IEA Bioenergy
Technology Collaboration Programme

Task 33 Country report The Netherlands

April 2023

Berend

Canada / Online via Teams

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Gasification activities in the Netherlands

TNO, Petten
R&D center on gasification

Mavitec, Heerhugowaard
Technology provider

ESKA, Hoogezand
Active CFB Gasifier

Perpetual Next & Gasunie JV
12 miljoen m3 per year
Torrgas based technology

Torrgas, Groningen
Technology provider
EF gasifier demo site

SCW, Alkmaar
Technology provider
Super critical gasifier demosite

Stercore, Emmen
Manure gasification project

BEN, Amsterdam
Active Fixed Bed Gasifier

GIDARA Energy, Amsterdam
Waste to Methanol project

Enerkem, Rotterdam
Waste to SAF project
GIDARA Energy, Rotterdam
Waste to Methanol
Gasification expertice centre(TUDelft)
Lowlands Methanol, Rotterdam
Waste to MeOH

HoSt,
Technology provider

Platform Groen Gas

NettEnergy, Boskoop
Technology provider

Synova, Maassluis
Technology provider

Amer, Geertruidenberg
Idle CFB Gasifier

Brightsite, Geleen
Gasification platform
Biomass to hydrogen (Torrgas)
Waste to chemicals (RWE)

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THE

G R E E N E S T

PRODUCTION COMPANY FROM THE NETHERLANDS

from bio-based residual materials to renewable, natural raw materials

STERCORE BV

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PROJECT PARTIES INVOLVED

provincie Drenthe

GasTerra

gasunie new energy

Tauw

New Energy Coalition

EnTranCe ENERGY TRANSITION CENTRE

GETEC PARK.EMMEN

DUURZAAM DICHT BIJ RENDO

MEILOF SMILDE
LOONBEDRIJF MESTDISTRIBUTIE TRANSPORT
Rijksweg 246 | 9423 PH Hoogersmilde | tel. 0592 - 459254 | www.meilof-smilde.nl

DNV·GL

gtl europe

Proud Partner of mushroom valley

rijksuniversiteit groningen / faculteit economie en bedrijfskunde

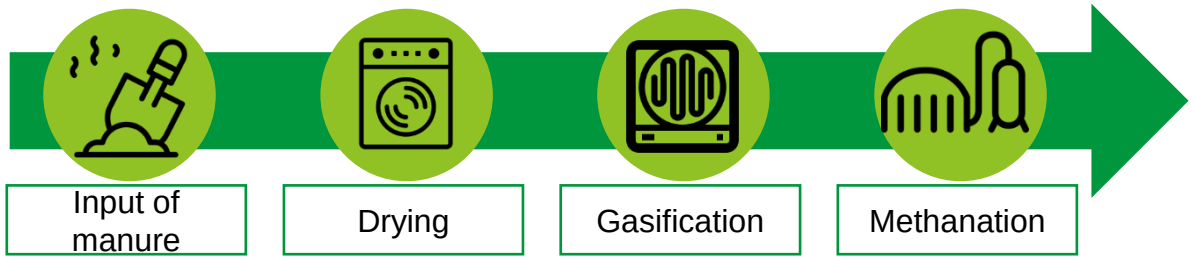
STERCORE at a glance

STERCORE *has developed a profitable production process that can have a real impact on the energy and sustainability transition*

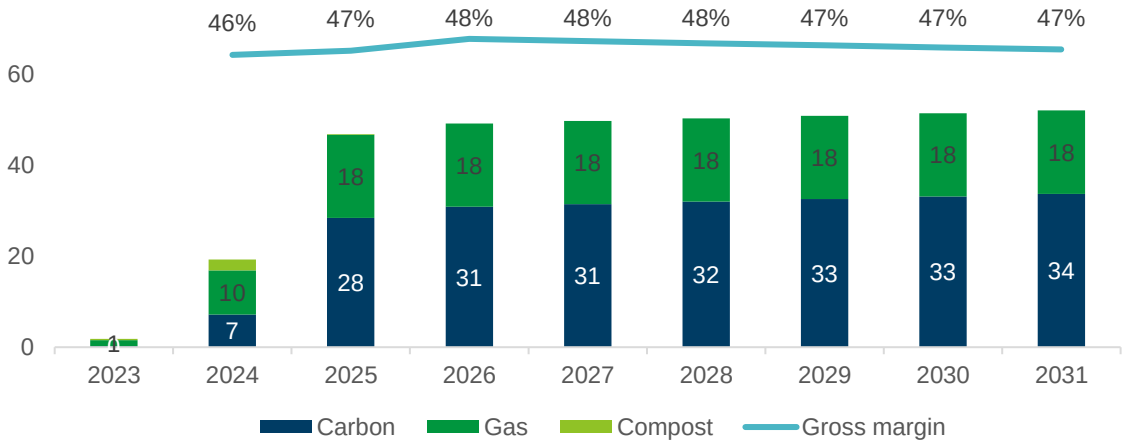
Description

- The two primary products of STERCORE are Bio-Based Carbon and green gas. Other products include liquid CO2, compost, and residual heat.
- After scaling up to 8 reactors, the factory of STERCORE in Emmen will realise approximately €50 million in revenues annually and achieve a strong gross margin of 48%.
- After the factory in Emmen has proven to be successful, further expansions are planned in the Netherlands as well as abroad.

Process flow



Revenues and gross margin development (€m)



Products

Green gas

Bio-Based Carbon

Other

Historical and planned future timeline

2016
- Founding of STERCORE by Hans Jansen and Richard Kusters in november

2017
- Testing Proof of Concept with Gasunie, GasTerra, DNV.GL, Meilof, Entrance, New Energy Coalition, and others.

2018
- Green Deal with the province of Drenthe to carry out a feasibility study to build a factory in Emmen. Cofinancing by Gasunie, GasTerra, RENDO | N-TRA, Meilof and others.

2019
- Green Deal with the province of Drenthe to build a test and adjustment installation in Emmen. Cofinancing by Gasunie, GasTerra, RENDO | N-TRA, Meilof and others

2021
- Permit granted to build a plant in Emmen
- Preparing Technical and Economical Due Diligence
- Selecting equipment and suppliers, getting quotations and starting engineering
- 1st purchase contract Bio-Based Carbon signed

2023
- Start building 1st phase of the plant in Emmen
- Irrevocable permit granted

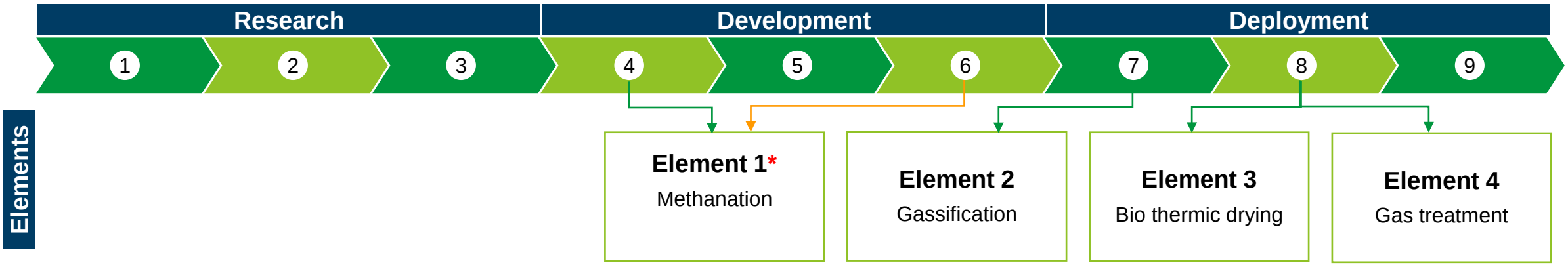
2024/2025
- Operational 1st phase plant Emmen
- Start scale up with 6 additional reactors
- Start rollout company

2026
- Completing phase 2 plant Emmen
- Start building 2nd plant Gernamy

2035
- 3 STERCORE factories in The Netherlands
- At least 15 STERCORE factories in other EU countries
- At least 18 STERCORE factories worldwide

Technical Due Diligence

Technology Readiness Level (TRL) STERCORE



Description

- STERCORE's production process consists of several individual elements which can operate independent of each other and have a TRL of 7+
- Only a single element of the methanation process has a relatively lower TRL. This element has been well-tested but is not yet operating on industrial scale resulting in the lower TRL level
- STERCORE works together with well known suppliers with a good track record to get maximum support
- STERCORE is a system integrator who combines proven technology with an innovative twist to get maximum results
- The management of STERCORE is highly experienced in the field of expertise its active in

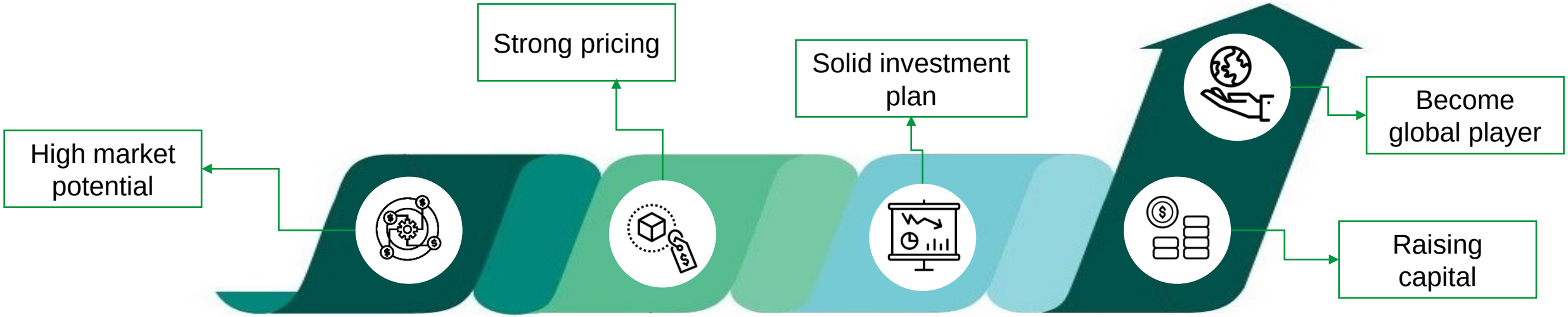
Results Technical Due Dilligence DNVGL

- Elements have a high technology readiness level, however that will not guarantee success for using the elements as a whole, the combined technique is new
- Full TDD report is available upon request
- Opportunities and threats are listed in the following slides, as well as their implications and proposed actions.

No	Low	Medium	High
No material risk identified and no action required	Risk identified that has been mitigated or where the risk level is low	Identified risk to be mitigated, risk can be material	Potentially big impact, mitigation is required

The modular methanation concept is currently being further developed on a multiple scale through a project with Gasunie, GasTerra, DNV and STERCORE. The project costs are approx. € 400K and will bring the TRL status to TRL 6. The development of this modular technology is also important for other initiatives as methanation is currently only available for the professional oil and gas sector.

Economic Due Diligence



Description

- Business economic analysis displays the financial forecast and describes the investment needs. All of STERCORE's financial assumptions are evaluated in this part.
- Commercial analysis: evaluates the way in which STERCORE puts the product on the market and the choices that STERCORE makes concerning product, pricing, promotion and location of the company. In addition, it describes the industry, the competition and the target group.

Results Economic Due Diligence KplusV

- STERCORE can acquire a position in the market and meet its budget, however given the innovative nature of the project, the aimed equity/loan capital ratio is unbalanced.
- EDD report is available upon request
- The components of the analysis are criticized using the following method:

	Red light	Great risk - not or difficult to mitigate
	Orange light	Medium risk - can be mitigated
	Green light	Limited risk - no mitigating measures necessary

STRATEGIC VALUE CREATION & SDGS | LIFECYCLE ANALYSIS

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‘This LCA indicates that with STERCORE’s current system a minimum of **2.126,3 ton** CO2-eq and a maximum of approx. **22.272,1 ton** CO2-eq will be emitted from well to wheel.

This is an impact potential of min. **-227.961 ton** CO2-eq and a maximum potential of **-345.014 ton** CO2-eq in avoided emissions.

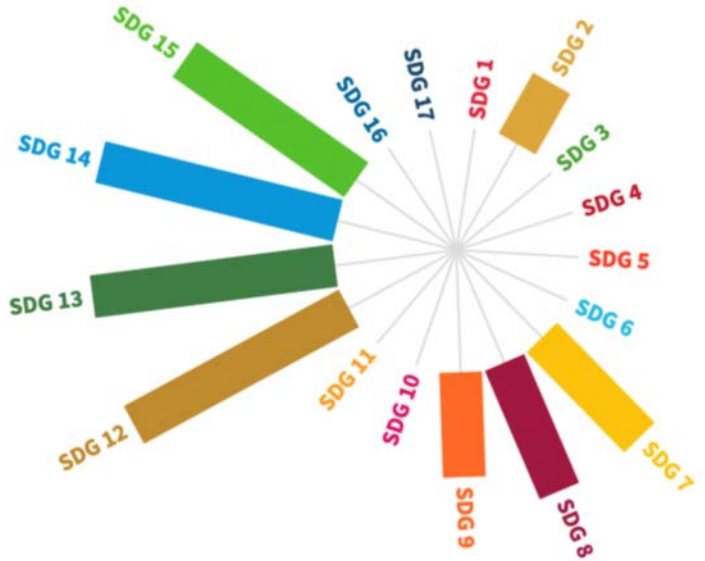
Depending on the selected LCA method, potential avoided emissions and method of allocation of the avoided emissions the carbon intensity per MJ green gas ranges between **-58** and **-294** g CO2-eq.

CONCLUSION

It can be concluded that STERCORE in all cases leads to climate change mitigation compared to the conventional system.

Therefore, overall STERCORE can be seen as an improvement compared to the current situation of co-digestion, the spread of manure on land, production of chemical fertilizers and the application of it.”

New.Economy.eco



current co value creation potential Image

Indication of STERCORE SDG contribution and potential

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CARBON REMOVAL CREDITS

The Voluntary Carbon Market supports and incentivizes projects that mitigate CO2 emissions

CARBON REMOVAL CREDITS

Biobased Carbon / Biochar is supported on the voluntary carbon market. Applicable methodologies for Biochar exists within the Verra and Puro.earth programs.

PROJECT SUMMARY

STERCORES project provides end-to-end benefits for the agricultural sector.

STERCORE creates high-value bio based carbon out of agricultural waste. Making use of this waste material prevents GHG emissions to the atmosphere and water pollution.

What's more, the bio based carbon nourishes agricultural land with stored carbon, so it mitigates fertiliser use and its associated pollution issues

The facility even produces Green Gas as a by-product, which contributes to the clean energy transition

RESULTS OF THE STUDY

VOLUME

The study found that in the low scenario, ~49,000 CO2 removal credits can be produced

PRICE RANGE

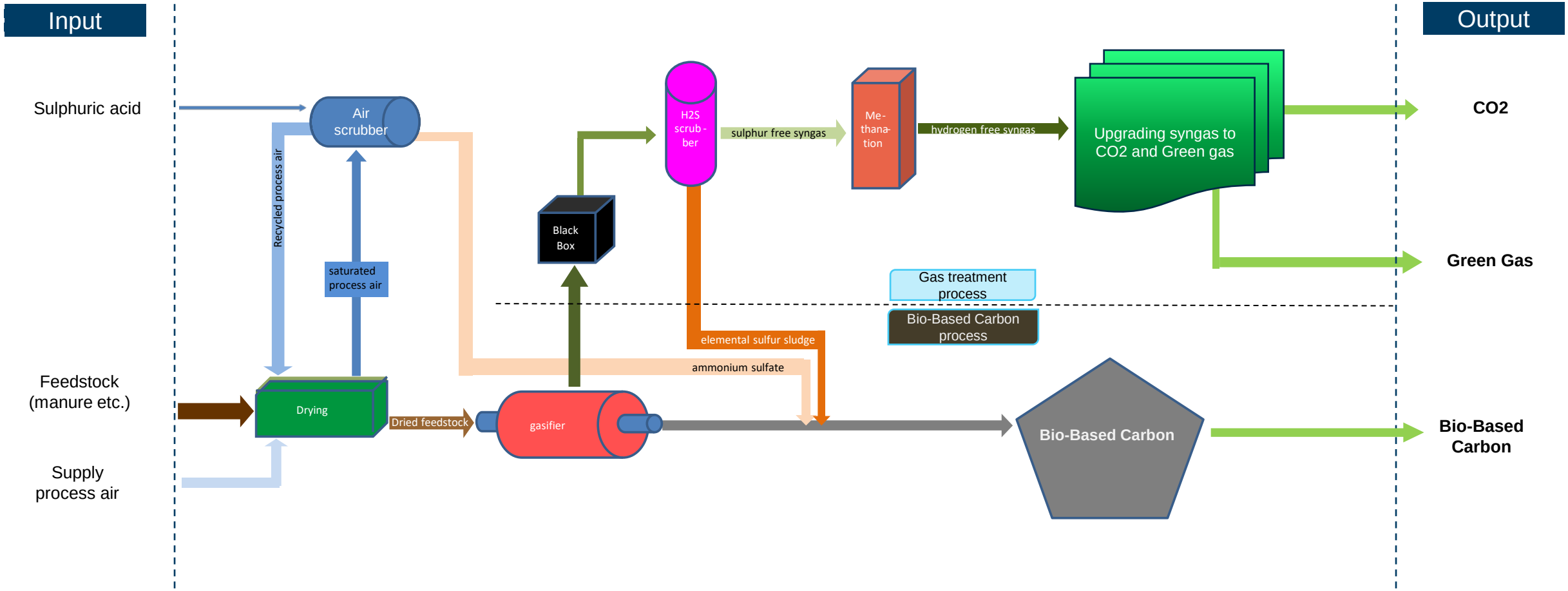
STERCORE can expect a price per credit between €92 to €110

TOTAL VALUE

This would yield STERCORE €4.5 mil total per year, when producing 76,000 tons of Biochar/year

ZERO

Detailed technical process flow

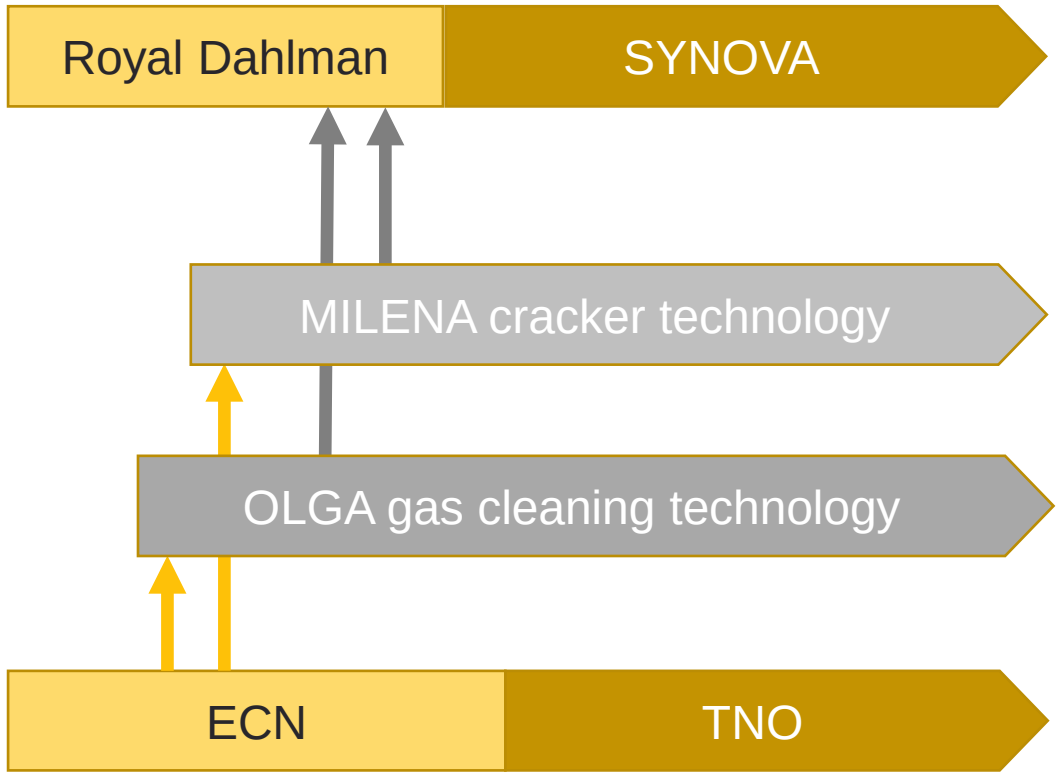


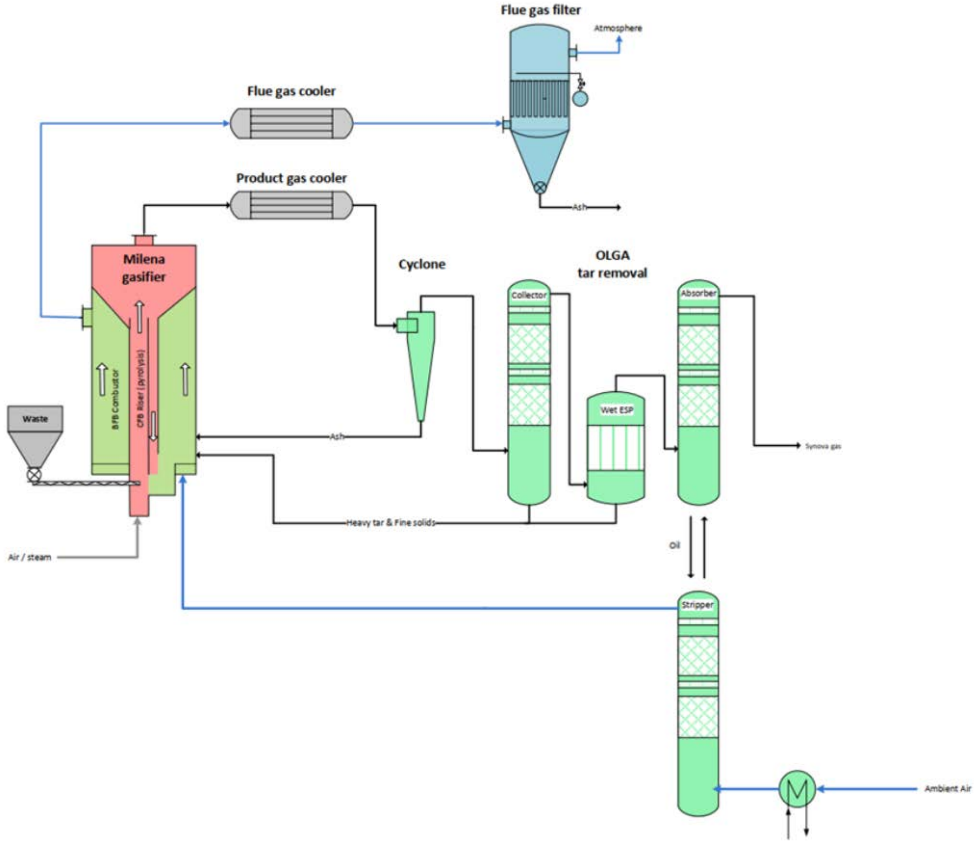
SYNOVA

NEW HIGHLY EFFICIENT PLASTIC RECYCLING METHOD

WHO ARE WE?

A strong team providing GreenChem solutions



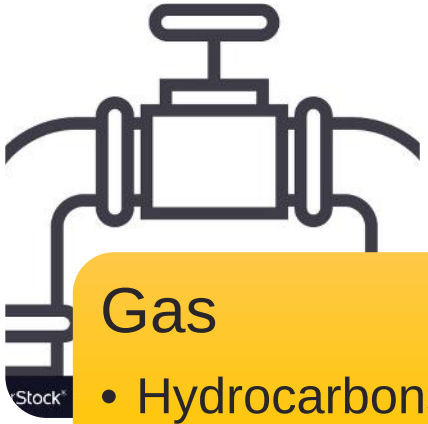


WHAT DO WE DO?

Converting waste into High Value Chemicals (HVC)

Feedstock

- Waste
  - Plastics
  - Biomass



Gas

- Hydrocarbons

Products

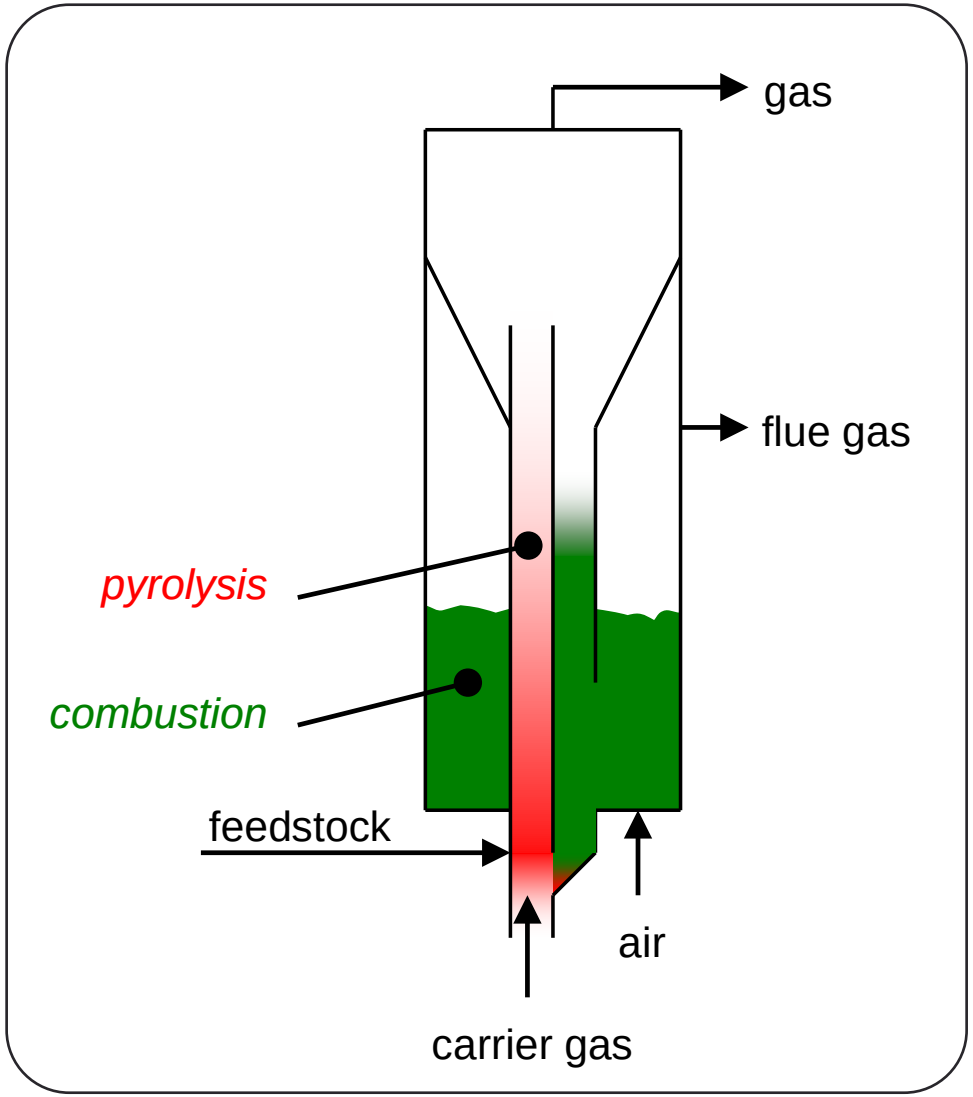
- BTX[1]
- Olefins[2]
- Styrene

[1] *BTX: Benzene + Toluene + Xylenes*

[2] *Olefins: mainly ethylene and propylene and butadiene*

MILENA CRACKER

- Operating at ~750°C: medium temperature (see next page)
- Fluidized bed technology
- Similarities with FCC technology: coupled fluidized beds, energy provided by burning residues, but:
  - Using sand instead of catalyst
  - Feeding solids instead of liquids
  - Dealing with water, oxygenates, glass, stones, …
- No external fuels required (coke and heavies removed in OLGA are combusted to provide the energy for the cracking)



MILENA CRACKER

750ºC

feedstock conversion:

feed + heat → gas + char + tar

810ºC

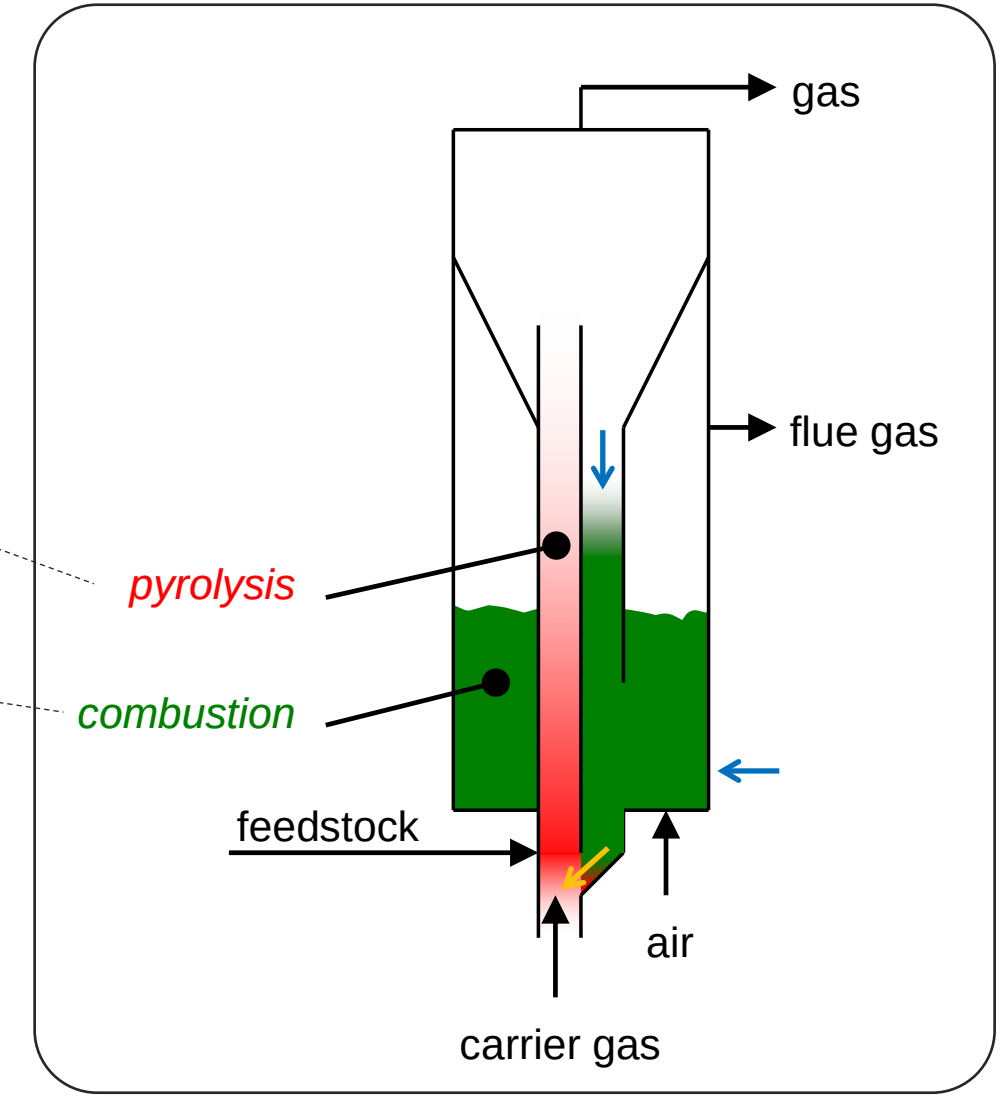
energy production:

fuel + air (λ > 1) → flue gas + heat

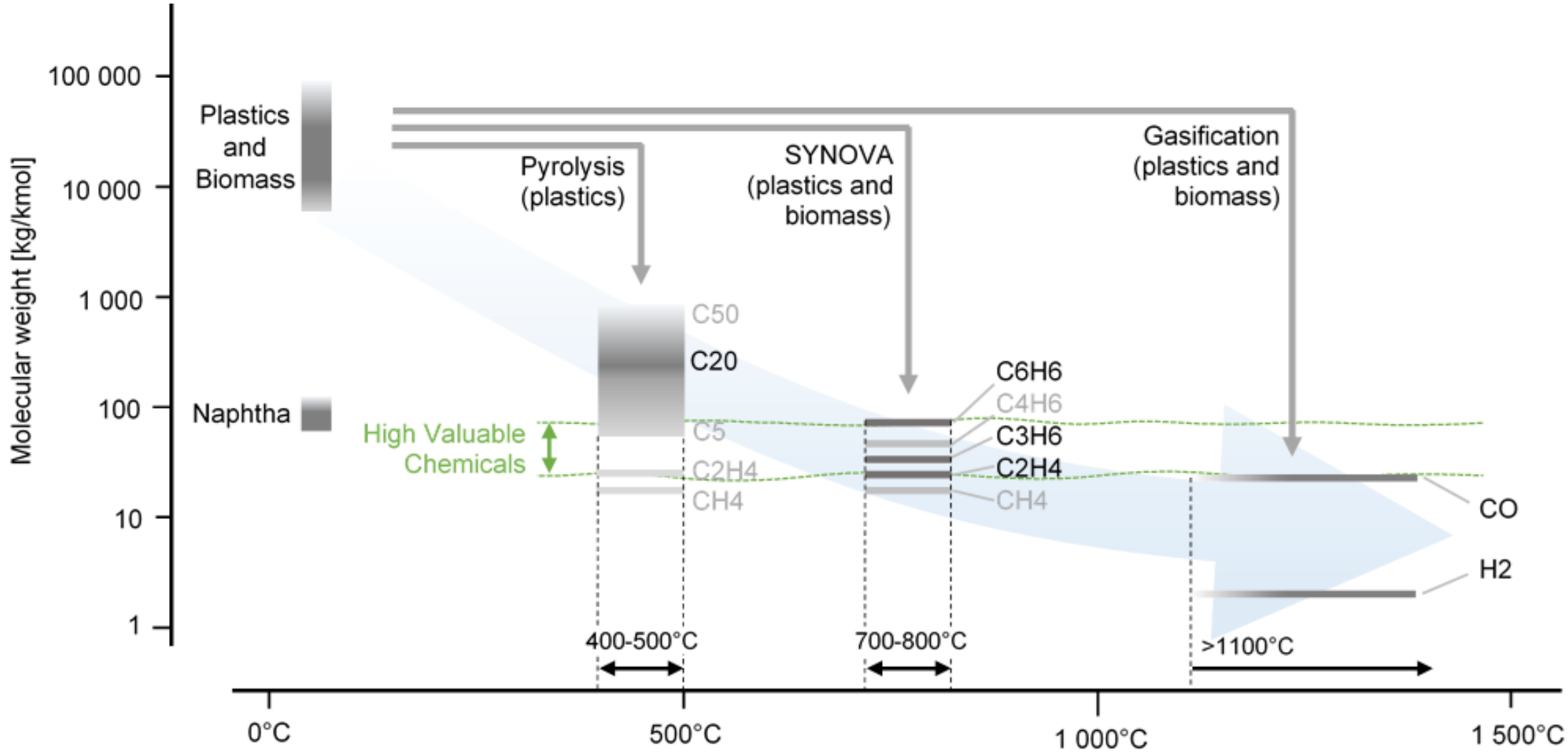
+

overall:

feed + air (λ<<1) → gas

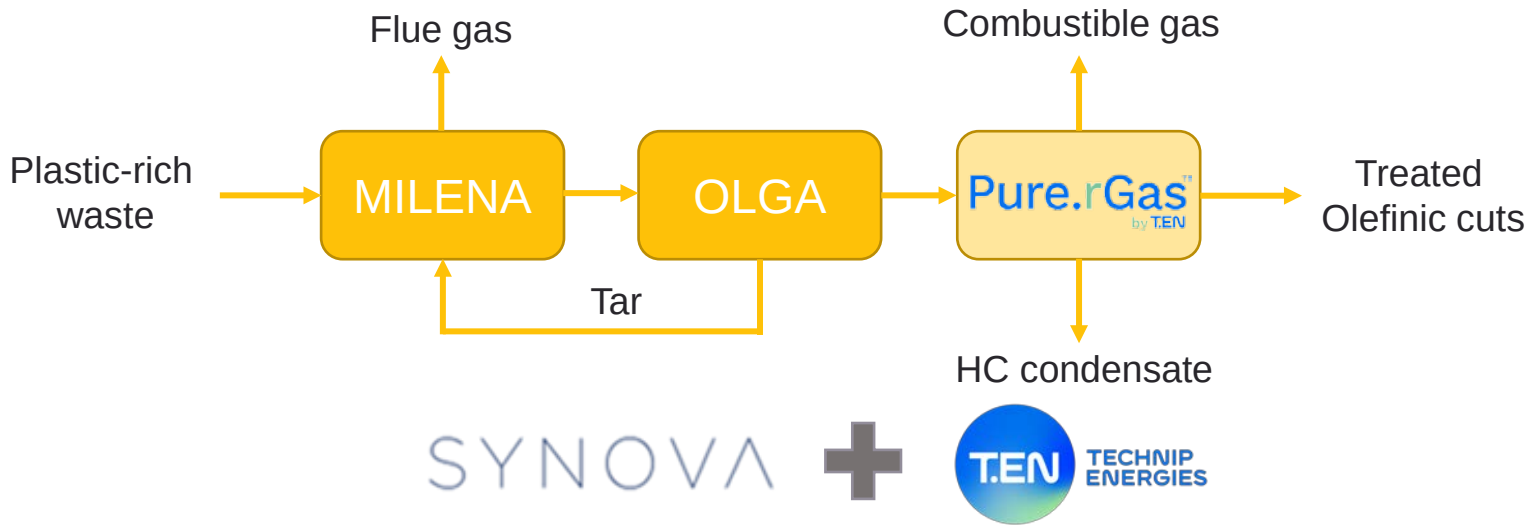


MEDIUM TEMPERATURE = INSTANT CHEMICALS



Olefins

WASTE-to-OLEFINS



- Integration with existing steam crackers by-passing the cracker furnaces
- Integration possible with liquid and gas crackers
- Typical savings of 2.5 t CO_2/t HVC[1] compared to naphtha cracking with waste incineration for end of life
- HVC yield of 64wt% (Plastic-to-HVC)
- First commercial plant announced by Sabic

[1] *HVC: C2,C3,C4-Olefins + BTX*

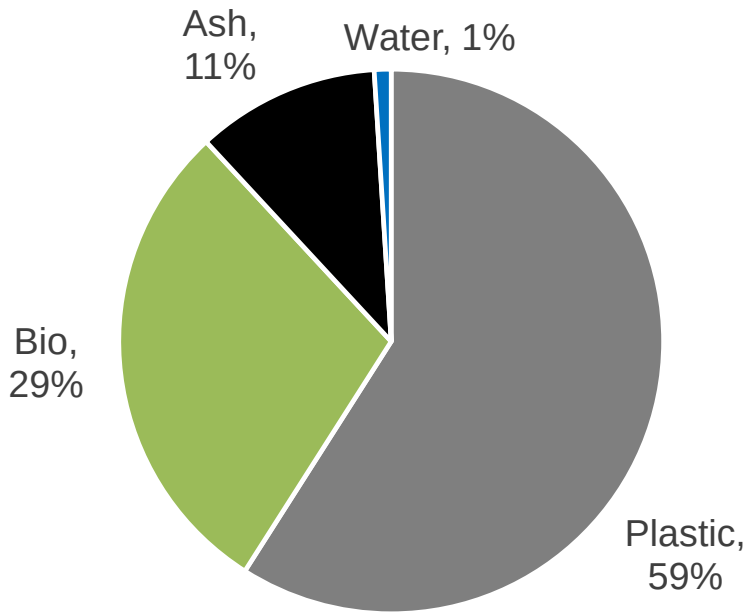
WASTE-to-OLEFINS MASS BALANCE

Example feedstock with 59% plastic

- Feedstock: sorting waste from MSW
- 59% plastics + 29% biomass + 12% water and inert
- Temperature: 750°C
- Scope: MILENA cracker / OLGA gas cleaning

- Yields:
  - 565 kg HVC[1] directly + 73 kg HVC indirectly (recycle)
  - 64% HVC from plastic (total mass)
  - 68% HVC from plastic (carbon basis)

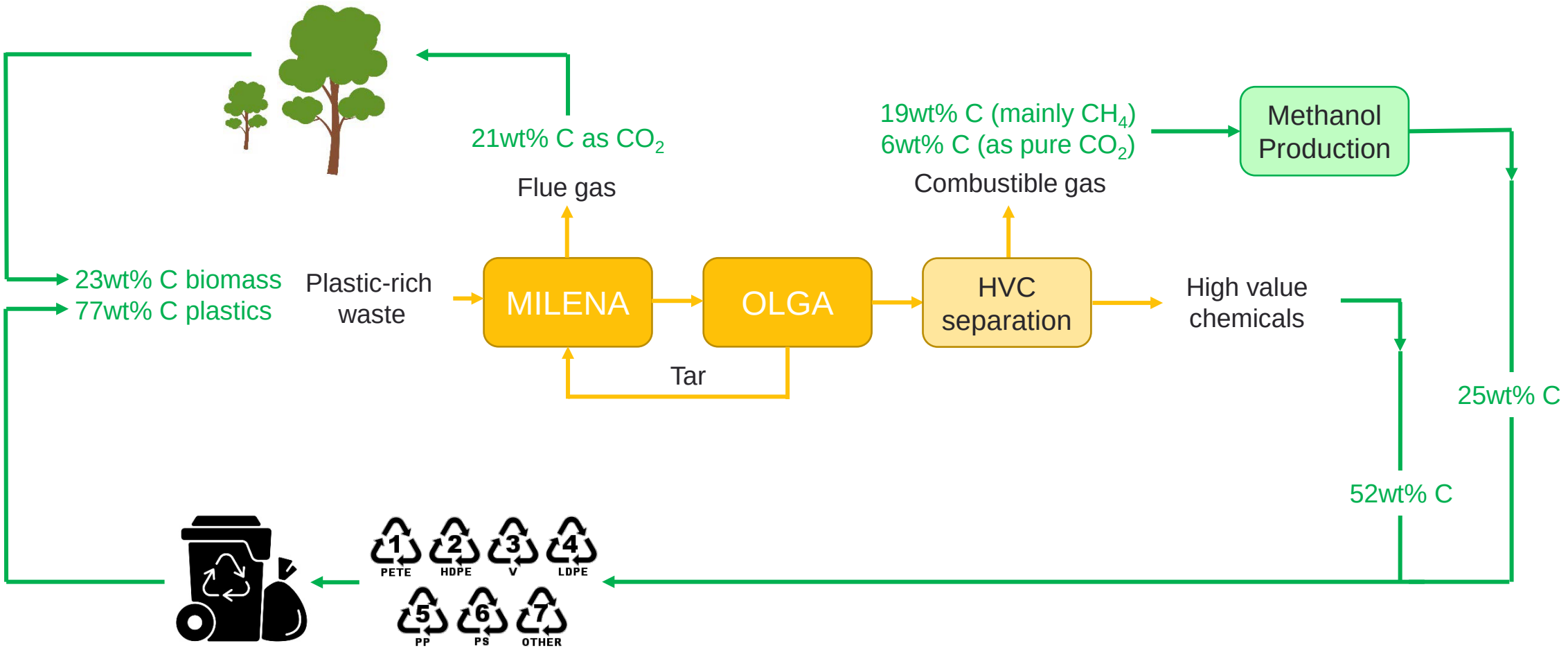
- Co-products:
  - Fuel gas (CH4, CO, H2, …)
  - CO2 (99+% purity)



[1] *HVC: C2,C3,C4-Olefins + BTX*

READY FOR NET ZERO

Outlook to a closed carbon loop HVC production

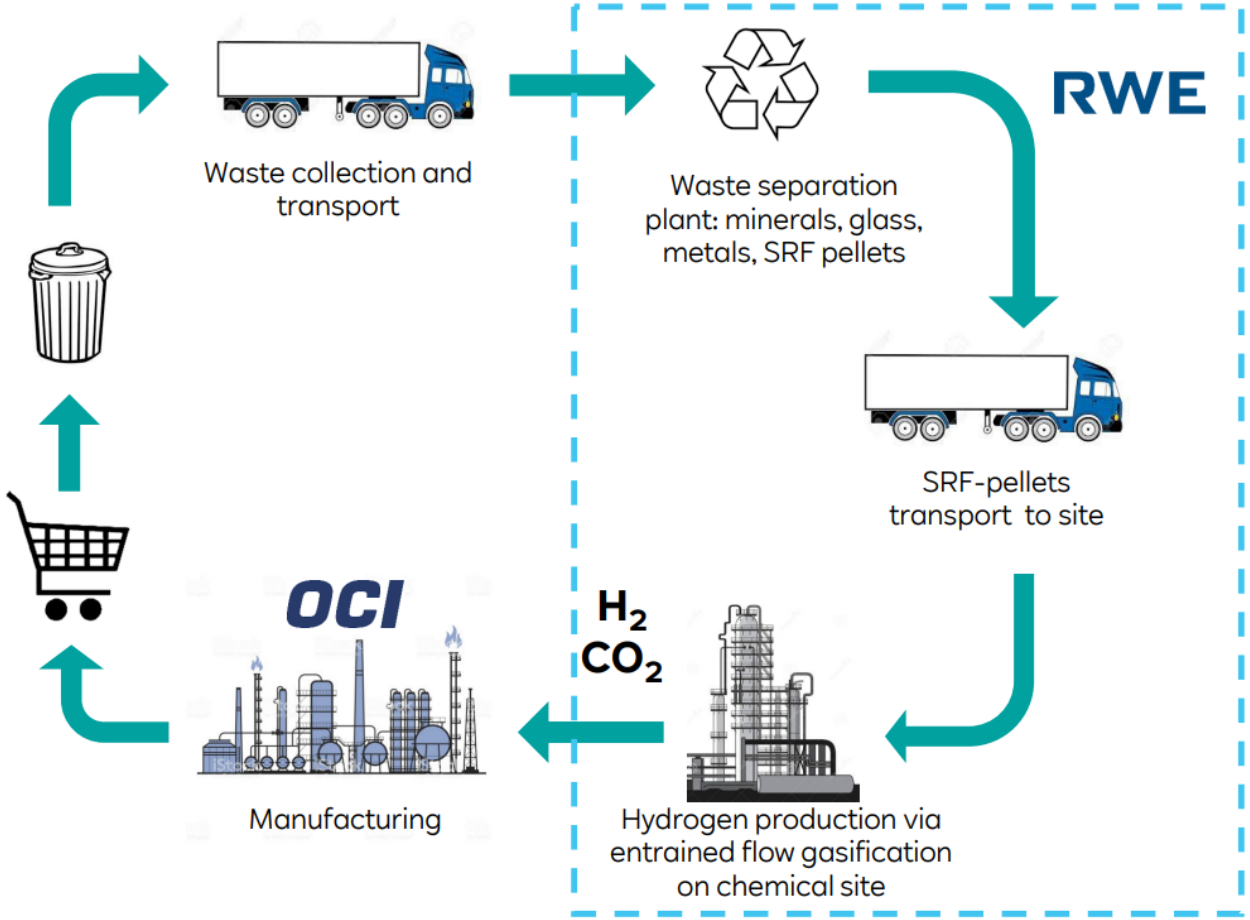


Assumption: Sufficient renewable hydrogen and renewable electricity is available

Furec - RWE

Waste-to-hydrogen produces green and circular hydrogen

Contributing to Project FUREC („Fuse Reuse Recycle")



PROJECT furec

Project typicals

- Processing of Municipal Solid Waste and dried sewage sludge (700.000 t/a)
- Production of hydrogen (≈50.000 t/a)
- CO_2 reduction:
  - 475.000 t/a @ 0 kg/MWh Power
  - 330.000 t/a @ 180 kg/MWh Power
- 800.000 t/a of CO_2 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

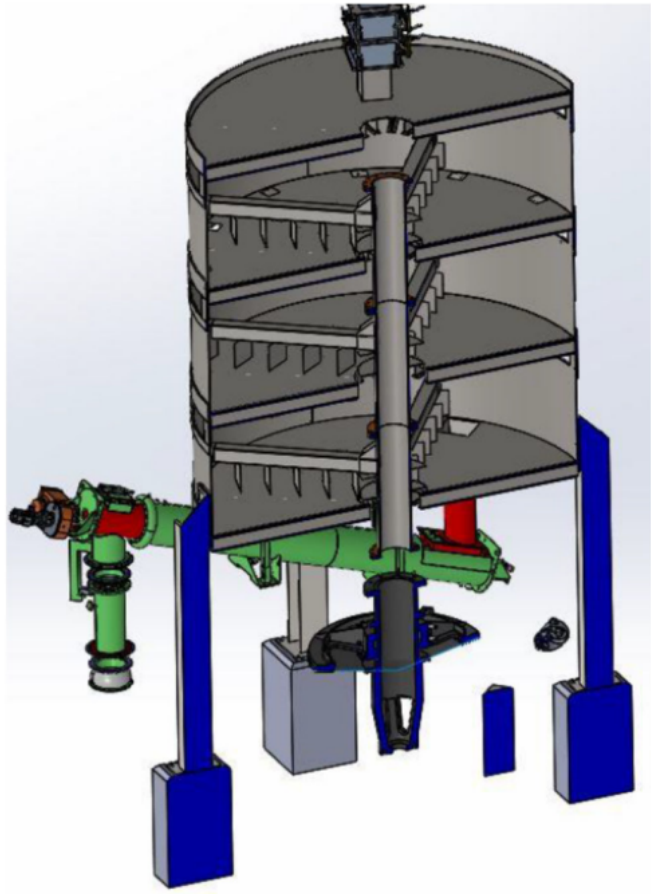
Furec - RWE

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 m | H_t = 9 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



HoSt

- Large Bioenergy company in the Netherlands. Active in the field of digesters and gasifiers. Past years mainly on digestion, combustion, CO_2 capture and gas upgrading.
- Recently entered the hydrogen market by purchasing Hygear, now SMR, PSA, electrolysis and hydrogen recovery part of the portfolio.
- Two important project running
  - Developing MeOH reactor technology
  - Refurbishing an existing CFB gasifier to O_2/H_2O blown gasification for SNG production

Well equipped company capable of delivering turn-key solutions from gasification, cleaning to end-product

NettEnergy

Turning side road gras into hydrogen and biochar.

Pilot technology

Van bermgras kun je waterstof maken: 'De zeppelin kan weer terugkomen'

Rob Vasbinder (links) en Sebastiaan Joosten bij de proefopstelling.

© Foto's Vermeulen Groep/Manon Divendal

Yvonne Hulsbos Zaterdag 5 november 2022 om 11:55

Gasunie

- Still supporting the SNG projects in the Netherland, actively supporting projects to realise the Dutch 2 bcm ambition. Involved in:
  1. SCW Systems
  2. Torrgas

Gasunie and Perpetual Next formed a Joint Venture to be able to better support the market introduction of Green Gas / Syngas platforms.

SCW

Produced SNG based on super critical water gasification!

13 februari 2023 SCW Systems

Doorbraak: met water op industriële schaal groen gas uit afval

Picture from: Duurzaamondernemen.nl

Berend

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