Role of Gasification in a Bio-Based Future

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ROLE of GASIFICATION in a BIO-BASED FUTURE

Bram van der Drift

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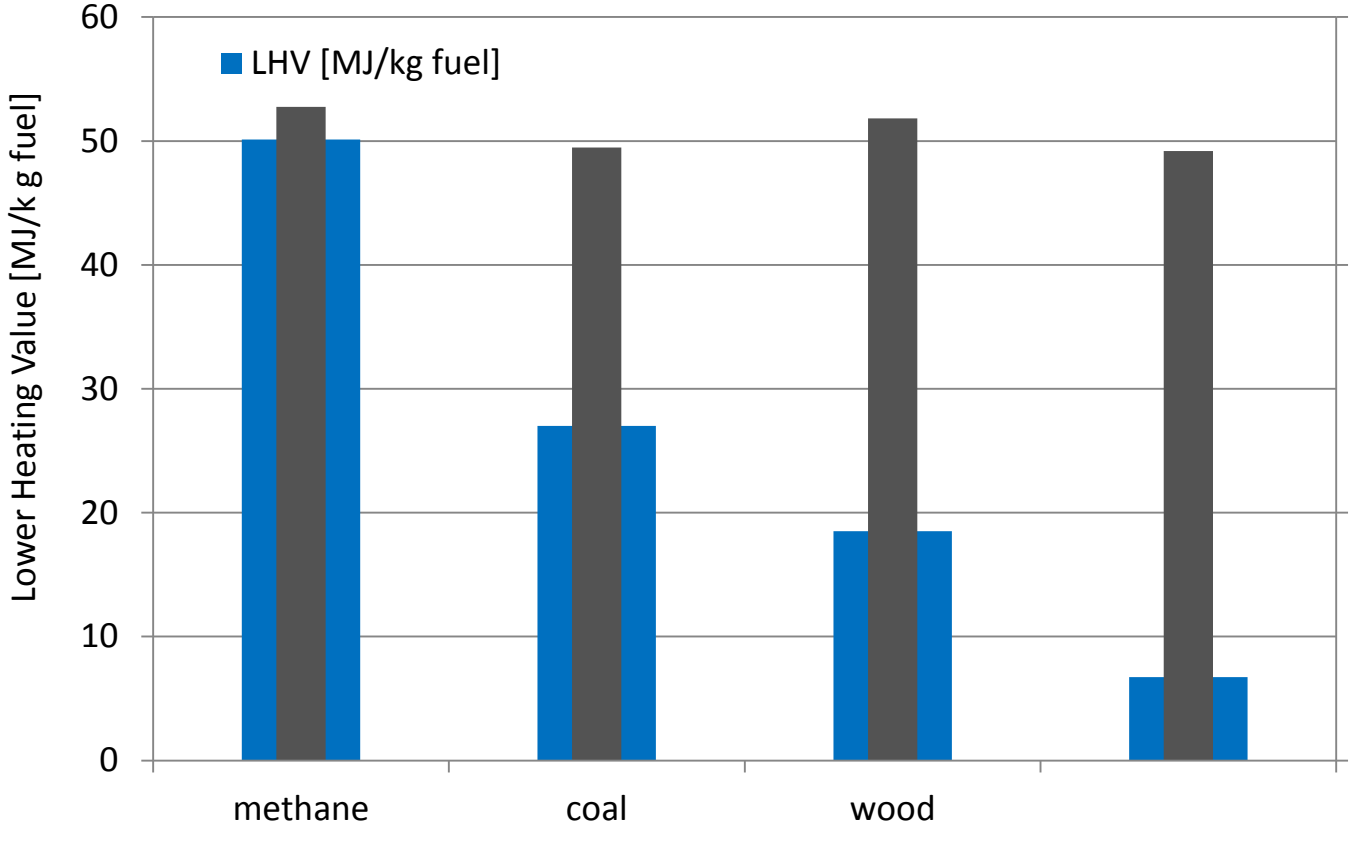
European Biomass Conference, Vienna

www.ecn.nl

BIOMASS is NOT a BAD FUEL!



THE SECRET of BIOMASS

- It contains oxygen

- The oxygen makes biomass a good fuel
- The oxygen makes biomass a reactive fuel
- The oxygen makes biomass a good feedstock for chemistry

GASIFICATION

GASIFICATION

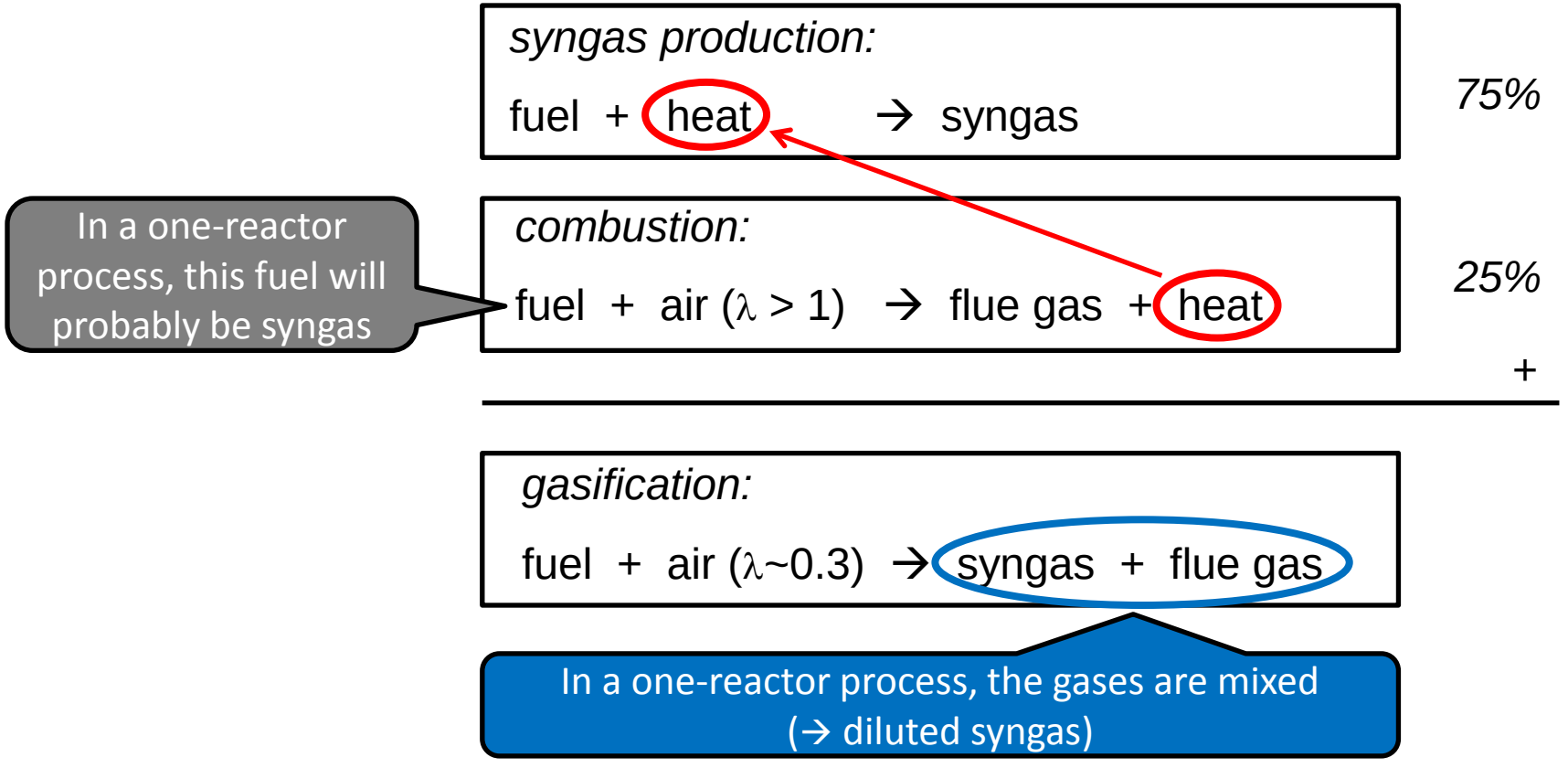
wood, agricultural residues, waste, coal, …

- Gasification converts solid fuel to gaseous fuel (chopping molecules)
- Opens the door to existing energy systems:
  - Boilers
  - Engines
  - Turbines
  - Steel industry
  - Refineries
  - Chemistry
  - Fuels

H_2, CO, CH_4, …

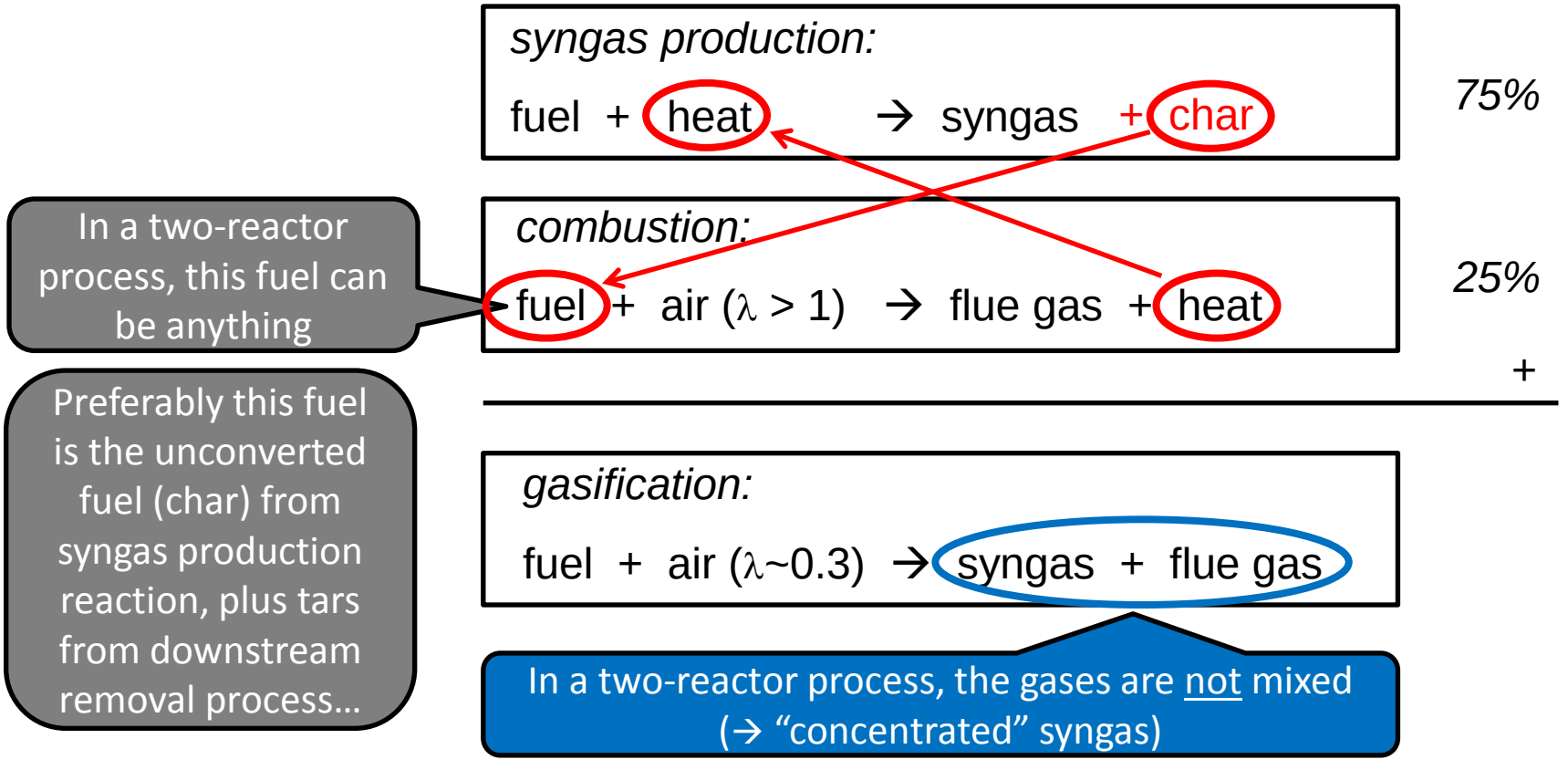
GASIFICATION = 2 REACTIONS

matching the energy consumption and production



TWO REACTORS

degree of freedom: fuel for the combustion reaction



THE TWO REACTOR GASIFIER

also called: allothermal gasifier, indirect gasifier

8 MW Oberwart, Austria

14 MW Senden, Germany

32 MW Gothenburg, Sweden

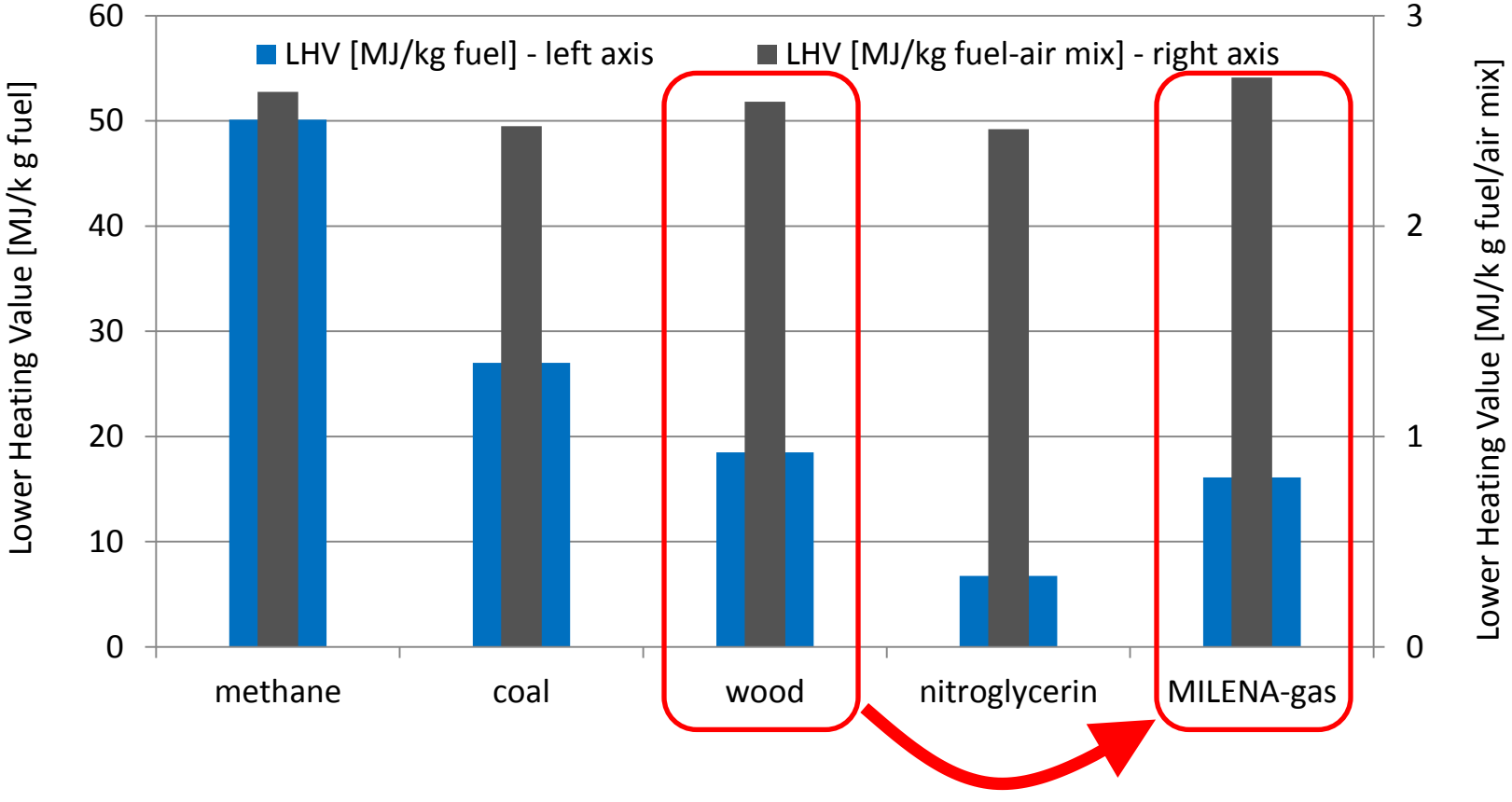
8 MW Güssing, Austria

40 MW Burlington, USA

4 MW Washim, India

THE GAS is also a GOOD FUEL

MILENA is ECN technology for indirect gasification



BIOMASS is a REACTIVE FUEL

BIOMASS

high oxygen and volatile content

		Bituminous Coal	Wood
Oxygen	wt% daf	14%	43%
Volatiles	wt% daf	42%	82%

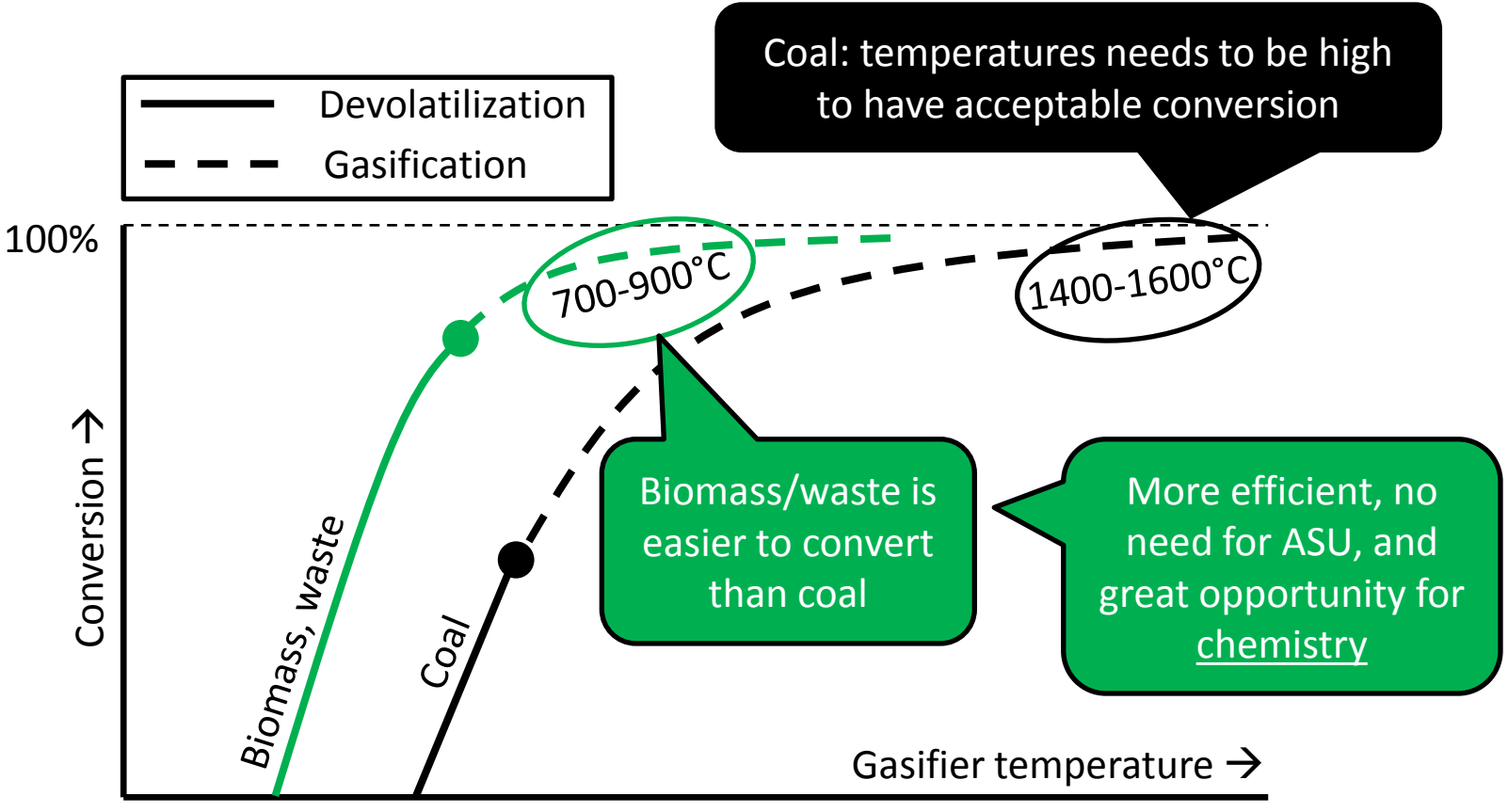
daf: on dry and ash-free basis
Source: www.phyllis.nl

BETTER GAS from BIOMASS

	Oxygen-blown IGCC (Shell)	Air-blown indirect gasifier (MILENA)
Feedstock	Coal	Wood
LHV feedstock	31 MJ/kg	18 MJ/kg
Gas	(essentially N_2-free)	(essentially N_2-free)
LHV dry gas	10 MJ/Nm^3	15 MJ/Nm^3

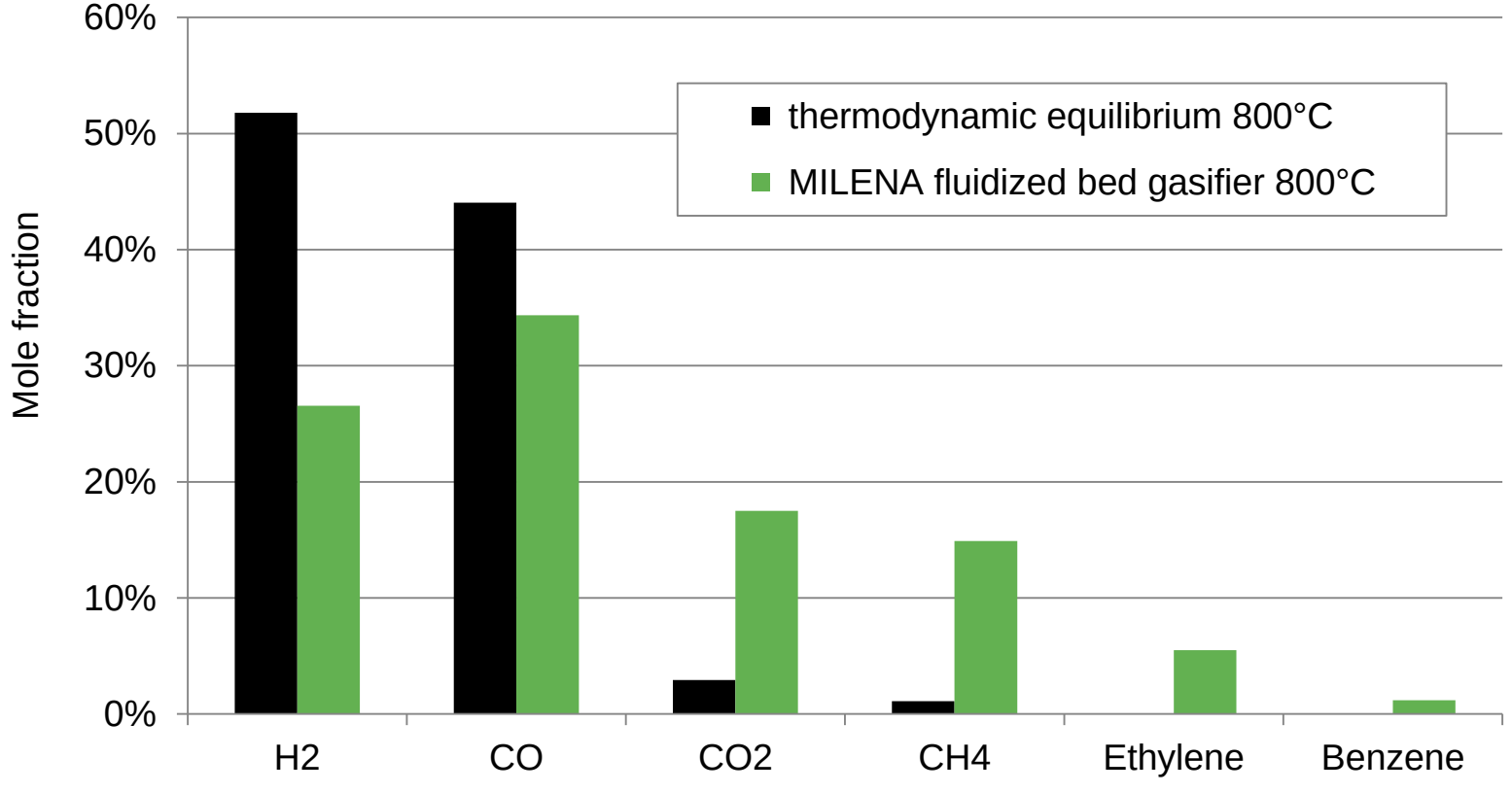
CONVERSION vs. TEMPERATURE

biomass and waste do not need severe conditions



THERMODYNAMICS

at 800°C: far from thermodynamic equilibrium



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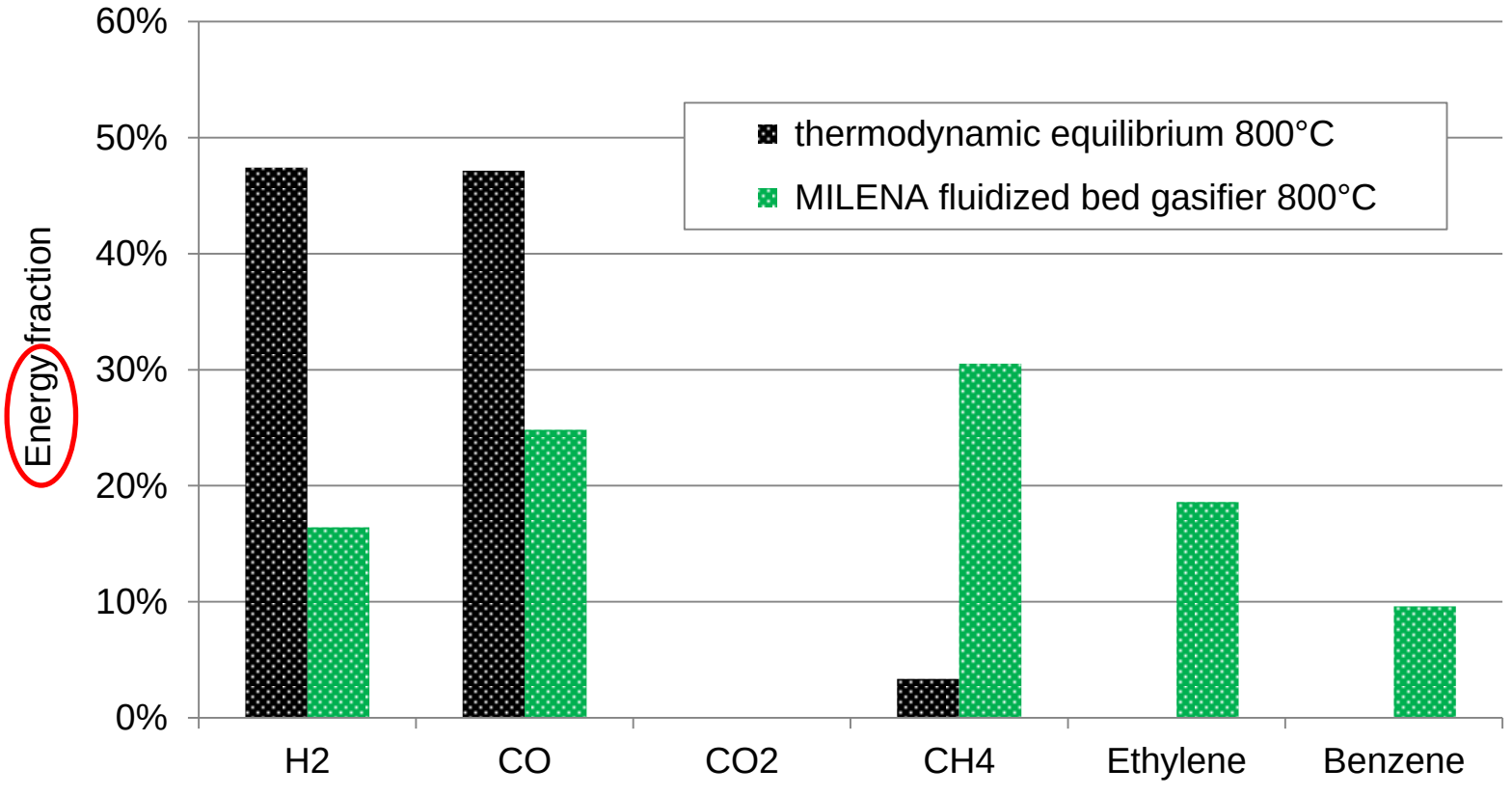
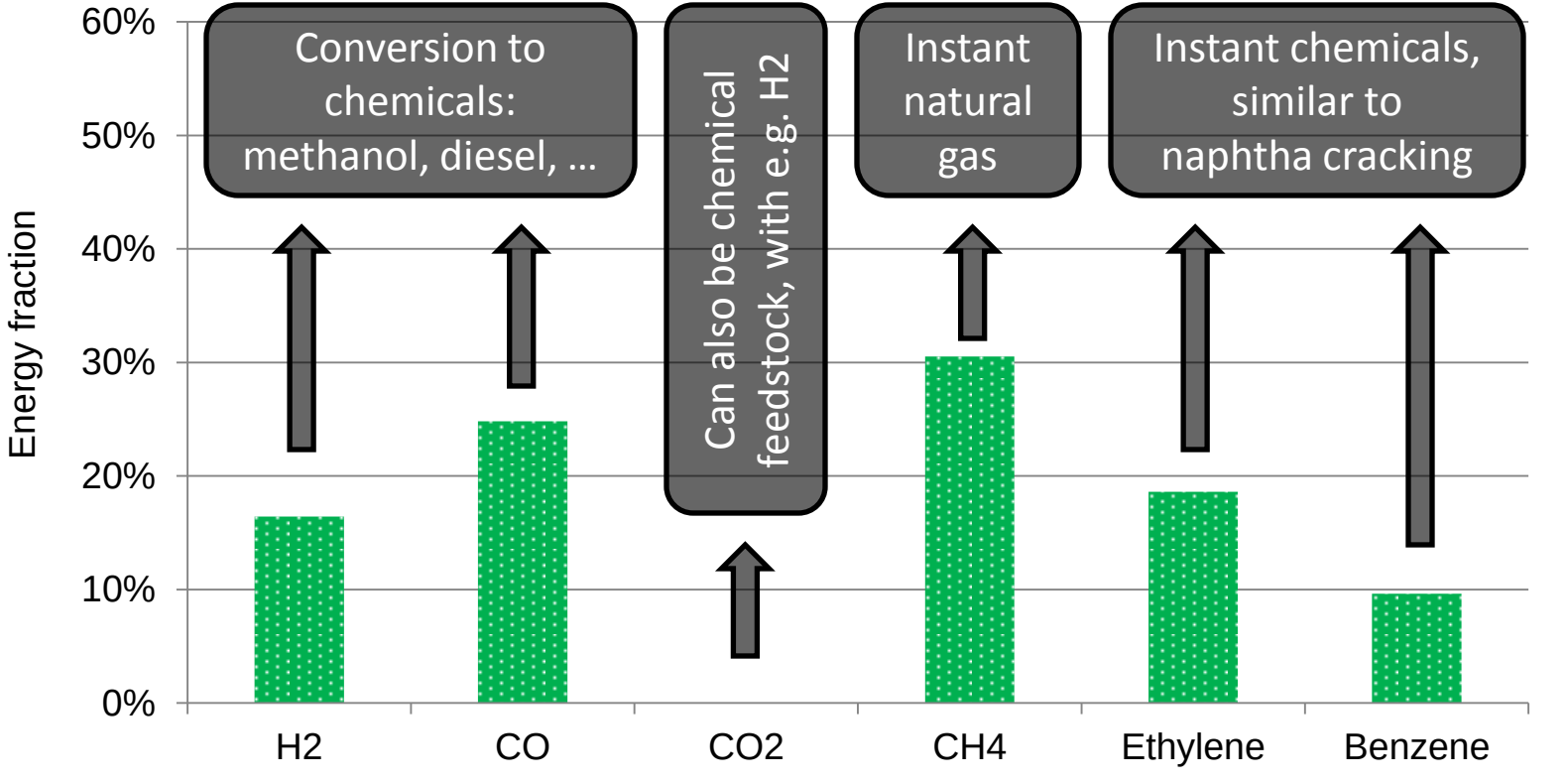


CHEMICALS

CHEMICALS from GASIFICATION

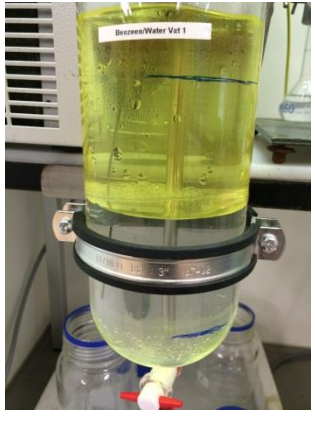
fluidized bed gasifier at 800°C

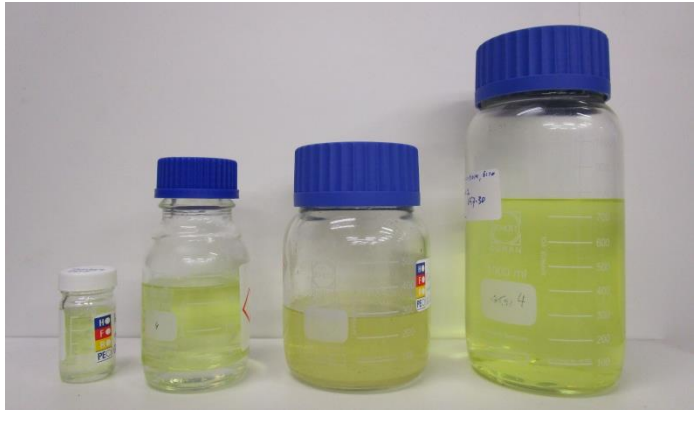


GETTING THE CHEMICALS OUT

example: BTX removal

- BTX removal by absorption/regeneration scrubbing technology
- Proprietary liquid sorbent
- Tested downstream fluidized bed gasifier
- >97% BTX removal efficiency

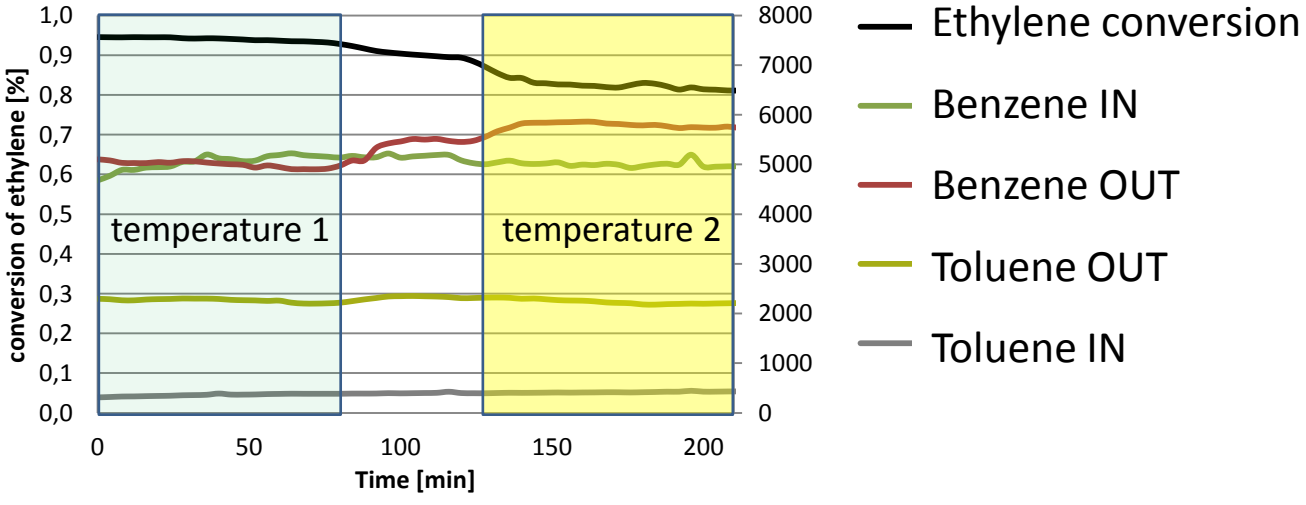




GETTING THE CHEMICALS OUT

example: ethylene

- Diluted Ethylene Aromatisation: DEA
- First test showed 95% ethylene conversion
- Conversion to aromatics (mainly toluene) and C3/C4 hydrocarbons
- DEA is an option to convert ethylene to something easier to separate



FUTURE

NOTIONS

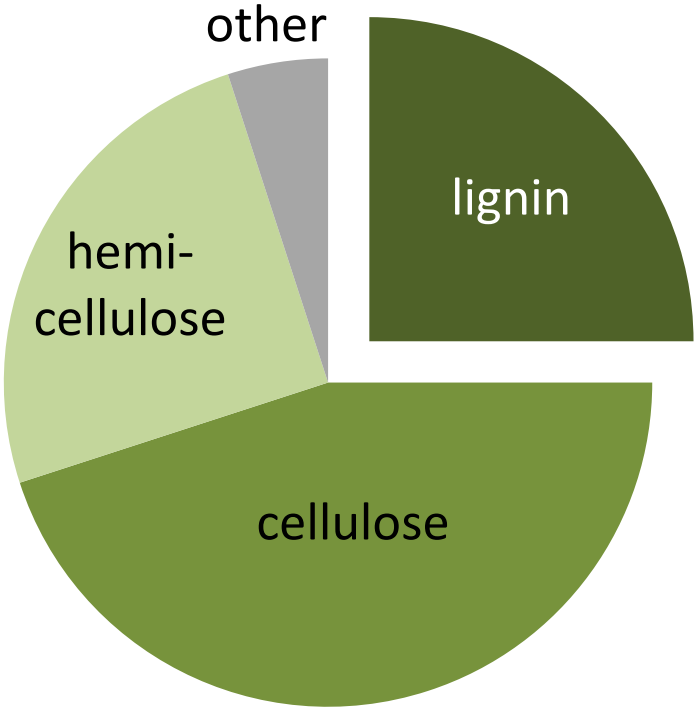
- Renewable power and heat has many options besides biomass (solar, wind, hydro, tidal, geothermal, …)

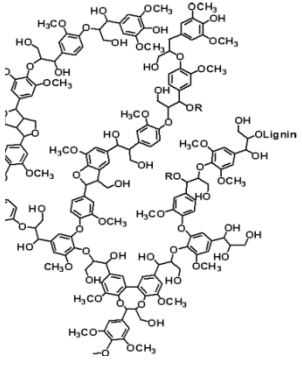
- Biomass is the only concentrated renewable carbon source
- Renewable materials and chemicals therefore must come from biomass

- Biology works fine, but only can handle part

LIGNO-CELLULOSIC BIOMASS

biology can only handle part of it





mass fractions in woody biomass

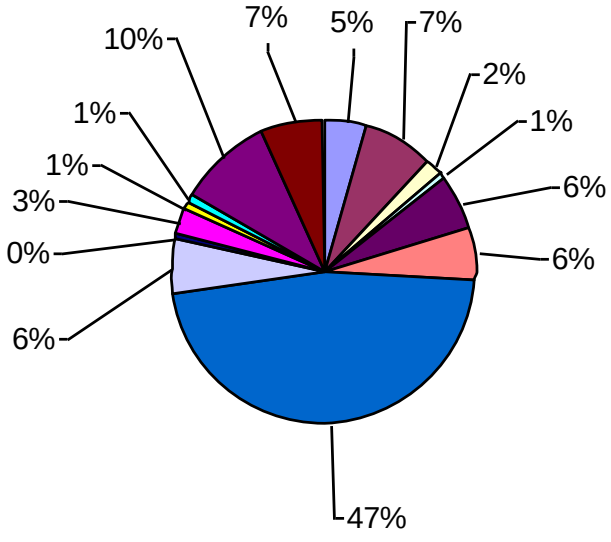
- Lignin is near biologically inert
- Biological conversion processes will never convert (hemi-) cellulose completely

- On energy basis: ~50% is left

ENERGY ISLAND is EXPENSIVE

gasification with co-products can improve this

- Case: 2G ethanol plant
- Lignin-rich residue combustion for energy
- This energy island is:
  - Not trivial due to contaminants, fouling, corrosion, emissions, …
  - The single largest investment of a biorefinery



Case: investment of lignocellulosic ethanol plant, 47% for energy island

- Gasification can improve the business case
- With BTX separation, ethanol production costs reduce with 5 €ct/liter ethanol

GREEN GAS by GASIFICATION

potential cost reductions (base-case 14-24 $/GJ)

- -3 $/GJ by bio-BTX
- -5 $/GJ by bio-ethylene (either separated or converted into aromatics)
- And more:
  - H_2/CO for bio-chemicals
  - CO_2 for storage or utilization
  - Increasing bio-BTX yield and bio-ethylene yield
  - Accommodate excess (renewable) H_2 to make methane (P2G)

Green Gas can become cheaper than natural gas!





CO-PRODUCTS GENERATE THE $$

a common way to make the main product cheaper

Shale Gas, Bakken (US)	Energy output [%]	Revenue [%]
Natural Gas	62%	41%
Natural Gas Liquids	38%	59%

Lignite-to-SNG, Dakota (US)	Energy output [%]	Revenue [%]
SNG: Synthetic Natural Gas	79%	41%
Naphtha, phenol, oil, CO_2	21%	59%

CONCLUDING REMARKS

- Biomass is the only concentrated renewable carbon source
- Renewable chemicals/materials must come from biomass
- Biomass (thanks to the oxygen) is a good and reactive feedstock for chemicals production

- Gasification plays a key role
- It can produce syngas with H_2 and CO that can be converted to chemicals
- It also produces instant bulk chemicals like ethylene and BTX

- Gasification can handle a lot, including waste biomass from biological conversion processes
- Chemistry from biomass gasification makes sense; energy will be a major co-product

MORE INFORMATION

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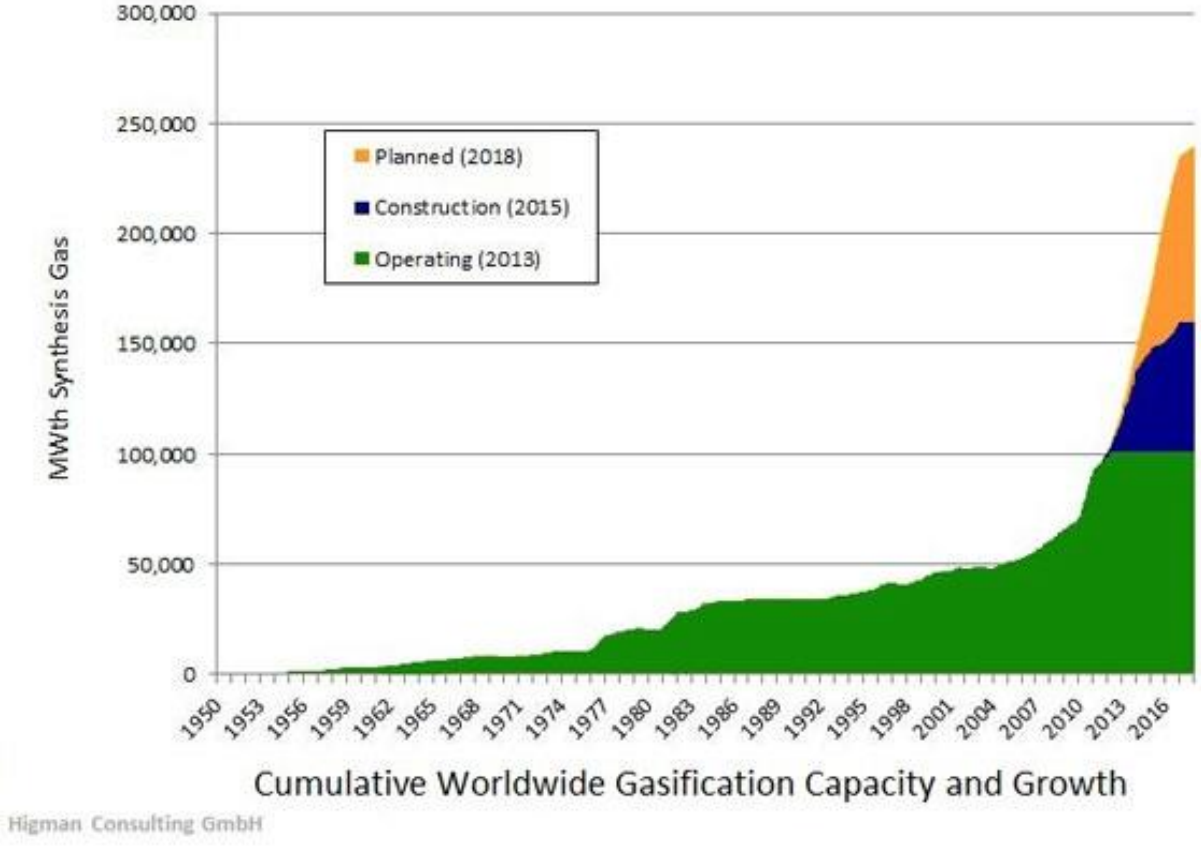
STATUS of GASIFICATION

TRENDS in GASIFICATION

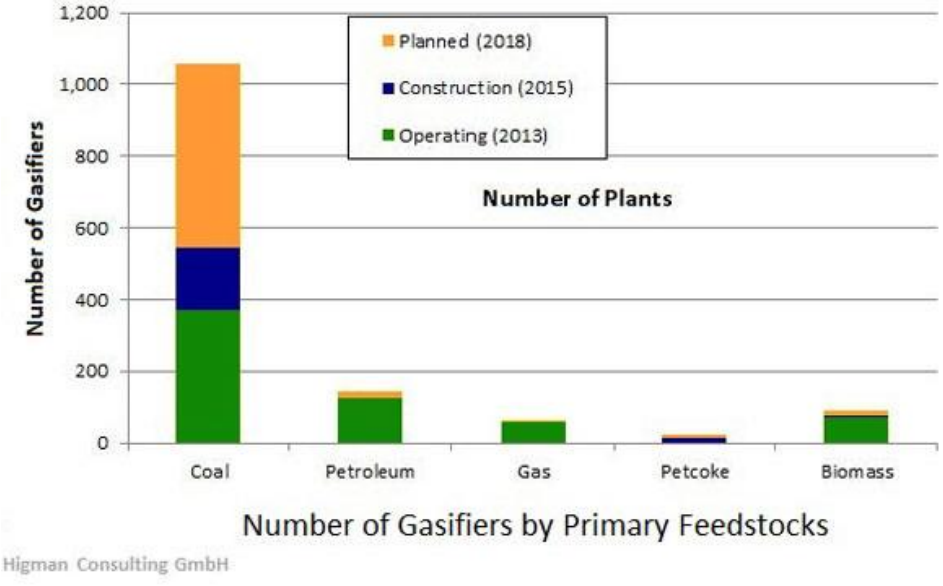
6%/y growth last 30 years, 11%/y growth next decade

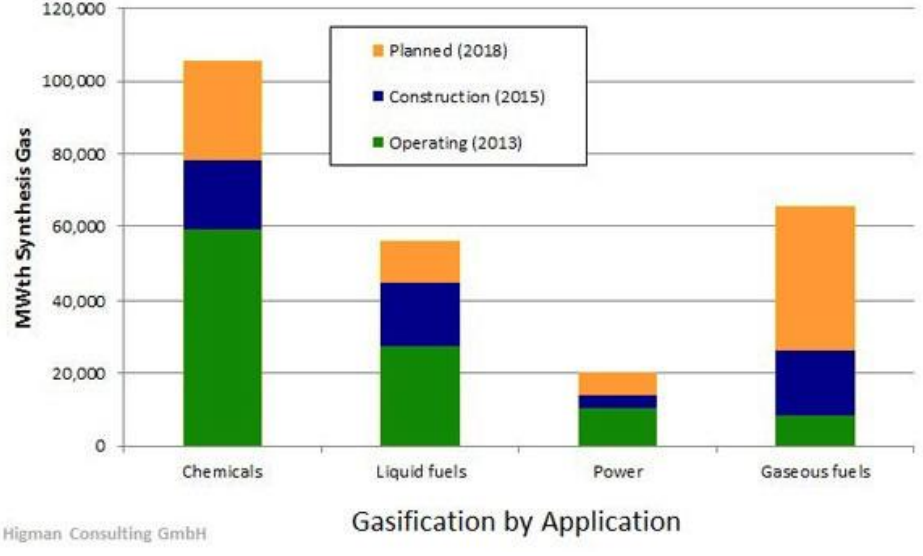


source: www.gasification.org

STATUS of GASIFICATION

mainly coal-to-chemicals/fuels





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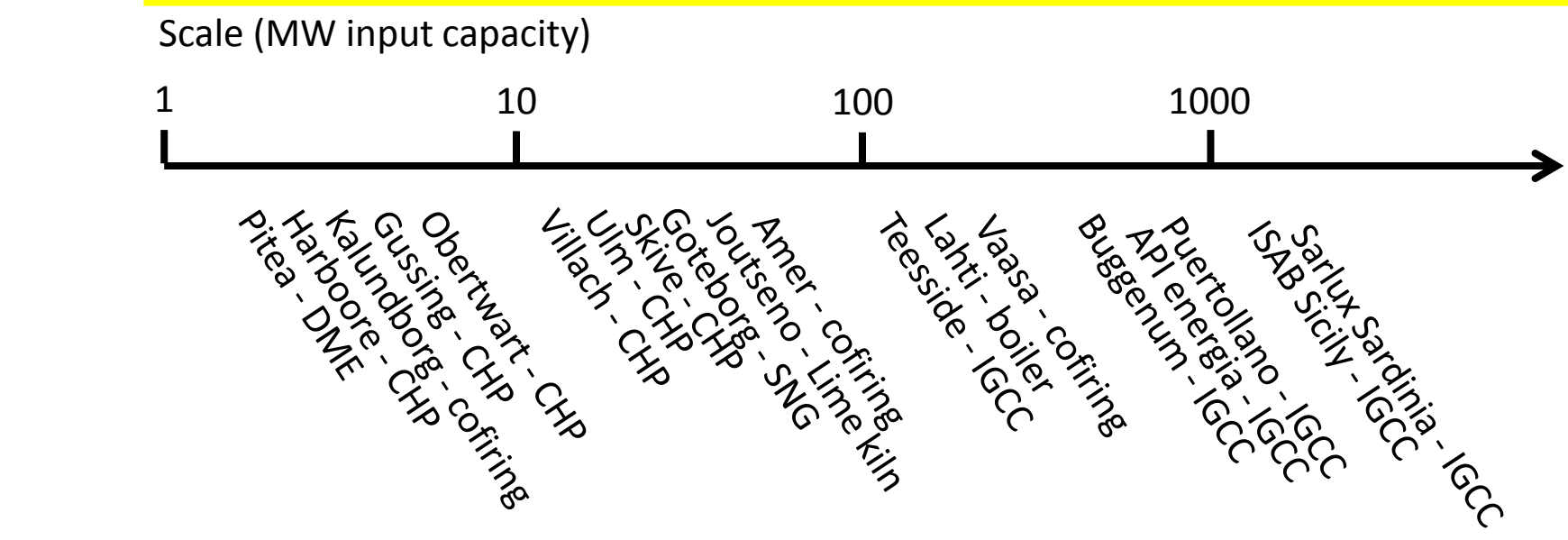
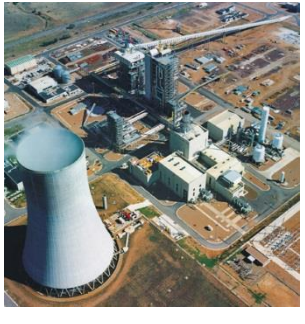
EXISTING GASIFICATION PLANTS

in Europe







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