



DAHLMAN 

Brasil –EU Workshop

*Gasification of bagasse to syngas and
advanced liquid fuel production*

December 8th 2015
São Paulo, Brasil
Martin van 't Hoff

ECN & Royal Dahlman

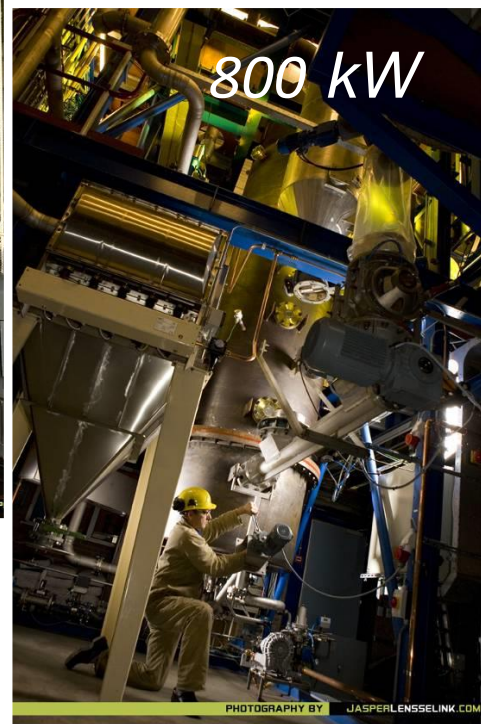


- A 15 year relationship in R&D, Engineering and Operation of gasification technology and gas cleaning technology.
- ECN is the R&D institute of the Netherlands focusing on sustainable energy
- Dahlman Renewable Technology is supplier of key technologies
 - High efficient indirect gasifier (MILENA)
 - High efficient tar removal system (OLGA)
 - High efficient BTX scrubbing technology
- Together offering the possibility to integrate new technologies in existing installations (Lab & pilot facilities in Petten and/or Demonstration scale in Alkmaar)

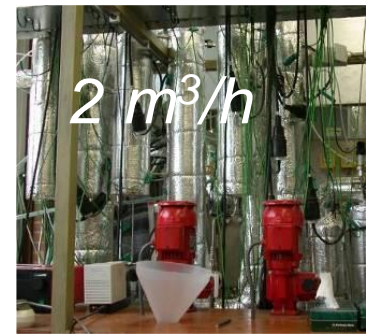
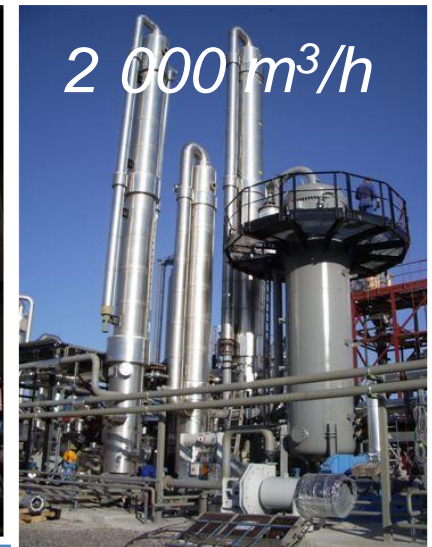
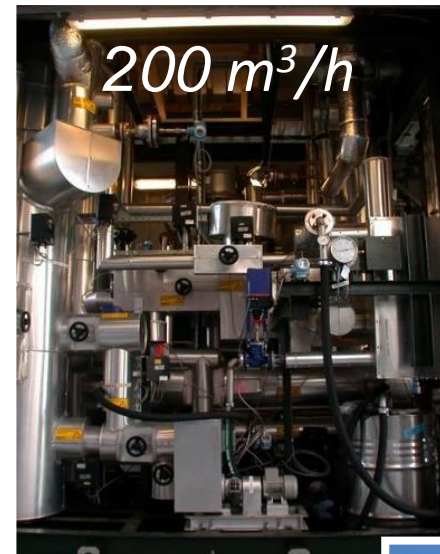


Gasification and Gas Cleaning

MILENA gasification



OLGA tar removal



Fuel flexible MILENA technology

Wood pellets



Demolition wood B



RDF



Demolition wood A



Soya stalk



SRF



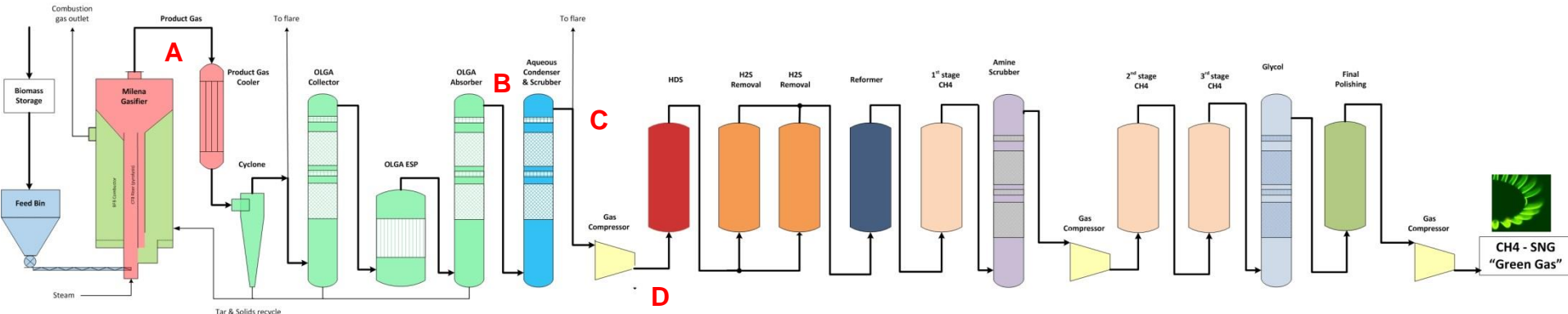
Gasification and Gas Cleaning

MILENA-OLGA combination

Washim (India) 4 MW Soya Stalk

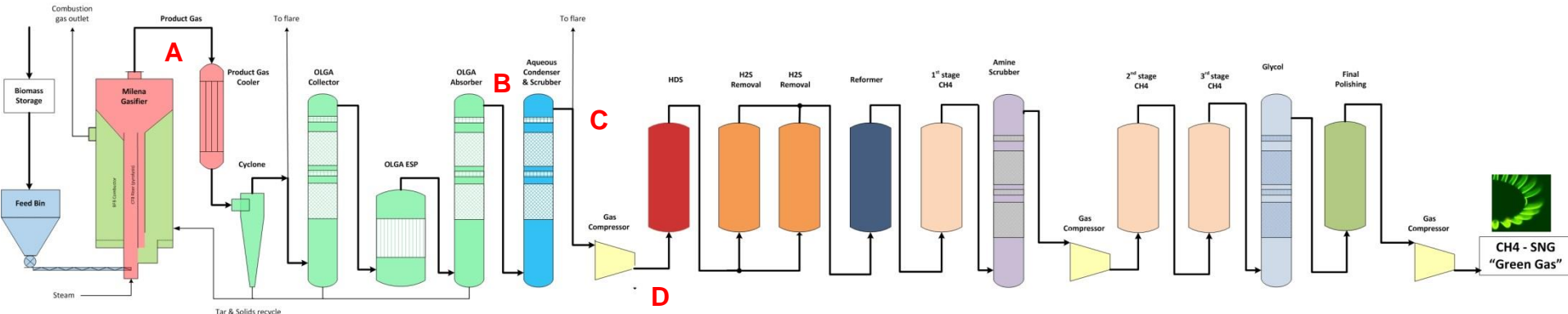


Example of gas compositions and qualities



Product gas	Unit	A MILENA tar rich product gas	B MILENA tar free product gas	C MILENA water free product gas	D MILENA compress. product gas
CO	[Vol%]	19.0	19.0	28.5	30.0
H ₂	[Vol%]	16.8	16.8	25.2	26.5
CO ₂	[Vol%]	6.5	6.5	9.8	10.3
O ₂	[Vol%]	NR	NR	NR	NR
H ₂ O	[Vol%]	37.2	37.2	6.0	0.9
CH ₄	[Vol%]	8.1	8.1	12.1	12.8
N ₂	[Vol%]	6.2	6.2	9.3	9.8
Ar	[Vol%]	NR	NR	NR	NR
C ₂ H ₂	[Vol%]	0.2	0.2	0.4	0.4
C ₂ H ₄	[Vol%]	3.3	3.3	4.9	5.2
C ₂ H ₆	[Vol%]	0.2	0.2	0.2	0.3
C ₃ H ₆	[Vol%]	NR	NR	NR	NR
C ₆ H ₆	[Vol%]	0.9	0.8	1.2	1.2
C ₇ H ₈	[Vol%]	0.1	0.1	0.1	0.1

Example of gas compositions and qualities



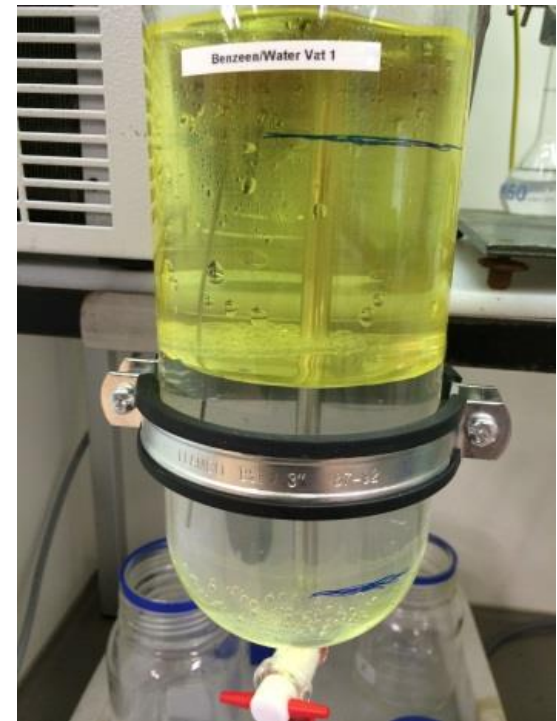
Product gas	Unit	A MILENA tar rich product gas	B MILENA tar free product gas	C MILENA water free product gas	D MILENA compress. product gas
H2S	[ppmv]	1,147	1,147	1,718	181
COS	[ppmv]	114	114	171	180
Thiophenes	[ppmv]	116	116	173	183
NH3	[ppmv]	4,633	4,633	4,510	476
HCN	[ppmv]	618	618	648	68
HCL	[ppmv]	502	502	8	8
NOx	[mg/Nm ³]	not applicable	not applicable	not applicable	not applicable
SOx	[mg/Nm ³]	not applicable	not applicable	not applicable	not applicable
Dust	[mg/Nm ³]	50,000	< 5	< 5	< 5
Tar dew point ^{VII}	[°C]	450	< 20	< 20	< 40
Water dew point	[°C]	80	80	30	50
Gas temperature	[°C]	850	85	35	140
Gas pressure	[bara]	1.30	1.15	1.10	5

Advanced utilization of product gas

MILENA-OLGA product gas contains more value than the ability to produce power alone

- Green gas, SNG, pipeline quality methane
70% efficiency from biomass or waste to SNG
- Liquid fuel production such as Fisher Tropsch, Hydrogen, Methanol, Ethanol, Jet Fuels, etc.
- Easy BTX co-production by an OLGA add-on,
 - 10% of the energy value of the gas
 - >95% Separation Efficiency

Production of
BTX-water mixture

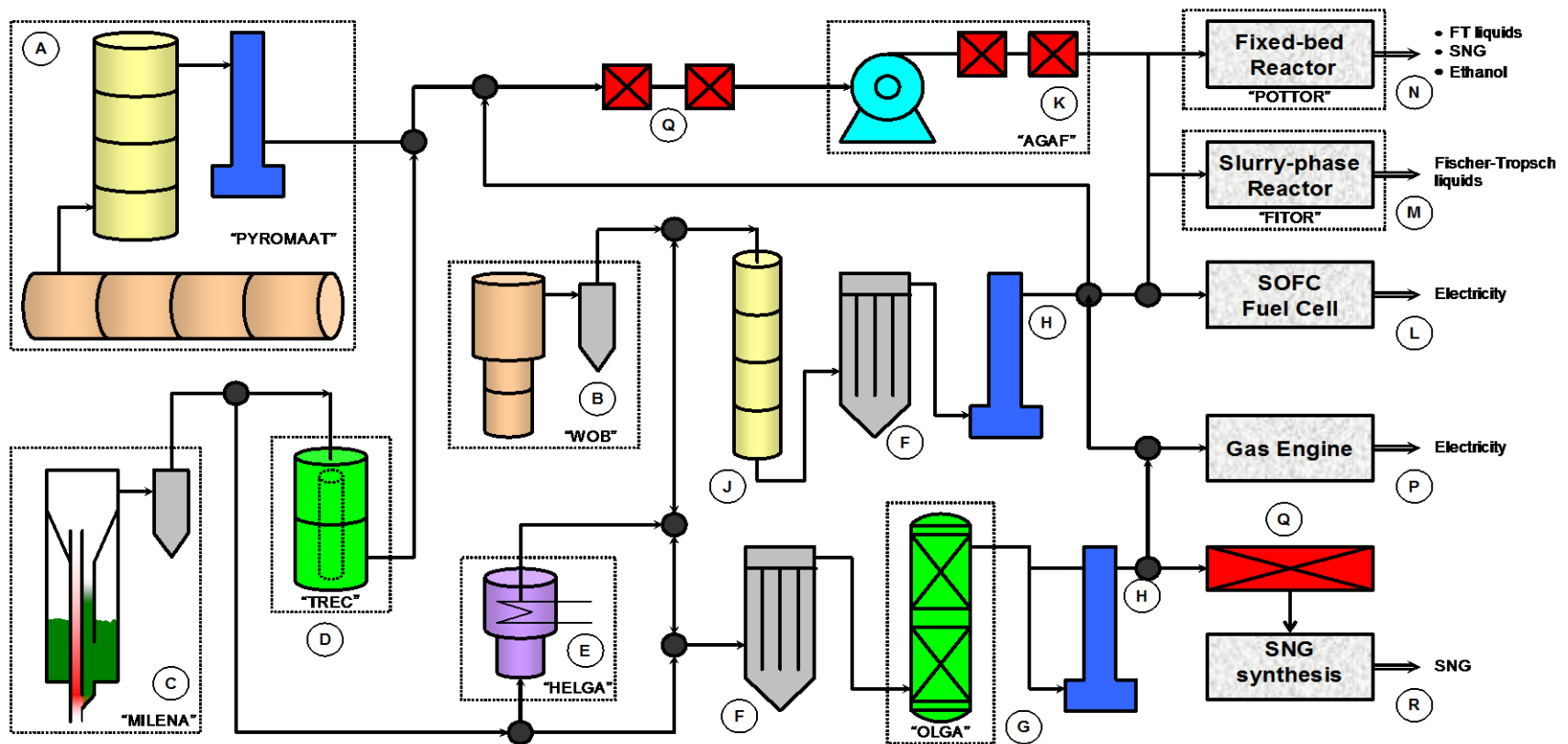




ECN laboratories

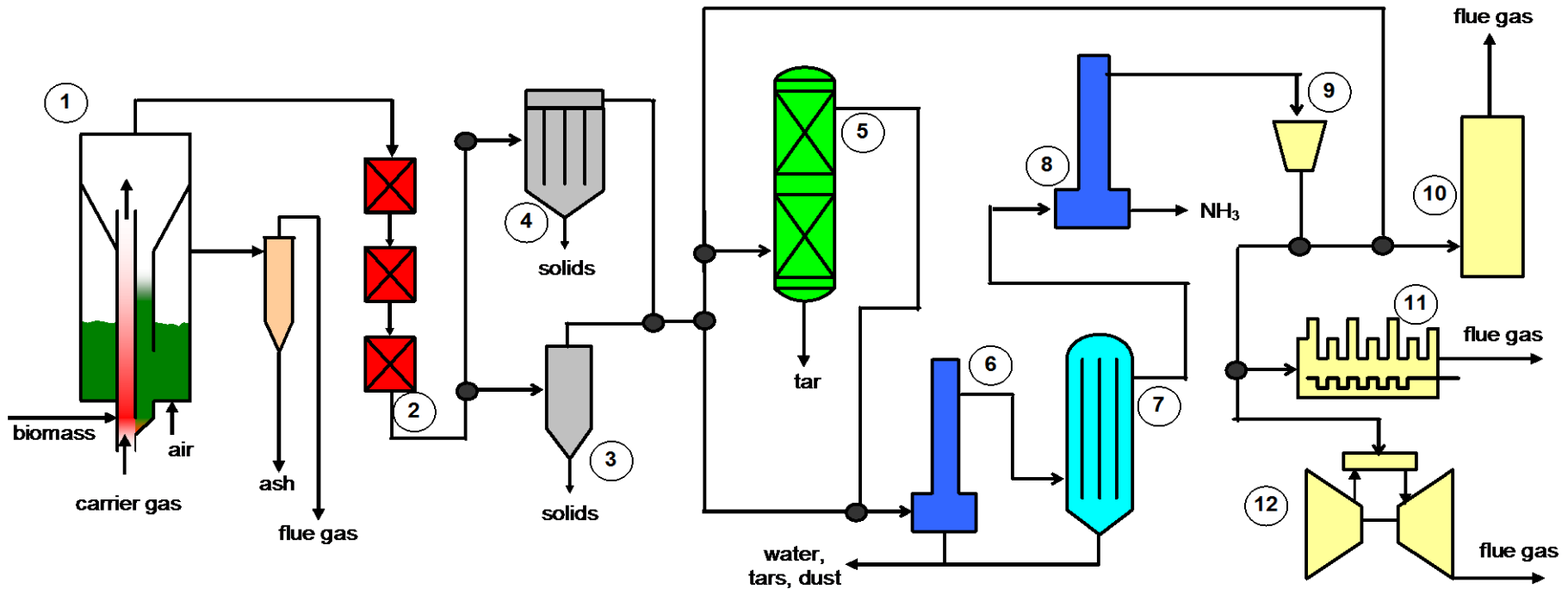
Multiple test facilities interconnected

Lab-scale, 1-5 kg/h feedstock



A: 20 kW_{th} screw reactor (PYROMAAT), B: 5 kW_{th} fluidised bed gasifier (WOB), C: 20 kW_{th} fluidised bed or indirect gasifier (MILENA), D: tar reduction module (TREC), E: gas cooler (HELGA, removed), F: hot gas filter, G: oil based tar washer (OLGA), H: water scrubber, J: thermal tar cracker, K: compressor 60 bar with guard beds (removed), Q: dry gas cleaning, L, M, N, P, R: different options to use the gas. Recent additions: HDS, second hot gas filter.

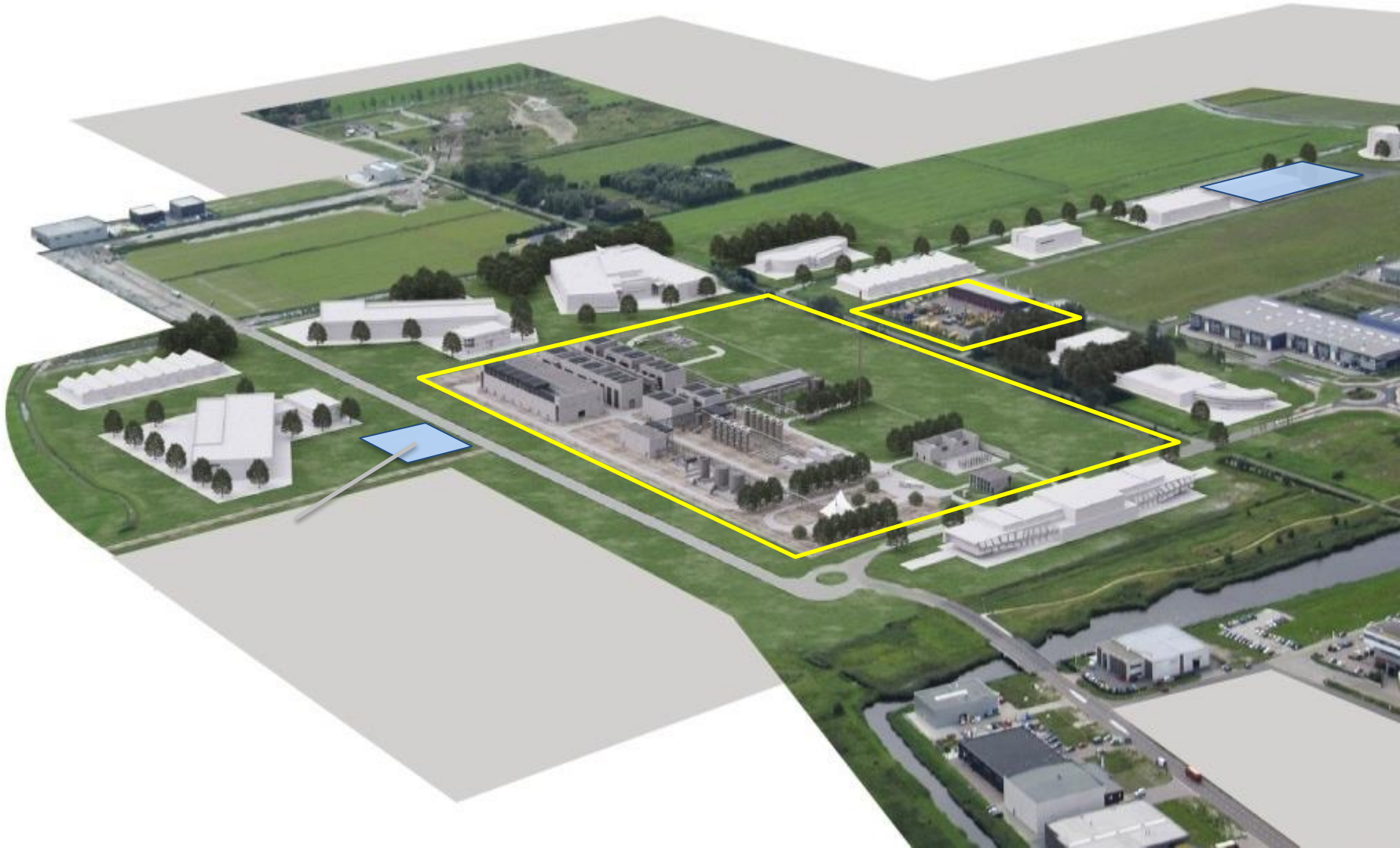
Pilot-scale, 160 kg/h feedstock



1: 800 kW_{th} MILENA indirect gasifier, 2: three-stage cooler, 3: cyclone (typically 300-400°C), 4: hot gas metal-fibre filter, 5: oil based tar washer (OLGA), 6: water quench, 7: wet electrostatic precipitator (ESP), 8: wet scrubber, 9: booster, 10: boiler with low-NO_x burner, 11: gas engine with grid connection (removed), 12: gas turbine (removed)

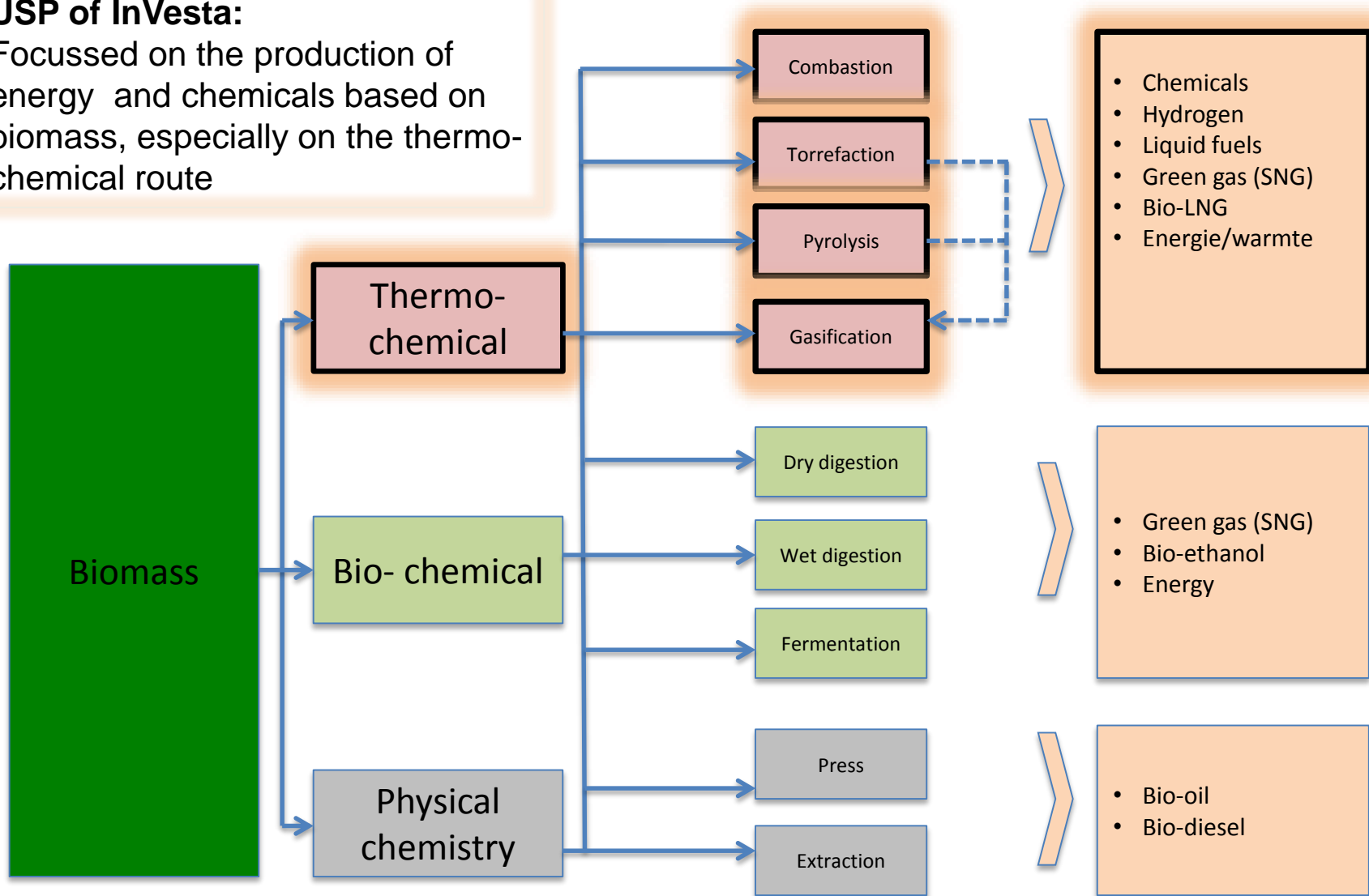


Expertise centre for biomass and
gasification technology

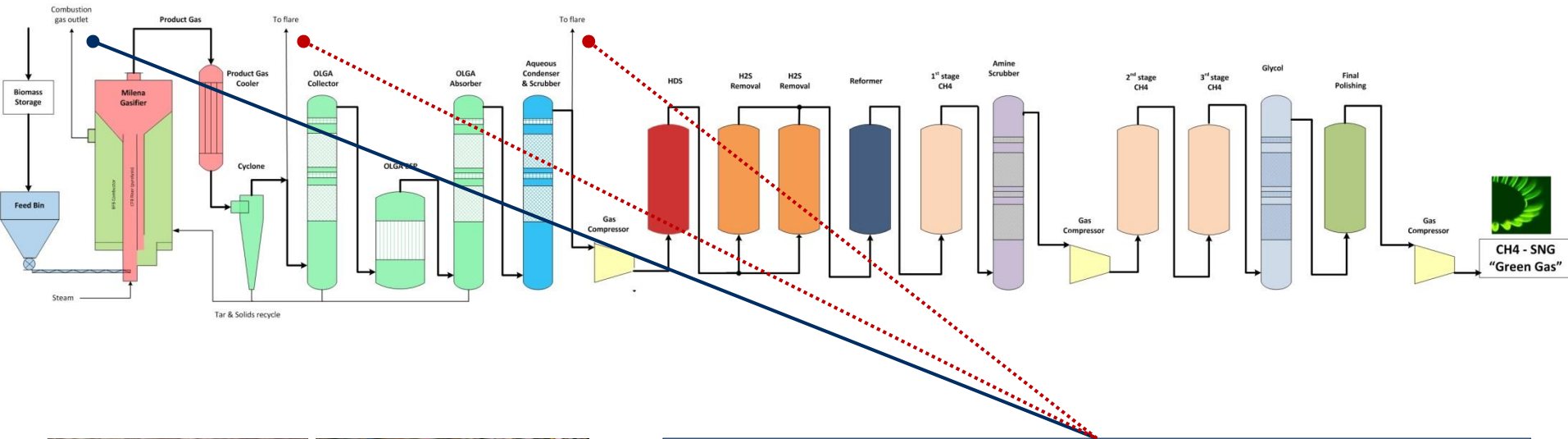


USP of InVesta:

Focussed on the production of energy and chemicals based on biomass, especially on the thermo-chemical route



Demo-scale, 1.000 kg/h feedstock



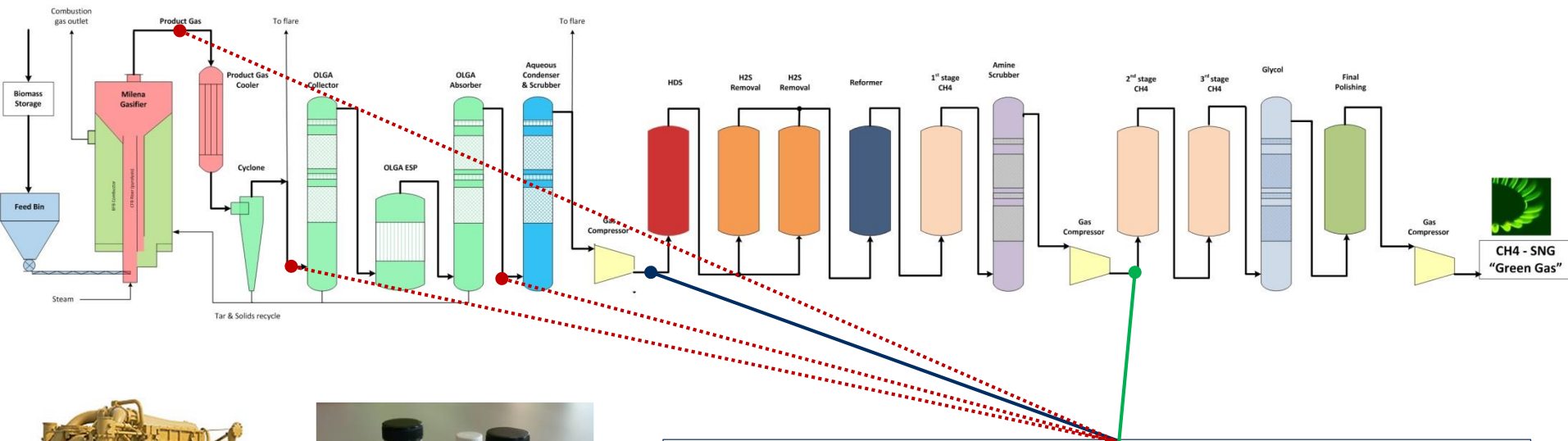
woodchips



RDF

CEMS on flares/stacks and sample points on gas lines
 Test runs not only allow for optimization of the gasification and gas cleaning, but also demonstration of the concept for multiple feedstocks

Demo-scale, 1.000 kg/h feedstock



Long duration tests of e.g. fuel cells, reciprocating gas engines or synthesis are possible at very low costs

Tie-in for (slip stream) tests

Plant capacity, $\approx 4 \text{ MW}_{\text{th}}$

Clean product gas at $16\text{-}20 \text{ MJ/Nm}^3$ ($540\text{-}690 \text{ Nm}^3/\text{hr}$)

Available at 1 bara, 6 bara or 20 bara

Using current infra structure

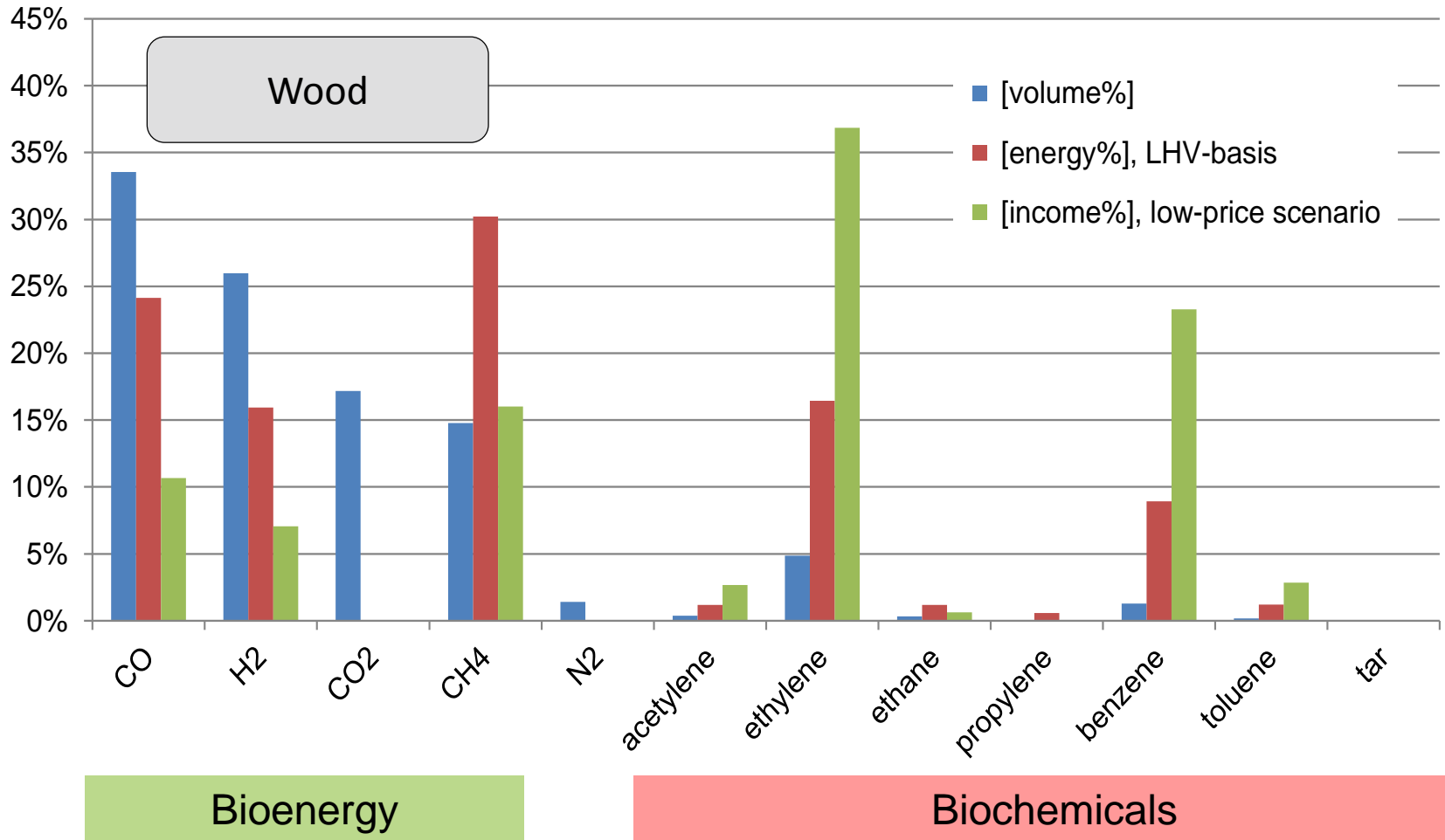
Co-production is key in efficient, flexible and low cost fuels production

→ Possible routes given below←

1. Combining BTX removal with FT production, yields a green BTX to be blend in current petrol and green FT diesel/kerosine
2. Combining a reforming with complete FT production, focusing on one bio-fuel/aviation fuel
3. Combining a “simple” FT production with LNG production, resulting in two fuels
4. Combining BTX removal with DME production
5. Etc.

Biomass indirect gasification

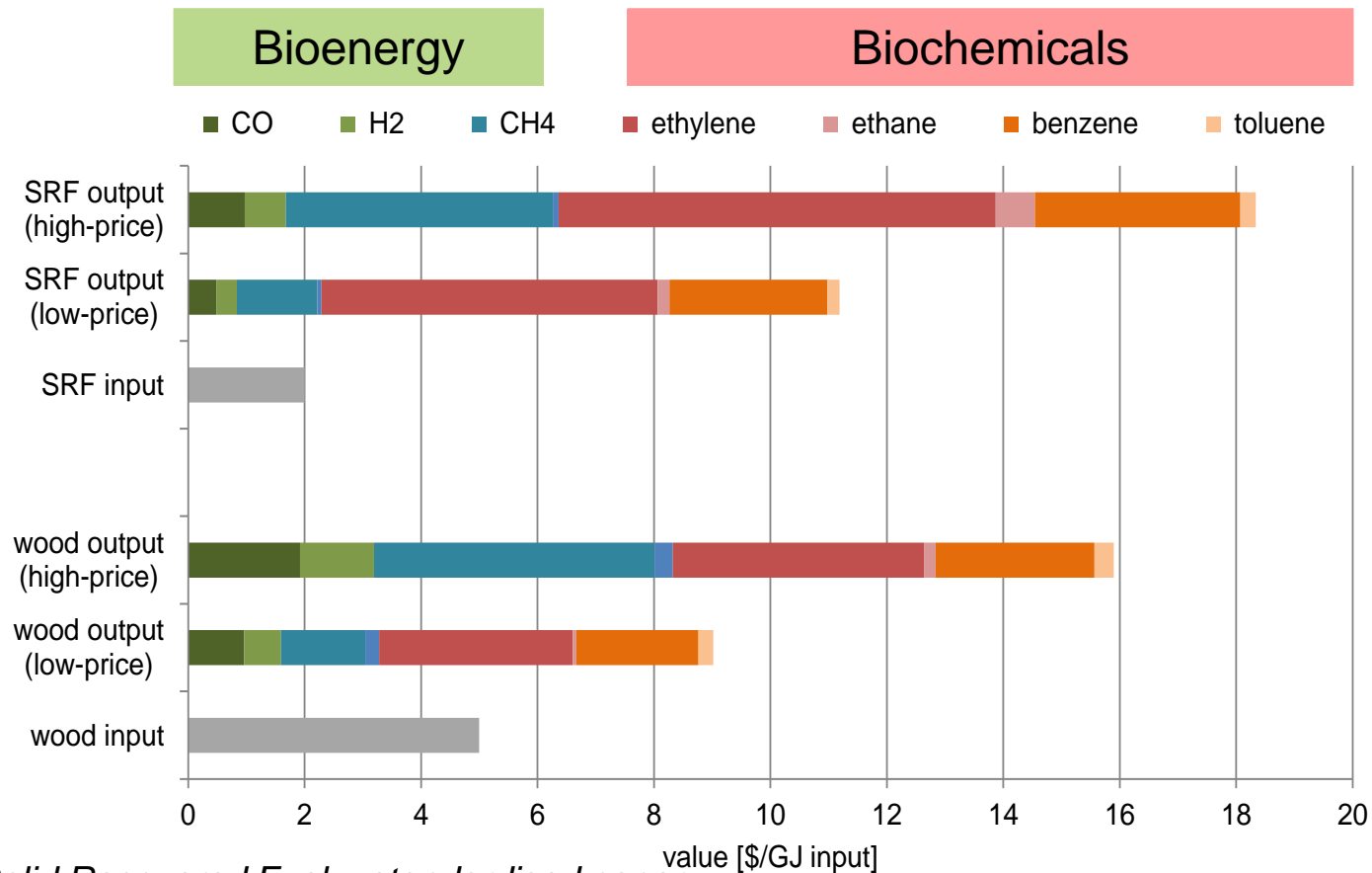
Gas composition: small concentrations, high value



Biomass indirect gasification economics

Impact of feedstock cost and chemicals co-production

(low-price = based on fossil prices; high-price = 100% premium on syngas, 200% premium on methane, 30% premium on biochemicals)



SRF = Solid Recovered Fuel = standardised paper-plastic residue

Gasification-based biorefinery

“harvesting the chemicals”

Biomass gasification is the basis of a bio-refinery, similar to the biochemical (sugar-based) approach:

- A sequence of harvesting “instant chemicals” and syngas-based products
- But with the ability to convert all kind of (contaminated) low-quality feedstock to high-value chemicals
- Alternative feedstock: residues from biochemical bio-refineries, often low-value lignins and humins
- Chemicals fit current petro-chemistry
- So, biomass gasification becomes a way of producing chemicals, rather than only being a pre-treatment to produce an easy-to-use gaseous fuel from a difficult-to-use solid fuel
- Biomass gasification offers a new way of producing green chemicals

Parties that can contribute

- Bagasse supplier (perhaps ethanol producer)
- FT producer / catalyst developer
- DME producer / catalyst developer
- LNG producer / catalyst developer
- University – LCA work
- Techno economic evaluation



DAHLMAN 

The word 'DAHLMAN' is written in a large, white, serif font. To the right of the word is a white crown icon. The entire logo is reflected on a dark blue surface below it.

Thank You!

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