Available sources for low-carbon gas production DKarbonation

Nov. 2025

CFP ZIBAC – Study of available sources for low-carbon gas production through waste gasification

Identification and quantification of feedstock sources for low-carbon gas production

1. General context and objectives of the study

France has committed to achieving carbon neutrality by 2050. To reach this goal, industrial zones are expected to become exemplary decarbonization hubs. The "low-carbon industrial zones" (zibac) call for projects, launched by ademe, is part of this initiative.

The dkarbonation project, selected under this call and led by écosystèmed, aims to accelerate the energy transition in the dunkirk area — one of the most industrialized regions in France.

Within this framework, the study entrusted to pôlenergie had three objectives:

1. identify and quantify sources of organic materials that can be mobilized to produce low-carbon gas.
2. evaluate technologies suitable for these sources (methanization, pyro-gasification, hydrothermal gasification).
3. develop territorial scenarios to guide a coherent energy roadmap.

The scope covers the dunkirk urban community (cud) and the community of communes of hauts-de-flandre (cchf).

2. Mobilizable sources in the territory

The identification of mobilizable sources is based on an analysis combining exchanges with industrial actors, farmers, and local authorities, regulatory data (icpe, waste reports), national technical sources (ademe, fao, franceagrimer), and comparison with flows already valorized locally. The analysis distinguishes three main categories of sources: industrial resources, agricultural residues, and flows from municipalities and private managers.

source category	theoretical potential	already valorized	mobilizable potential
agro-food by-products (IAA)	≈ 2,000,000 t/year	82% (animal feed, methanization)	≈ 0 t/year
industrial liquid effluents	40,758 t/year	94% (internal treatment / dedicated channels)	≈ 10,877 t/year
non-food industrial sludge	≈ 4,700 t/year	almost fully valorized	1.4 t/year
crop residues	455,000 t/year	97% (agronomic constraints and valorization)	≈ 15,000 t/year
livestock effluents	449,000 t/year	186,000 t/year already methanized	≈ 135,000 t/year
public wastewater treatment sludge	> 10,000 t/year	partially valorized	≈ 10,000 t/year
residual organic matter & plastics	61,553 t/year	mostly incineration with energy recovery / recycling	mobilizable fraction

The territory has a fairly large volume of organic matter, but a significant portion is already integrated into established valorization channels. The truly mobilizable potential mainly comes from agricultural flows, wastewater treatment sludge, and a fraction of wet industrial effluents, with an **estimated energy potential of approximately 110 GWh/year.**

3. Evaluated valorization technologies

Methanization
A mature technology already present in the territory, it efficiently valorizes wet organic feedstocks with a high yield (≈90%), but requires significant spreading areas, a structured supply logistics, and careful management of the biological balance of the process.

Pyro-gasification
This thermochemical technology is suitable for dry feedstocks such as srfs, plastics, or residual municipal waste. It allows the production of syngas and biochar with yields of 70–80%, while valorizing non-fermentable waste. However, it is less mature and characterized by a still high investment cost.

Hydrothermal gasification
Hydrothermal gasification, nationally supported as an emerging technology, efficiently treats wet or complex feedstocks (effluents, sludge, digestates) with yields of 65–80%, while eliminating the need for spreading and generating valorized co-products such as mineral salts and nitrogen.

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4. Studied scenarios

Three scenarios were tested using a techno-economic model developed for the study.

Scenario 1 – Use of all sources (theoretical maximum vision)

This scenario, which is not realistic, explores the territory's maximum potential by mobilizing all sources, including those already engaged in existing channels. It would lead to a production of 42.8 TWh over 15 years with an investment of approximately €387 million.

technology	production (TWh / 15 years)	lcoe (€/MWh)
methanization	36.3	105
hydrothermal gasification	3.5	40
pyro-gasification	3	79

Scenario 2 – Mobilization of only truly available sources

This second scenario assesses the feasibility of a project relying only on the flows that can actually be mobilized. The resulting energy potential is insufficient to reach an industrially competitive scale, and due to the lack of economies of scale, production costs increase sharply, limiting the economic viability of a project based solely on these sources.

Scenario 3 – Scénario raisonné (réaliste et optimisé)

The third scenario combines the truly mobilizable sources with an optimized allocation of feedstocks and insights from sensitivity analysis. It would achieve approximately 3.2 TWh over 15 years (≈210 GWh/year) with an investment of €59 million and a reduction of about 528 ktCO_2e, representing a realistic, sustainable trajectory consistent with local decarbonization dynamics.

technology	production (TWh / 15 years)	lcoe (€/MWh)
methanization	0.55	44
hydrothermal gasification	1.13	56
pyro-gasification	1.51	78

This scenario is realistic, sustainable, and aligned with local decarbonization dynamics.

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5. T erritorial roadmap

The study proposes a roadmap structured around three main axes:

Axis 1 — Structuring the territorial ambition

The territorial ambition should be based on a low-carbon gas production target that is consistent with industrial needs — steel, chemicals, logistics — while anticipating the increase in renewable gas demand between 2030 and 2050.

Axis 2 — Consolidating the supply/demand balance

The balance between local supply and demand must be strengthened by mobilizing residual unvalorized sources, encouraging the pooling of flows, and developing structuring industrial partnerships.

Axis 3 — Fostering a sustainable economic ecosystem

The economic dynamic relies on supporting innovative technologies such as hydrothermal gasification or pyro-gasification, using bilateral contracts to secure gas valorization, and optimizing co-products such as biochar, salts, and nitrogen.

Overall conclusion

The dunkirk territory has a significant organic resource, but most of it is already valorized. Only a fraction is available for new projects. However, a strategy combining methanization, pyro-gasification, and hydrothermal gasification would allow:

- achieving 3.2 TWh of low-carbon gas production,
- investing in a local value-creating sector,
- significantly reducing greenhouse gas emissions,
- strengthening the territory's energy sovereignty.

This roadmap fully aligns with the ambitions of the national zibac program and with the ecological transition of the hauts-de-france region.

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