RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

DKarbonation

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

EXPERTISES

FRANCE 2030

Pre-feasibility study for carbon capture and storage (CCS)

AAP ZIBAC - 331B ZIBaC - DKarbonation - CCS study summary - Dillinger

1. Background and challenges

The DILLINGER Dunkirk steel production site emits approximately 70,000 tonnes of CO_2 per year. A significant share of these emissions comes from the reheating furnaces, which account for around 80% of the site's energy consumption and represent the main source of direct emissions.

As part of the European objective of achieving carbon neutrality by 2050, these residual emissions, which are difficult to reduce through energy-efficiency measures or electrification alone, must be addressed through complementary solutions.

Carbon Capture and Storage (CCS) is therefore considered a relevant option for reducing these emissions, particularly within an industrial ecosystem such as Dunkirk, which is well suited to the development of shared infrastructure and collaborative solutions.

2. Study objectives

The study aims to:

- Assess the feasibility of CO_2 capture from the main emission sources, particularly the reheating furnaces;
- Compare two carbon capture technologies;
- Estimate performance levels and energy requirements;
- Quantify capital and operating costs;
- Support future investment decision-making.

3. Technologies evaluated

3.1 Chemical absorption (amine-based technology - reference solution)

A mature and proven technology, well suited to the site's current operating conditions:

- CO_2 capture rate > 95%
- High CO_2 purity
- High energy consumption (steam requirement)

3.2 Solid adsorption (SVANTE technology)

An innovative technology offering:

- Greater operational flexibility in response to process variations;
- A CO_2 capture rate of approximately 90% (up to >95%);
- An intermediate level of technological maturity.

4. Performance and technical challenges

Both technologies are capable of capturing nearly all of the targeted emissions, particularly those generated by the pusher reheating furnaces.

The main technical challenges identified are:

- Variability of flue gas flow rates;
- Thermal and electrical energy requirements;
- Integration within an existing industrial site;
- Management of captured CO_2 streams and utility systems.

The amine-based absorption process produces CO_2 with very high purity (>99.9%), meeting the transportation and storage specifications considered at the time of the study.

However, this stringent purity requirement is a key design driver for the process. It entails:

- Additional treatment and purification steps;
- Increased energy consumption (compression and dehydration);
- Higher capital expenditures (CAPEX) and operating expenditures (OPEX).

5. Economic assessment

5.1 CAPEX

- Amine-based scenario: approximately €137 million
- Adsorption-based scenario: approximately €174 million

5.2 OPEX

Estimated operating costs: approximately €20 million per year

Cost breakdown:

- Depreciation: ~€9 million/year
- CO_2 transport: ~€4.3 million/year
- Maintenance and operations: ~€1.6 million/year
- Utilities (including energy): ~€5 million/year

5.3 Comparison with carbon pricing

At the prevailing CO_2 price, the site's annual emissions represent a theoretical carbon cost of approximately: ~€5 million per year

This cost remains significantly lower than the estimated CCS operating costs (~€20 million per year).

This highlights that:

- CCS deployment cannot rely solely on the current carbon price signal;
- Its economic viability requires public funding support, dedicated support mechanisms (such as carbon contracts for difference), and shared infrastructure development.

6. Integration and future outlook

The project could be integrated into a CO_2 hub strategy in Dunkirk, enabling:

- Shared CO_2 transport and storage infrastructure;
- Reduced unit costs through economies of scale;
- Improved energy efficiency through waste heat recovery and integration opportunities.

As the reheating furnaces represent the site's largest energy-consuming process, they constitute a priority target for maximizing the impact of carbon capture implementation.

7. Next steps

The next phases of the project will focus on:

- Evaluating and selecting the most suitable carbon capture technology, including a more detailed assessment of alternatives beyond the solutions already studied, in order to identify the option that best meets the site's specific constraints (flue gas variability, industrial integration, energy performance, and economic efficiency);
- Conducting a Front-End Engineering Design (FEED) study to refine technical choices and cost estimates;
- Strengthening the business case by incorporating market conditions, support mechanisms, and the costs associated with CO_2 transport and storage infrastructure;
- Securing long-term CO_2 transport and storage solutions at the regional level;
- Ultimately, preparing the Final Investment Decision (FID).

8. Conclusion

The study confirms the technical feasibility of CO_2 capture at the DILLINGER site, particularly on the pusher reheating furnaces, which are the site's main contributors to direct CO_2 emissions.

However, with a CAPEX of approximately €135 million, an OPEX of around €20 million per year, and a current carbon price that remains below the operating costs of CCS, the project will require favorable economic conditions to be implemented.

Nevertheless, Carbon Capture and Storage (CCS) represents a strategic solution for the decarbonization of both the DILLINGER site and the wider Dunkirk industrial area, especially within a framework of shared industrial infrastructure and regional cooperation.

RÉSUMÉ

The DILLINGER steel plant in Dunkirk has launched a pre-feasibility study to assess the implementation of a Carbon Capture and Storage (CCS) solution at its facilities. The site emits approximately 70,000 tonnes of CO_2 per year, with the majority of emissions originating from the reheating furnaces, which account for around 80% of the plant's energy consumption.

Two technologies were evaluated: a mature amine-based chemical absorption solution and an innovative solid adsorption solution. The results show that both technologies can achieve CO_2 capture rates exceeding 90%.

The capital expenditure (CAPEX) is estimated at €137 million for the amine scenario and €174 million for the adsorption scenario, while operating costs (OPEX) are estimated at approximately €20 million per year. In a context where the carbon price is €80 per tonne of CO_2, the project represents a significant opportunity for emissions reduction, although its viability remains dependent on economic mechanisms as well as the availability of CO_2 transport and storage infrastructure.

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