

Diversification of applications downstream of pyrogasification

Marion MAHEUT, Lab CRIGEN (ENGIE R&I)

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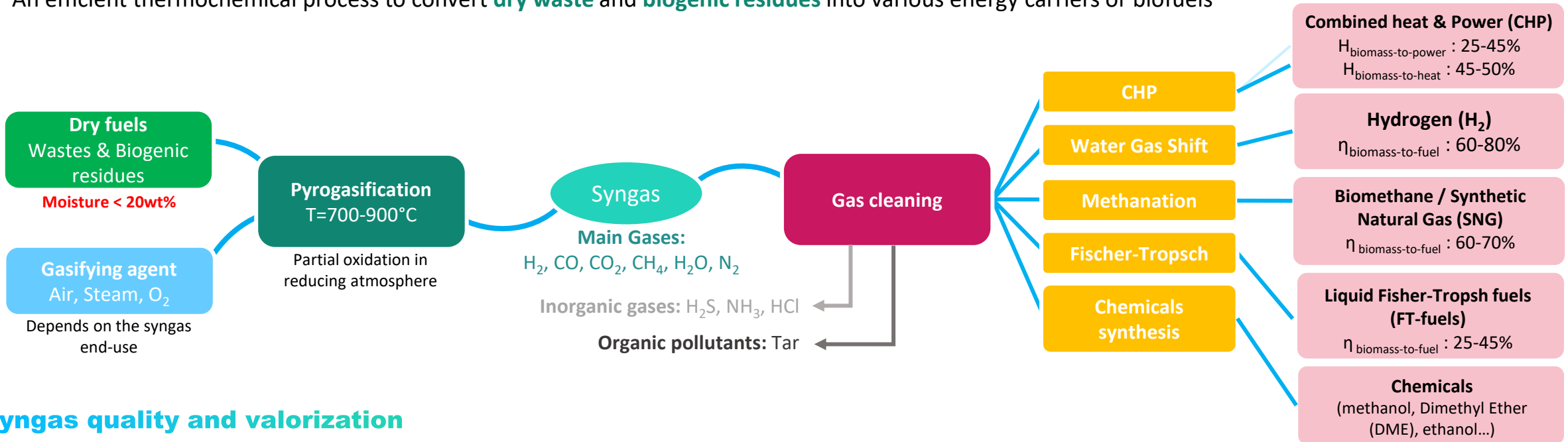
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Syngas produced by pyrogasification is a good chemical precursor for multiple applications

What is pyrogasification?

An efficient thermochemical process to convert **dry waste** and **biogenic residues** into various energy carriers or biofuels



Syngas quality and valorization

Syngas quality depends on the feedstock type, operating conditions and the pyrogasification technology.

The syngas purification intensity depends on the targeted energy applications

Many gasification technologies are available on the market suitable for different energy applications (CHP, heat, SNG, H₂, liquid FT-fuels, chemicals)

	Capacity	Common energy applications <u>up to now</u>	+	-
Updraft fixed bed	few 10 kW _{th} - MW _{th}	Heat / CHP applications	Production of gas with high LHV	Production of higher level of tars and higher effluents treatment required
Downdraft fixed bed	up to few MW _{th}	Heat / CHP applications	Production of high-quality syngas (lower tar content)	Control of the input granulometry and humidity
Single fluidized bed (bubbling or circulating)	500 kW _{th} - 50 MW _{th}	Heat / CHP applications <i>(on-going developments for SNG, H₂ production)</i>	Handling of a variety of inputs, if "cheap" oxygen available this techno is a good candidate for SNG	Air blown demonstrated but syngas with low LHV, oxygen blown are more expensive, no steam blown at commercial scale
Dual fluidized bed	500 kW _{th} - 100 MW _{th}	Heat, CHP, SNG <i>(on-going development for H₂, chemicals, liquid fuels)</i>	Production of high LHV syngas (steam blown) and significant amount of methane, limited temperature	Coolers systems are very sensitive to pollutants, erosion related constraints on the refractory in high velocity areas
Direct plasma gasifier	> 50 MW _{th}	CHP applications	Production of high-quality syngas	High power consumption
Entrained flow bed	large scale > 100 MW _{th}	Liquid FT-fuels, chemicals	Production of a high-quality syngas with high H ₂ content	Need for a finely torrefied and grounded feedstocks
Two-stage processes (pyrolysis + gasification)	Depends on the gasification technology downstream pyrolysis	H ₂ , liquid FT-fuels, chemicals, ... (depends on the gasification)	Low tar and hydrocarbons content, high H ₂ /CO ratio, possible biochar production	Moderate flexibility to feedstocks, lower conversion efficiency into final gas or liquid product when biochar is co-produced)

Tested by ENGIE at demo-scale

ENGIE Lab CRIGEN pyrogasification demonstration projects



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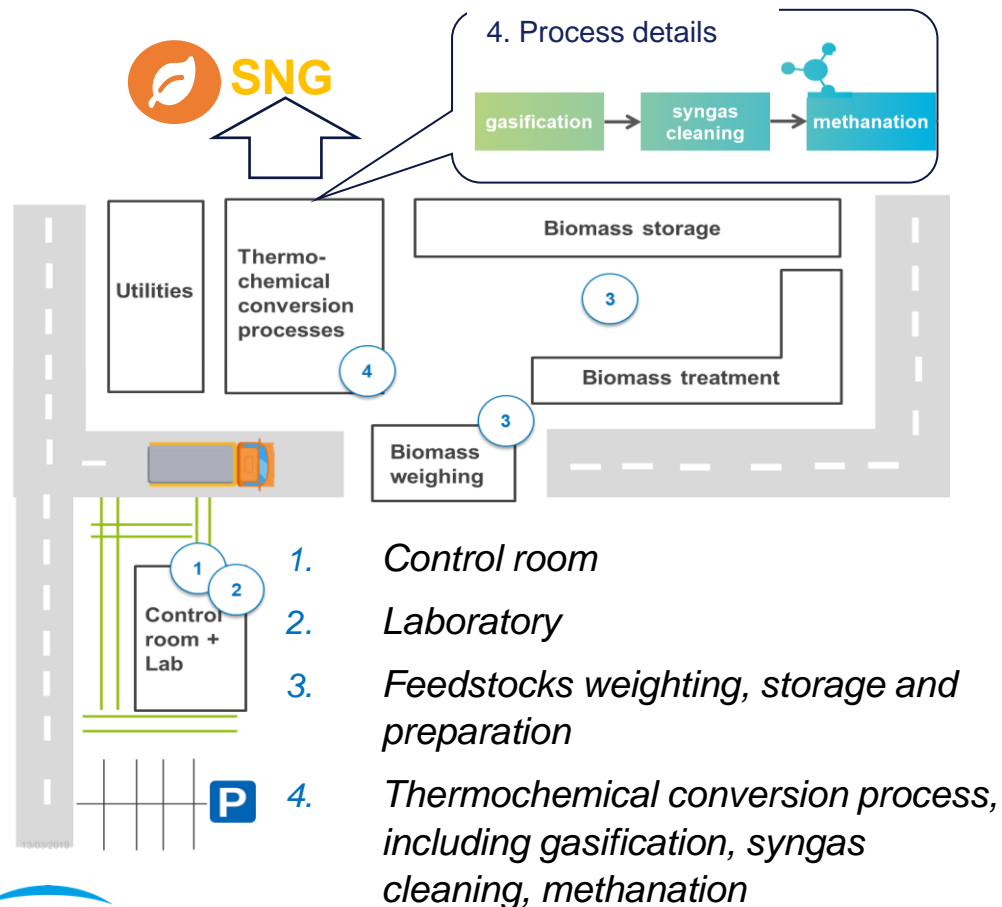


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ENGIE has built and still operates the GAYA demonstration plant

A cutting-edge R&D and highly automatized demonstration plant to produce bio/low carbon fuels from biomass & waste pyrogasification



Saint-Fons, in the Chemical Valley, in the south of Lyon

GAYA platform is a cutting-edge semi-industrial R&D facility...


- With more than 3000 sensors
- Highly automatized with a complete control system
- By design, modular to welcome new technologies
- The only R&D platform covering the whole production chain

...with 3 main uses

- Research & Development
- De-risk and boost industrialization
- Communication

GAYA was an ambitious R&D project coordinated by ENGIE to produce biomethane / SNG

Project co-funded by ADEME within the framework of the Call for Expression of Interest (AMI) and the "Second-generation biofuels" Demonstrator Fund

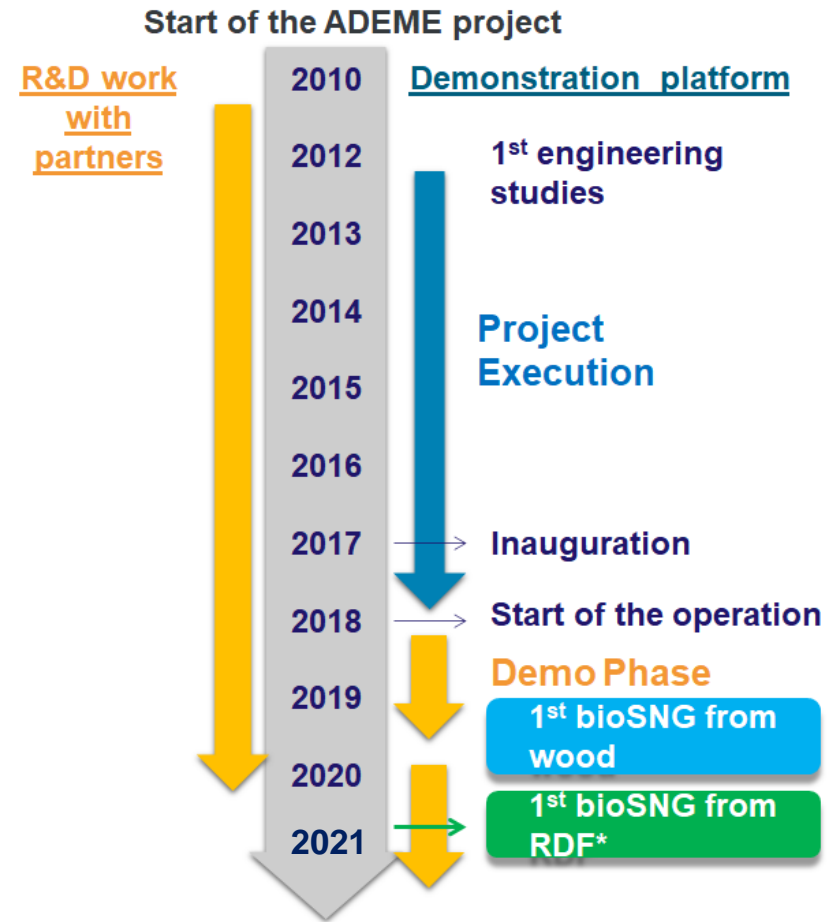


Objective of the project
 Demonstrate the technical, economic and environmental viability of biomethane / bioSNG production from biomass gasification

A 10-year R&D program
 11 partners



With the support of:

ADEME: French environmental agency
 bio-SNG: bio-Substitute of Natural Gas (biomethane)



Thanks to the GAYA project ENGIE succeeded to develop and innovative, robust and more cost-effective production chain than the state of the art...



Technical validation of the process at demo-scale (TRL 7-8)

- > 150 tests performed
- Long duration tests in continuous mode (24h/24h)

The entire production chain has successfully been proven to be robust and flexible to convert several feedstock



Lowering production costs

- Innovations (> 10 patents)
- Optimization of the process

-30 % of CAPEX and
-10 % to -100%
on feedstocks supply costs compared to the state of the art

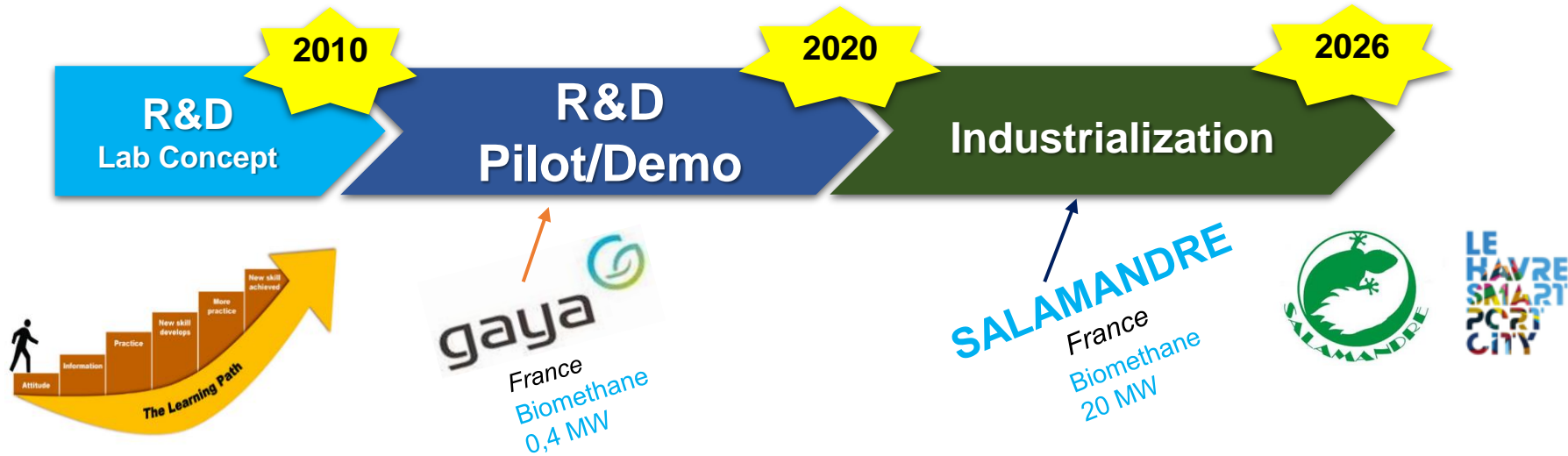


Environmental benefit confirmed

- Life Cycle Analysis performed
- Compliance with thresholds imposed by RED II (for heat or bio-fuels)

-86 % of GHG
reduction using 2G
biomethane compared
to fossil fuels (RED II)

...paving the way towards the industrialization and market uptake of biomethane production from gasification



A first sketch of the commercial project

Salamandre project: ENGIE's first commercial project of SNG from gasification to be installed in Le Havre

Project led by:

storengy (100% ENGIE subsidiary)

Partners:



Localization :



Le Havre



Salamandre:

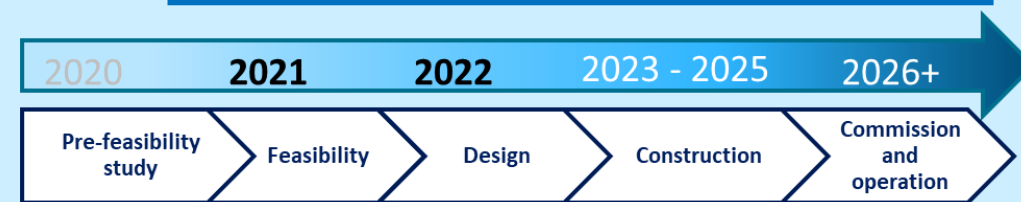
Produce, on an industrial scale, a low-carbon synthetic gas that can be injected into the network or used as fuel (synthetic LNG), from solid fuels



170 GWh of SNG / up to 11 ktpa of synthetic LNG - For heavy / maritime transport and intensive industries
+ ~40 GWh of renewable heat - For industries and urban networks

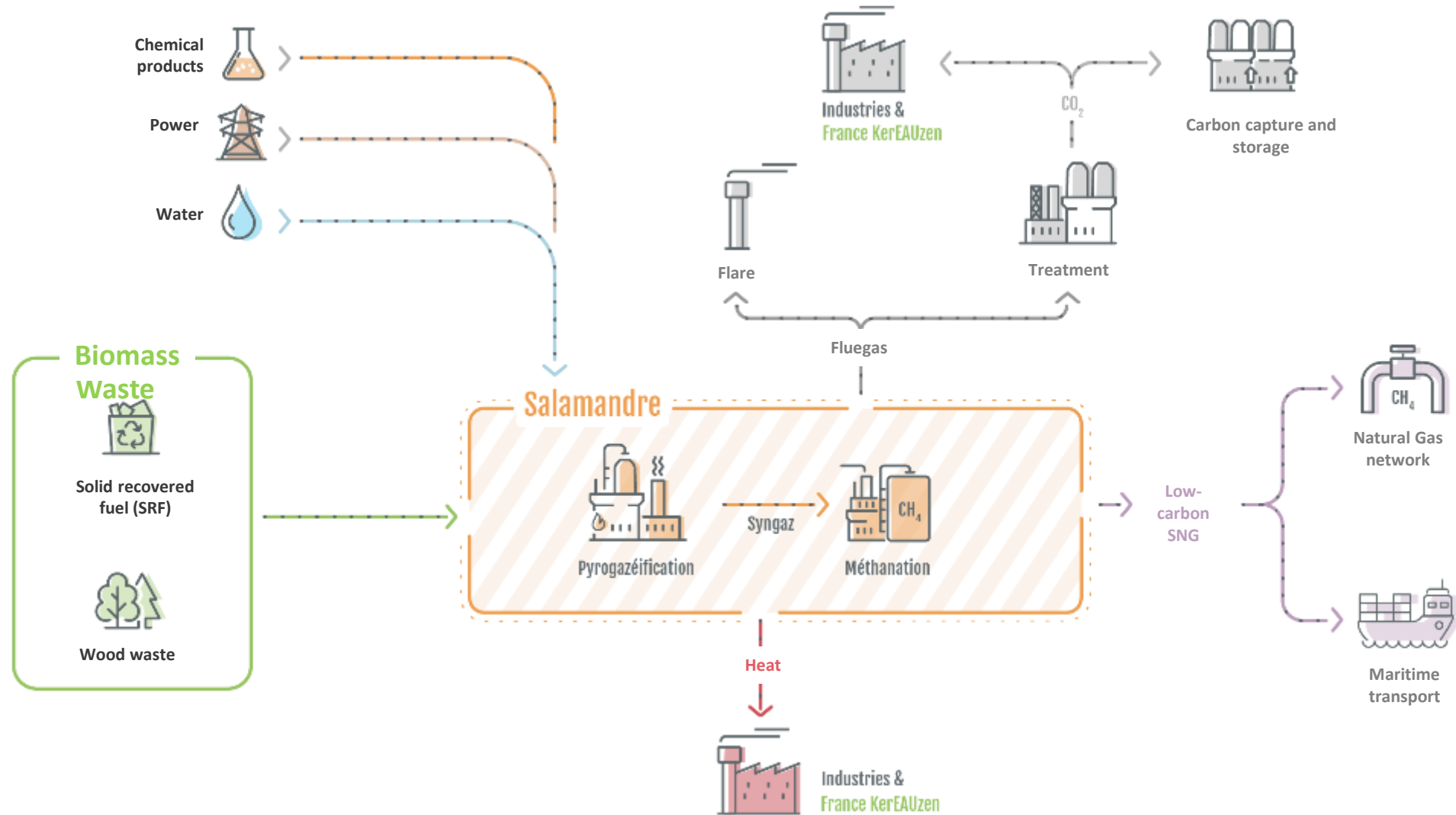


70 000 t/year of non-recyclable waste recovered - Supplied regionally, otherwise exported, incinerated or landfilled



From TRL 8 to 9
Replicability of the solution

The creation of a renewable fuels hub for heavy mobility and intensive industries



GAYA platform transformation (> 2023)

✓ A **semi-industrial trial environment made available for start-ups / SMEs...** to test, de-risk and validate innovative solutions thanks to the modular design of the GAYA platform

- Syngas cleaning technologies
- Catalysts
- Syngas conversion technologies
- SNG upgrading technologies

✓ An **experimental platform available for future research programs**

- Pursue feedstock diversification, in particular waste gasification
- Study inorganic behavior in the gasifier to optimize syngas cleaning step
- Comparison of various syngas cleaning approaches at low, medium or high temperature
- Investigate production of H₂ or even H₂/CH₄ (CRIGEN patent)



Academic partnerships



European projects

- MEASURED (granted), SNG upgrading innovation, coordinated by TU Eindhoven



<https://www.measured-project.eu/>



- BUTTERFLY (granted), co-production of SNG and rDME, coordinated by TNO

BUTTERFLY

Biomass Utilized To The Extended portfolio of Renewable Fuels with Large Yields

19/10/2023

Bioenergy in a net zero future

Prepared by:

Marion Maheut



BUTTERFLY



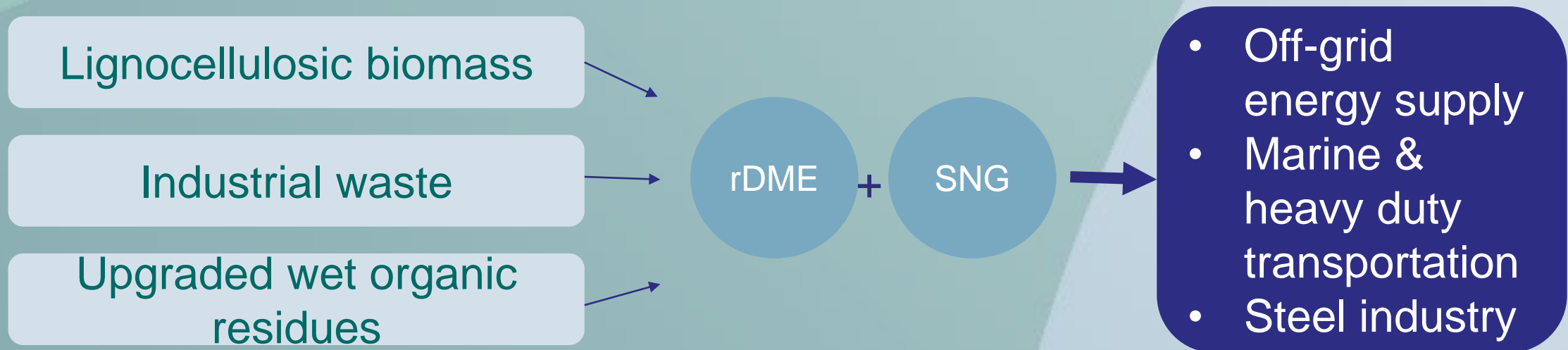
Funded by
the European Union





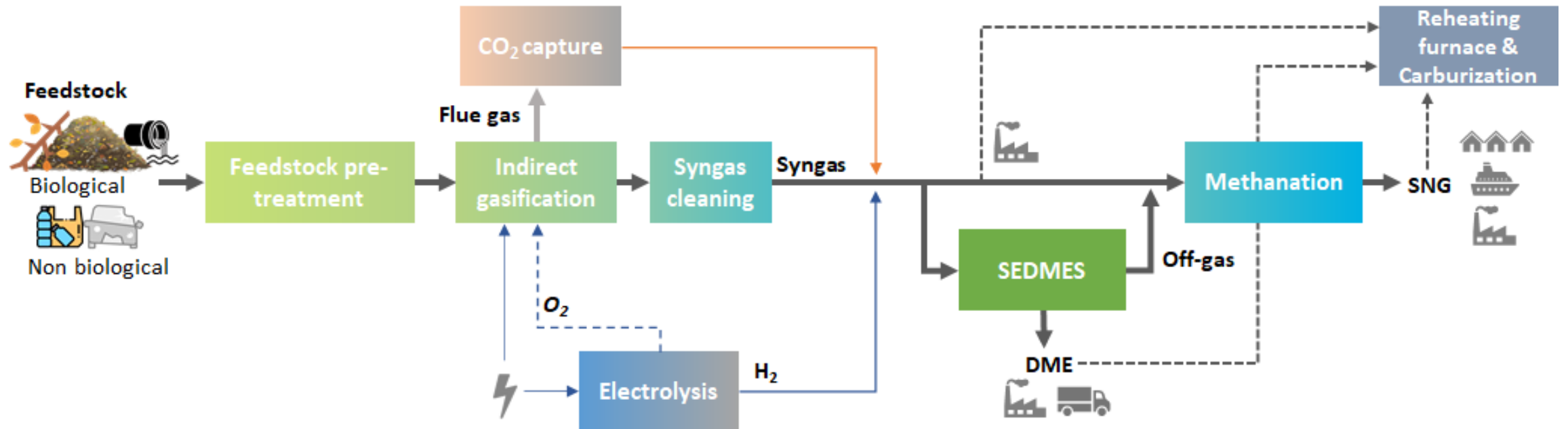
The project

BUTTERFLY is a Horizon Europe Innovation Action project that aims to validate three complete different value chains from waste and residual feedstock for the production of **advanced biofuels** and **renewable fuels** (rDME and SNG, at a tuneable ratio). The application of these green fuels will be the «**hard-to-decarbonize**» sectors.



The process

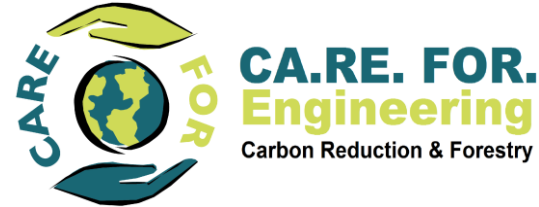
Flexible co-production of rDME and SNG and maximum carbon efficiency will be achieved thanks to innovative integration of **indirect gasification**, sorption-enhanced DME synthesis (**SEDMES**) and SEDMES combination with downstream **methanation**.



The goals

- Improve biomass-to-fuel **conversion efficiency by 15%**
- Achieve up to **97% carbon efficiency**
- **Optimise the synergy** of rDME and SNG production

BUTTERFLY's partners



Thank you for your attention !



Contact

Marion MAHEUT
GAYA R&D project leader
ENGIE CRIGEN
Biogas, Biomass & Waste Lab
marion.maheut@engie.com