French strategy for decarbonization and CCS projects

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GREEN FUTURE SOLUTIONS – A French-Norwegian concept

#5 Decarbonization of the industry

Opportunities for bilateral cooperation on CCS

9 March 2022

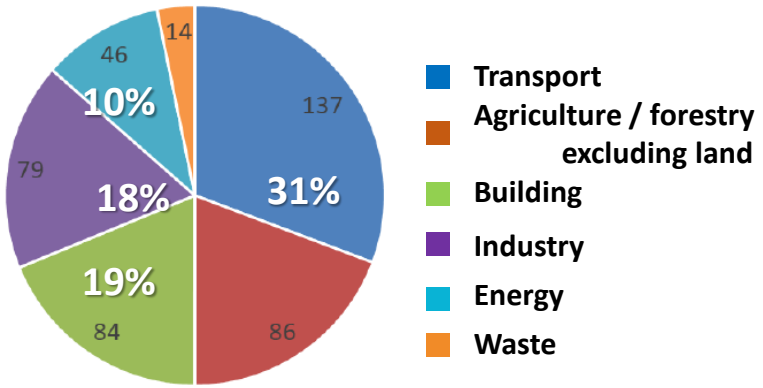
"Club CO_2", *the French team for CCUS*

1. An association founded in 2002 which brings together the French actors involved in CCUS
2. A forum for exchanges of information and initiatives between industrial, research and institutional players in France
3. A key element in the organization of French actions in the field of CCUS promoting national cooperation between the public and private sectors, and federates national actions

How do we plan to achieve carbon neutrality by 2050 in France?

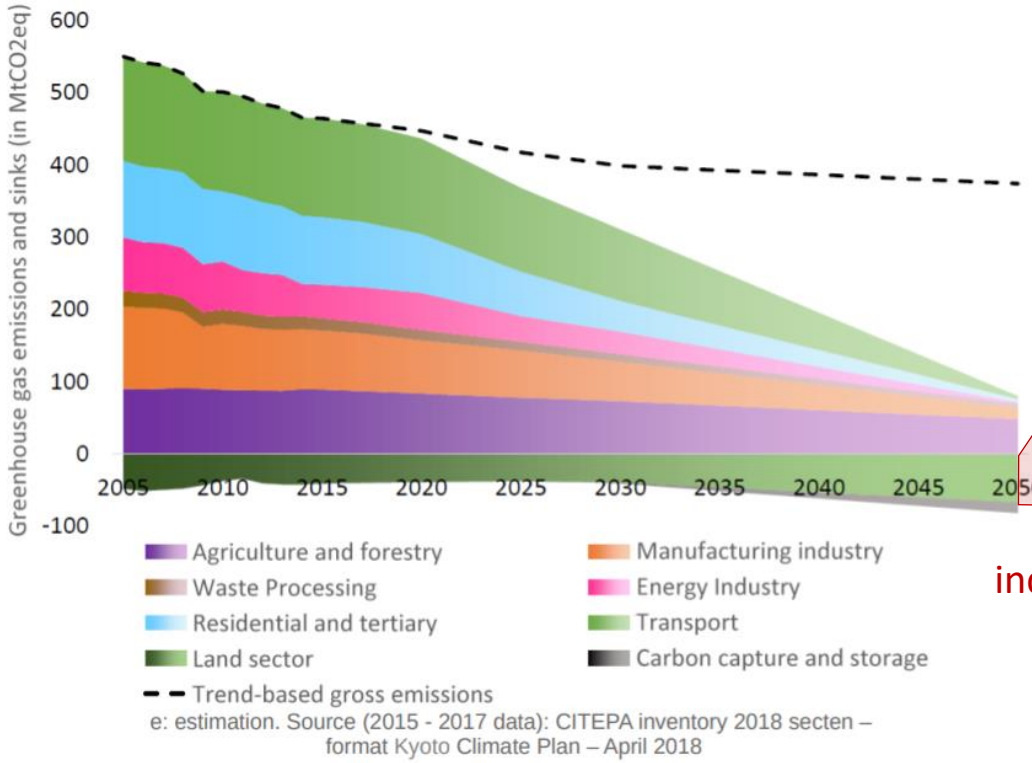
@ 2018

- **445 Mt CO_2eq**: France's territorial emissions

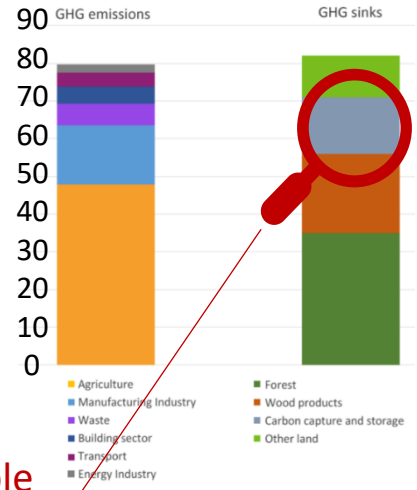


- **750 Mt CO_2eq**: France's carbon footprint:
  11.2 t CO2eq/capita

- Fully decarbonise energy production
- Significantly reduce energy consumption in all sectors
- Reduce non-energy-related emissions
- Increase carbon sinks (natural and technological)



80 Mt CO_2 of incompressible emissions



15 Mt CO_2 by CCUS

- 5 Mt → Hard-to-abate industry emissions
- 10 Mt → Negative emissions

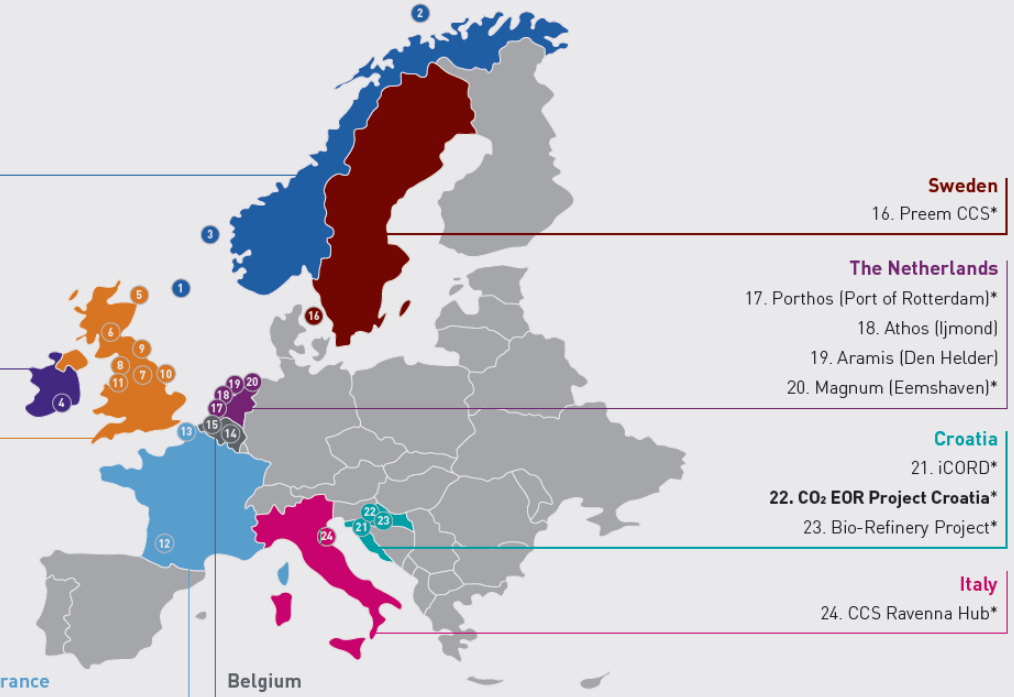
Source: SNBC2, 2020

Which role for CCUS in France?

A solution complementary o energy efficiency and renewable energy

- Towards the first CCS implementations on an industrial scale from 2025 and 2030
- As a priority in French industrial regions with access to storage capacities already identified (North Sea)

Overview of existing and planned CCUS facilities



Norway
1. Sleipner CO_2 Storage*
2. Snøhvit CO_2 Storage*
3. Northern Lights*

Republic of Ireland
4. ERVIA

UK
5. Acorn*
6. Caledonia Clean Energy
7. H21 North of England*
8. Liverpool-Manchester Hydrogen Cluster
9. Net Zero Teesside*
10. Humber Zero Carbon Cluster*
11. Liverpool Bay Area CCS Project*

France
12. Lacq*
13. DMX Demonstration in Dunkirk*

Belgium
14. Leilac
15. Port of Antwerp*

Sweden
16. Preem CCS*

The Netherlands
17. Porthos (Port of Rotterdam)*
18. Athos (Ijmond)
19. Aramis (Den Helder)
20. Magnum (Eemshaven)*

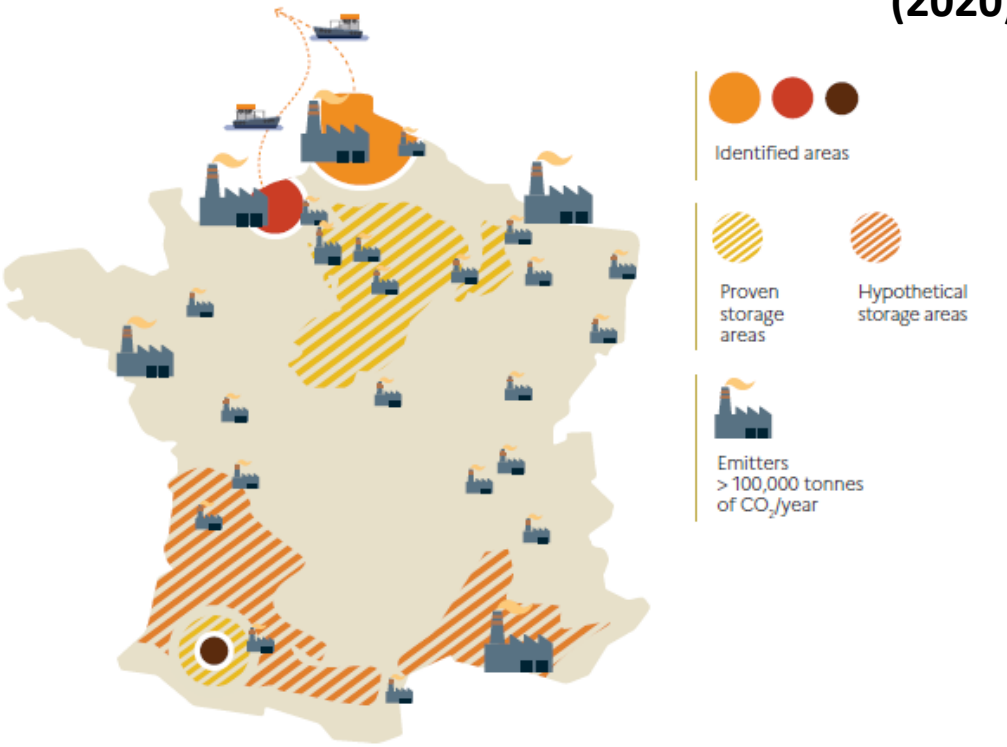
Croatia
21. iCORD*
22. CO_2 EOR Project Croatia*
23. Bio-Refinery Project*

Italy
24. CCS Ravenna Hub*

* Project where IOGP members are involved
Projects listed in **bold** are in operation

(IOGP, 2020)

Regions for CCUS deployement identified by ADEME (2020)



Hauts-de-France (Dunkirk) **15 $MtCO_2$/year**

- ⊕ Possibility of offshore storage (North Sea)
  Large volumes of CO_2 for setting up CO_2 transport infrastructure
- ⊖ Regulatory obstacle to be removed on the possibility of exporting CO_2 emissions outside the country and by boat
  Estimated minimum cost of €100/t CO_2

Normandy (Le Havre-Rouen) **6 $MtCO_2$/year**

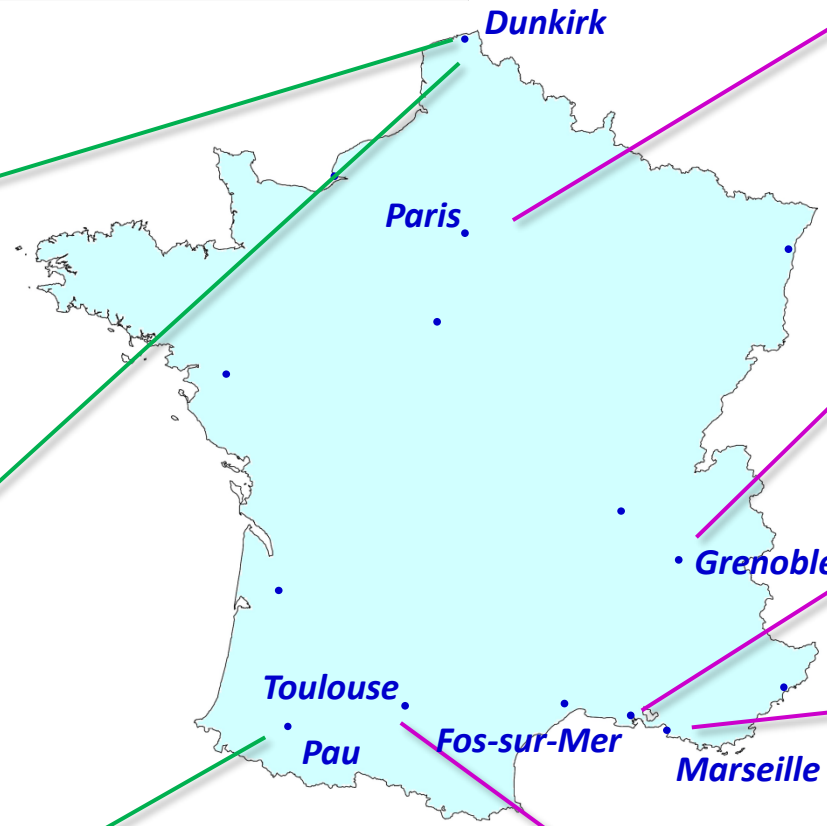
- ⊕ Interconnection with the Dunkirk CO_2 hub for offshore storage (in the North Sea)
  Large volumes of CO_2 for setting up CO_2 transport infrastructure
- ⊖ Regulatory obstacle to be removed on the possibility of exporting CO_2 emissions outside of the country and by boat
  Estimated minimum cost of €125/t CO_2
  Durability of sites (industrial sectors that will be impacted by the energy transition)

Nouvelle-Aquitaine (Lacq) **3 $MtCO_2$/year**

- ⊕ Existing infrastructure (former gas reservoir)
  Estimated minimum cost of €88/t CO_2
- ⊖ Low volume of CO_2
  Onshore storage area

A long track record in France supporting CCUS development from R&D to pilot and demonstration

- ✓ More than 200 laboratories with CCUS dedicated teams
- ✓ Industrial players fully engaged in CCUS



IGAR – Demonstrator-based validation of injection in a blast furnace for the reduction of steelmaking gases [ArcelorMittal]

3D "DMX Demonstration in Dunkirk" – CO2 capture (DMX technology) from steel factory (pilot) with possibility to develop the future European Dunkirk North Sea cluster [IFPEN, ArcelorMittal, AXENS, TOTAL]

Lacq – CO2 capture test facility [TOTAL]

FASTCARB – Production of recycled concrete through mineralization [IFSTTAR]

CEMENTALGUE – Captured CO2 for algae cultivation [VICAT]

Jupiter 1000 – Methanation process with CO2 [GRTgaz]

VASCO2 – Production of algal biomass via industrial sources of CO2 [Port of Marseille]

CARBOVAL – Mineralization of mining industry waste [University of Toulouse]

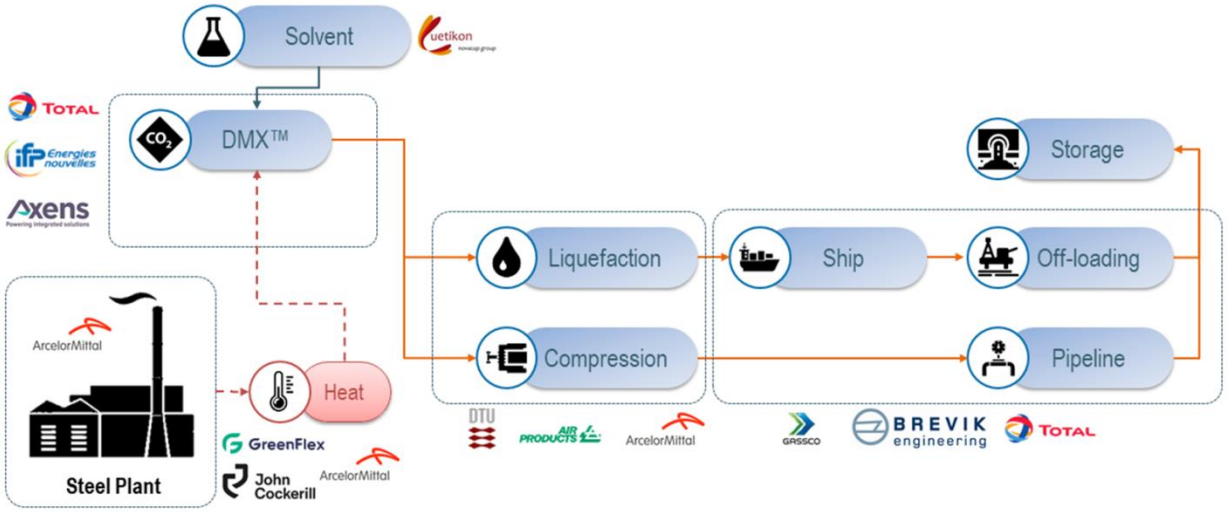
An example, the 3D project in Dunkirk

https://3d-ccus.com

May 2019 – April 2023

1. Demonstrate the **DMX™ process** for CO_2 capture
   Pre-industrial demonstrator (blast furnace, Arcelor Mittal, Dunkirk)
2. Prepare a first CCS large-scale demonstrator (**> 1M tCO_2eq/y**)
3. Study the CCS cluster 2035 Dunkirk-North Sea (**10 $MtCO_2eq/y$**)

CO_2 3D DMX DEMONSTRATION DUNKIRK



Social Sciences and Humanities, Life Cycle Analysis and Cost

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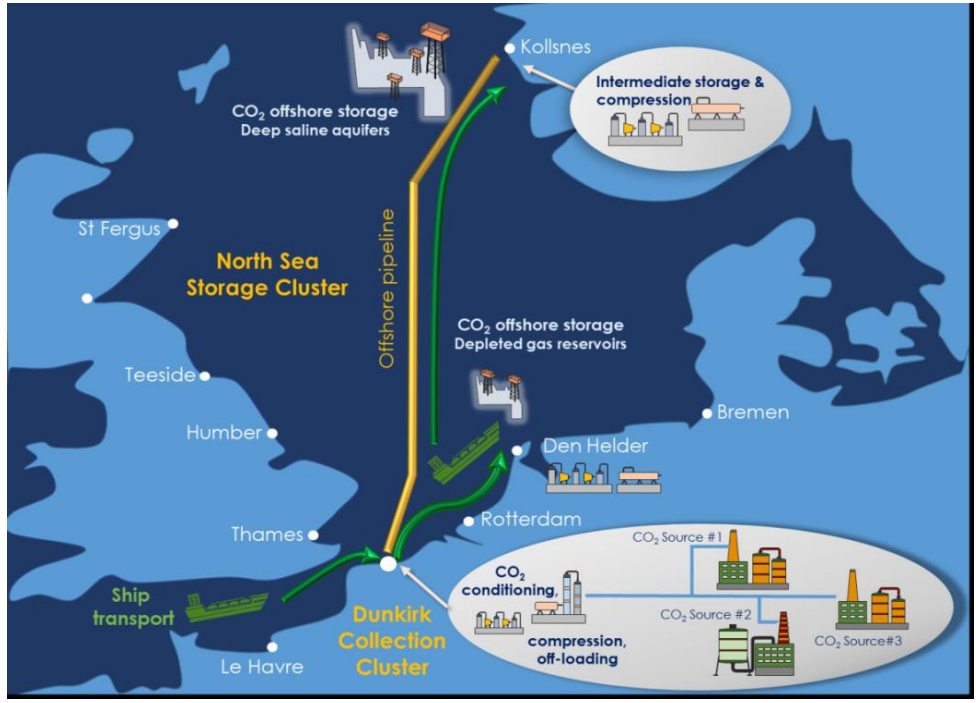
CCS cluster 2035 in Dunkirk

TOTAL



Perspectives

https://www.club-co2.fr/files/2021/10/ClubCO2-position-paper-3.pdf

- In France, the development of the CCS should
  - Enable the development of a French CCS technology sector
  - Strengthen the offer of industrial services
  - Contribute to promoting the safeguarding, or even the creation, of jobs in French territories

French actors have all the assets to create a sector of excellence at the international level on the whole the CO_2 capture, transport, and storage chain

SAVE THE DATE !

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16TH GREENHOUSE GAS CONTROL TECHNOLOGIES CONFERENCE

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