RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

DKarbonation

ADEME AGENCE DE LA TRANSITION ÉCOLOGIQUE

EXPERTISES

Study of the potential of CO2 transport infrastructure in Hauts-de-France

Juil. 2025

FRANCE 2030

CFP ZIBAC

The CCUS (carbon capture, utilization, and storage) strategy of France, published in July 2024, outlines the implementation of value chains for CO2 capture, transport, and storage in areas identified as key and priority. The Dunkerque area and the Hauts-de-France region are among these. While CO2 transport chain projects are being studied in the Dunkerque area, which accounts for the majority of CO2 emissions in the Hauts-de-France region, the prospects for developing CO2 transport infrastructure at a broader regional scale across Hauts-de-France have not yet been assessed.

The objective of this study is therefore to provide guidance to public authorities and industrial stakeholders on the feasibility of implementing CO2 capture and storage solutions (through export from Dunkerque) or CO2 utilization at a broader scale across the Hauts-de-France region, considering the development of a CO2 export and utilization hub initiated in Dunkerque.

To this end, the study includes an in-depth territorial analysis of emission sources, prospective modeling of CO2 volumes by 2050, and an assessment of possible CO2 transport infrastructure for the implementation of carbon capture, transport, and storage (CCUS) value chains.

In a second phase, it proposes a strategic vision for the development of a regional CO2 pipeline network, taking into account economic, technical, and territorial considerations. It also includes an assessment of the potential for incorporating biogenic CO2.

Evaluation and confirmation of the need for CO_2 transport in Hauts-de-France

The study first focuses, in its initial phase, on characterizing emission sources, defining a projection methodology, and simulating energy transition scenarios based on ADEME's work. The objective is to identify the sectors and industrial sites most relevant for the deployment of CCUS solutions in Hauts-de-France.

State of CO2 emissions

Fossil CO2 emissions in Hauts-de-France decreased by 40% between 2005 and 2023, reaching approximately 15 Mt/year in 2022. This year is used as a reference for projections, as it corresponds to the most recent year available in the IREP and SEQE-EU databases. The sectoral distribution shows that two sectors account for more than 60% of regional emissions:

- Ferrous metal production: 32 %
- Energy production: 31 %

Other significant sectors include food processing (10%), non-metallic minerals (7%), waste recovery (7%), glass manufacturing (4%), chemicals (3%), and non-ferrous metal production (3%).

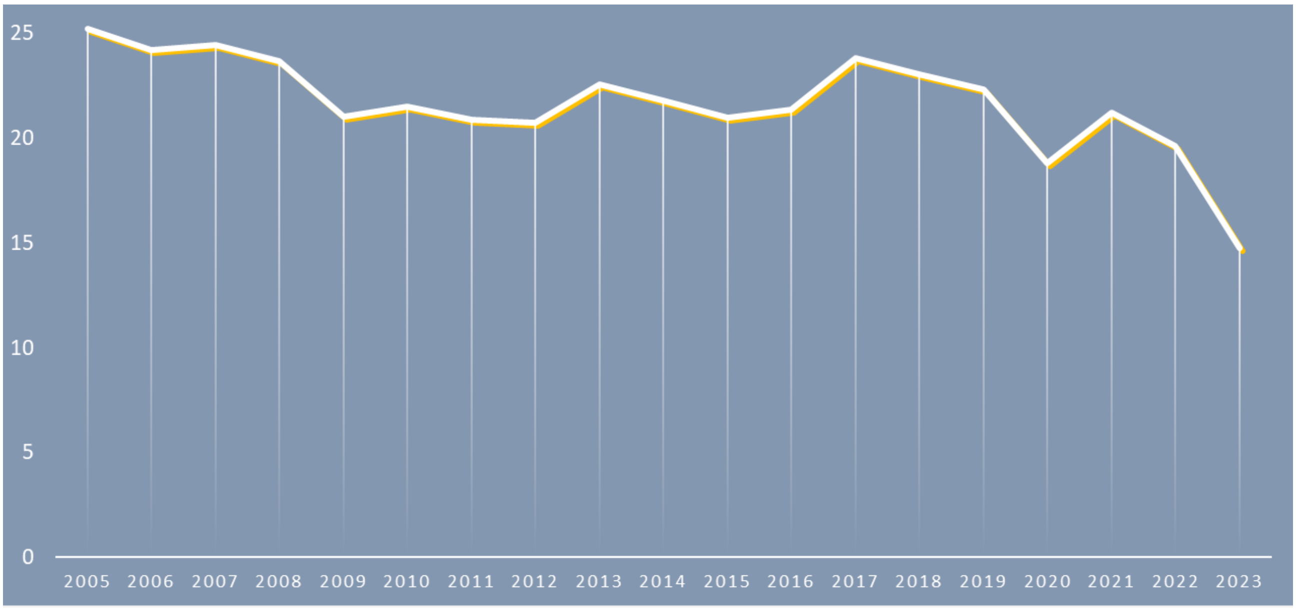


Figure 1 – Evolution of fossil CO2 emissions in Hauts-de-France since 2005 (in Mt CO2)

State of CO2 emissions

Industrial CO2 emissions in Hauts-de-France are characterized by a concentration in the Dunkerque area, which accounts for 51% of regional emissions, with 11.5 Mt CO2 in 2022, 90% of which come from the Engie DK6 and ArcelorMittal sites. The remaining 49% of emissions in Hauts-de-France are dispersed throughout the region. This geographic concentration, along with the diffuse nature of other emissions, is a key factor for planning transport infrastructure.

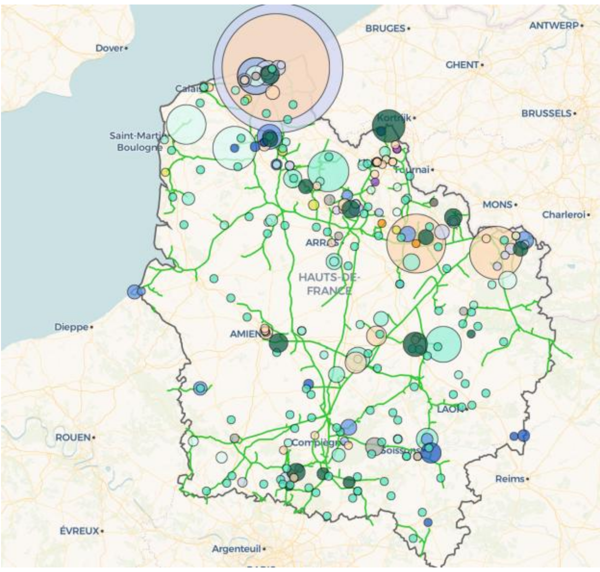


Figure 2 – Distribution of emissions in Hauts-de-France

Biogenic CO2 emissions are also mapped and assessed by sector. Biogenic CO2 is significant in the sectors of anaerobic digestion, landfill sites, and incineration. It represents an opportunity for direct carbon removal (DCR) solutions, notably through BECCS (Bioenergy with Carbon Capture and Storage).

Secteurs d'activité	Emissions totales tCO2/an	% Emissions totales	Emissions Fossiles tCO2/an	% Fossile	Emissions Biogéniques tCO2/an	% Biogénique	Emissions Minérales tCO2/an	% Minérale
Production de métaux ferreux	7 146 648	32%	7 146 648	37%	0		0	
Production d'énergie	6 992 223	31%	6 569 623	34%	422 600	19%	0	
Agroalimentaire	2 366 083	10%	2 084 883	11%	281 200	13%	0	
Minéraux non métalliques	1 555 571	7%	509 081	3%	72 900		973 590	87%
Valorisation	1 518 900	7%	681 086	4%	842 214	38%	0	
Fabrication du verre	792 148	4%	646 326	3%	0		145 822	13%
Chimie	691 145	3%	691 145	4%	0		0	
Production de métaux non ferreux	592 602	3%	592 602	3%	0		0	
Production de papier ou de carton	409 005	2%	244 405	1%	164 600	7%	0	
Méthanisation	326 707	1%	0		326 707	15%	0	
Site d'enfouissement	103 100	0,5%	0		103 100	5%	0	
Industrie automobile	58 466	0,3%	58 466	0%	0		0	
Pharmaceutique	6 608	0,0%	6 608	0%	0		0	
Service informatique	82	0,0%	82	0%	0		0	
Total général	**22 559 288**		**19 230 954**		**2 213 321**		**1 119 413**	
% Total			85%		10%		5%	

Figure 3 – Distribution of activity sectors by type of CO2 emissions in 2022

Projection methodology for emissions to 2050

The emissions projection is based on ADEME's energy transition scenarios (Transition(s) 2050), adapted to the regional scale :

- **Scénario 1 – Frugal Generation:** energy sobriety, strong reduction in demand.
- **Scénario 2 – Territorial Cooperation:** recycling, biomass, energy efficiency.
- **Scénario 3 – Green Technologies**: innovation, electrification, hydrogen, CCU.
- **Scénario 4 – Restorative Bet:** geological capture and storage, strong electrification.

Scenarios 3 and 4 were selected for the projections, as they incorporate CCUS as a major decarbonization lever.

Emission volumes are projected for 2030, 2040, and 2050, by cross-analyzing :

- Industrial production trends
- Progress in energy efficiency

- Electrification rate
- Greening of the gas network

Specific assumptions are applied according to sectors (intent to implement CO2 capture), major categories of industrial sites, and available technologies (ease of capture), and are compared with interviews conducted with key industrial stakeholders as part of the study.

The industrial stakeholders consulted have ambitious emission reduction targets, ranging from 10% to 50% by 2030. However, they report a lack of visibility regarding the cost per ton of CO2 and the profitability of CCUS solutions. CCUS is often considered a last-resort solution for unavoidable emissions, with obstacles related to economic uncertainty, land and energy availability, and regulatory complexity.

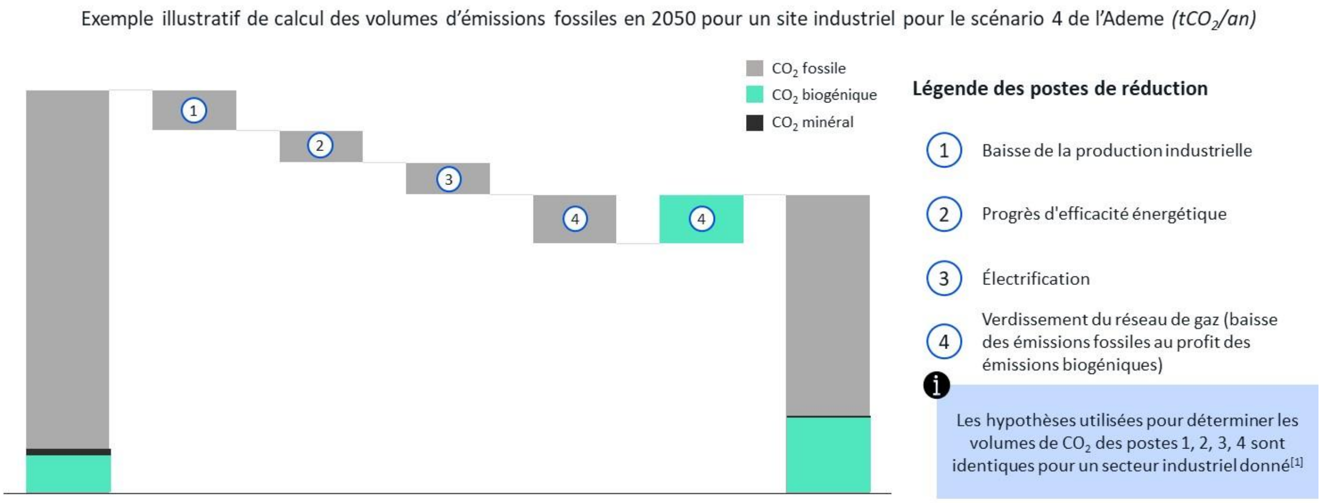


Figure 4 – Example of calculating fossil emission volumes in 2050 for an industrial site

<u>Projection results</u>

The projections show a significant reduction in fossil emissions :

- **Scenario 3 :** 4.4 Mt CO2/year in 2050, corresponding to a fourfold decrease in industrial fossil emissions by 2050.
- **Scenario 4 :** 11.2 Mt CO2/year, corresponding to a 41% reduction over the same period.

They also show that fossil CO2 volumes in Hauts-de-France would remain above 4 Mt/year in 2050, justifying the deployment of CCS regardless of the scenario considered.

The projection exercise also highlights the strong growth of biogenic CO2 volumes linked to the region's decarbonization efforts. Biogenic CO2 represents an increasing share of total emissions :

- 73% in 2050 under scenario 3
- 50 % under scenario 4

Furthermore, in both scenarios, nearly half of fossil emissions in 2050 would be located in the hinterland (outside the Dunkerque industrial zone), supporting the need to consider CO2 transport infrastructure in Hauts-de-France.

The main emitters in 2050 remain concentrated in the industrial clusters of Dunkerque, Bouchain, Maubeuge, MEL (Métropole de Lille), and Saint-Omer.

Secondary clusters (Arras, Compiègne, Soissons, etc.) have lower volumes but could be strategic for infrastructure sharing. Transport infrastructure could connect points of biogenic emissions, which represent potential for deploying direct carbon removal (DCR). Indeed, the proximity of biogenic and fossil emissions facilitates shared collection infrastructure. In Scenario 4, however, the volume of biogenic CO2 is lower, raising questions about the relevance of collection synergies.

Identification and description of 2 CO2 pipeline network deployment scenarios

To identify the most relevant sites for connection to a CO2 network, a cluster-based approach was adopted. The projection of CO2 emission volumes identified 18 clusters (20 km in diameter and more than 100 ktCO2/year of emissions in 2050), varying in emission volumes.

These 18 clusters include a total of 123 sites (45% of Hauts-de-France sites) and account for over 72% of regional emissions. The remaining 28% are more dispersed sites with diffuse emissions across the territory.

Optimistic scenario, or « maximum potential »

A CO2 transport infrastructure structured around a main backbone and the Seine-Nord canal could serve many clusters: building a single backbone connecting several aligned sites allows transport costs to be shared.

The pipeline is the solution with the fewest operational challenges for transporting the large CO2 volumes from northern Hauts-de-France

- Road or rail transport would require a very large fleet of trucks/trains
- Transport by barge is complicated due to the distance of some clusters from navigable canal

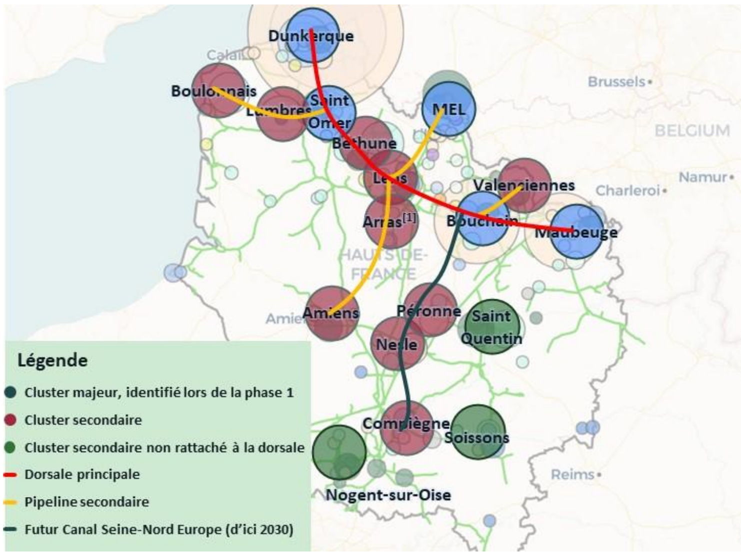
A backbone connecting the main clusters is therefore economically preferred.

The Seine-Nord Europe Canal additionally provides an effective logistical solution for transporting CO2 from the industrial clusters in Oise and Somme.

This network could connect 14 clusters for which :

- Capture and logistical costs (connection to the backbone, injection, gasification, intermediate storage, transport via the backbone) are estimated below a threshold of approximately 140€/tCO_2
- There is sufficient industrial willingness to capture CO2 (industrial capture intent is above 2 according to the defined methodology)

In an initial approach, due to their geographic distance and technical challenges in connecting to the canal, connecting the clusters of Amiens, Nogent-sur-Oise, Saint-Quentin, and Soissons to the backbone was excluded.

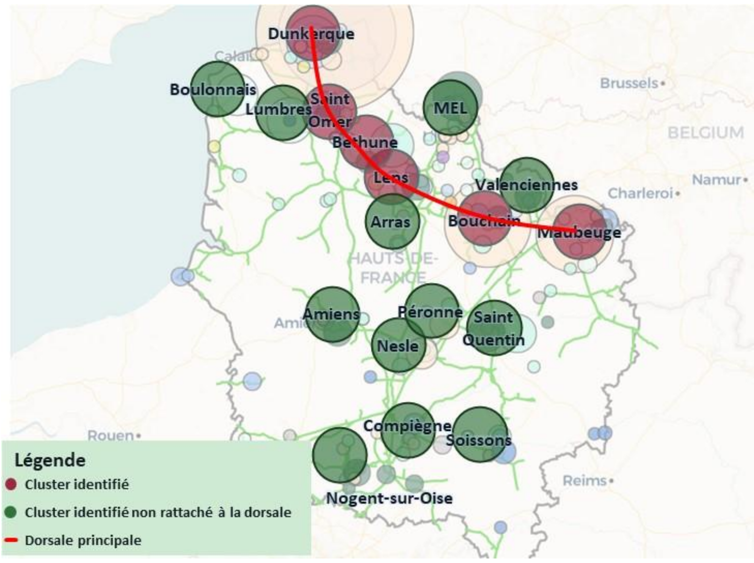


Pessimistic scenario, or « limited »

An alternative, more limited scenario considers that clusters not located along the backbone route are not connected.

This limited CCUS infrastructure deployment scenario corresponds to a network connecting only the clusters located on the backbone route and also excludes the Boulonnais and Lumbres clusters, which are currently directly involved in the Artagnan project.

Only the 5 clusters along the route are connected to the backbone, reducing the maximum transport volumes by 35% compared to the "maximum" scenario.



Techno-economic analysis of the CO2 capture and transport chain

The techno-economic analysis distinguishes three logistical chains according to the location and size of the sites, as shown in the table below.

	Captage	Collecte	Raccordement	Transport	Exutoire	Explication
#1	Captage			Carboduc (dorsale) jusqu'à l'exutoire	Stockage	**Point d'injection** - Cas d'un grand site émetteur issu d'un cluster sur la dorsale (Maubeuge, Bouchain, Lens, Béthune ou Saint-Omer)
#2	Captage		Barge ou Carboduc secondaire connecté à la dorsale	Carboduc (dorsale) jusqu'à l'exutoire	Stockage	**Point d'accroche** - Cas d'un grand site émetteur isolé, relié à un point d'injection par carboduc secondaire ou barge
#3	Captage	Camion		Carboduc (dorsale) jusqu'à l'exutoire	Stockage	**Point de collecte** - Cas d'un petit site émetteur issu d'un cluster sur la dorsale, relié à un point d'injection par camion
#4	Captage	Camion	Barge ou Carboduc secondaire connecté à la dorsale	Carboduc (dorsale) jusqu'à l'exutoire	Stockage	*Cas non considéré*[1]

Thus, costs vary depending on the industrial site's location relative to the backbone and its distance from Dunkerque. Capture represents the largest share of the total cost, particularly for sites located on the main backbone. The choice of capture technologies considered (amine scrubbing or cryogenics) depends on CO2 concentration, technological maturity, and the energy constraints of the sites.

Overall, the logistics share of CO2 transport accounts for 5% to 20% of the total cost.

In the "limited" scenario, with nearly 70% of CO2 coming from Bouchain and Maubeuge, connecting these sites to the backbone is key to the economics of pipeline transport.

In the "maximum" scenario, handling the additional quantities compared to the "limited" scenario reduces transport costs along the backbone by 35%, partially offsetting the costs of connecting these sites to the backbone.

Conclusion

CO2 transport in Hauts-de-France requires an integrated approach, combining a main backbone, secondary connections, and optimization of capture and transport costs. The comparative scenario study shows that even if the volumes of CO2 transported are limited by a low connection rate in the pessimistic scenario ("limited" scenario), the impact of transport costs on the total cost for the emitter remains marginal. These results thus justify investment in a backbone, regardless of the future evolution of emitter site connections.

Overall, the prospective scenarios indicate that the success of the project will depend on territorial dynamics, the evolution of technological costs and carbon pricing, and the ability to unite industrial stakeholders around a shared vision for decarbonization and the development of a shared transport infrastructure.

RÉSUMÉ

This study evaluates the potential for deploying CO2 transport infrastructure in Hauts-de-France, based on an assessment of industrial emissions, projections to 2050 using ADEME scenarios, and a techno-economic analysis of capture and transport chains.

The results show that, despite a significant reduction in emissions, residual fossil CO2 volumes exceeding 4 Mt/year would remain in 2050, justifying the use of carbon capture and storage, while the increase in biogenic CO2 opens opportunities for direct carbon removal.

The study highlights the relevance of a shared transport infrastructure, structured around a main backbone connecting the principal industrial clusters, with transport representing a limited share of the total cost. The success of the project will depend on territorial dynamics, economic visibility, and the ability to unite industrial stakeholders around a common decarbonization pathway.

Ce document est diffusé par l'ADEME

ADEME
20, avenue du Grésillé
BP 90 406 | 49004 Angers Cedex 01

CITATION DE CE RAPPORT

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

www.ademe.fr