



IEA Bioenergy
Technology Collaboration Programme



Actual trends in gasification technology

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TNO

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IEA Bioenergy Task 33 in the new triennium

Focus: Gasification of biomass and waste, and its application

What do we do:

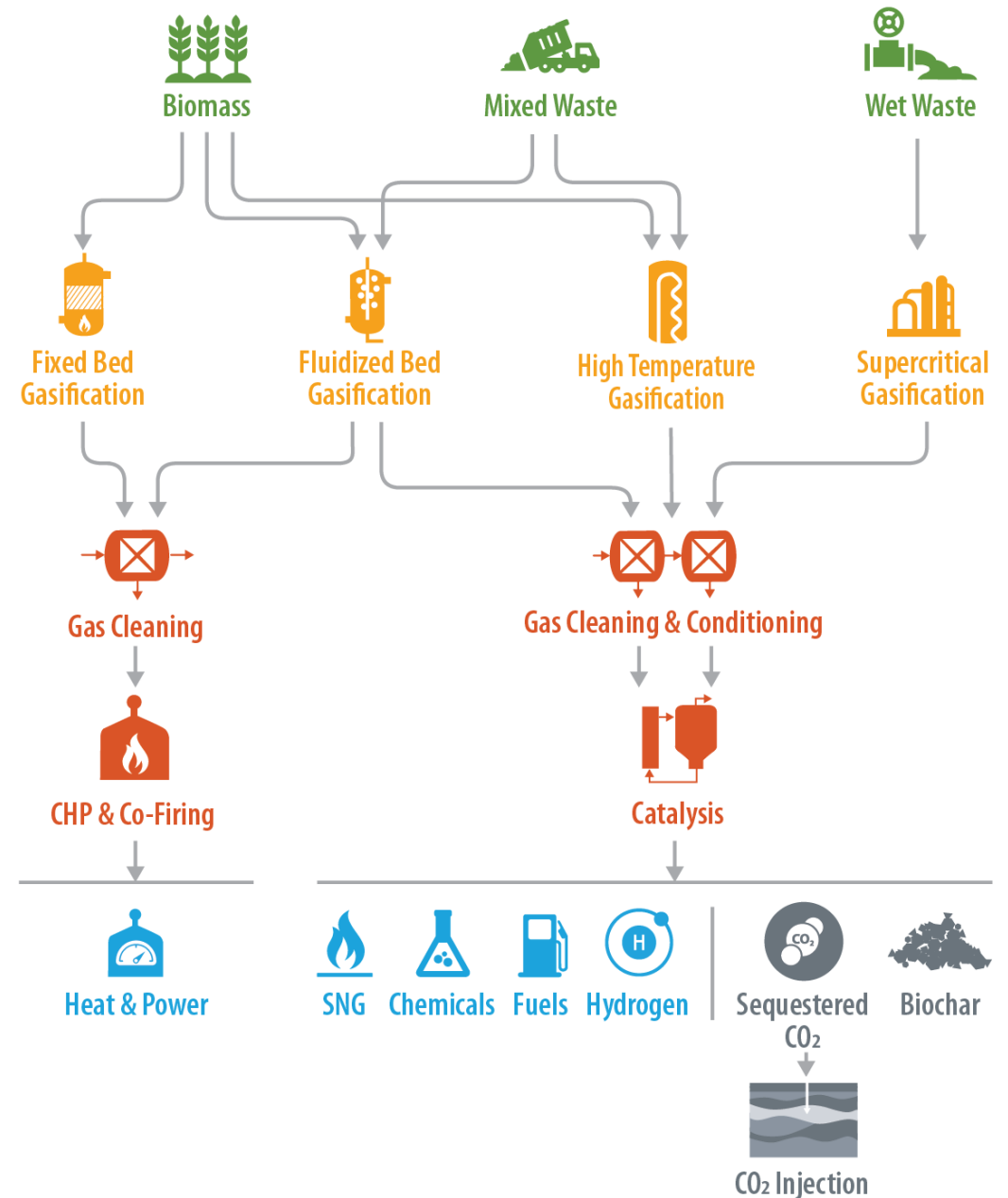
- Keep track of ongoing R&D developments and share this with our members.
- Keep track of commercial activities and provide a platform to disseminate information provided by our national technology providers
- Support the gasification community by developing relevant report.
- Aim to develop position papers to steer and influence policy makers to the benefit of the deployment of gasification technology

Gasification and applications!

We aim to develop comprehensive information on the various applications






We aim to highlight in particular the role gasification plays with respect to the GHG balance

We might increase the application topics if deemed necessary, special section on ammonia or syngas fermentation for instance.



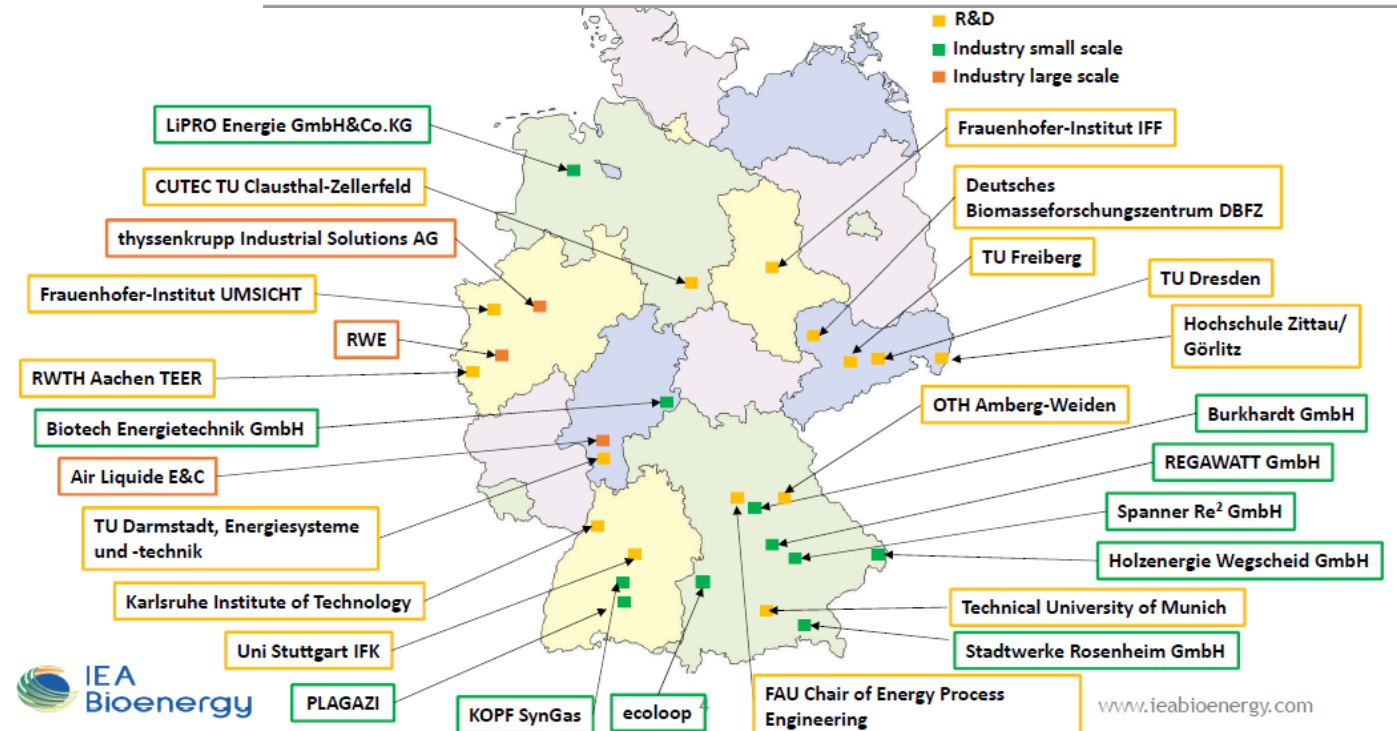
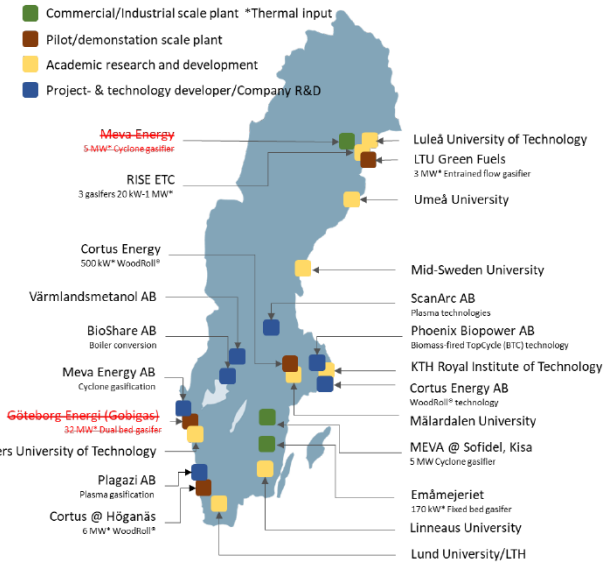
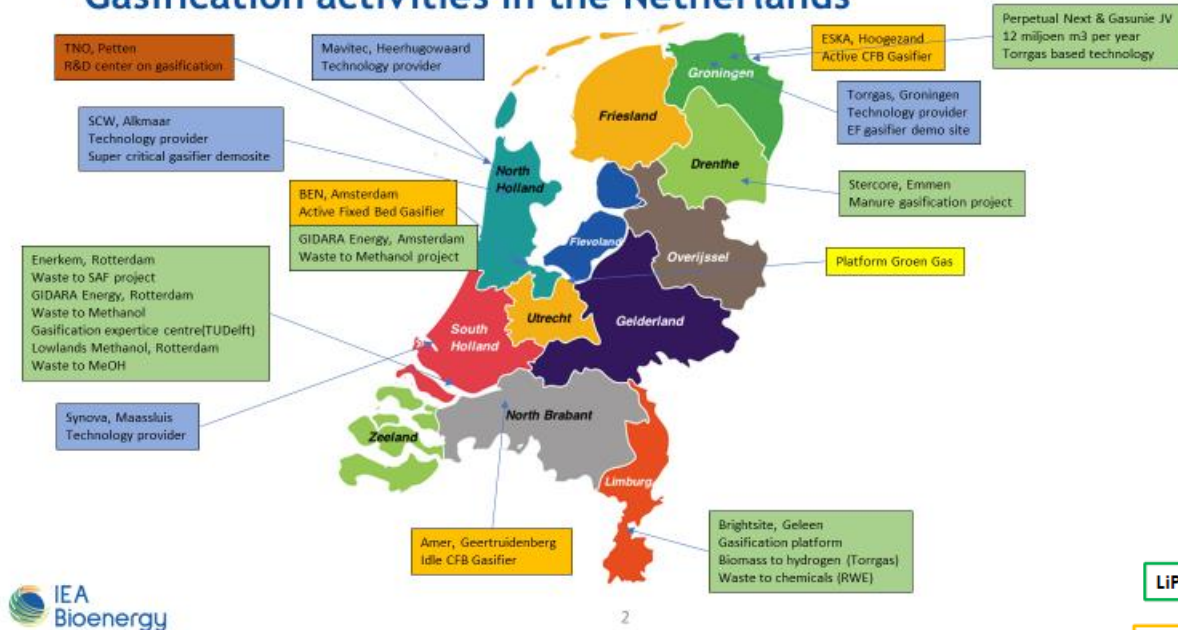
Who we are and who to contact

If you have information that you want to share and to support the deployment of gasification, contact your national contact point.

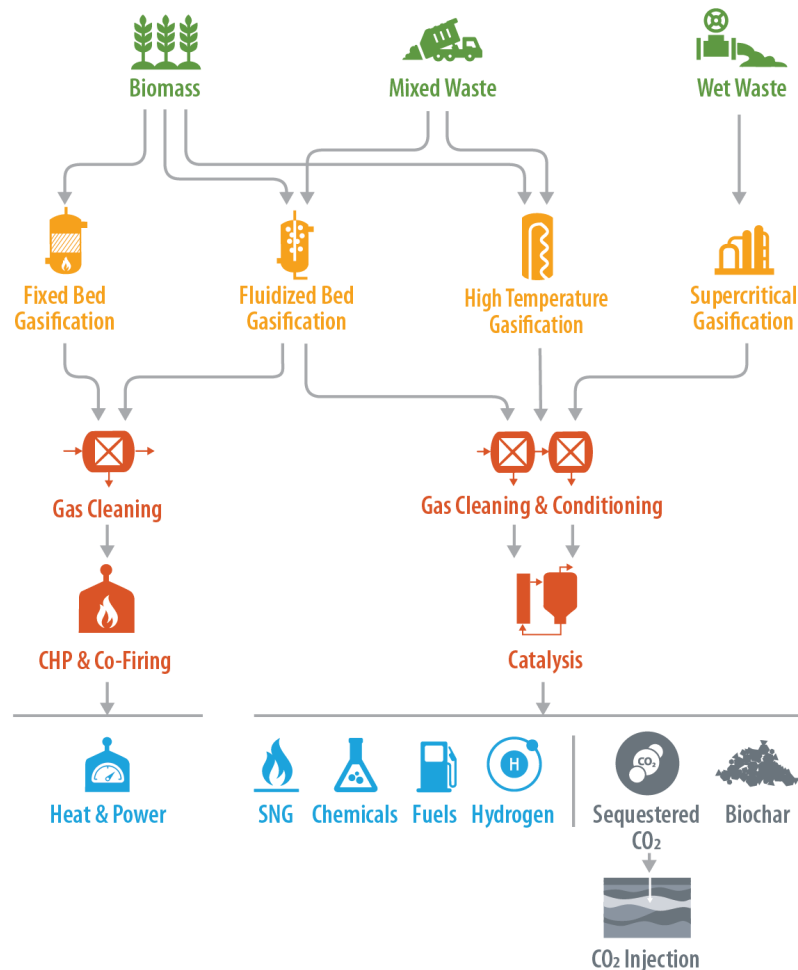
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What does it look like

Gasification activities in the Netherlands



Actual trends in gasification



- Heat and power is well established and still growing. Perhaps we see a boost now due to the war in Ukraine, however biomass prices are also increasing
- SNG or biomethane has a European mandate of 35 bcm, which **could** boost gasification pathways
- Chemicals and Fuels are a market that go hand in hand with FT and MeOH developments world wide
- Hydrogen is booming and we see some development in project based on gasification
- The Fact that biomass gasification can have significant impact on GHG emissions by generation of negative C-emissions is starting to get recognized and will change the playing field in the future.

Trends in CHP applications

Some numbers

- Germany has over 1000 CHP based gasification plants ~80 Mw_{el}
- Italy over 210 in total
- Austria over 140 in total
- India has ~660 MW installed gasification based capacity.

Large numbers for small capacity plants → however successful.

Trends in SNG applications



Observations with fuels/chemicals

MeOH and FT pathways both facilitate the advanced biofuel production and supply the chemicals market

Methanol

- Enerkem Edmonton
- Enerkem Varennes
- Enerkem Rotterdam → JETfuel
- Enerkem Spain Ecoplanta El Morell
- Gidara Rotterdam
- Gidara Amsterdam
- Lowlands Methanol

Fischer Tropsch

- Red Rock Biofuels
- Fulcrum Bioenergy
- Bayou Fuels
- BioTFuel

Fulcrum



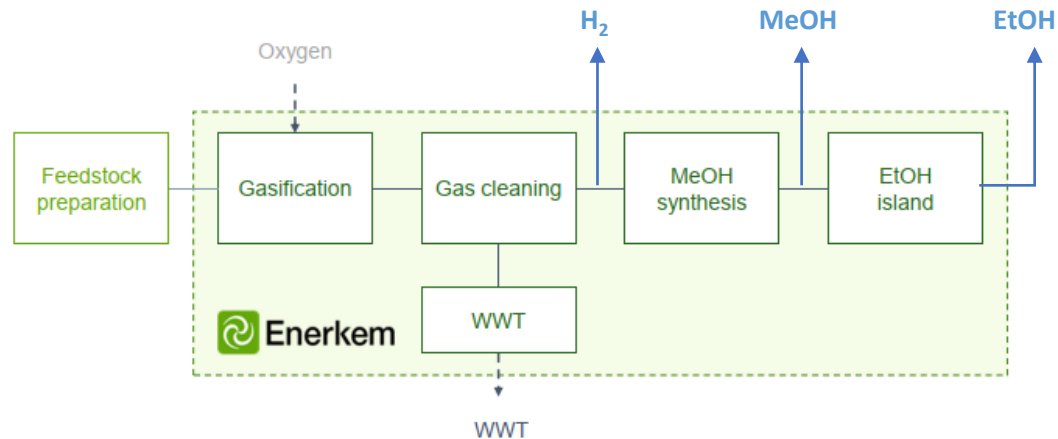
Fulcrum Bioenergy/Sierra Biofuels, Reno NV: (11MM GPY)

- 1) MRF operational since 2016; at landfill 10 miles from biorefinery
 - a) 350,000 tons per year raw MSW => 175,000 tons per year prepared MSW
 - b) 20 TPH throughput
- 2) Gasification/FT
 - a) MSW feedstock/TRI indirectly heated fluid bed steam reforming gasifier
 - b) Johnson Matthey DAVY™/BP fixed-bed FT
- 3) Phase I is for Fischer-Tropsch wax
 - a) Wax to be refined by Marathon
 - b) Other offtakers include United and Cathay Pacific, BP Air, World Fuels
 - c) FT jet fuel capability to be added in Phase II
- 4) Plant is 'full scale'; scale up (3X) planned with parallel trains
 - a) 12 new projects currently planned/underway
- 5) Status: Plan now undergoing start-up operations



Technology Status:

- TRL9, commercial roll out
- > 25,000 hours of operation
- Feedstocks:
 - Pure plastics
 - Construction & Demolition (C&D)
 - RDF
 - Industrial, Commercial, and Institutional (ICI)
 - Biomass
 - Agricultural and forestry residues
- Commercial plant in Edmonton, Canada
 - 90 MWth producing IMPCA methanol and ASTM Ethanol
- Best of class carbon intensity
 - **Lowest carbon intensity on BC LCFS regime**
- Commercial syngas, hydrogen, methanol, and ethanol platforms



Rotterdam, Netherlands: project undergoing a review

- 400,000 tons of non-recyclable municipal solid waste
- Original project was a 220,000 tons of methanol per year
- Project under-review to determine feasibility of drop-in fuels production; i.e. coupling syngas to drop-in fuels technology package

Other Project Status:

Varenes Montreal, Canada: project in construction

- Partners: Shell, Suncor, Proman
- 200,000 tonnes per year of non-recyclable residual waste and wood waste
- annual production of nearly 125 million litres of low carbon fuels
- <https://www.shell.com/energy-and-innovation/new-energies/new-energies-media-releases/shell-invests-in-quebecs-first-waste-to-low-carbon-fuels-plant.html>

Tarragona Spain : project in engineering design

- Partners: Repsol, Suez
- 400,000 tons of non-recyclable municipal solid waste from its surrounding regions
- 220,000 tons of methanol, contributing to avoid 200,000 tons of CO₂ and reducing the waste that ends up in the landfill
- <https://www.bioplasticsmagazine.com/en/news/meldungen/20210430-Repsol-to-join-Enerkem-and-Agbar-on-waste-to-chemicals-plant-project-in-Tarragona.php>



WASTE-TO-JET ROTTERDAM

- Type: Commercial facility with two production lines
- Input: ~360,000 metric tons per year (2x standard Enerkem system)
- Feedstock: reject fractions from waste recycling plants
- Benefits: 70% reduction in GHG emissions
- Output: Up to 80,000 tons of renewable products
- Product: Sustainable Aviation Fuel (75%), Naptha





Enerkem



VCR

Varenes
Carbon
Recycling

VARENNES CARBON RECYCLING (VCR)

Capacity: 125 million litres of MeOH per year
(1x standard Enerkem system with H2 import)
includes 87 Mwe electrolyser supplying H2 and O2

Feedstock: 200,000 dry tonnes of non-recyclable waste

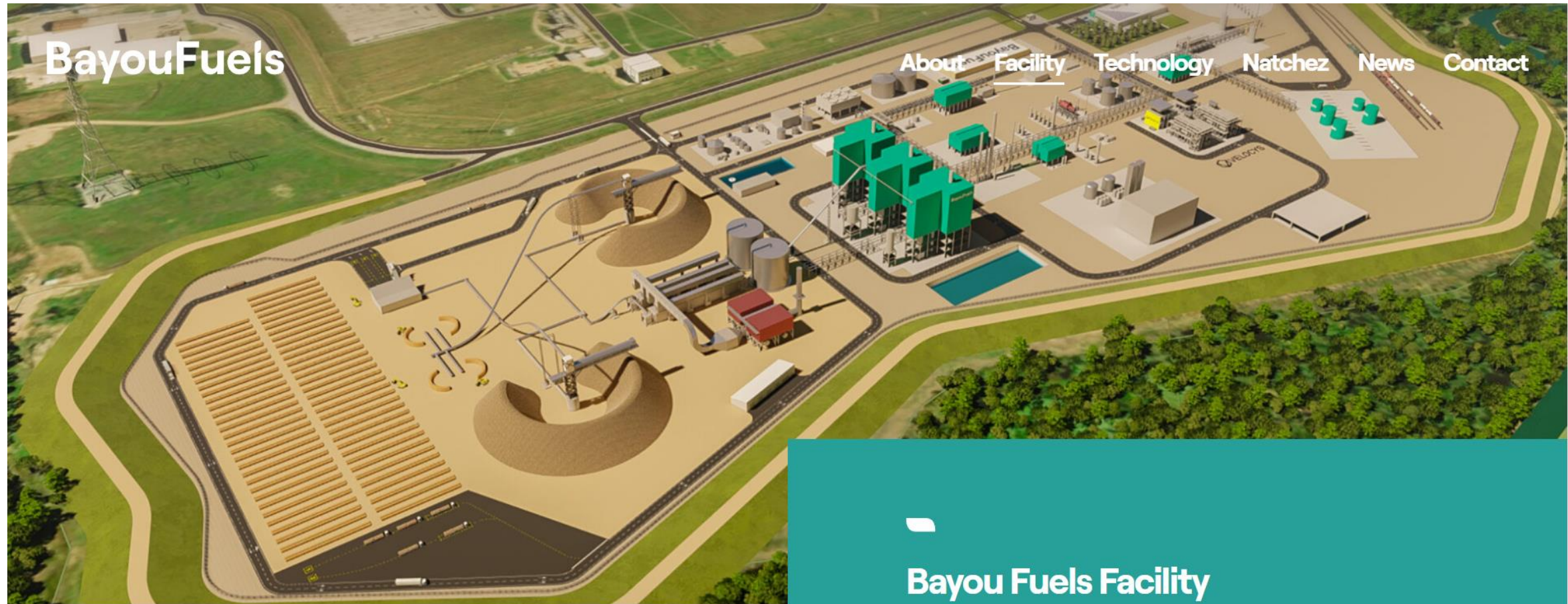
Other benefits: 500 jobs during construction
100 permanent direct skilled operational roles
CAD \$85m of annual benefits for Québec



Status end of 2020



Bayou Biofuels - Velocys



Forest residues to produce 25 MM GPY

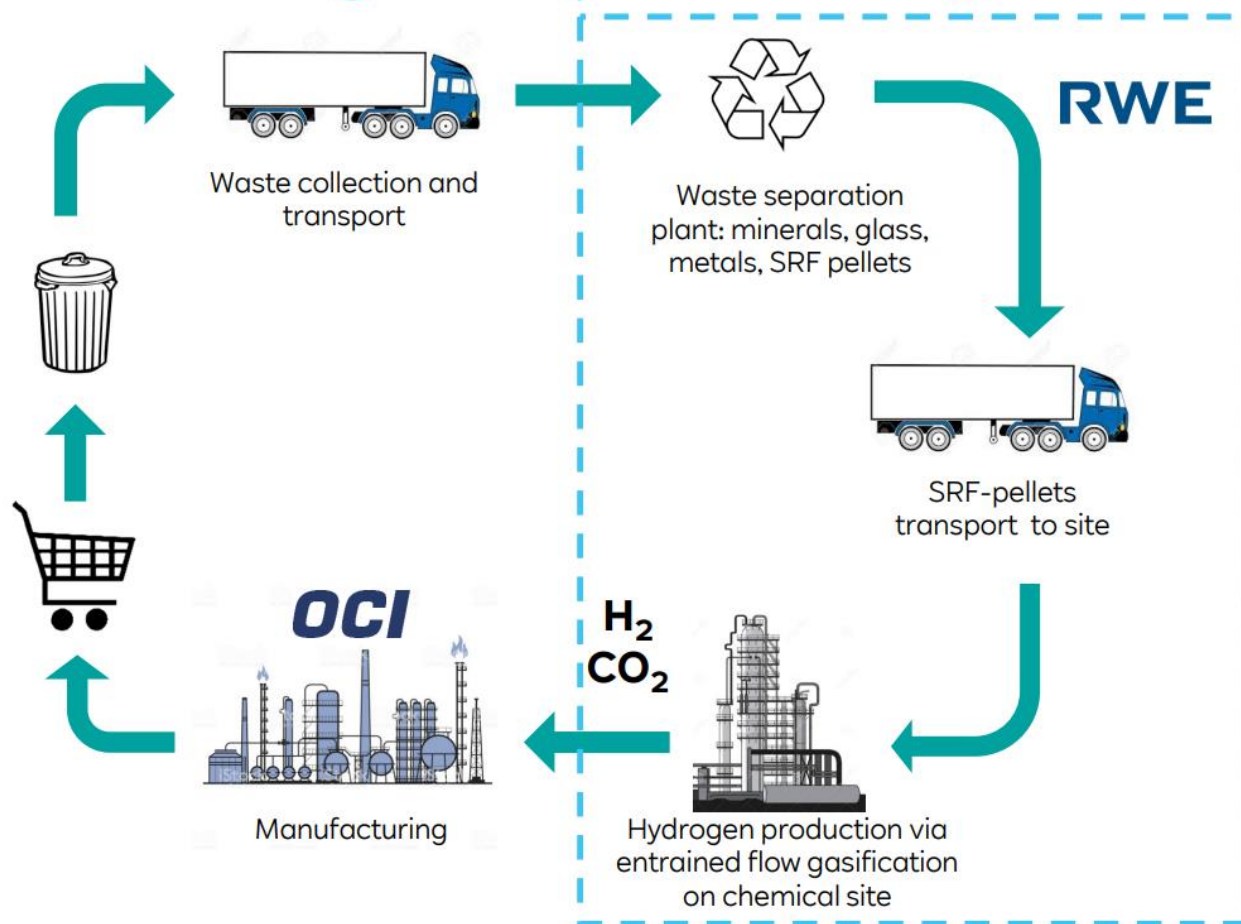
Hydrogen the underdog?

- Basically any syngas platform can be tuned towards maximizing hydrogen, there is no difficulties in tuning the CO:H₂ ratio
- Value is in carbon

- RWE - FUREC
- Torrgas - BrigH2
- Plagazi
- Several others

Furec - RWE

Waste-to-hydrogen produces green and circular hydrogen Contributing to Project FUREC („Fuse Reuse Recycle“)



Project typicals

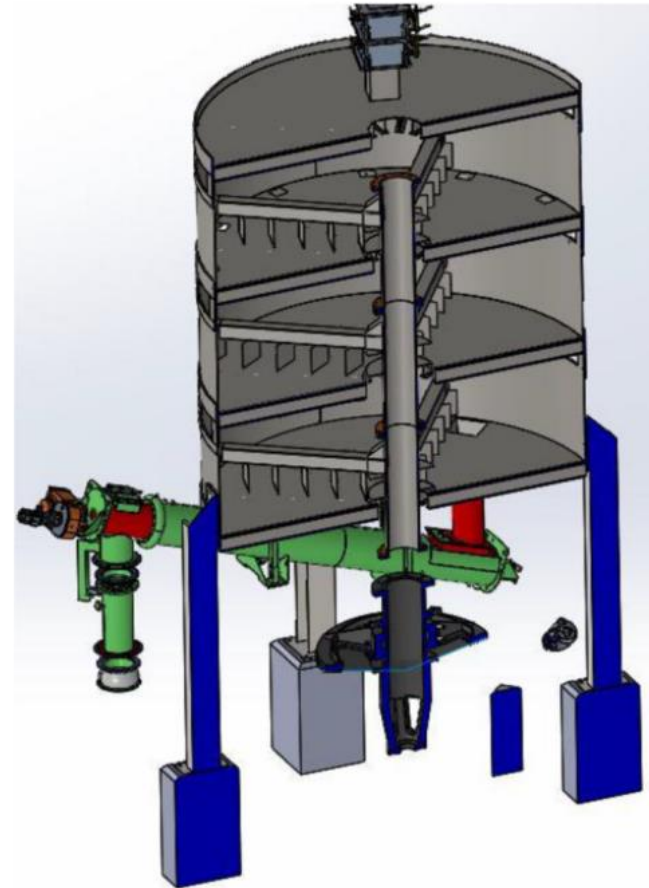
- Processing of Municipal Solid Waste and dried sewage sludge (700.000 t/a)
- Production of hydrogen (≈50.000 t/a)
- CO₂ reduction:
 - 475.000 t/a @ 0 kg/MWh Power
 - 330.000 t/a @ 180 kg/MWh Power
- 800.000 t/a of CO₂ pure, ready for CCS/CCU
- Estimated investment: >500 M€
- Other positive value products: minerals / glass / metals / slag / sulfur / salt
- Commissioning: 2026

Permitting in progress
Planning on track
Engineering started
Pilot MHF
construction started

Furec - RWE

Multiple Hearth Furnace Pilot Plant Design Basics and next steps

- Low Temperature Pyrolysis (Torrefaction) of lumpy Feedstock @ 260-320 °C in order to enable grinding of fuels like
 - Biomass or
 - Pelletized RDF
- for Entrained Flow Gasification (FUREC, MFC-Plant)
- Size: $D_o = 4 \text{ m} \mid H_t = 9 \text{ m}$
- Input: 240 kg/h
- Output: ca. 140 kg/h char
- Heating: Indirect via Thermal Oil
- Schedule: 09/21 – Order placed at John Cockerill SA
11/22 – Start of assembly on site
04/23 – trial run



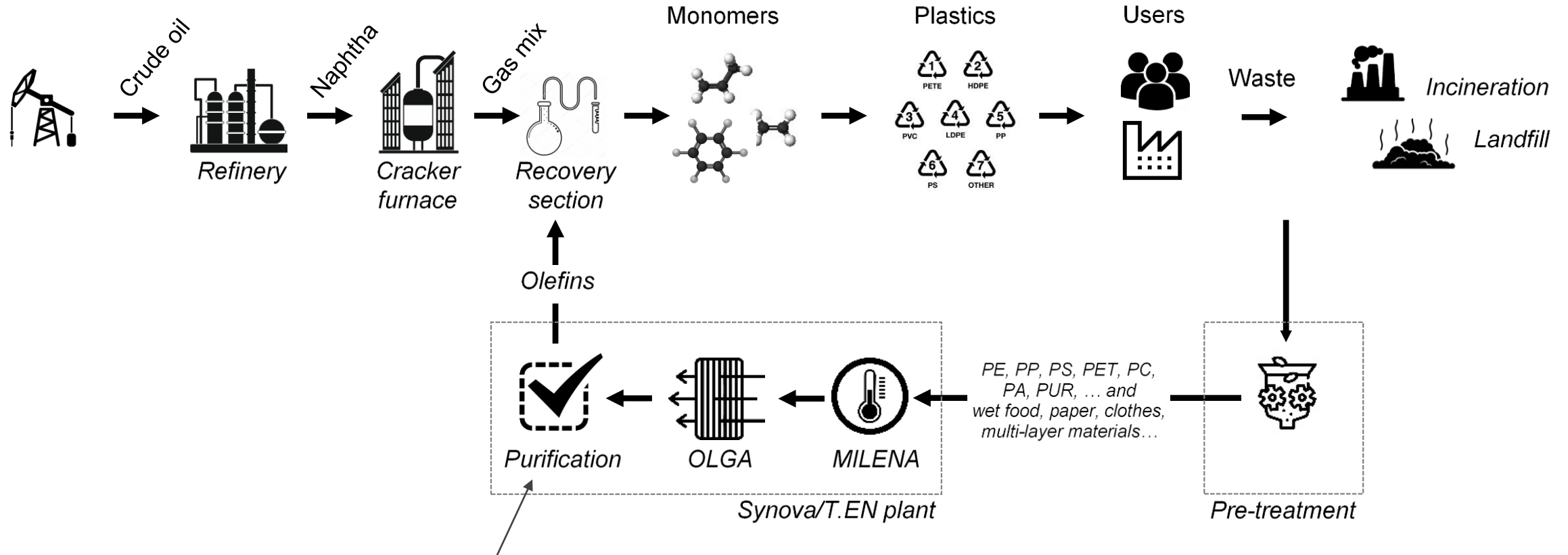
Other developments

1. Mixed plastic waste recycling
2. Dedicated plastic recycling
3. Gasification to fertilizer or to food



Olefy from VTT announced something on plastic recycling august 2022

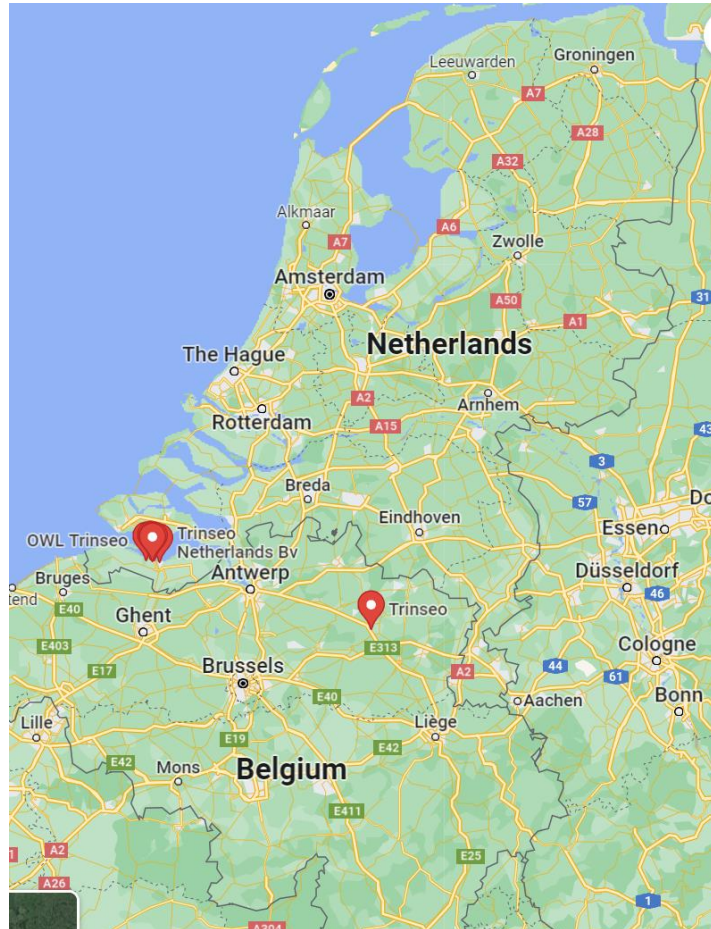
SYNOVA/T.EN's SOLUTION REPLACING THE CRACKER FURNACE



SYNOVA joins forces with Technip Energies (T.EN)
<https://synovatech.com/?s=technip.html>

POLYSTYRENE DEPOLYMERIZATION for TRINSEO

<https://investor.trinseo.com/home/news/news-details/2022/Trinseo-Chemical-Recycling-Plant-on-Track/default.aspx>



MILENA for PS-depolymerization:

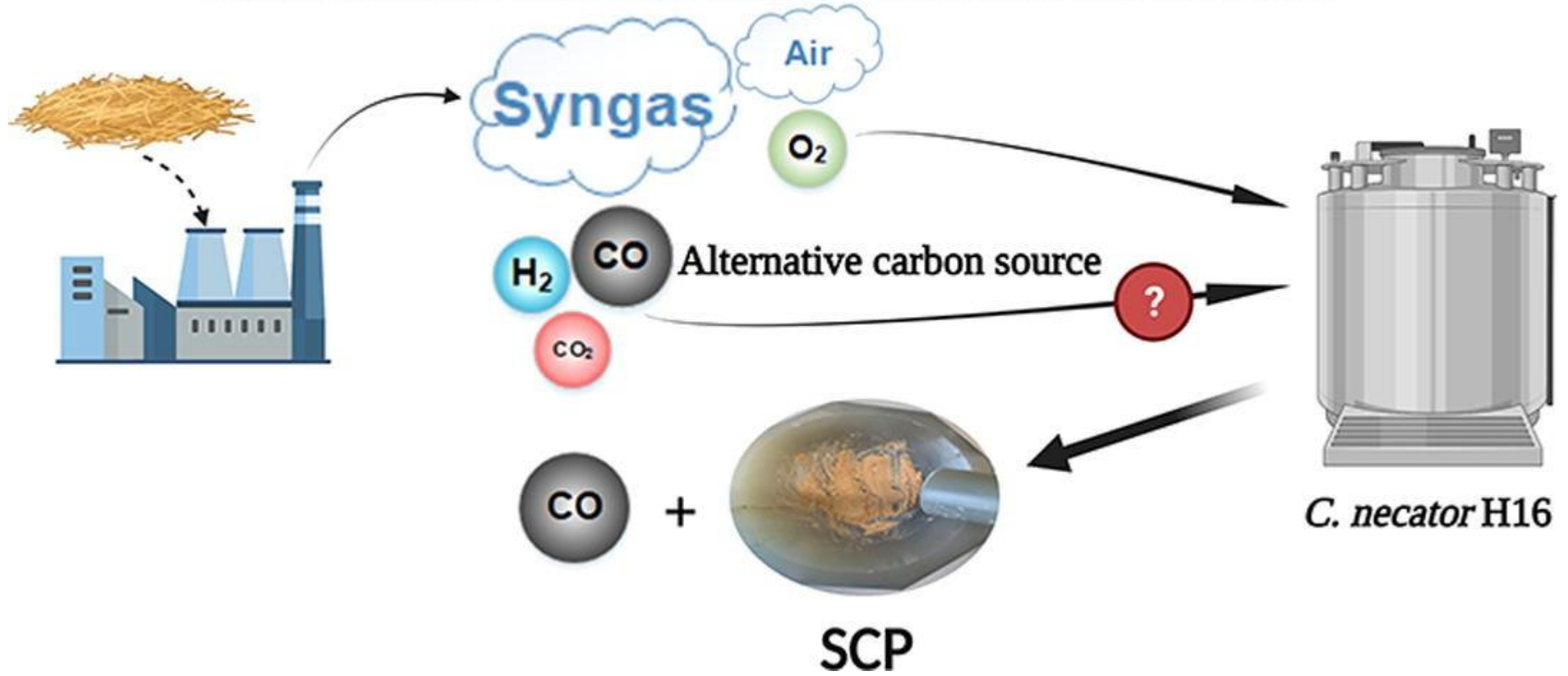
- 2 ton/h polystyrene-rich waste input capacity
- Trinseo, Tessenderlo (Belgium)
- Start construction late-2022
- Recycled PS (rPS) production

- MILENA technology prevents over-cracking and maximizes styrene liquid yield



TRINSEOTM

Syngas to Single Cell Protein



Concluding remarks

The energy and materials transition seems to forget that most of what we have today is based on carbon!

It is therefore essential to keep carbon in the loop.

However, other stimulants/driving forces may support a different application of biomass and waste.

Things we decide today will affect what we do the coming 25 years.

Keep thinking and keep asking

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www.ieabioenergy.com

Wrap up

- Gasification → Feedstock (wood, manure)
- Gasification → Products (SNG, BTX, CHP, Char,

- Gasification to deal with waste streams (manure)

- Maire Tecnimont