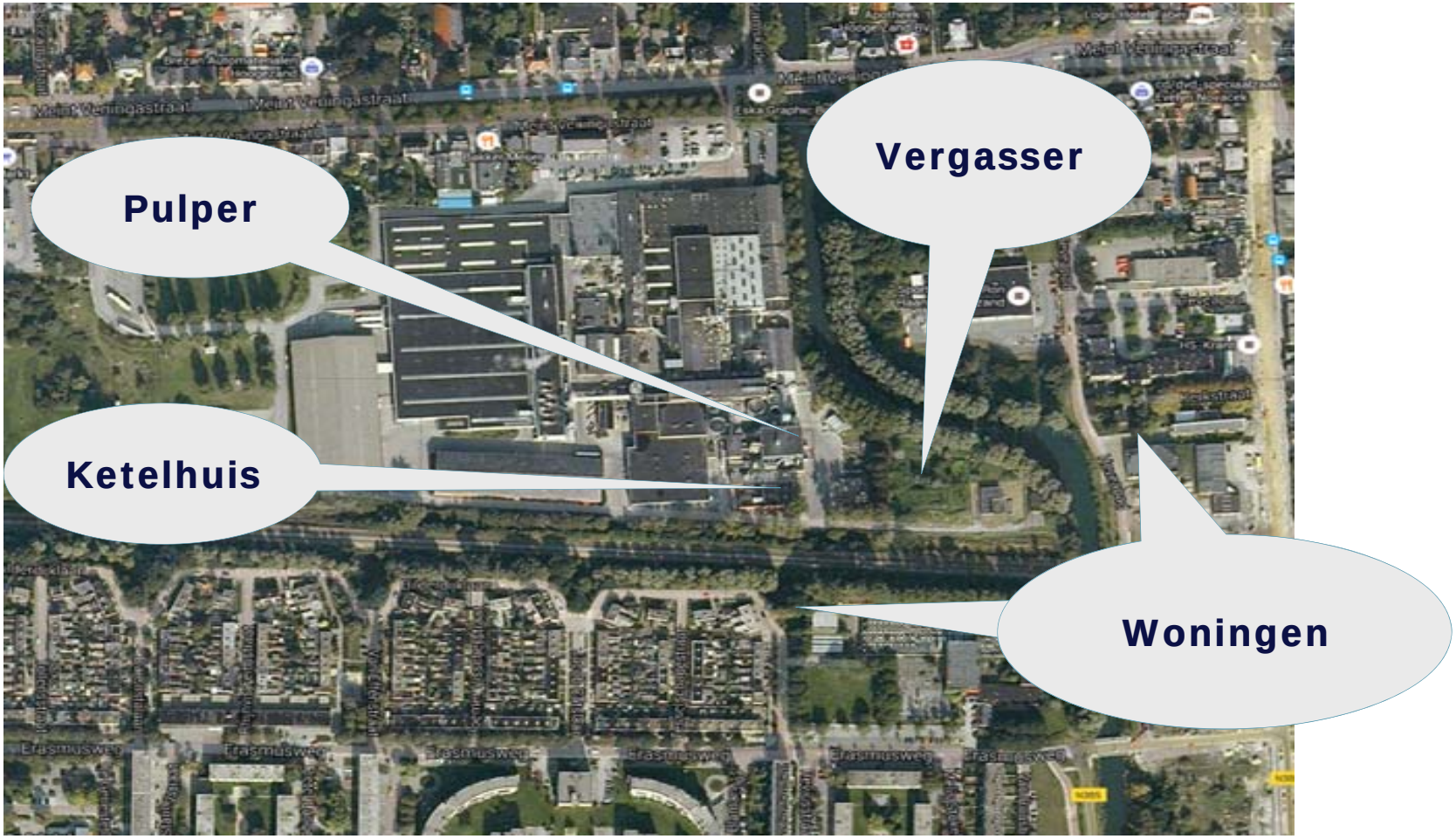
Site Hoogezand



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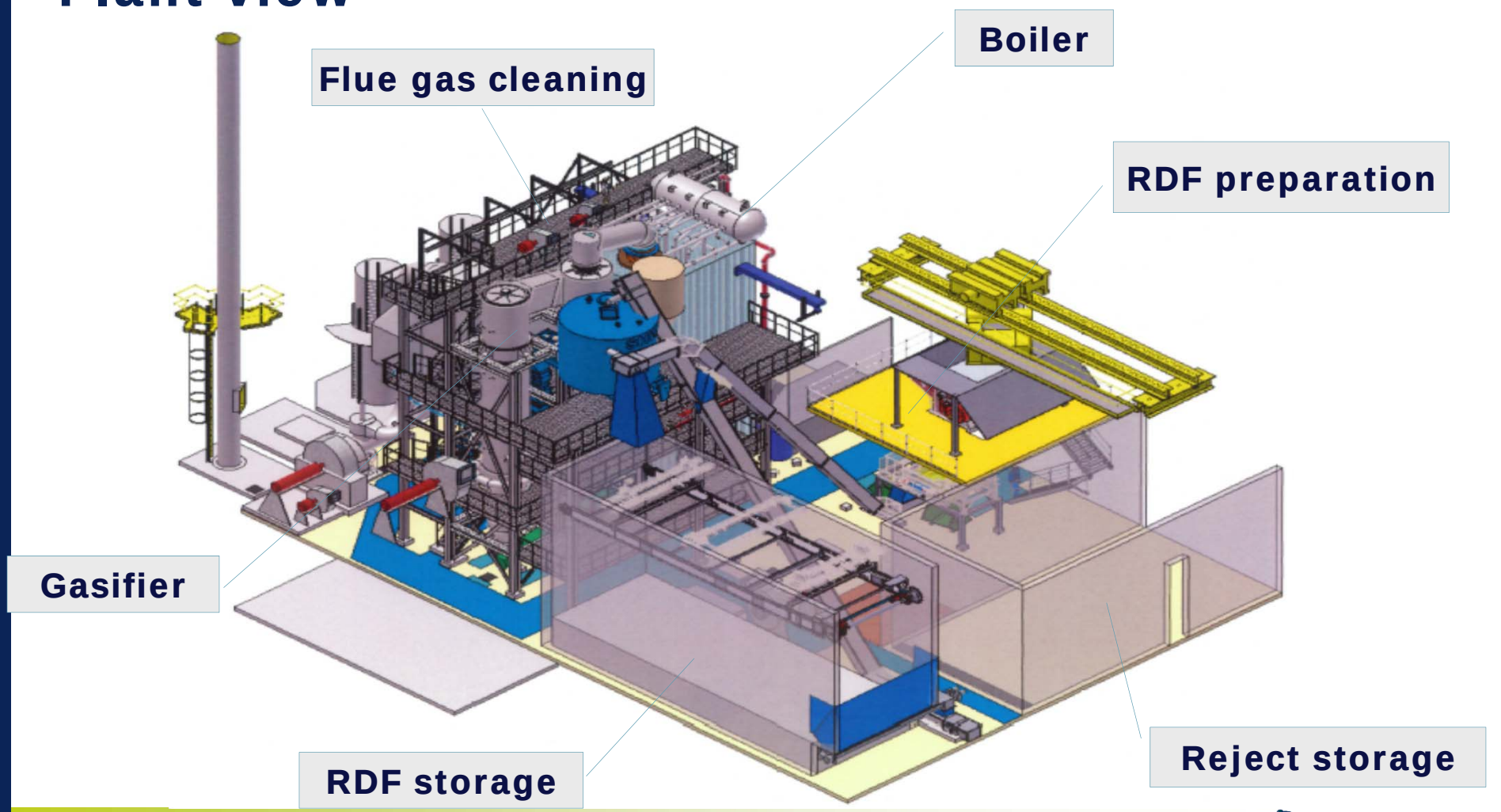
Plant view



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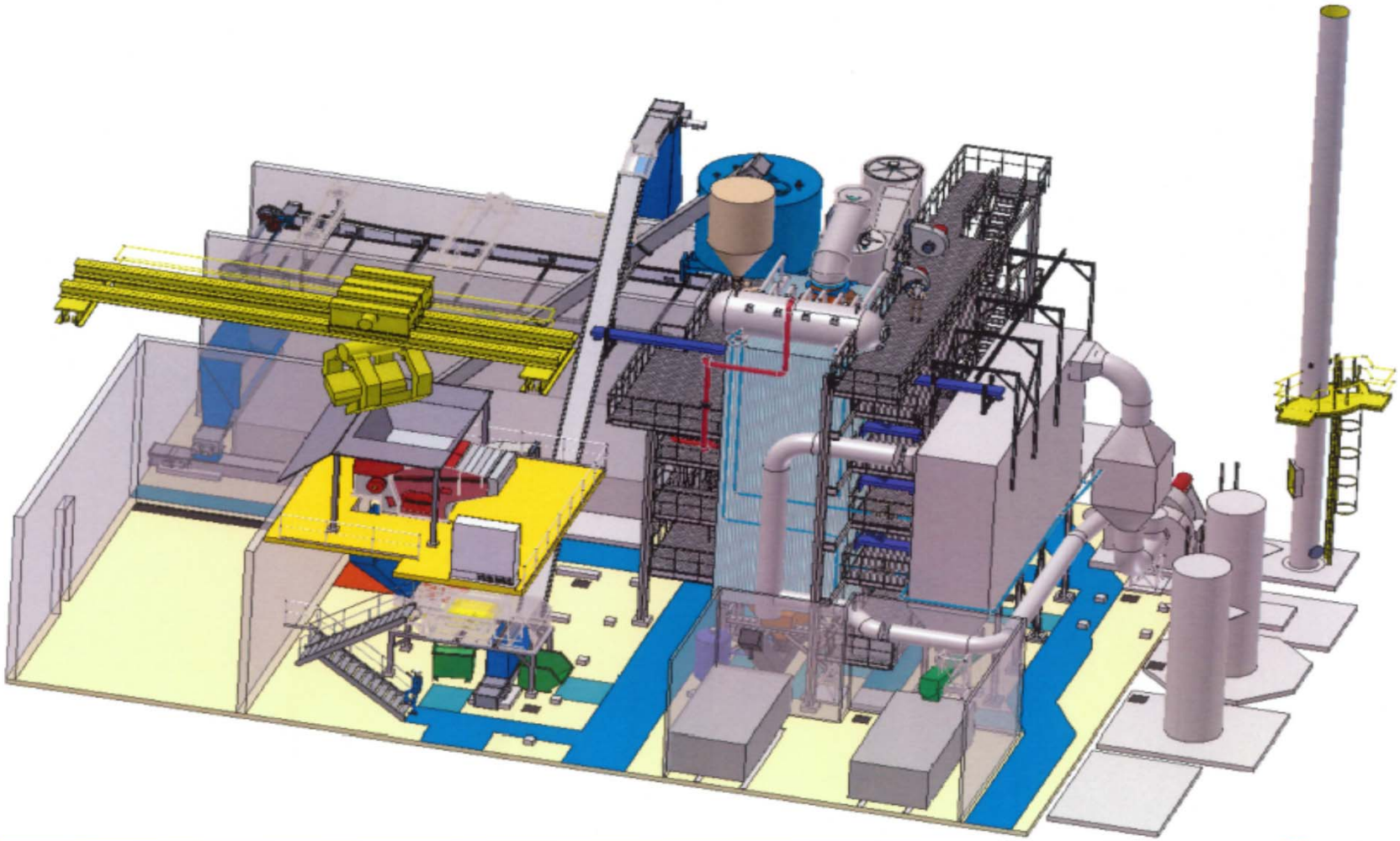

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18-8-2015

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9-11-2015

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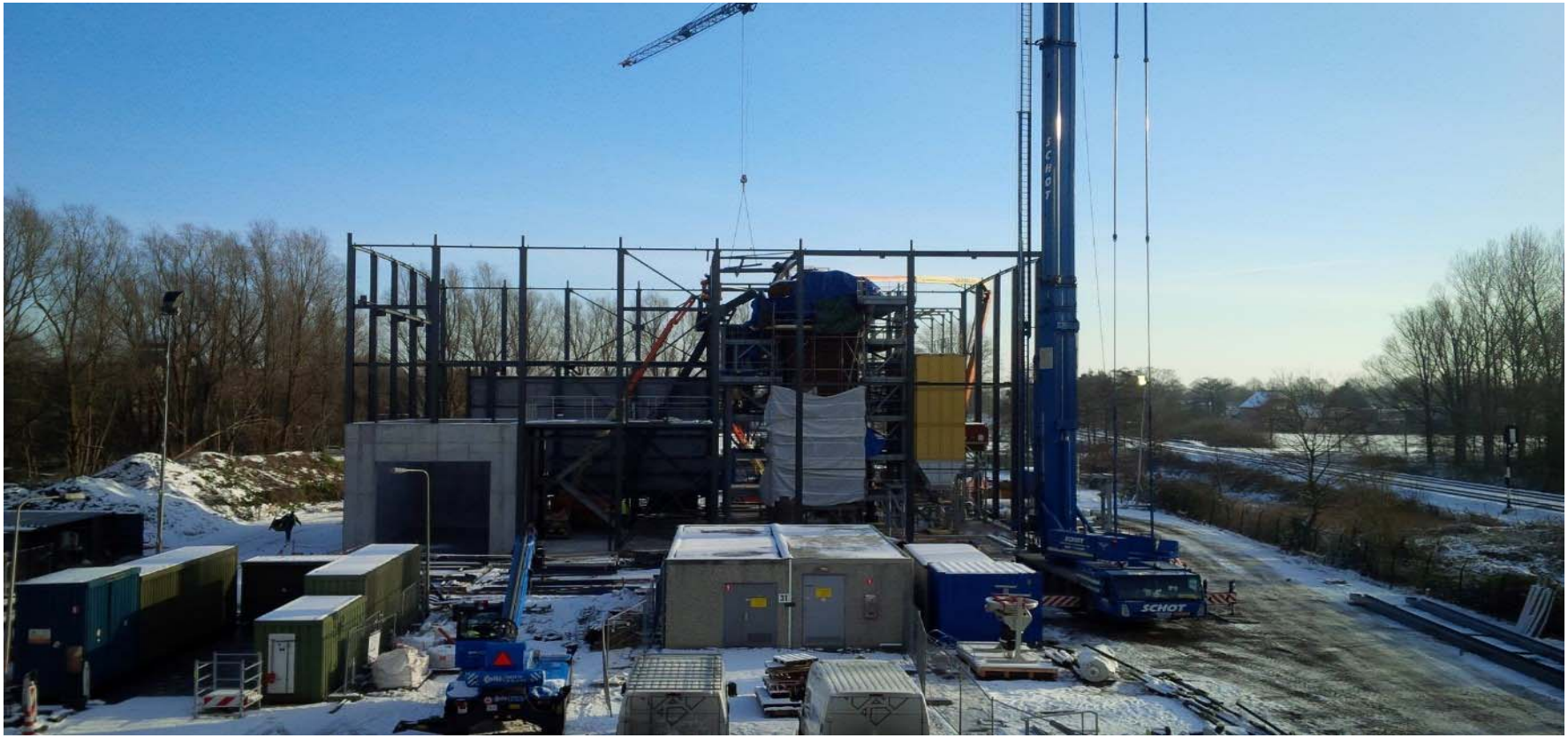
18-1-2016



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16-2-2016

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15-3-2016

18-4-2016

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Torrefied biomass has preferred (physical) properties; both in logistics as well as in downstream processing

ECN torrgas

Y	Tough	N
Y	Fibrous	N
Y	Hydrophyllic	N
Y	Biodegradable	N
Y	Heterogeneous	N
Y	Poor energy	N

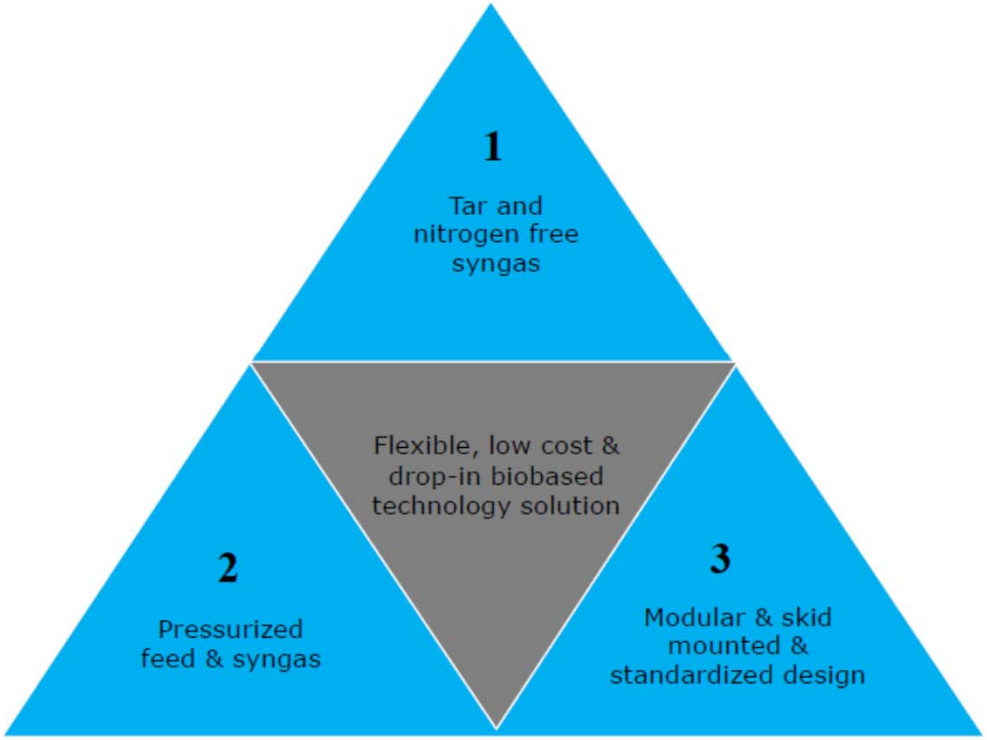
Torrefaction benefits in logistics:

1. Energy density from 2-3GJ/m3 to 15-20 GJ/m3
2. Hydrophillic: open air transport & storage possible
3. Commodity: biomass becomes a commodity instead of a local product

Torrefaction benefits in gasification:

1. Pulverized gasification ➔ short residence time ➔ high output/reactor volume
2. High (cold gas) efficiency due to absense of moisture
3. Continuity in both syngas composition aswell process handling

Torrgas technology combines three unique features for modular production of biobased syngas

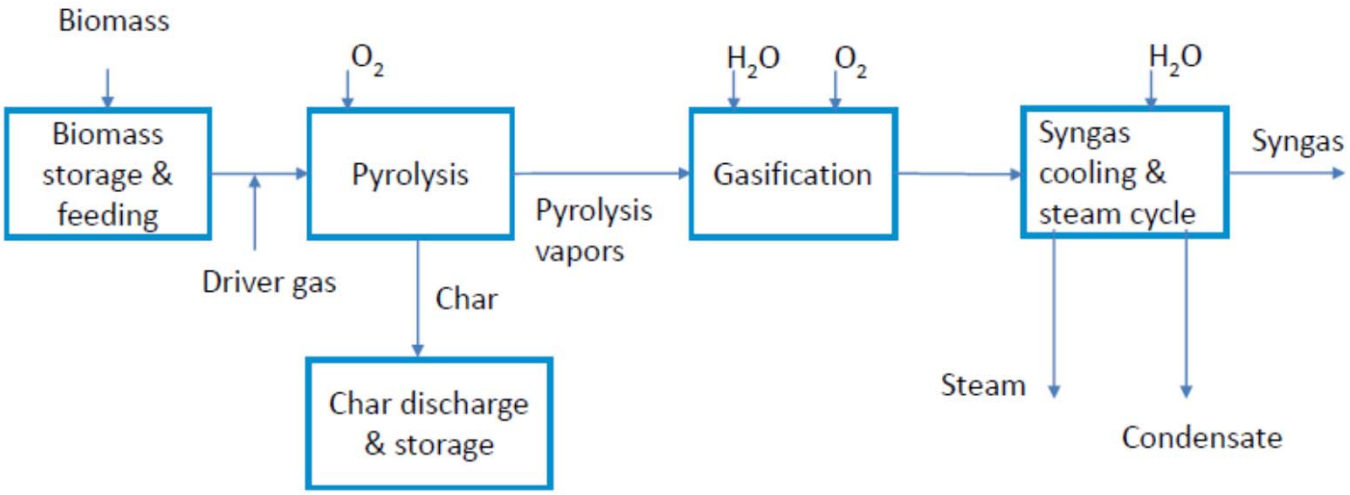


Torrgas setup – mitigating 3 key problems

ECN

torrgas

Process Flow Diagram

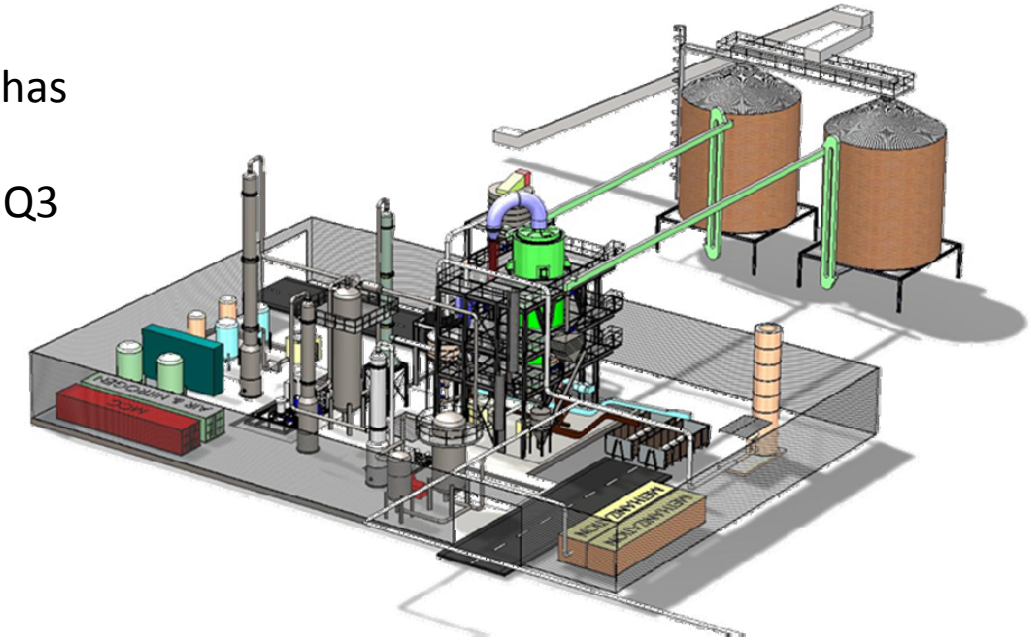


Syngas	Vol-%
H_2	31.5
CO	37.9
CO_2	20.9
CH_4	0.2
N_2	8.1
Others (incl. H_2O)	1.4

DEVELOPMENTS – SNG

Alkmaar demonstration

- 4 MW_{th} MILENA OLGA ESME
- Currently the Basic Engineering has started, completion and start of Detailed Engineering starting in Q3 2016



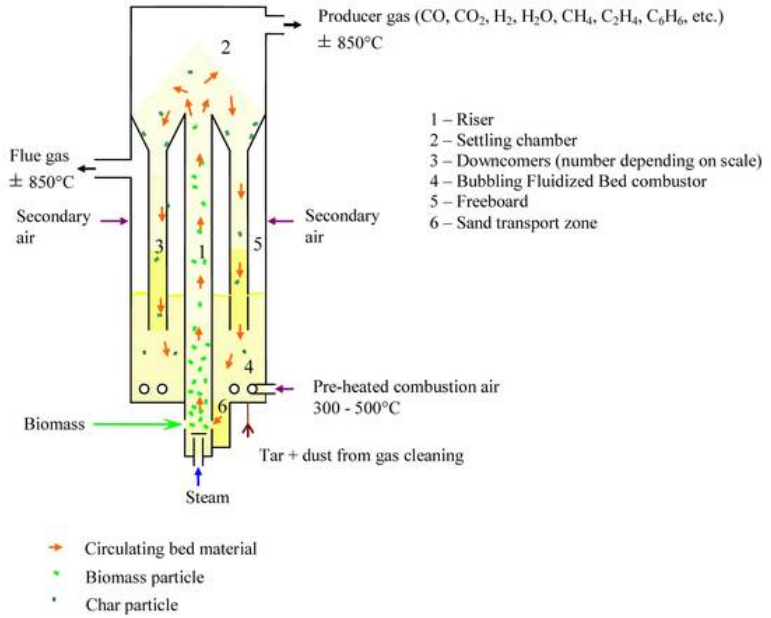
Developments @ ECN

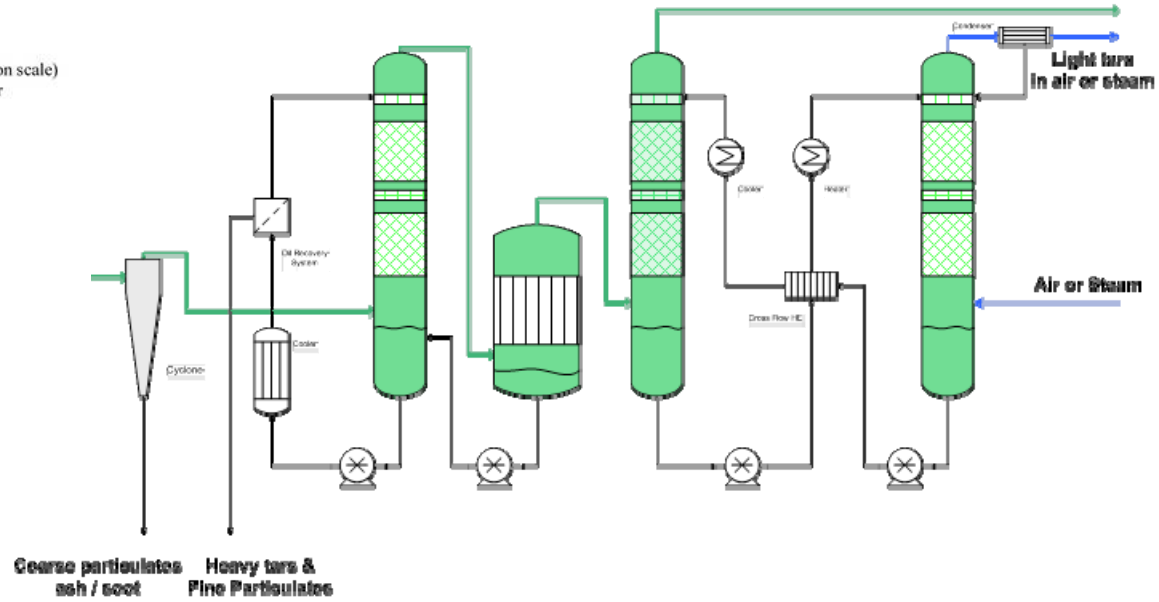
Harvesting light tars in case of low temperature gasification and/or waste gasification.

Both operating conditions provide more light tars and this energy is not needed in the gasifier; therefor harvesting light tars becomes an option.

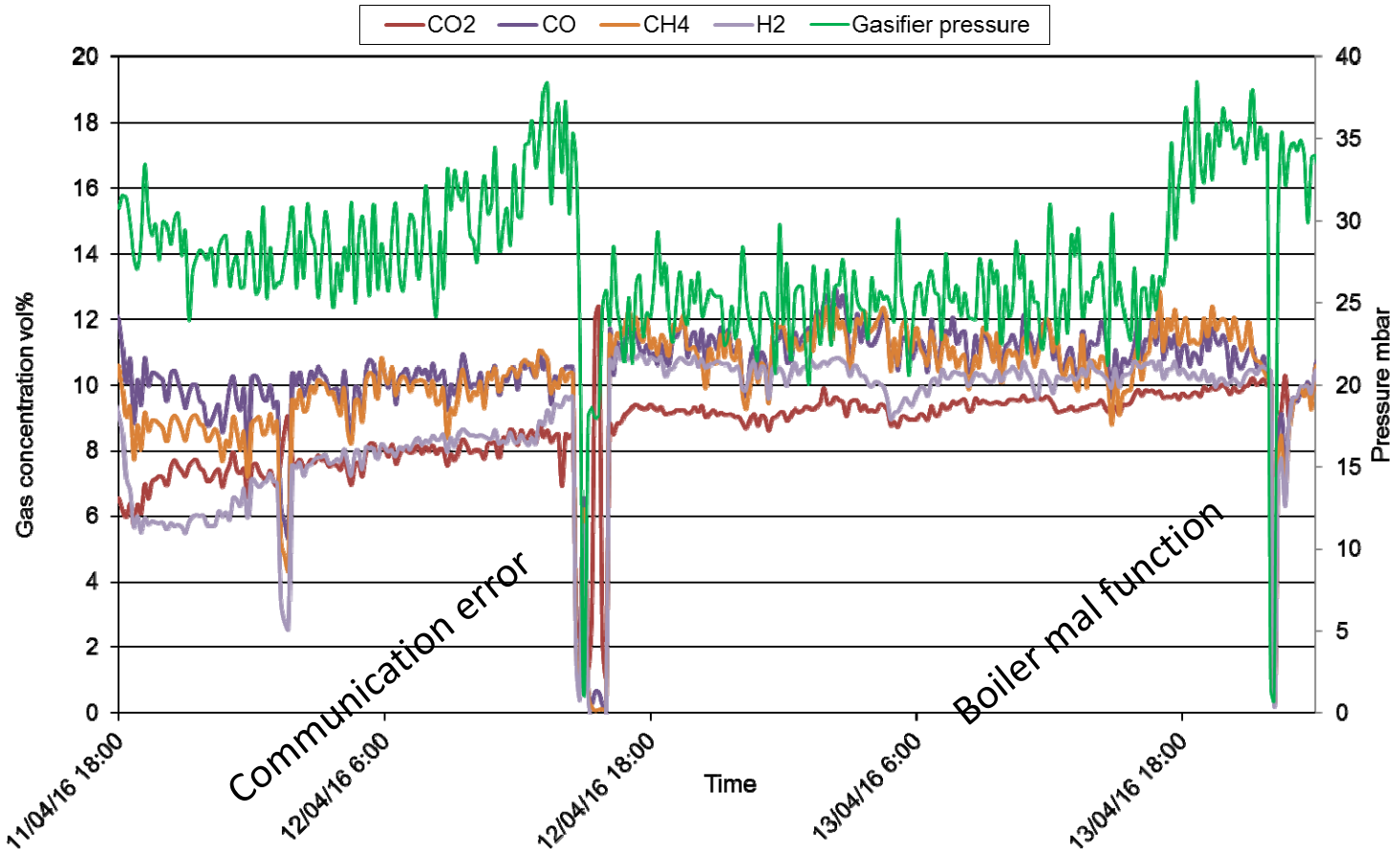
MILENA & OLGA

- MILENA = indirect gasifier (separated gasification & combustion)
- OLGA = multi-stage tar scrubber





ICOpower pellet gasification

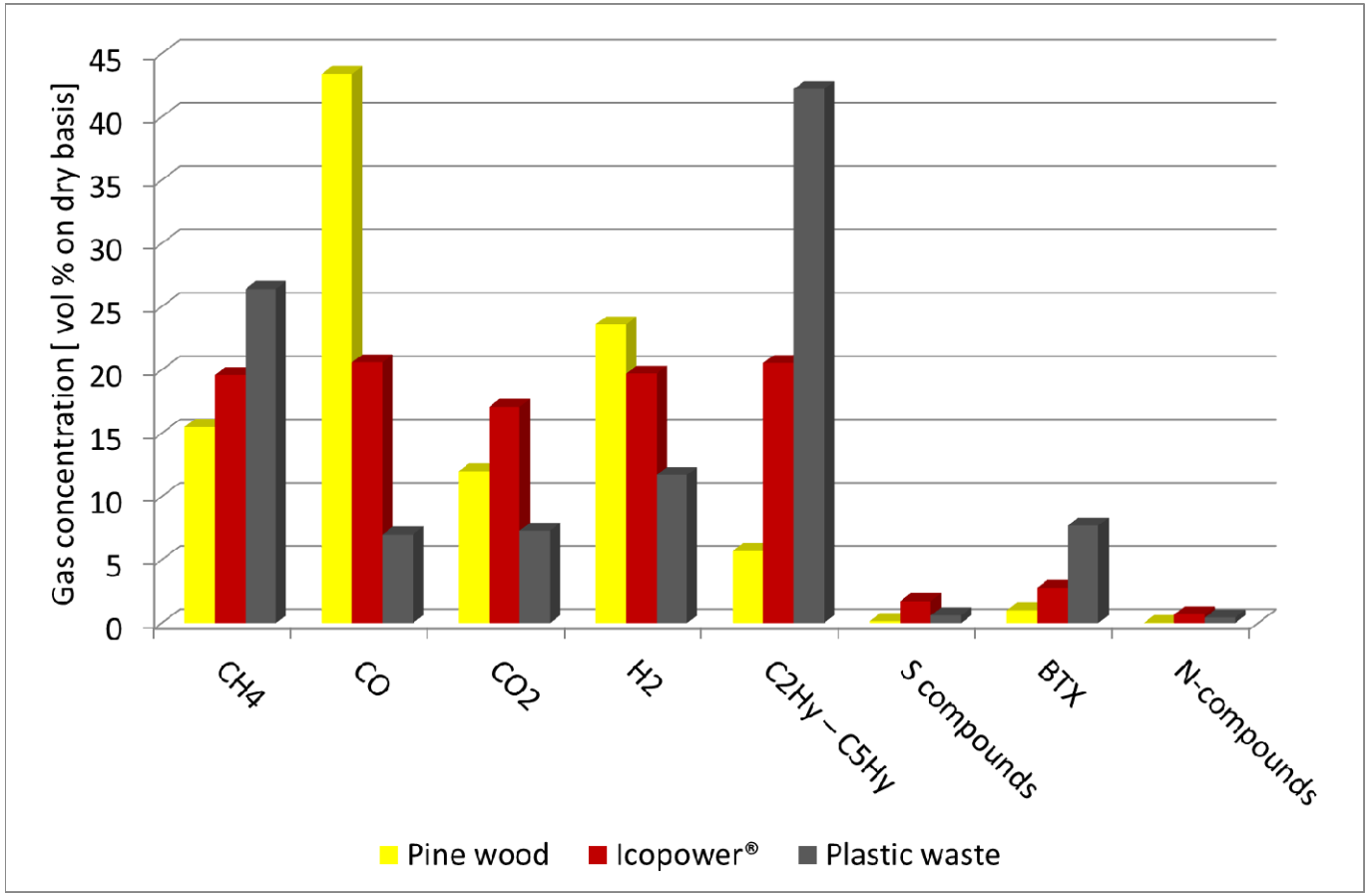


Pilot experiments: fuels

	Pine wood	Icopower®	Plastic waste
Gasification temperature (°C)	810	750	700
C (wt. %)	50.0	52.4	65.0
H (wt.%)	6.4	7.3	9.8
S (wt.%)	0.02	0.18	0.08
O (wt.%)	45	27.3	14.4
Cl (wt.%)	0.008	1.16	1.58
Ash 815°C (wt.%)	0.46	12.8	9.8
HHV (MJ/kg)	20.1	24	32.6

Pilot MILENA

Comparison of gas composition (N_2-free basis)



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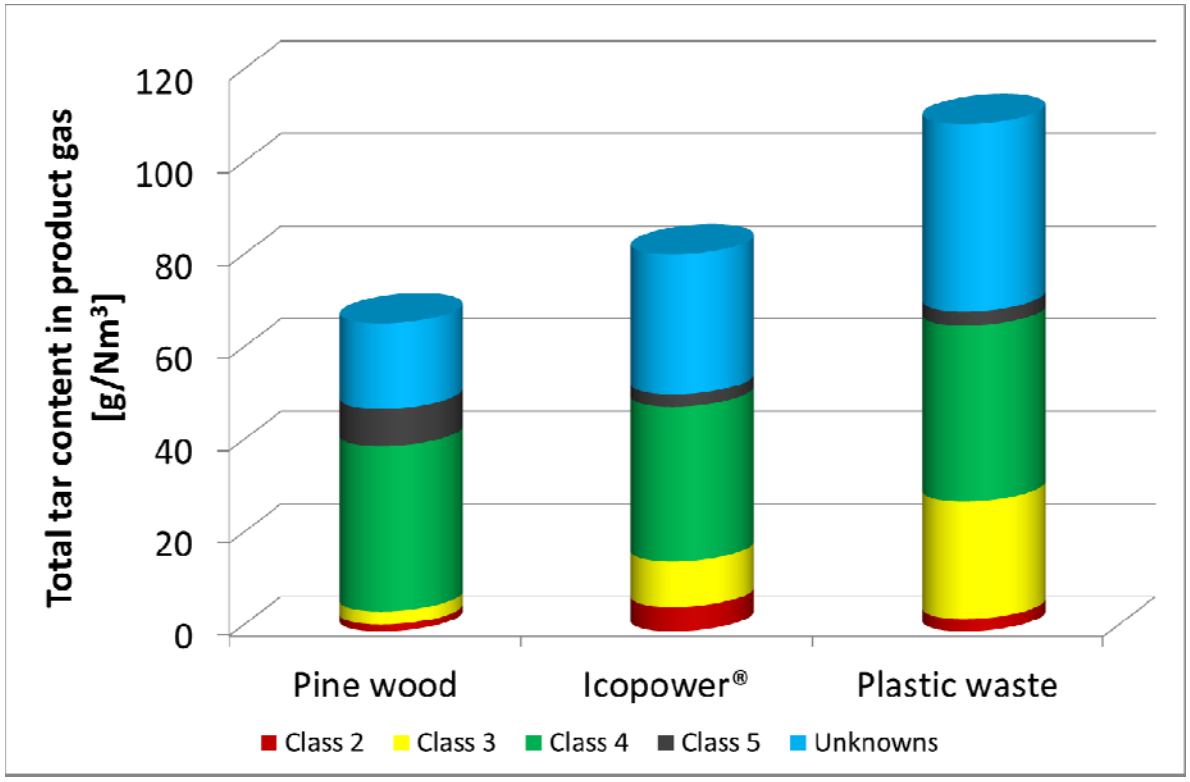


Tar classification:

2 = heterocyclic (e.g. phenol)

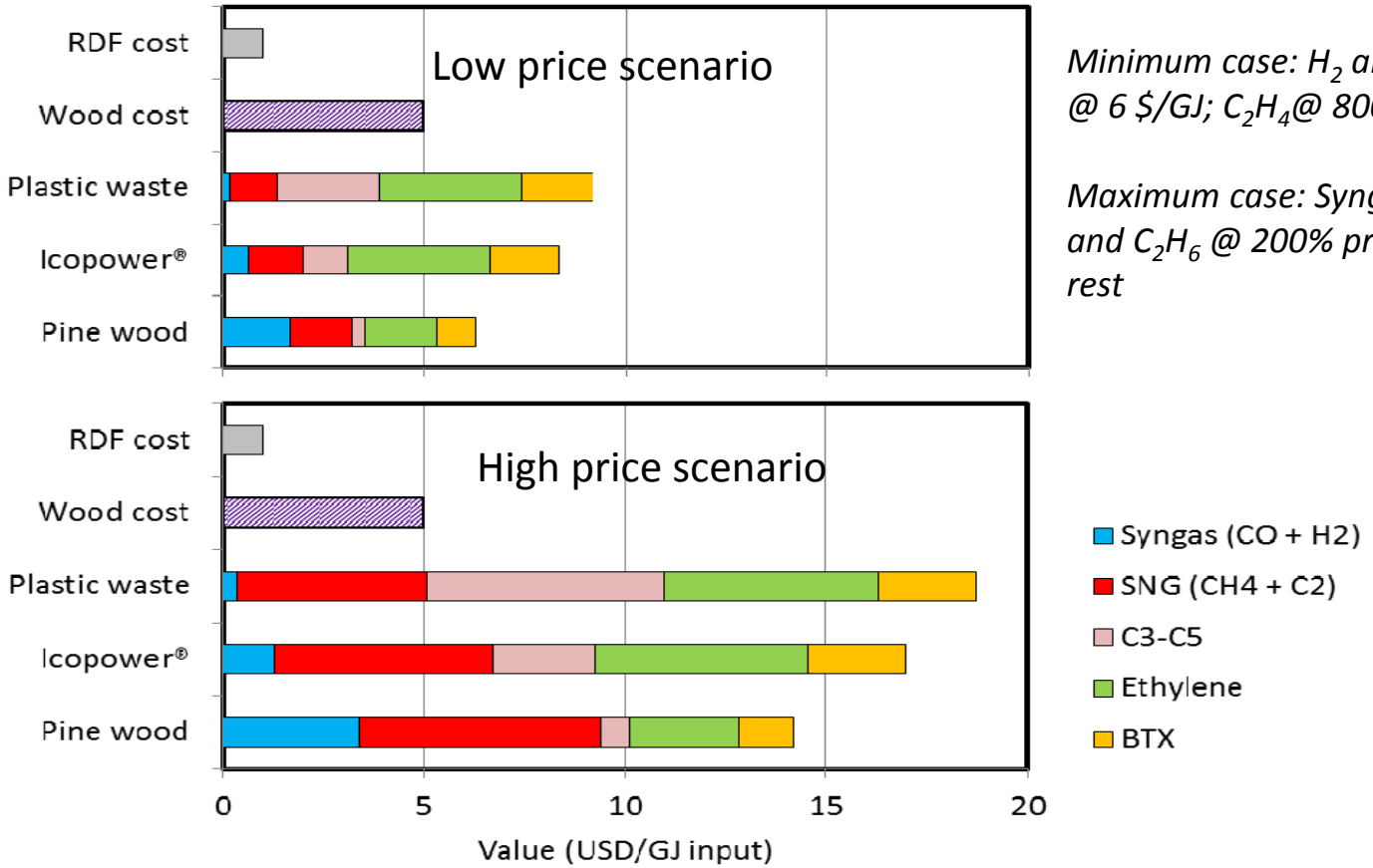
3 = 1-ring aromatic (e.g. xylene)

4 = 2, 3-rings (e.g. naphthalene)

5 = > 3-rings (e.g. coronene)

Class 5 = condense @ high T @ low concentrations

Waste gasification -> valuable gas



Minimum case: H_2 and CO @ 5 $/GJ; CH_4 and C_2H_6 @ 6 $/GJ; C_2H_4@ 800 $/ton; BTX @650 $/ton

Maximum case: Syngas with an 100% premium; CH_4 and C_2H_6 @ 200% premium as biofuel; 30% for the rest

MORE INFORMATION

Berend Vreugdenhil

ECN

Westerduinweg 3
1755 LE Petten
The Netherlands

P.O. Box 1
1755 ZG Petten
The Netherlands

T +31 224 564 504
M +31 610 111 176

vreugdenhil@ecn.nl
www.ecn.nl

Publications: www.ecn.nl/publications
Fuel composition database: www.phyllis.nl
Tar dew point calculator: www.thersites.nl
IEA bioenergy/gasification: www.ieatask33.org
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Energy research Centre of the Netherlands