

Commercialisation of WtE through gasification technology developed by ECN

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Bram van der Drift
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IEA Bioenergy, Task 33 workshop

ECN STARTED IN 1996



earlier, it was only coal gasification and gas cleaning

- Plan: 30 MWe IGCC on biomass for efficient power in Amsterdam (Lurgi or TPS technology)
- Local waste company (Afvalzorg) wanted information on suitability of their biomass/waste streams
- ECN constructed 0.5 MW (input) CFB gasifier for characterization: BIVKIN
- Many tests: wood, manure, sewage sludge, cacao husks, railway ties, ...

A. van der Drift et al, *Ten residual biomass fuels for circulating fluidized-bed gasification*. Biomass Bioenergy **20** (1), pp. 45-56, 2001

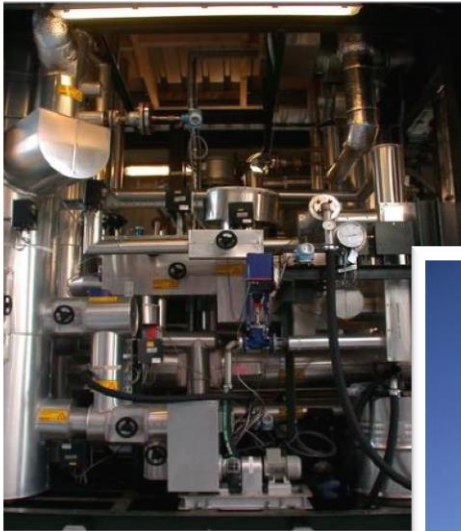
0.5 MW CFB GASIFIER at ECN



- Air-blown CFB technology, later also operated on oxygen/steam
- Licensed to HoSt in 2002
- Originally gas was flared at ECN
- Tar removal was added later
- Resulting in OLGA technology, now available from Royal Dhlman

OLGA SUPPLIED by DAHLMAN

OLGA tar removal based on oil scrubbing



*200 m³/h, connected
to MILENA*

*2 000 m³/h
connected to MILENA*



*2 000 m³/h,
connected to CFB*

*2 000 m³/h connected
to updraft*



GASIFIERS SUPPLIED by HoSt

CFB technology for difficult feedstock



4 MW plant in Portugal, chicken manure, 2009



3 MW plant in Tzum (NL), chicken manure, 2006

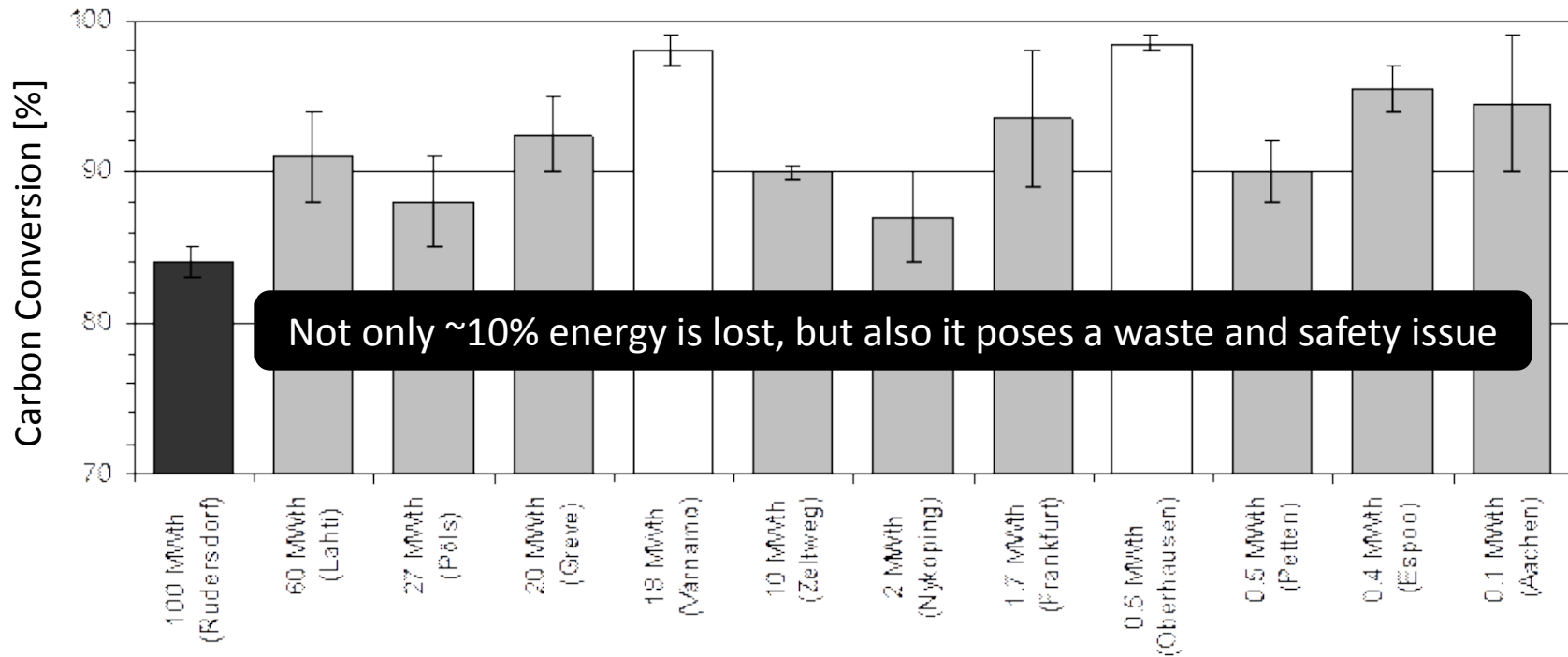


3-5 MW plant in Romania, sunflower husks, 2004

CIRCULATING FLUIDIZED BED

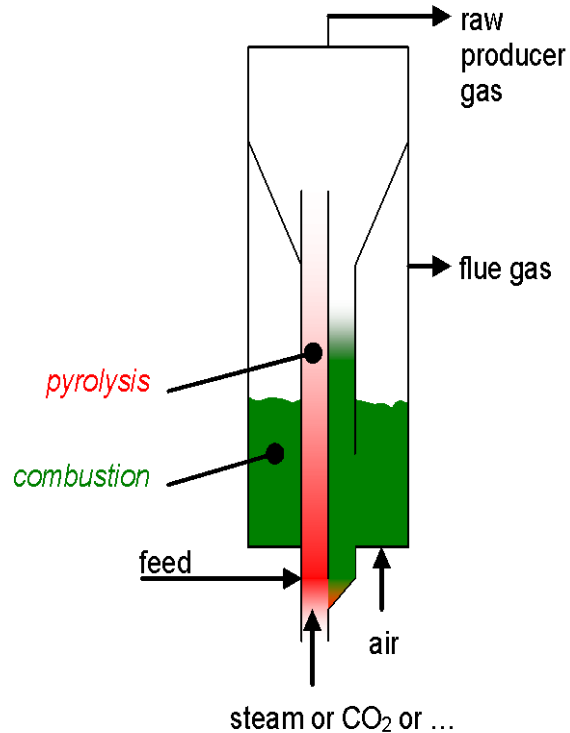


carbon conversion of CFB gasifier plants (2002 study)



MILENA TECHNOLOGY

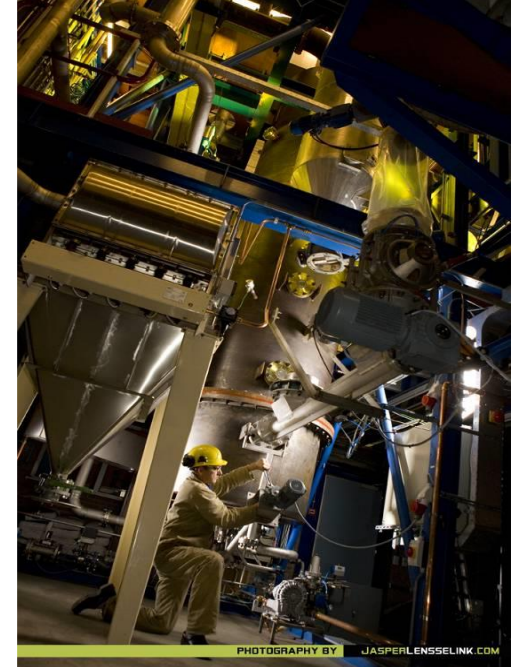
www.milenatechnology.com



25 kW facility at ECN, 2004



0.8 MW facility at ECN, 2008



USPs: complete conversion, N₂-free gas, fuel flexible, OLGA takes care of tars

ROYAL DAHLMAN

MILENA-OLGA plants

DAHLMAN 

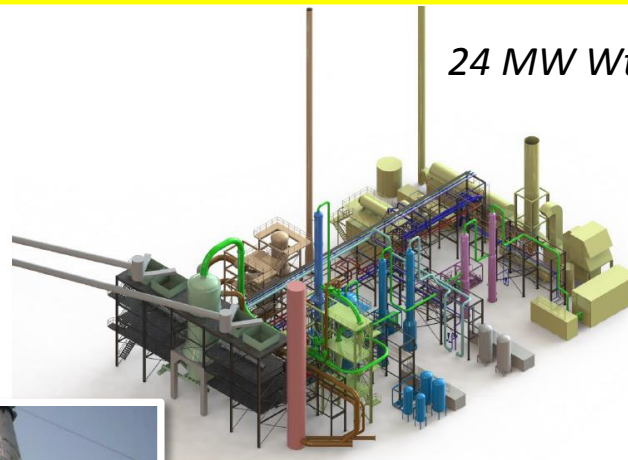
 ECN



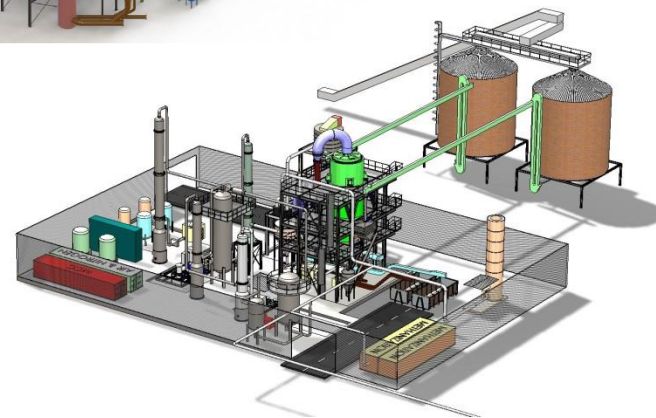
4 MW CHP, India, 2015



THERMAX
Sustainable solutions
Energy & Environment



24 MW WtE, UK, 2017



4 MW SNG, NL, 2017

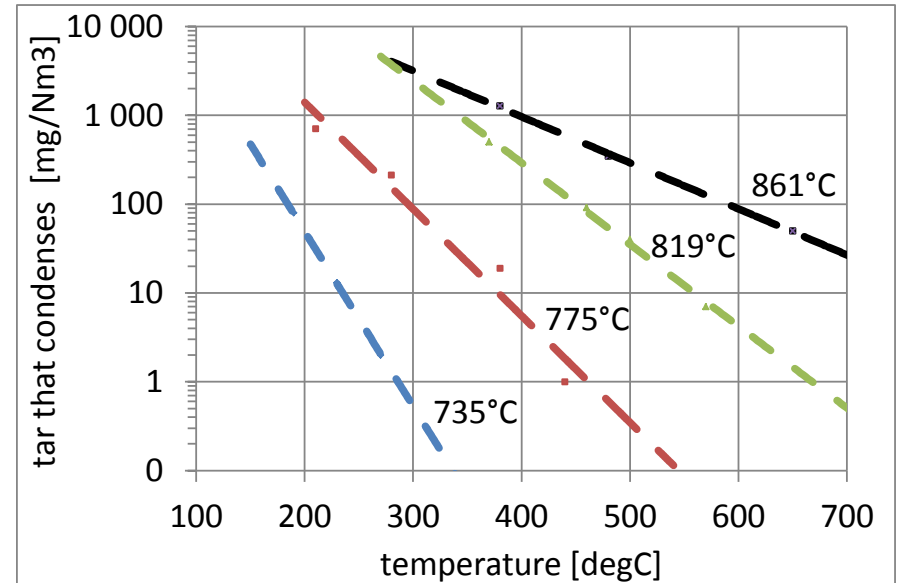
	MILENA gasifier	CFB/BFB gasifier
Conversion	100% / white ash	~90% / black ash
Cold Gas Efficiency	~80%	~70%
Temperature control	Good temperature control, no char accumulation	Less temperature homogeneity due to char hold-up
	Lower temperature = higher efficiency	Lower temperature = lower conversion
Fuel flexibility	Any size	Any size
	Wastes and agricultural residues	Less freedom
Gas	12-15 MJ/Nm ³	5-6 MJ/Nm ³
	Essentially N ₂ -free	~50% N ₂
Scale	Scalable (>100 MW)	Scalable (>100 MW)

LOWER TEMPERATURE is BETTER

Unlike conventional gasifiers, MILENA becomes better at lower temperature:

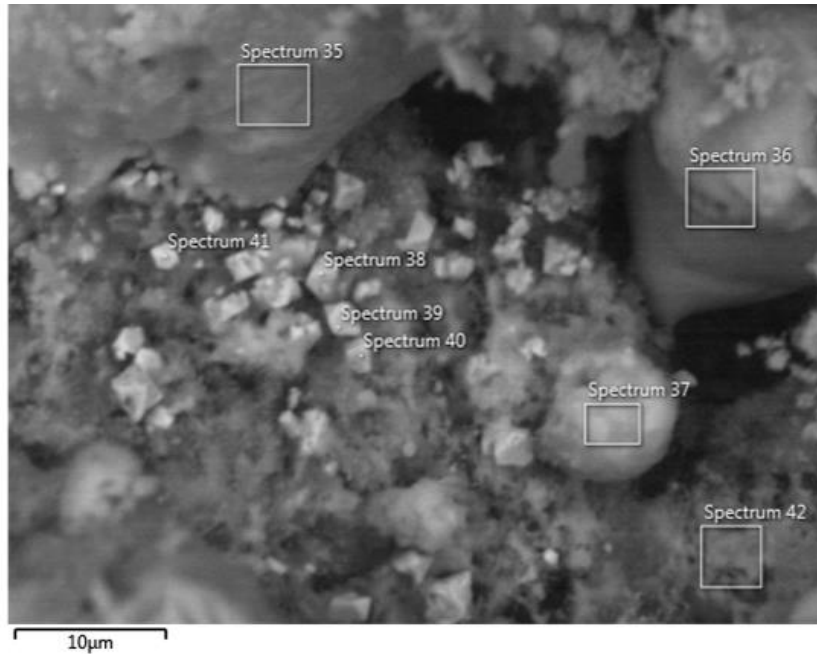
- Efficiency increases: unconverted char provides the energy and is not lost
- Less risk on melting/agglomeration
- Less deposit issues downstream
- Better tars
- More valuable hydrocarbons

Better tars: tars formed by gasification at lower temperature create much less condensation issues

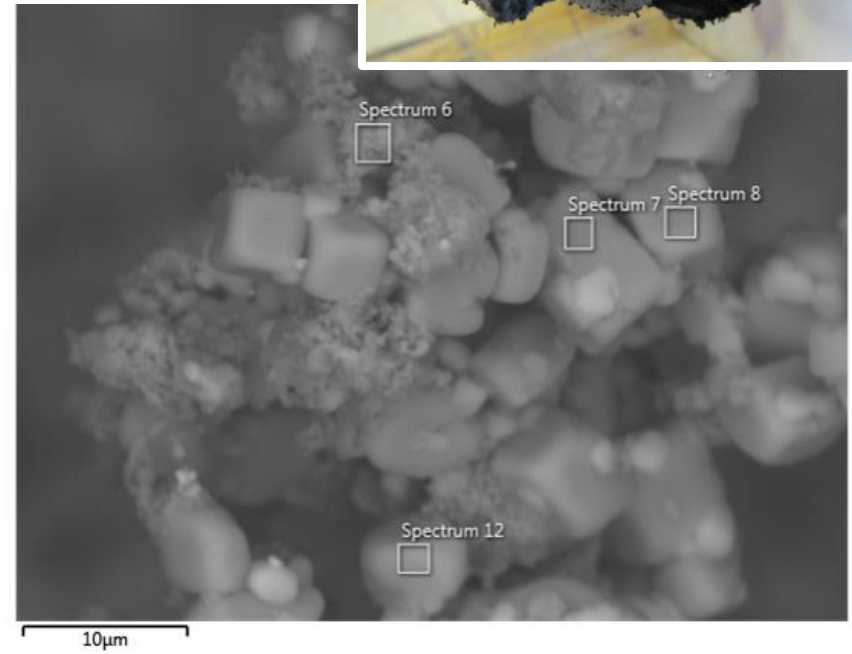


DEPOSITION on COOLER

deposition at 300-370°C surface



Gasifier at 850°C: deposit shows melt



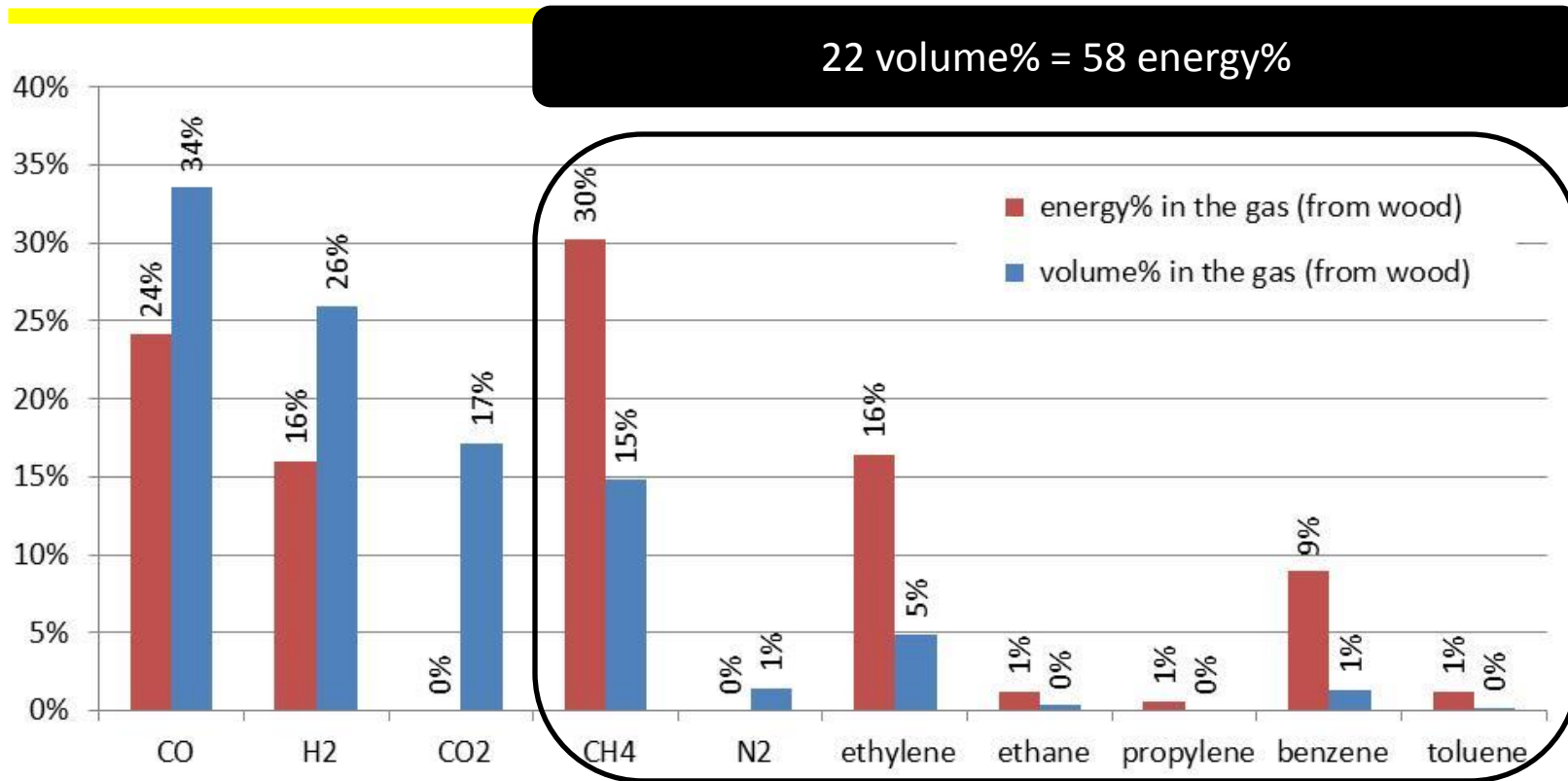
Gasifier at 700°C: deposit is dry

Indirect fluidized bed gasification (MILENA) of wood ~800°C,
composition after OLGA tar removal (tar free)

GAS COMPOSITION



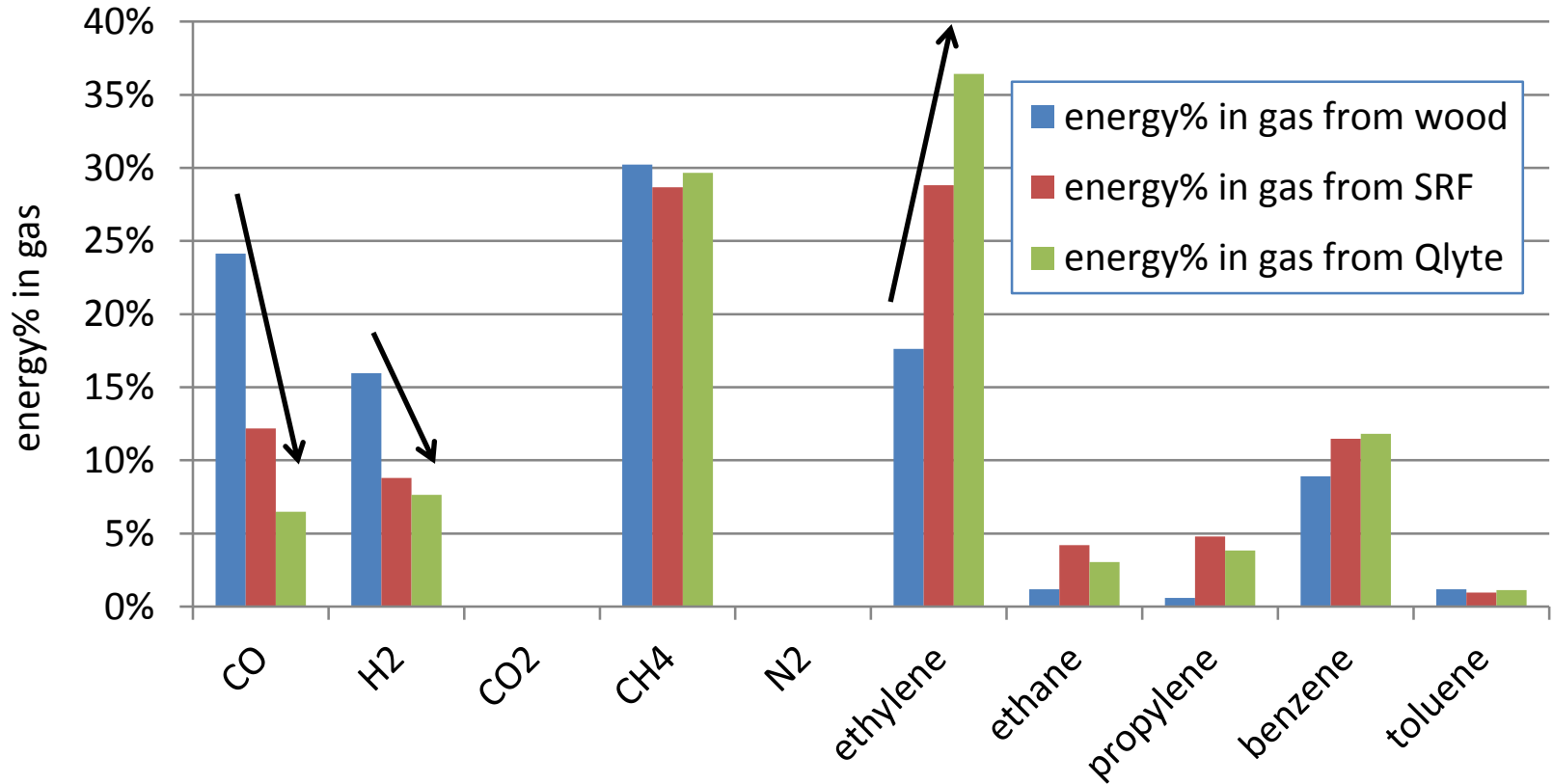
hydrocarbons: dominating in energy



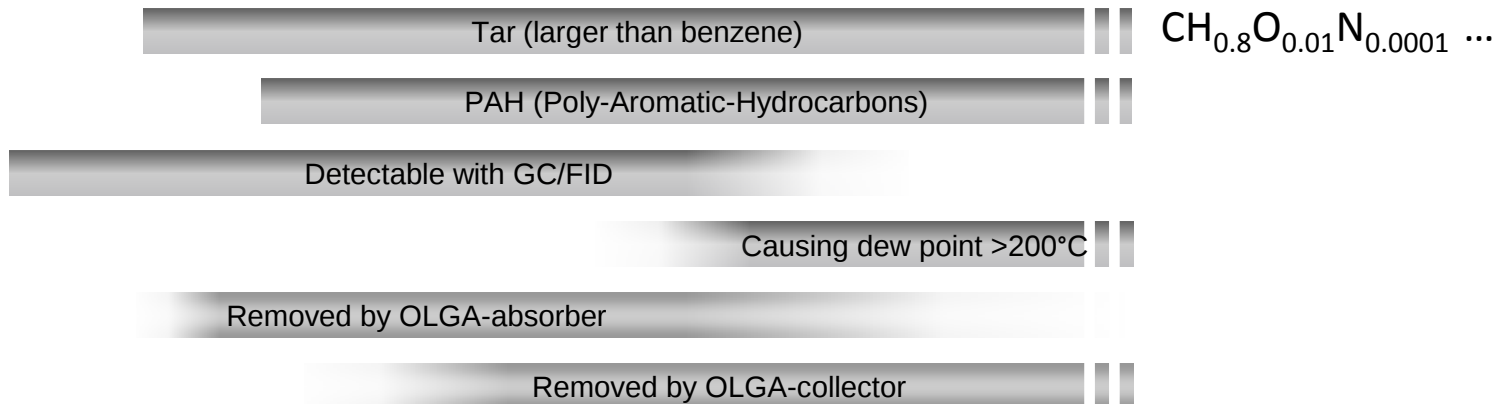
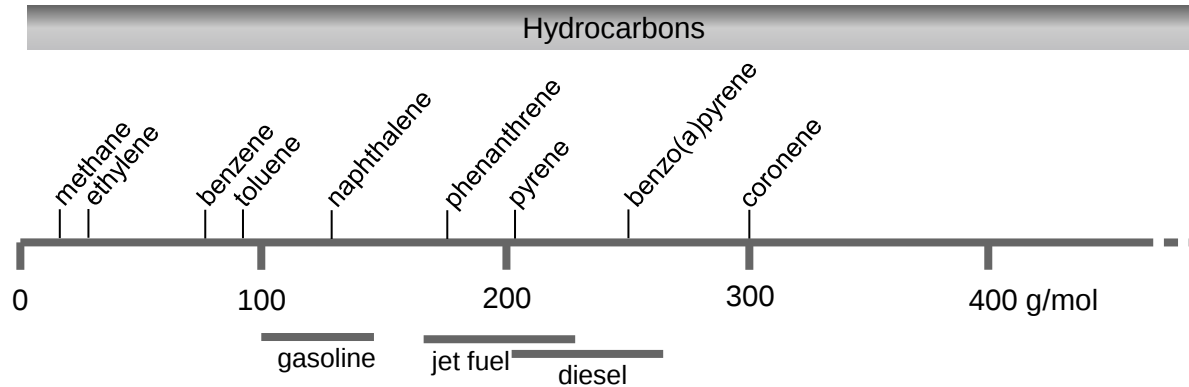
Hydrocarbons are responsible for high efficiency and high gas heating value

PLASTICS PRODUCE DIFFERENT GAS

Indirect fluidized bed gasification (MILENA) at ~800°C,
composition after OLGA tar removal (tar free)

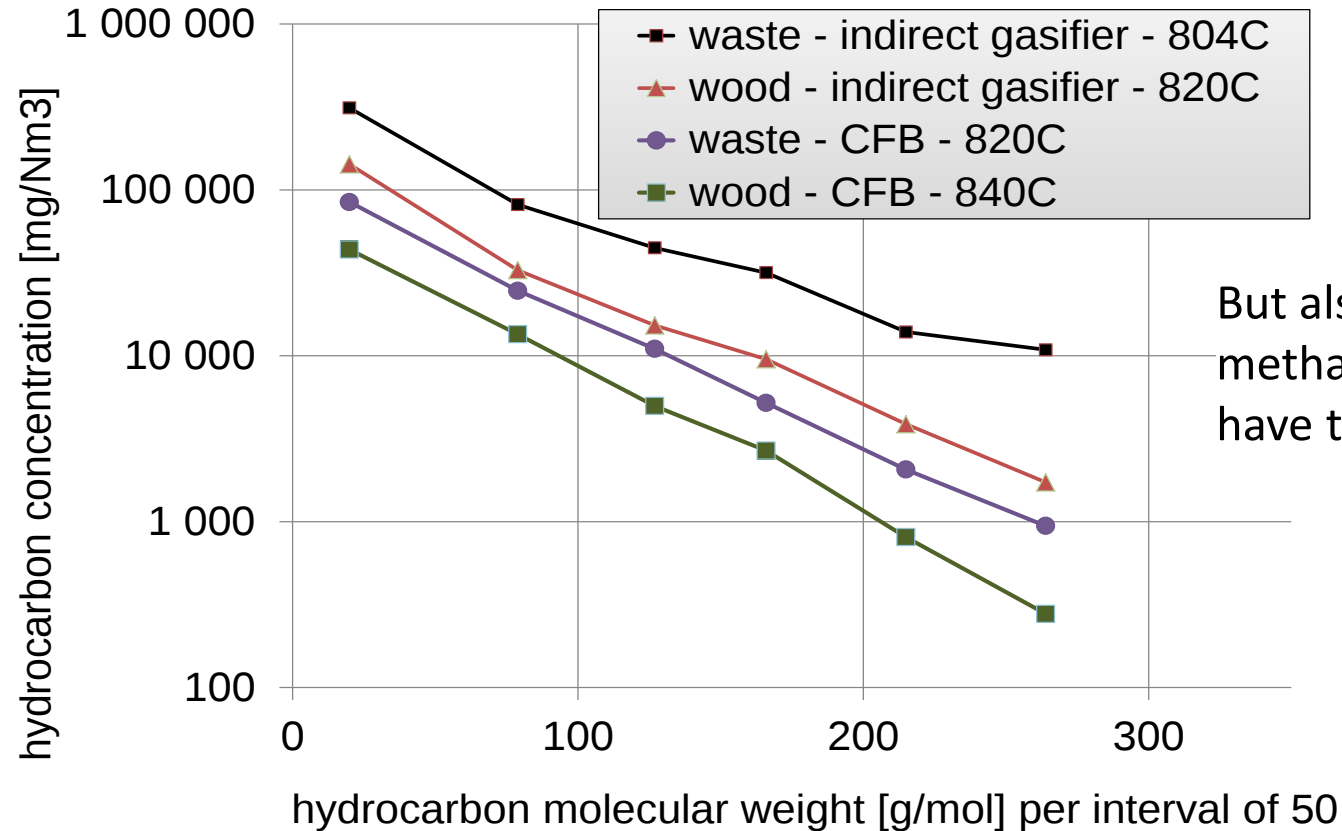


TAR



TAR

larger molecules = lower content

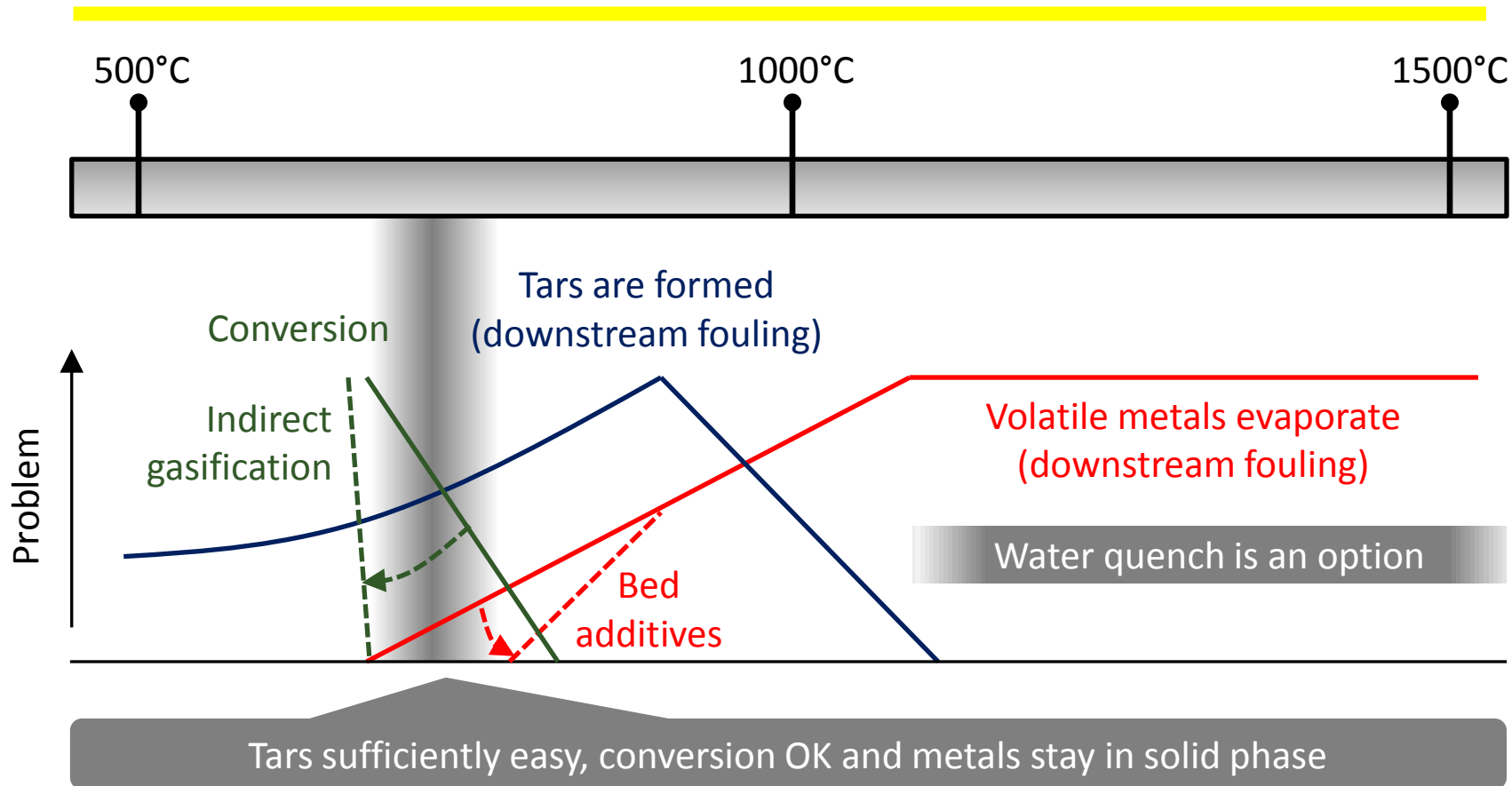


But also: if you want methane, you will have to deal with tars

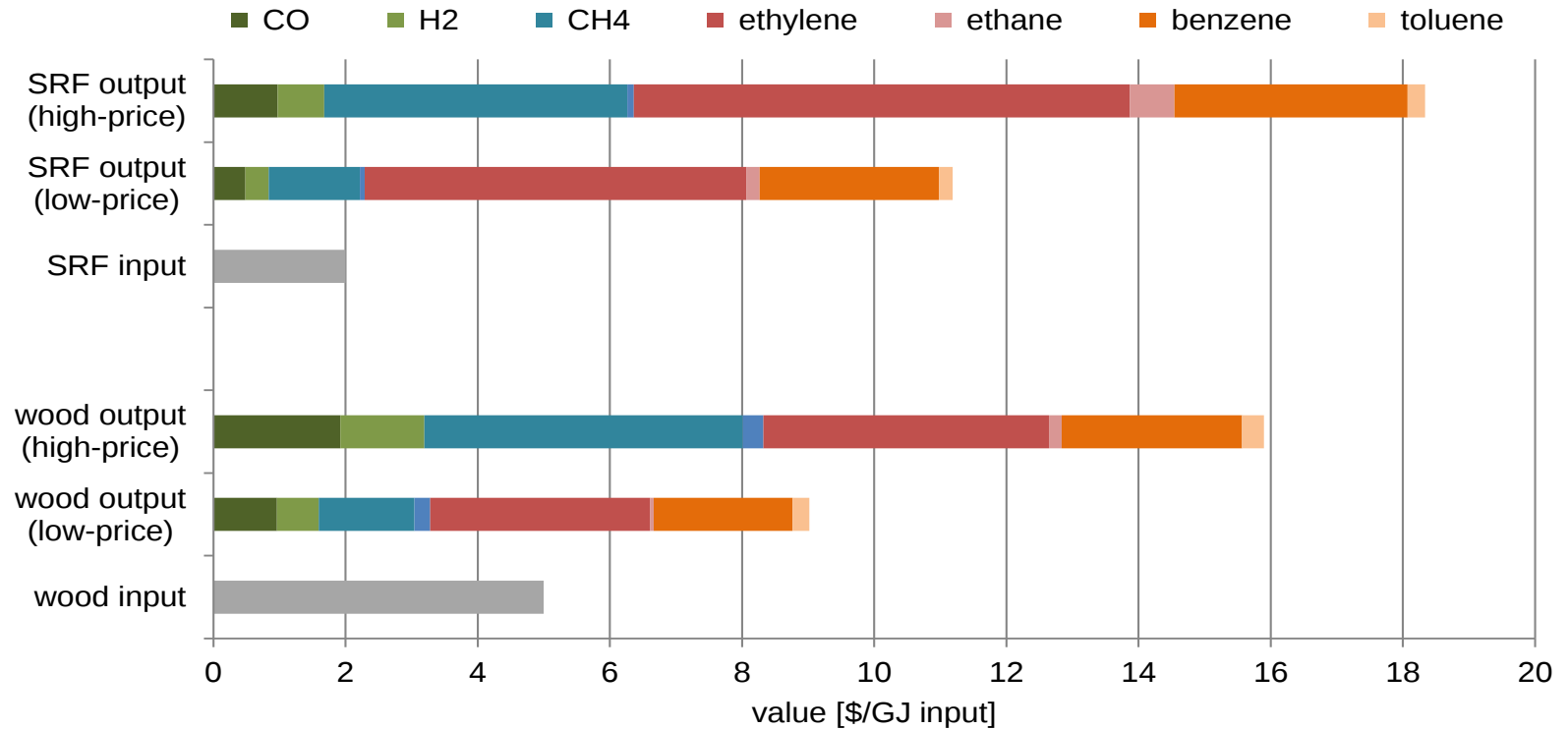
THE DILEMMA with WASTE



playing with tars, inorganics and conversion



WHERE IS THE MONEY?



BIOMASS-to-SNG

complete operating facility at ECN



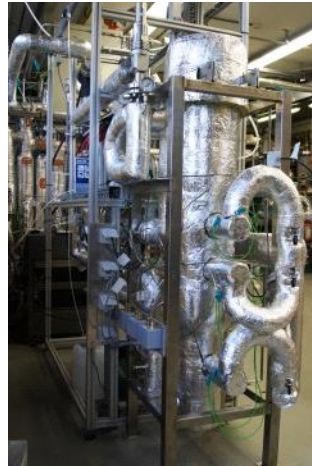
Natural Gas in
10 seconds!



MILENA gasifier



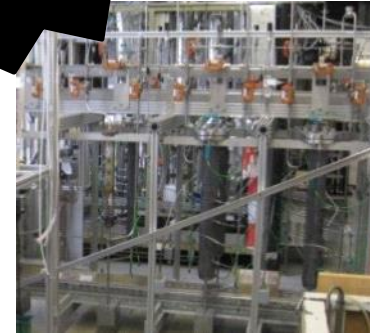
OLGA tar removal



HDS reactor



*Further gas
cleaning*

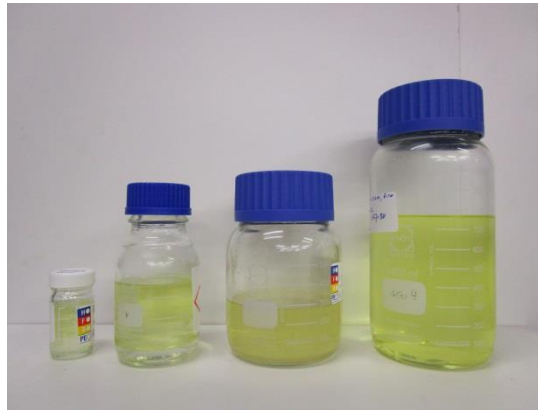
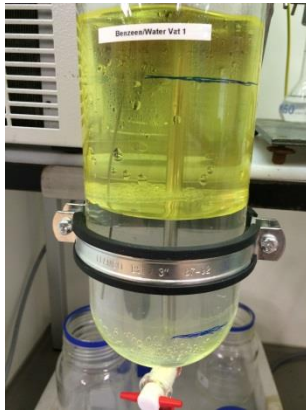


*Methanation
reactors*

70% energy efficiency from wood to bioSNG

BTX SCRUBBER

- Removes BTX (Benzene, Toluene, Xylenes)
- Scrubbing process
- Produces liquid BTX for further use



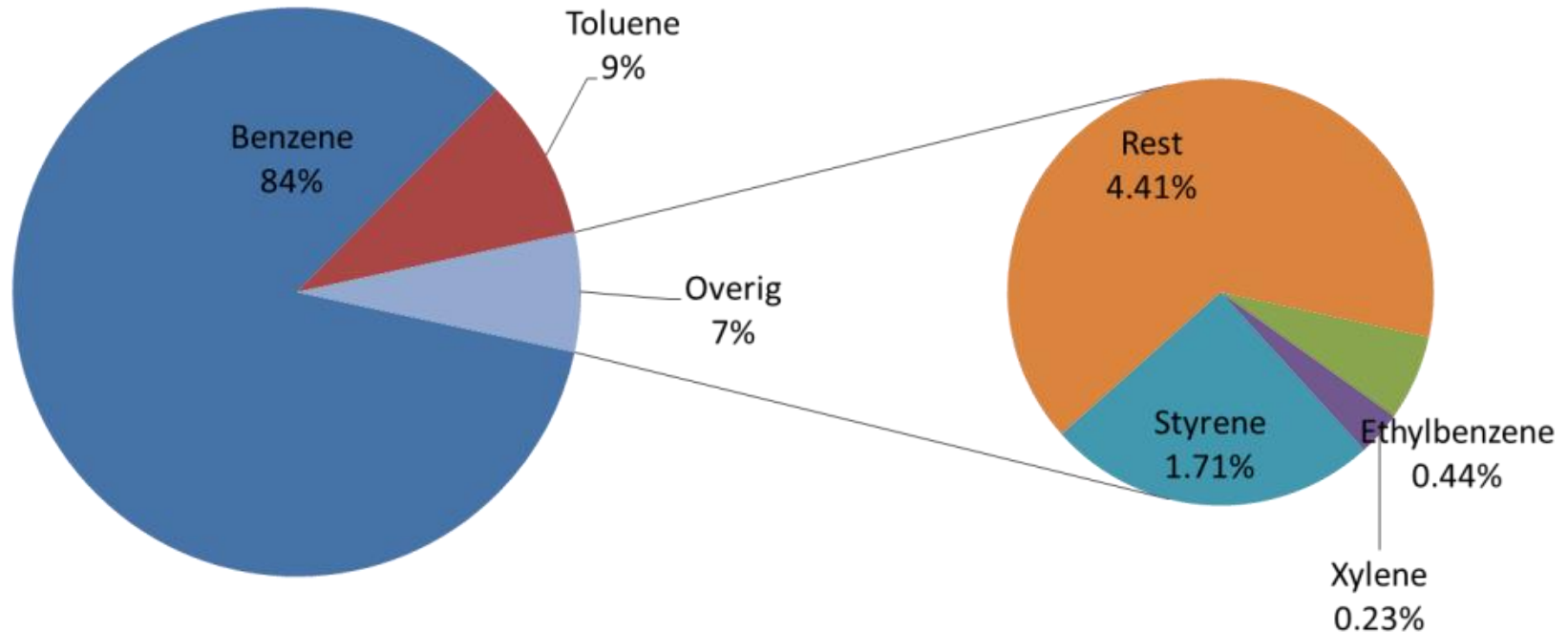
BTX scrubber, 2 nm³/h



BTX LIQUID COMPOSITION [wt%]

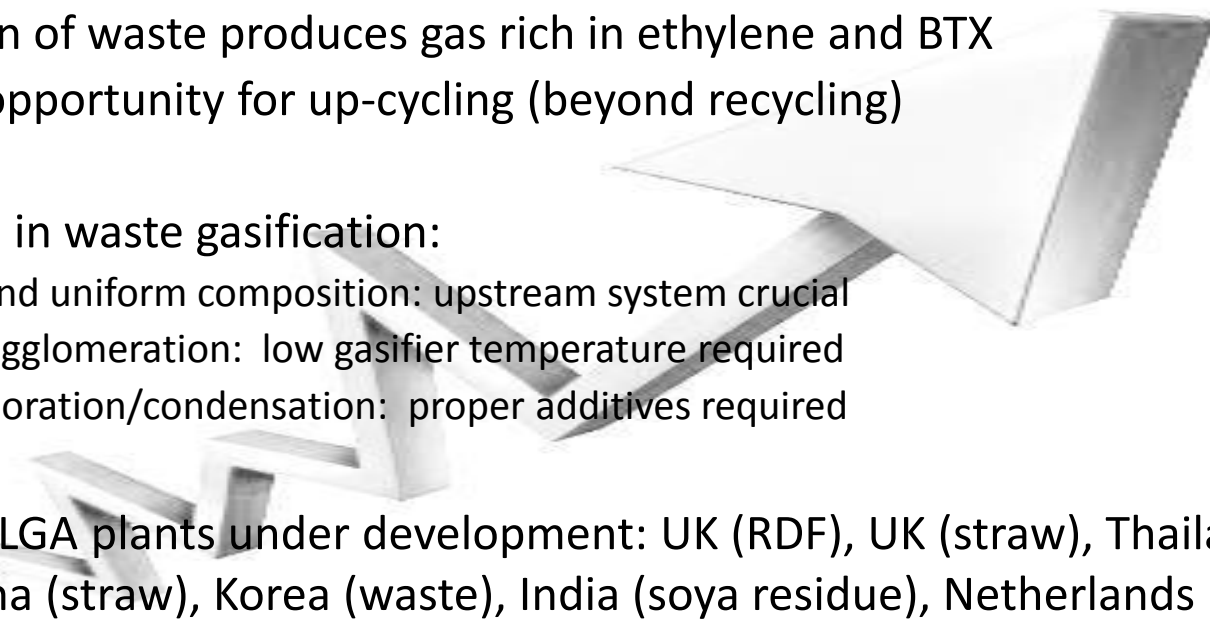


RDF gasification in MILENA, >97% removal



*Diluted Ethylene Aromatization (Zeolite) can boost
BTX yield; lab tests showed doubling of BTX*

CONCLUDING REMARKS

- Wood may be easier, but waste is more attractive
 - Gasification of waste produces gas rich in ethylene and BTX
 - This is an opportunity for up-cycling (beyond recycling)
 - Challenges in waste gasification:
 - Feeding and uniform composition: upstream system crucial
 - Melting/agglomeration: low gasifier temperature required
 - Salts evaporation/condensation: proper additives required
 - MILENA/OLGA plants under development: UK (RDF), UK (straw), Thailand (RDF), China (straw), Korea (waste), India (soya residue), Netherlands (wood)
 - Our partners: Royal Dahlman, Thermax, Synova, Posco, HoSt
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MORE INFORMATION

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publications: www.ecn.nl/publications

fuel composition database: www.phyllis.nl

tar dew point calculator: www.thersites.nl

IEA bioenergy/gasification: www.ieatask33.org

Milena indirect gasifier: www.milenatechnology.com

OLGA: www.olgatechnology.com / www.renewableenergy.nl

SNG: www.bioSNG.com / www.bioCNG.com



Gasification: make difficult feedstock fit

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