Making small scale chemical production work

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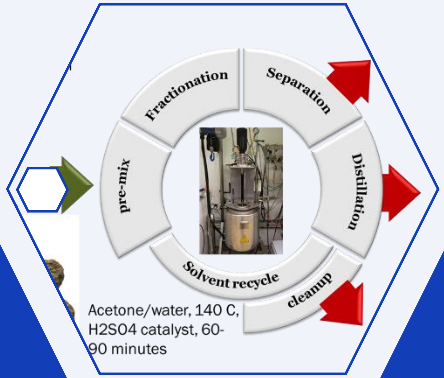
Start presentation

TNO innovation for life

Agenda

1. TNO and fuel development
2. Setting the scene
3. Explaining indirect gasification
4. Quick scan on the economics
5. Future outlook for MeOH production
6. Conclusions

TNO and fuel development



Fabiola^{TM} a pathway to 2nd generation sugars and furanic fuel components

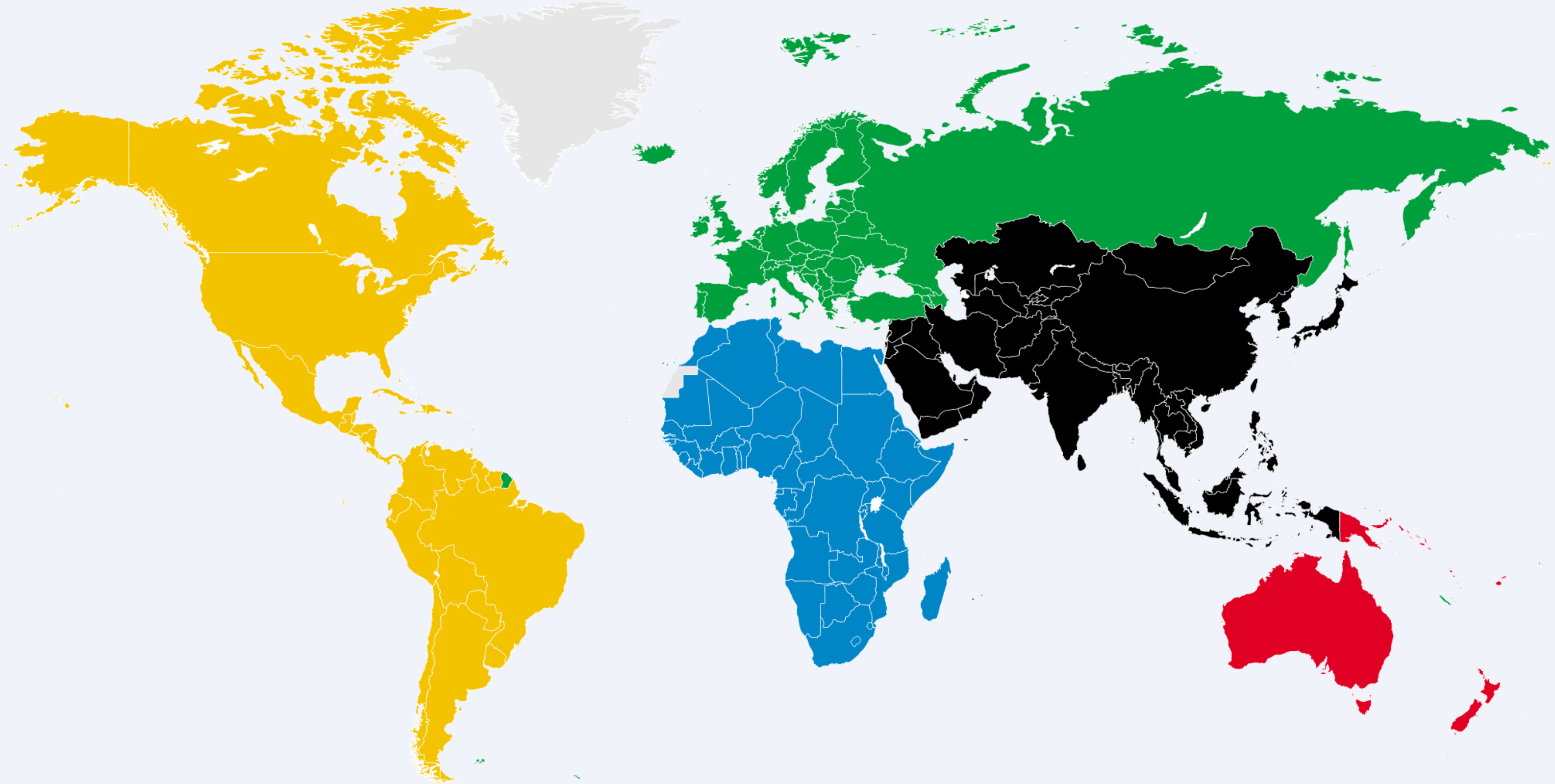
Hydro Thermal Upgrading converting wet organic reisdues into biocrude (55$/barrel)

MOVANTA

SEDMES technology for the conversion of synthesis gas (ratio agnostic) into r-DME

Indirect Gasification as a low cost, medium scale, pathway to MeOH

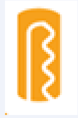
Setting the scene



FB techn + oxygen	Large
EF + torrefaction	Large
Indirect approach	Medium

Enerkem (2x) – Canada stopped + under construction
Fulcrum – USA stopped
KEW – UK operation
GoBiGas – Sweden stopped
Enerkem – Spain announced
Gidara – Netherlands
RWE – Netherlands
Salamandre – France
BioTFuel – France
ABSL - UK

Three approaches towards gasification for fuel production



Entrained flow gasification

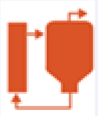
Entrained flow gasification is characterized by high temperatures, small particles and oxygen usage, aiming to produce syngas.

- RWE – Furec
- BioTFuel
- SkyFuelH_2
- Torrgas (not an exact fit)

Direct gasification

Direct gasification is characterized by fuel flexible, limited in scale, typical fluidized bed technology and oxygen usage, aiming to produce syngas.

- Enerkem
- Gidara
- ABSL – Swindon
- KEW



Indirect gasification

Indirect gasification is characterized by fuel flexible, semi-limited in scale, typical fluidized bed technology and **no** oxygen usage, aiming towards SNG production.

- Engie - Salamandre
- GoBiGas
- **TNO → MILENA**

Most direct approaches lead to syngas, subsequently used for H_2, MeOH or SAF production

Indirect approaches, focussed on CH_4 production

Syngas production is done in high temperature gasifiers!

Can an indirect gasifier be used for syngas production and if so, what would be the best approach?

Explaining gasification

Partial combustion of a feedstock, with the goal to generate heat that converts the remaining feedstock into gas.

Divisions can be made on:

Low – Medium – High temperature → *Temperature has a strong effect on the composition of the gas.*

Fixed bed – Fluid Bed –Entrained flow → *Determines to a large extend how the technology will be designed.*

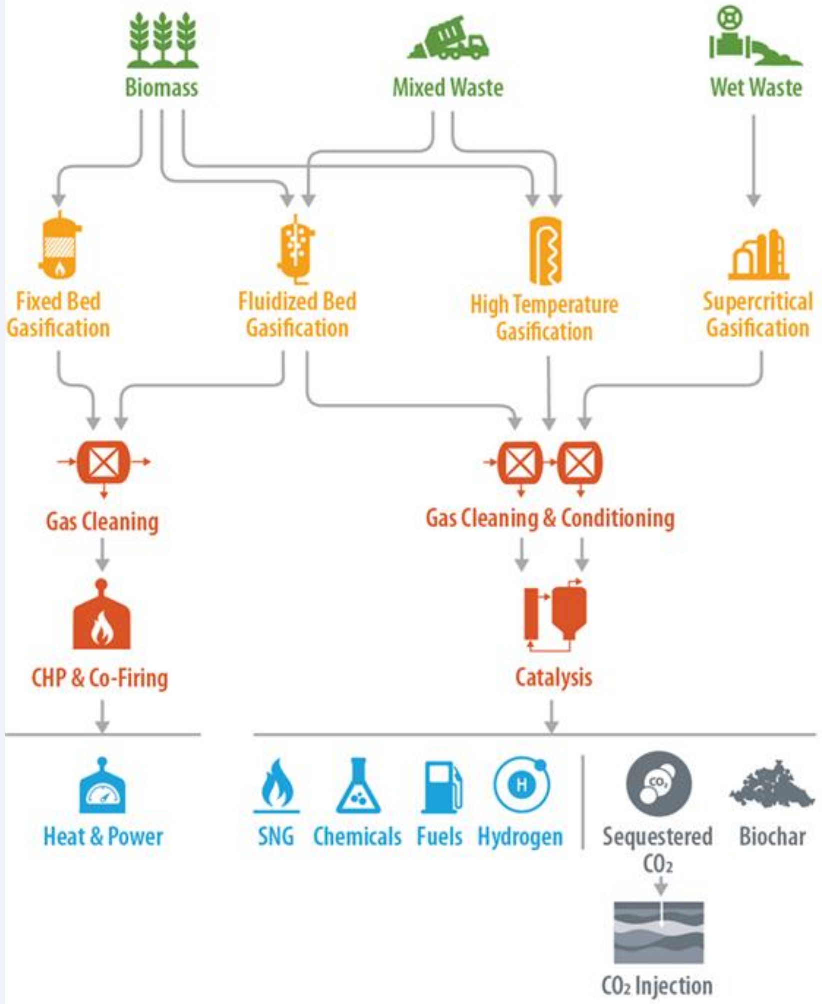
Direct vs. Indirect → *Heat transfer is done direct via combustion or transferred indirect (heat pipes or bed material). This has a strong effect on the quality of the gas.*

Applications based on gasification

- Heat and Power (CHP)
- Green Gas (SNG/RNG)
- Chemicals (overlaps with fuels)
- Liquid fuels (MeOH, DME, LPG, FT)
- Hydrogen (with CCS)

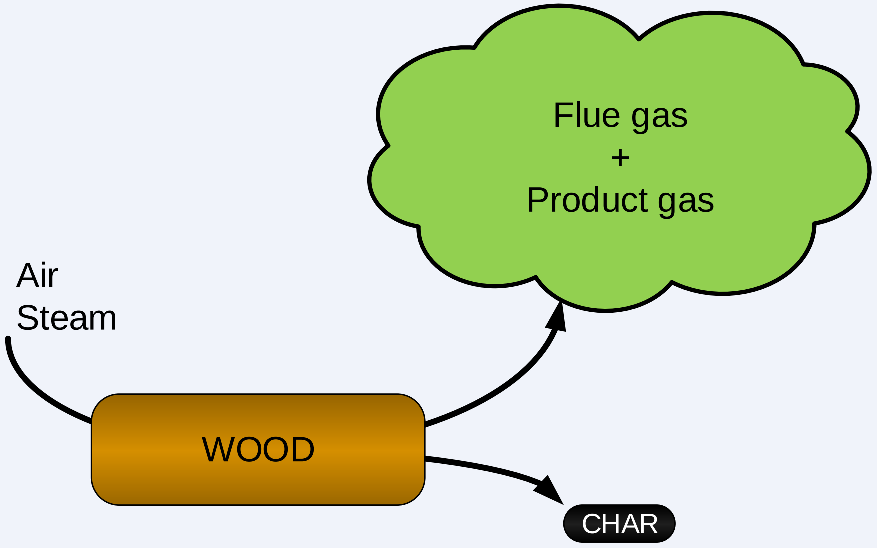
Large amount of different applications, since the technology utilizes a syngas intermediate.

Even more technology options for the gasification itself



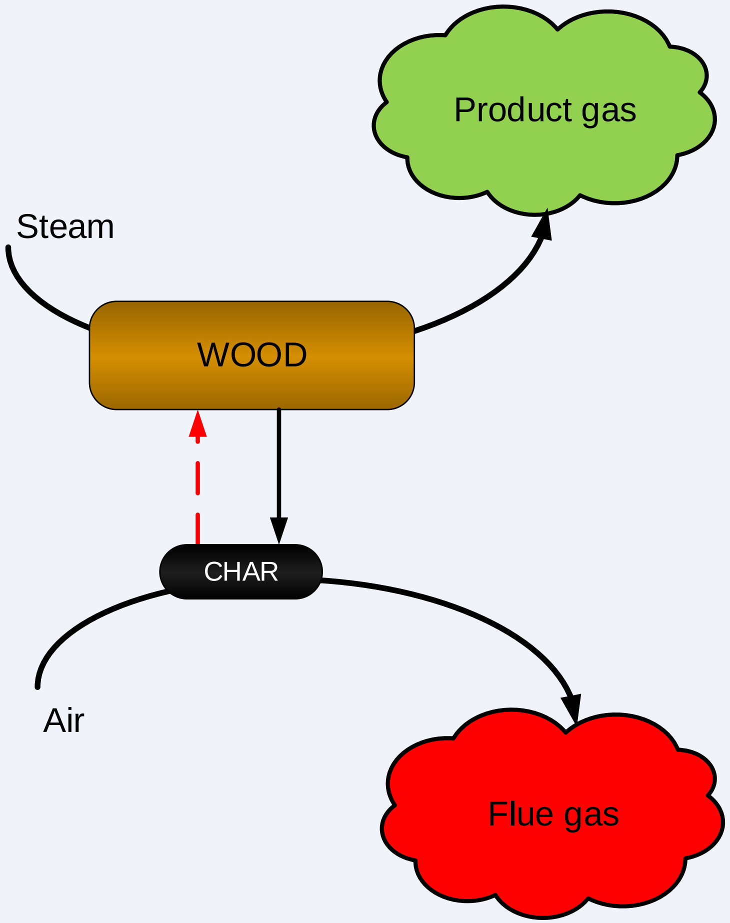
Direct vs. Indirect gasification

Direct gasification



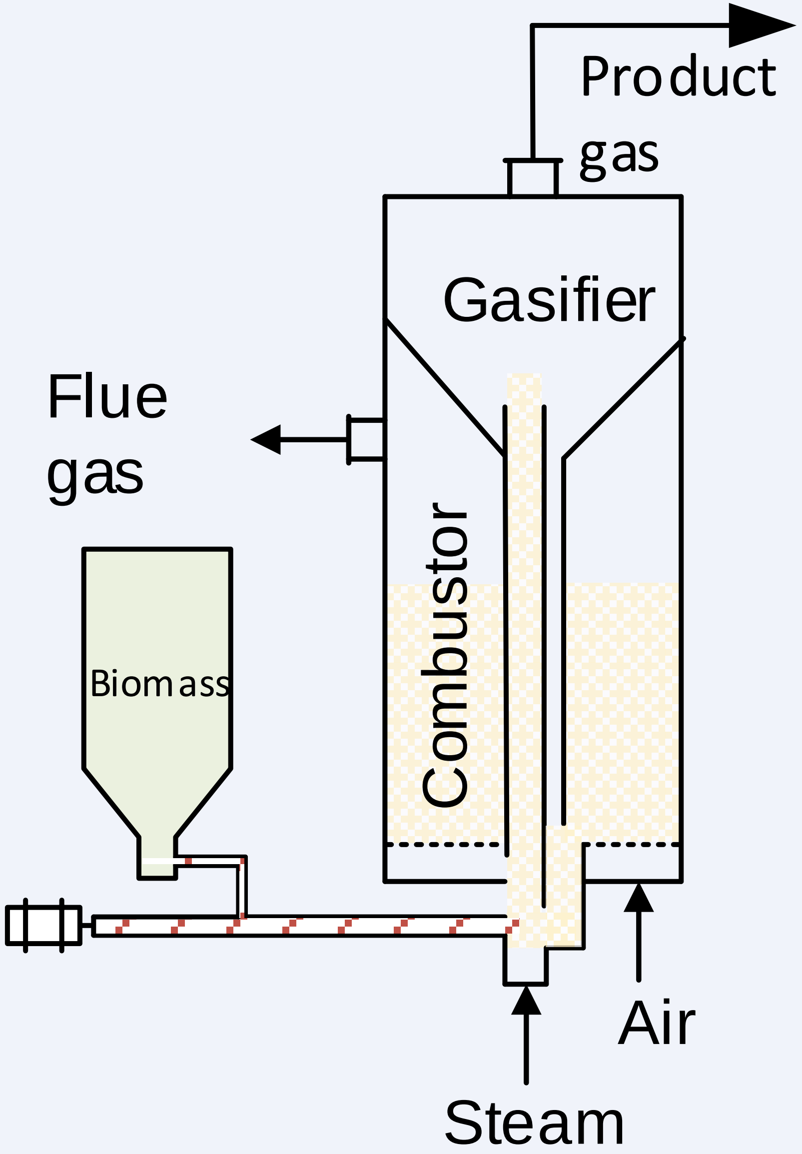
Heat + Feedstock (s) → Product (g) + Char (s)

Indirect gasification



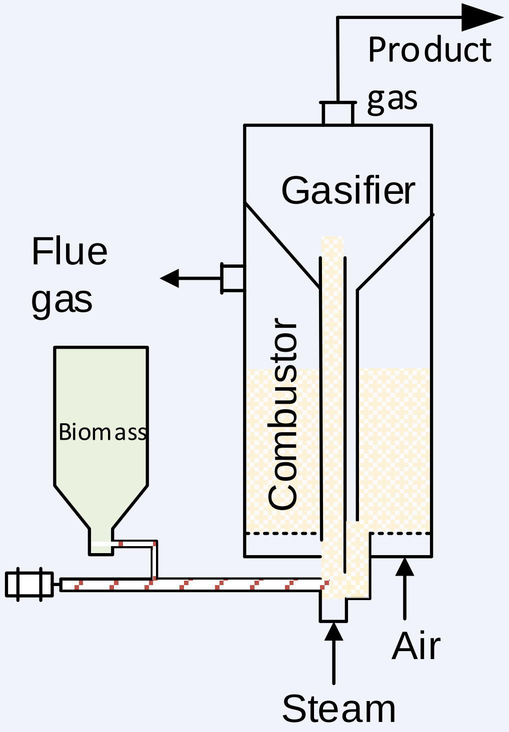
Heat + Feedstock (s) → Product (g) + CO_2 (g)

Indirect gasifier – MILENA



Indirect gasifier - MILENA

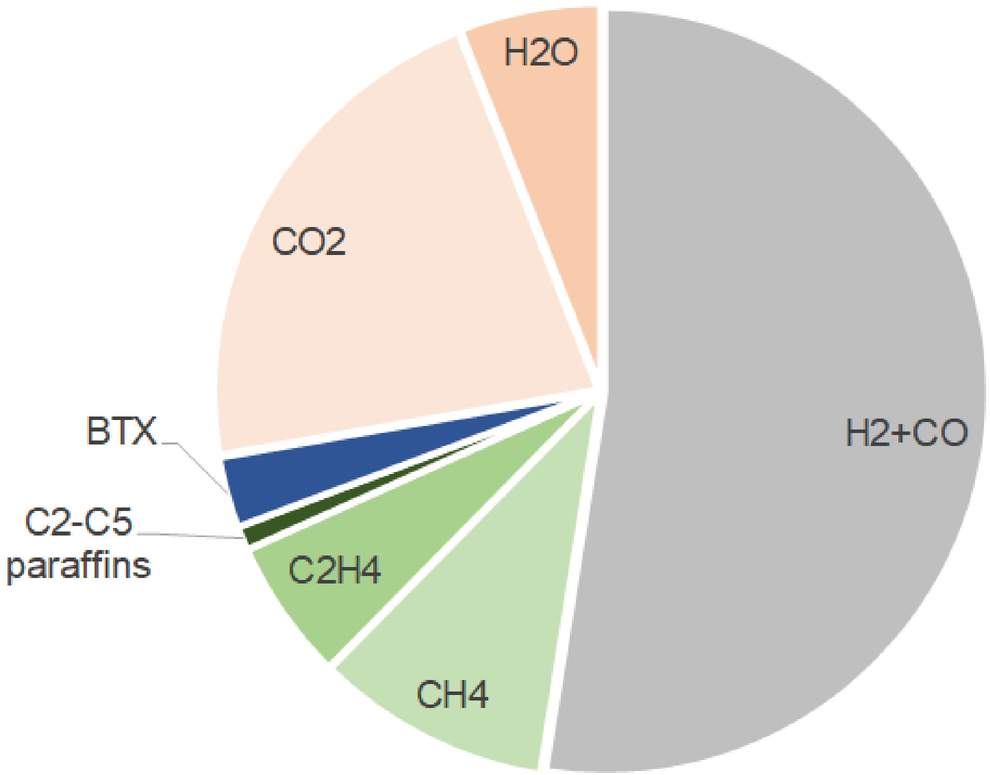
Characteristic	Description
Feedstock flow	6 kg/h max
Feedstock type (range)	biomass – RDF – plastic waste
Supply gases	N_2, CO_2, Air, Steam
Trace gases	Argon and Neon
Heating	Externally traced up to 900°C
Operating T	550 – 850 °C
Operating P	Atmospheric
Analysis	Product and flue gas



Features of indirect gasification

+ Complete feedstock conversion
+ High feedstock flexibility
+ Lower temperature levels in comparison to other syngas platforms
+ No oxygen required
+ Scalable, but economically interesting starting at small capacity (50 ktpa input)

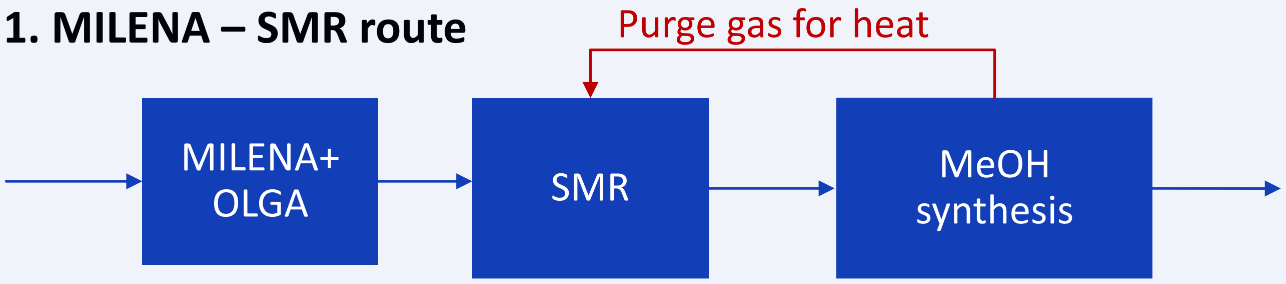
? Not a direct route to syngas



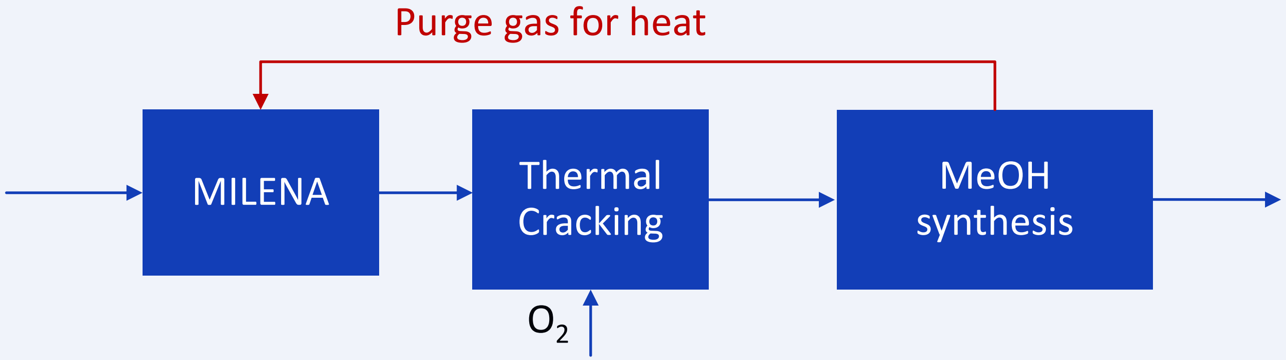
Quick scan on the economics

- Biomass is extremely heterogeneous, scattered and has a different cost price compared to fossil → Scale will be limited
- Comparison of two pathways based on indirect gasification
- Based on first reasonable scale of 30 MWth input (~ 50 kton/y demolition wood feedstock)

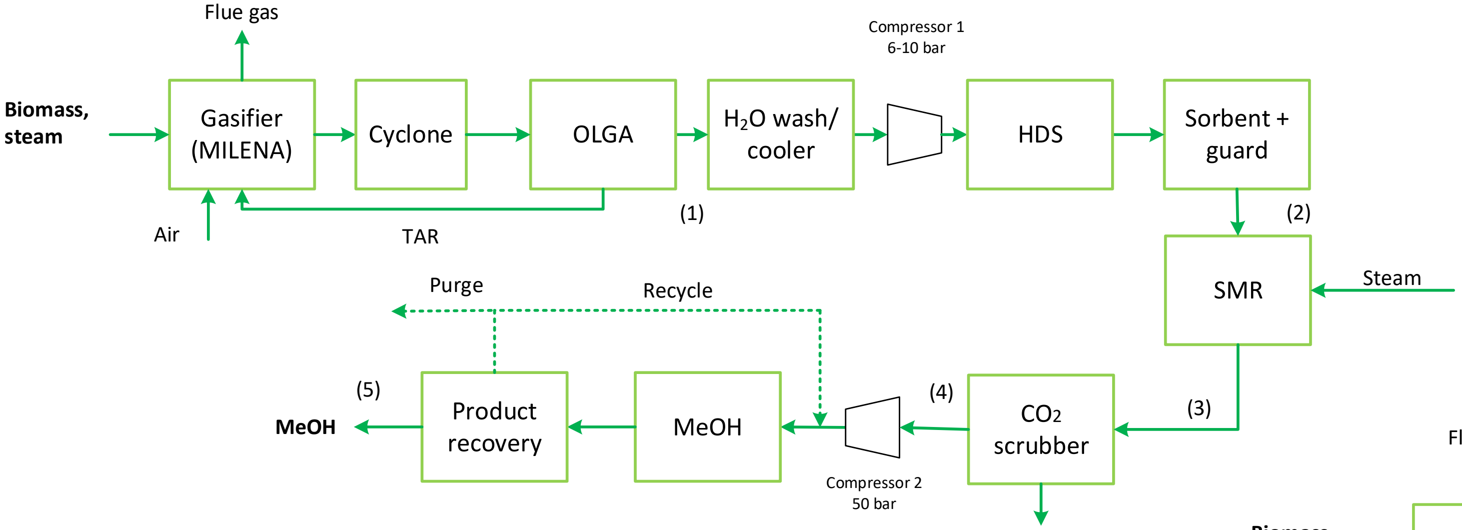
1. MILENA – SMR route

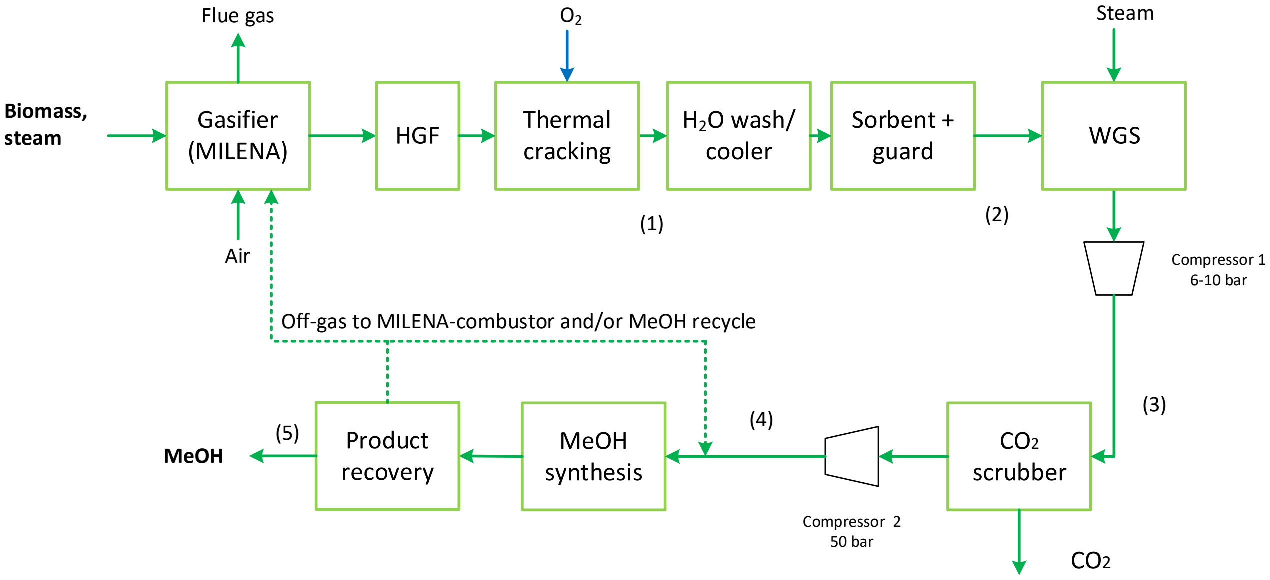


2. MILENA – Thermal cracking route

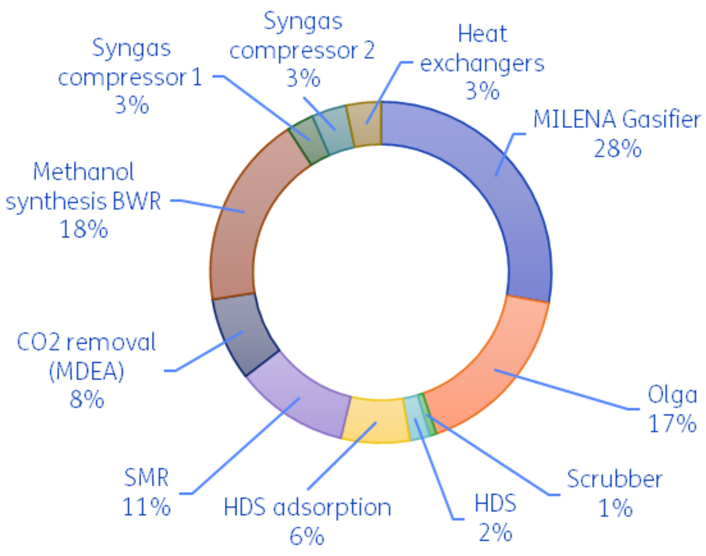


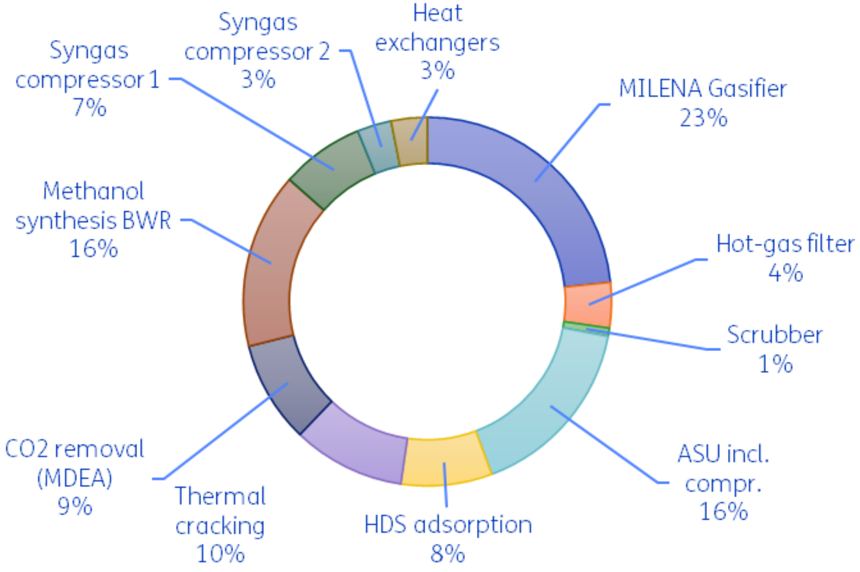
Two processes modelled in ASPEN





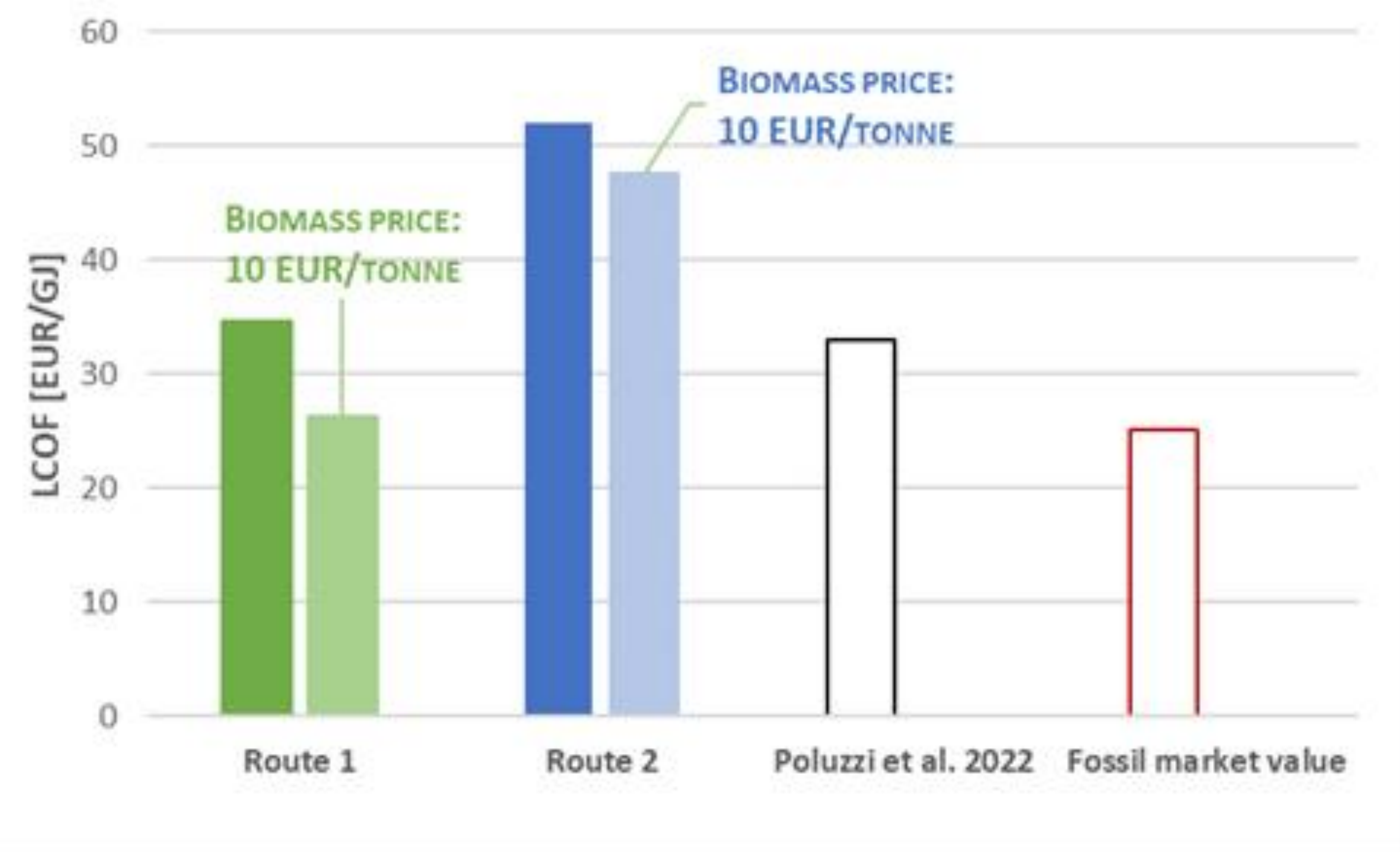
Results of a TEA between the two systems





Route 1 MILENA SMR	Route 2 MILENA Thermal cracker
CAPEX 55 M€	CAPEX 63 M€
Fuel efficiency 62%	Fuel efficiency 57.5%
LCOF ~34 €/GJ	LCOF ~51 €/GJ
	CAPEX higher due to ASU and syngas compressor OPEX higher due to larger power consumption

Comparison with other studies / fossil MeOH



a. Biomass in base case is 30% of the overall LCOF, with a reduction of feedstock price this will reduce significantly the LCOF.

b. The difference in CAPEX and efficiency translate to a big gap in LCOF for route 1 and 2.

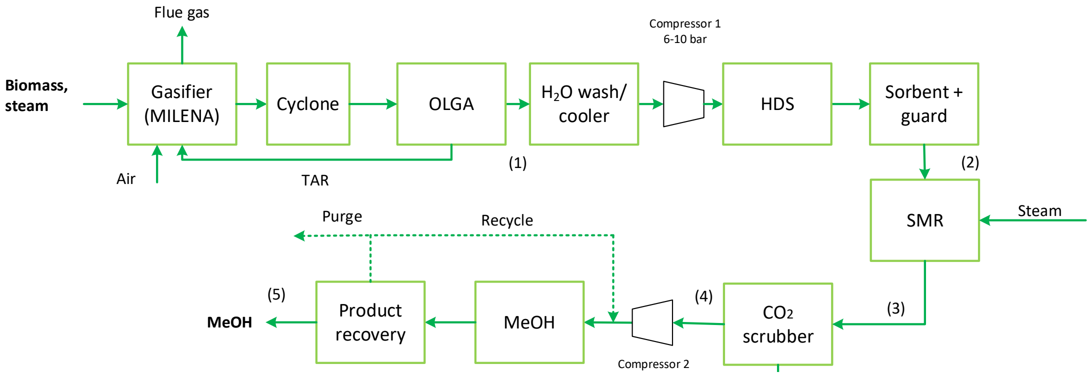
c. Study of Poluzzi includes direct (32,6 €/GJ) and indirect (34,2 €/GJ) gasification but both using and ASU to produce O_2. Both also at very large scale (300ktpa)

Quick scan results

- Two indirect pathways compared
- Distinct differences in CAPEX for both routes
- Distinct differences in overall efficiency
- Feedstock prices becomes more dominant when overall CAPEX is lower

The low temperature pathways to syngas (OLGA SMR) is looking more attractive from an efficiency and OPEX/CAPEX point of view

Image of a MeOH flame ;-)



Future outlook for MeOH production

- Focus on the processing steps after MILENA to generate the proper syngas quality for MeOH synthesis
- Develop a process design package
- Supporting LCA and TEA to identify weaknesses in the line-up
- Partnering to engage in a FEED study

Conclusions

- TNO has several technology under development for the production of advanced fuels and/or developments that aid in the line up towards advanced biofuels
- Indirect gasification is a feedstock flexible, small to medium scale attractive pathway to produce advanced biofuels
- TNO is looking for partnership to:
  - Help develop your specific pathway by providing access to state of the art lab facilities.
  - Co-develop indirect gasification based value chains toward MeOH (DME, FT, H_2 etc not excluded)
  - Co-develop the back-end solutions for synthesis of biofuels taking into account the limited availability of feedstock and hence smaller scale compared to fossil routes.

Thank you for your attention

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