IEA Bioenergy
Technology Collaboration Programme

Task 33 Country report
The Netherlands

October 2023

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Lyon

Gasification activities in the Netherlands

TNO, Petten
R&D center on gasification

Mavitec, Heerhugowaard
Technology provider

SCW, Alkmaar
Technology provider
Super critical gasifier demosite

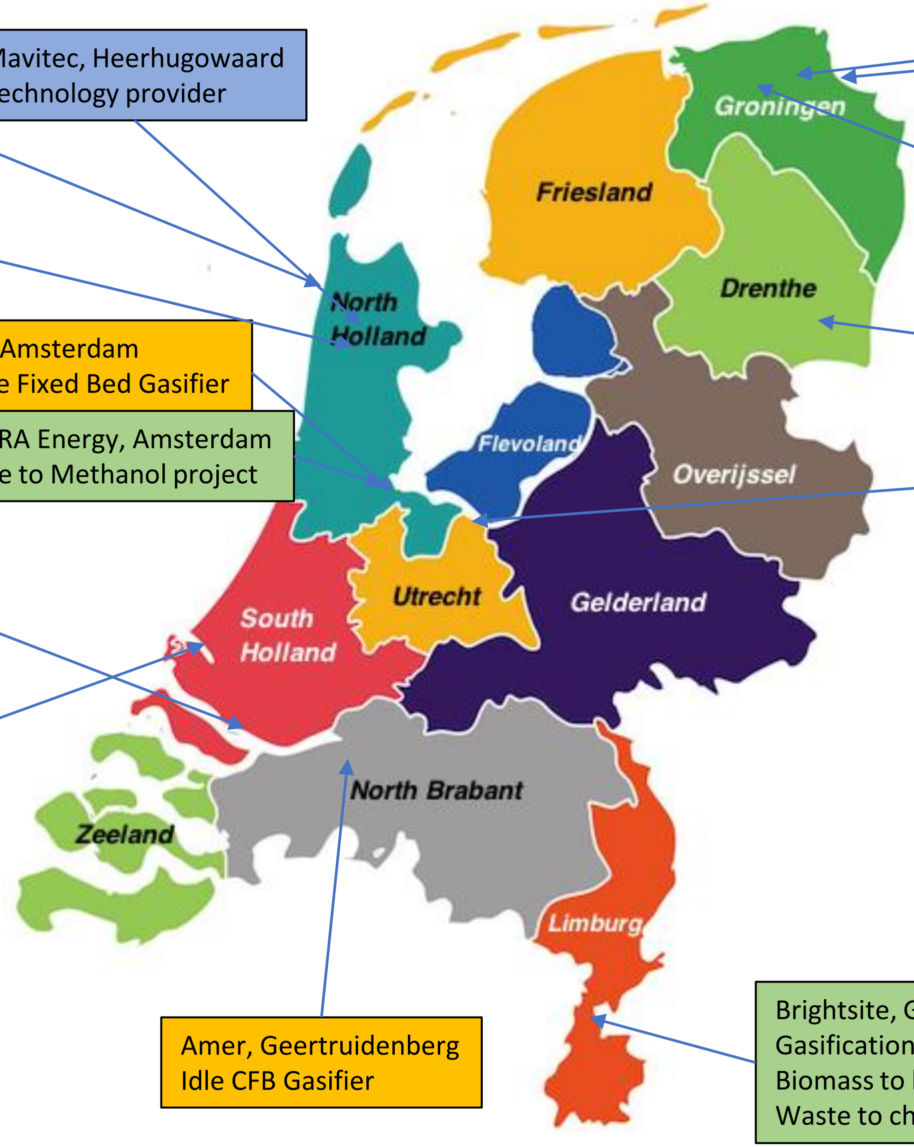
BEN, Amsterdam
Active Fixed Bed Gasifier

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

Synova, Maassluis
Technology provider

Amer, Geertruidenberg
Idle CFB Gasifier



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

Stercore, Emmen
Manure gasification project

Platform Groen Gas

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

Stercore

Input 350.000 – 400.000 ton manure

Outpout

- Green gas 23 million m^3
- Biochar 85.000 tons
- Liquid CO_2 30.000 tons
- Heat 5 MWth

Costs 55.000.000 Euro

- Verdict is positive for STERCORE, they can start construction of their manure gasification plant.

NettEnergy

- Pilot on road side grass produced H_2.
- Next step is a 500 kg H_2/day production facility

Technology:

Top draft – top fired moving bed reactor followed by a water scrubber.

PyroGasifier - Nettenergy

SYNOVA

Olefins and Aromatics production from waste

Our technologies

Developed over the last 10+ years to a TRL 7 level ready for commercial demonstration

MILENA cracker

- MILENA technology based on FCC technology coupled fluidized beds
- Heat transfer via circulating sand, no catalyst
- Operating at ~750°C
- No external fuels required (Coke and heavies removed in OLGA are combusted to provide the energy for the cracking)

OLGA gas cleaning

- OLGA technology based on Coke Oven Gas cleaning: gas/liquid contactors and Electrostatic Precipitator (ESP)
- Removes 99.9% of Poly Aromatic Hydrocarbons (heavies) and particles

Our solutions

Combining MILENA/OLGA with leading partner technologies

Solution	Integration options	Technology partner
Plastic-rich waste to Olefins	Downstream of steam cracker furnace	Technip Energies
Plastic-rich waste to BTX	Refinery or stand-alone	Koch Industries
Polystyrene-rich waste to Styrene	Polystyrene plant or stand-alone	Trinseo

Plastic-rich waste: 59% plastic, 29% biomass, 11% ash, 1% water
Polystyrene-rich waste: 80% Styrene, 20% other plastics, paper, etc.

We do not compete with mechanical recycling for feedstock

Feedstock quality guideline for pyrolysis of plastic waste*	
PE + PP	> 85%
All other contaminants	< 15%
but individually	
PVC/PDVC	< 1%
PET/EVOH/Nylon	< 5%
PS	< 7%
Inert materials	< 7%
Biomass	< 10%
Moisture	< 10%

Synova cracker feedstock for the production of HVC	
All plastics	60 - 80%
Biomass	20 - 40%
Inert materials	< 20%
Moisture	< 30%
Organic halogen content	< 1 %

Biomass is not a contaminant, but a bonus

- Improves the CO_2 reduction
- Keeps circularity high
- Avoids expensive upstream separation
- Keeps the feedstock readily available

**Feedstock quality guidelines for pyrolysis of plastic waste; Report by Eunomia Research and Consulting prepared for the Alliance to end plastic waste; August 2022*

scw systems

SCW GAS

20 MW demonstration plant

Alkmaar (NL)

SCW GAS Alkmaar

Total capacity (output): ~ 20 MW

Milestone February 2023: injection of on-spec high calorific gas into the 70-bar gas grid

Syngas from the gasifier (H_2, CH_4, CO_2, CO) converted into on-spec methane

Specifications for injection into the H-Gas high pressure grid in NL are strict (at PPM level)

> 50.000 m^3 on-spec gas injected into the grid in 2023

Scaling SCW GAS to reach NL target of 2 BCM and 35 BCM EU target

SCW Systems' 1BCM in 2030 program to contribute to the 2BCM biomethane target in 2030 in the Netherlands. From 2027, roll out is foreseen outside the Netherlands.

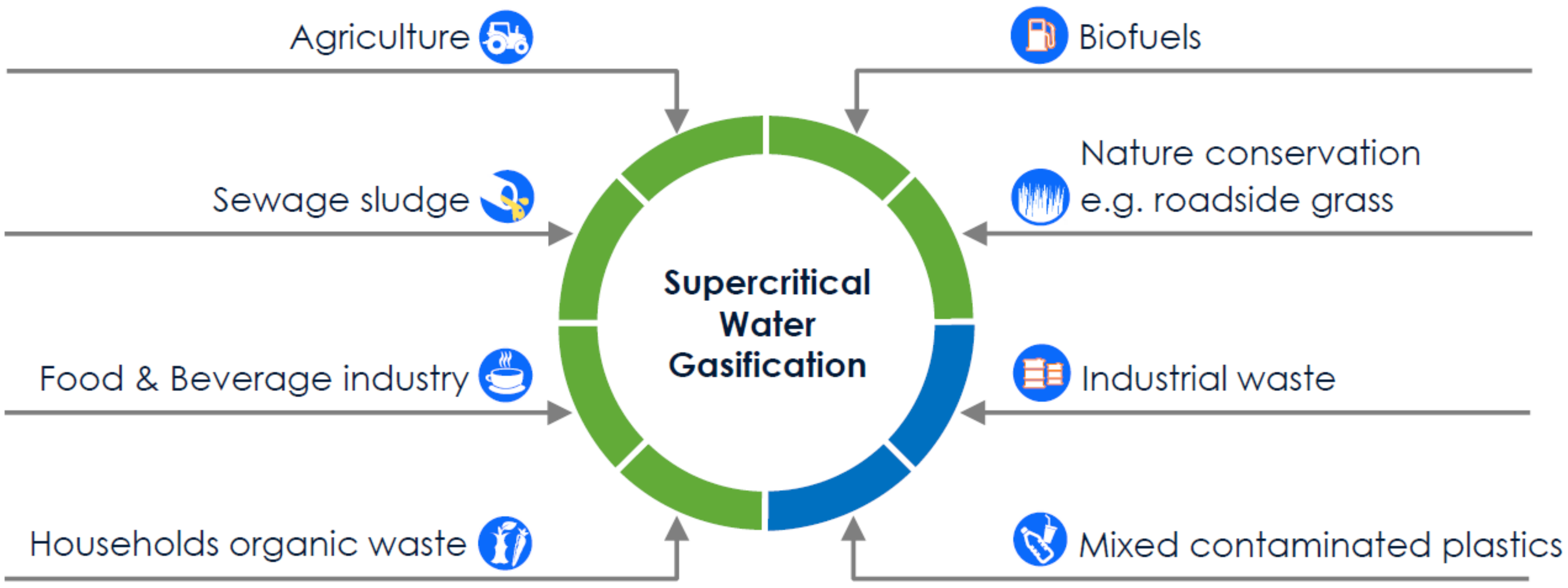
- Stepwise and controlled upscaling by duplicating the existing reactor

- Critical success factors for rapid scale up:
  - Demonstrate operation of technology
  - Unlocking residual flows
  - Regulatory and governmental preconditions:

- ❑ Stimulate demand for green methane
- ❑ Rapid development locations
- ❑ Use of non-biogenic residual flows for circular gas

scw systems

SCW GAS unlocks (problematic) residual flows for production of renewable gas

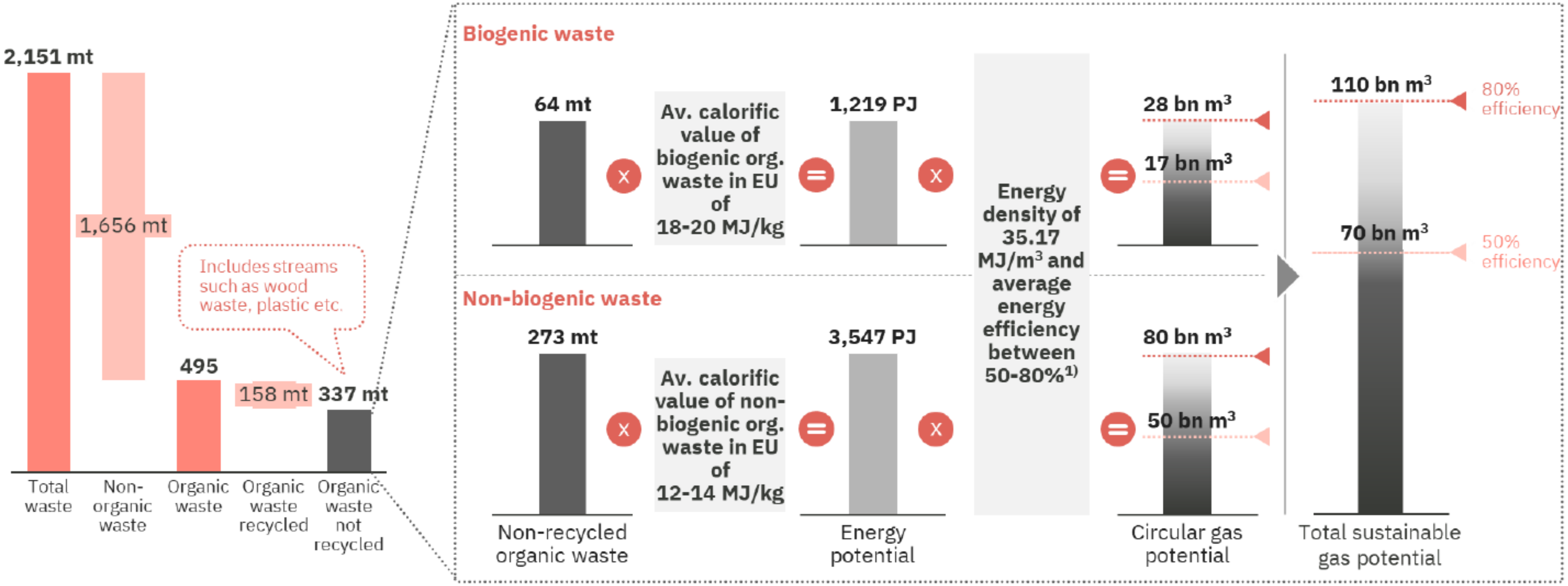


Production of green methane and circular gas

scw systems

With SCW GAS, up to 110 BCM sustainable gas can be produced from currently non-recycled waste streams

In relation to the 360 BCM gas consumption in the European Union in 2022, **~30%** could be replaced with sustainable gas produced from residual flows in Europe, processed via supercritical water gasification

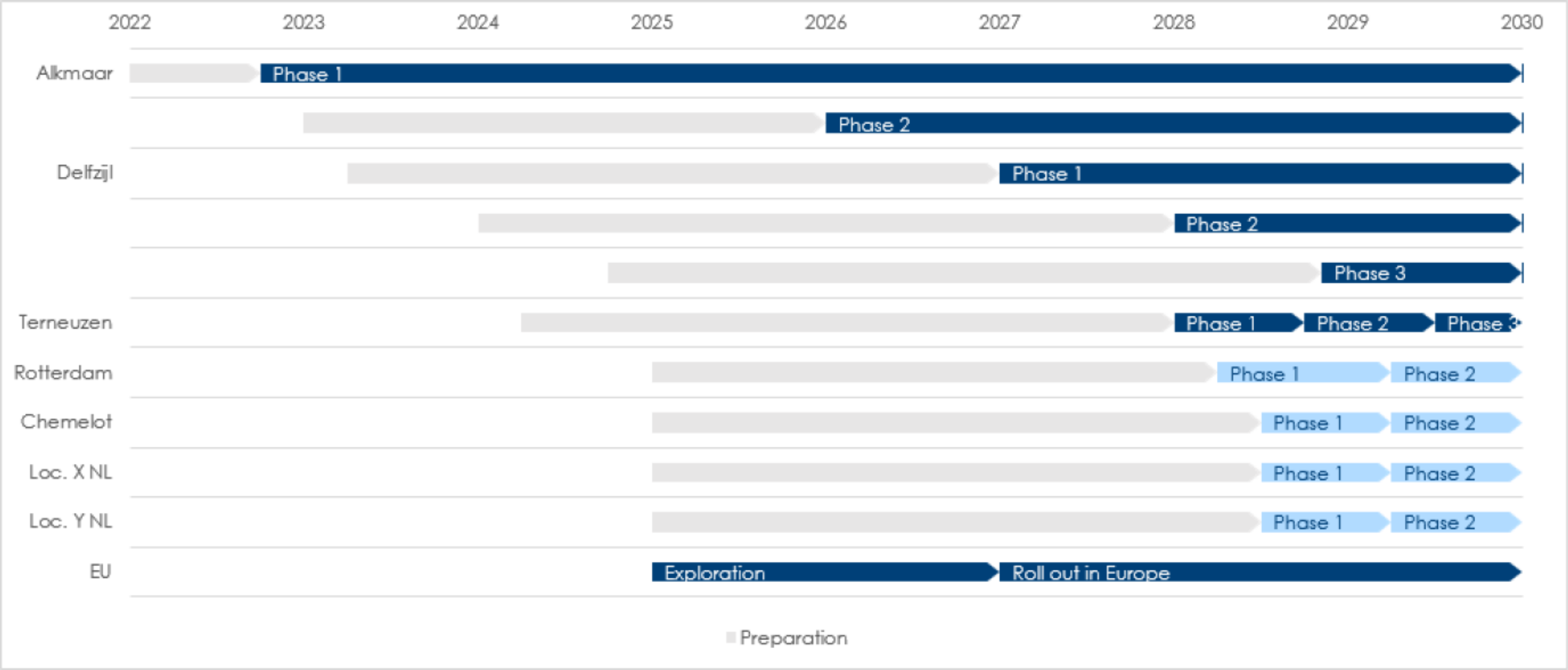


scw systems

Source: Feedstock Study Roland Berger 2023

Roland Berger

Roll-out SCW GAS in NL and EU



SCW GAS in Alkmaar (NL)

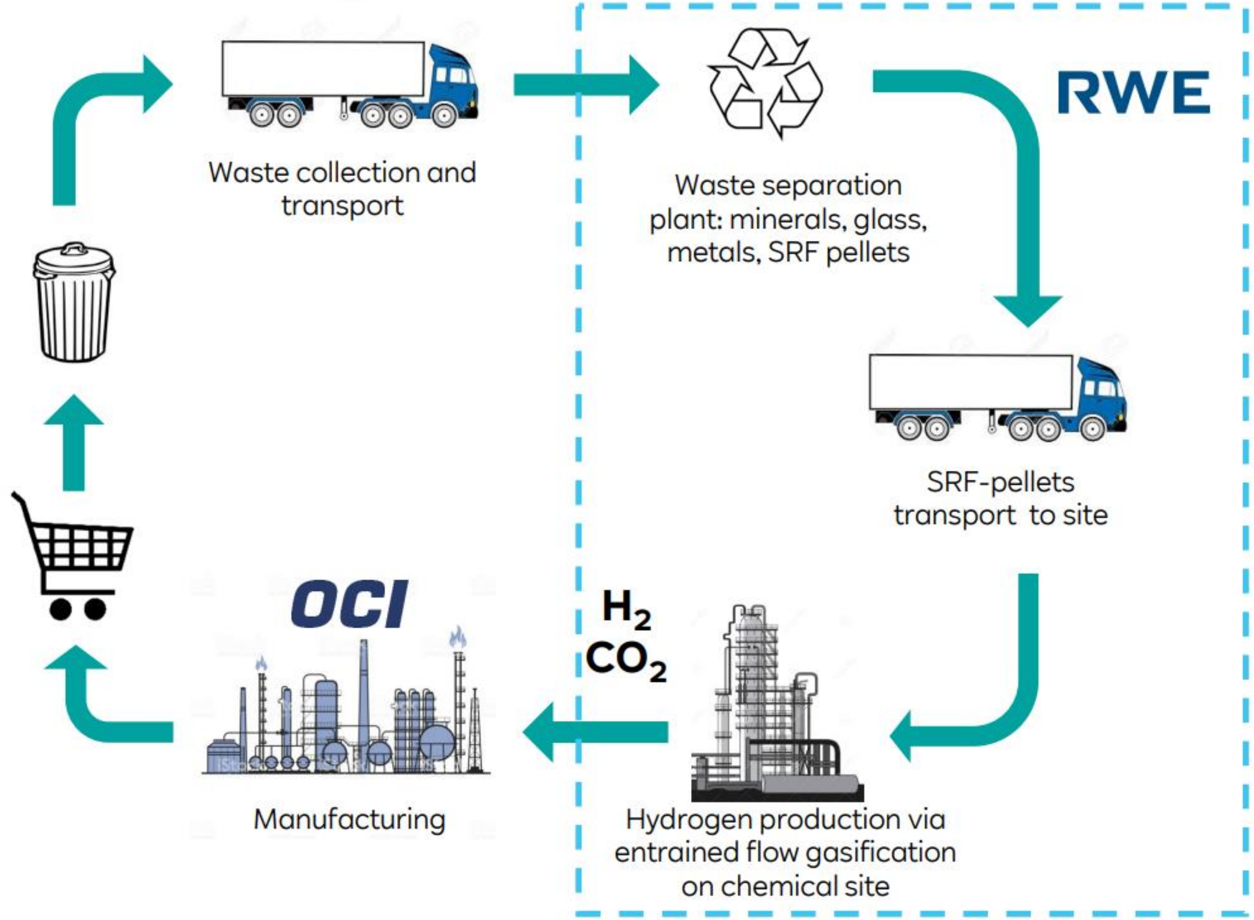
Collaboration TU Delft and GIDARA

Modelling and experimental validation of HTW bubbling fluidized bed gasification
TU Delft / G.I Dynamics
Aim of the gasification process is to generate a syngas which, after cleanup and upgrading, will be suitable for fossil-free methanol production. The goal of this project is to arrive at a simple transient one-dimensional model for the gasifier at GIDARA Energy, with the ability to predict the residence time distribution of gas/solids, the (axial) temperature distribution, and the chemical conversion and selectivity to various products. Focus lies on a research-scale bubbling fluidized bed gasifier operating with solid waste feedstock, e.g. sewage, wood, household and industrial types of solid waste. To arrive at such a model, the output of more detailed Computational Fluid Dynamics models (without reactions) will be analysed and reduced to simpler equations, after which chemical reactions will be added. Cold flow experiments using a downscaled version of the gasifier will be performed at TU Delft for model validation. Validation gasification measurements at the gasifier will be performed, targeting closure of mass- and energy balances and to obtain more insight in the conversion process of the challenging circular carbon feedstock for further scale-up. These include measurement of main gaseous and solid carbon species, but also online alkali species measurement and carbon-in-ash measurements.

Furec - RWE

Waste-to-hydrogen produces green and circular hydrogen

Contributing to Project FUREC („Fuse Reuse Recycle”)



PROJECT furec

Project typicals

Cold commissioning MHF started
Commercial waste dryer in operation for over a month now
Start Basic Engineering end of this year
FID end of 2024

Finding good engineering firms is an issue

- Other positive value products: minerals / glass / metals / slag / sulfur / salt
- Commissioning: 2026

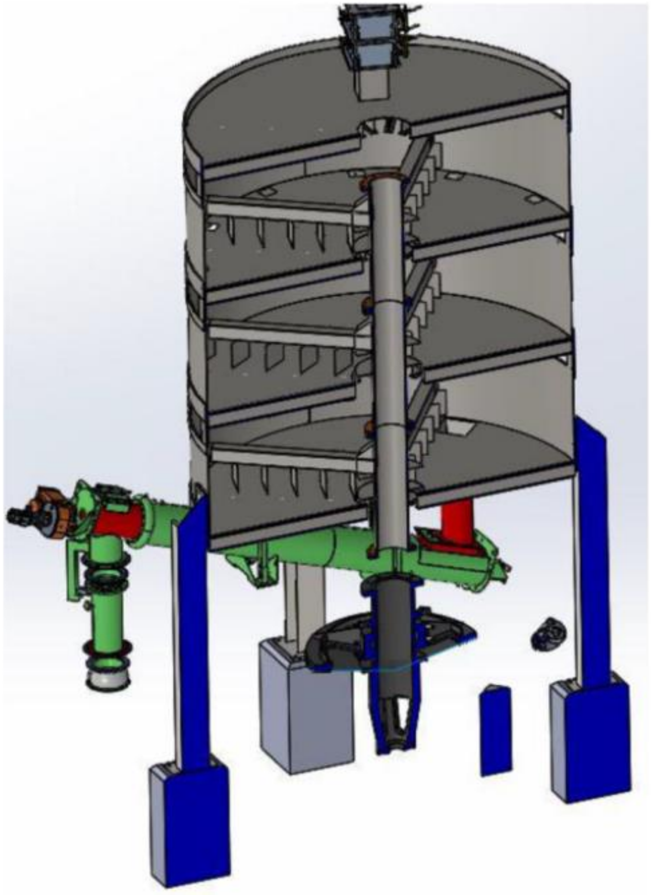
Furec - RWE

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



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