



2<sup>nd</sup> REUSE CO<sub>2</sub> SEMINAR  
October 21th, 2016

# CO<sub>2</sub> Capture and Reuse on Le Havre territory

by **Frédéric BERNARD**





# Content

**TERRITORIAL  
OVERVIEW**

**P 3**

**CO<sub>2</sub> CAPTURE:  
FROM RESEARCH  
TO INDUSTRY**

**P 6**

**NEXT STEPS**

**P 16**

An aerial photograph of the Le Havre-Seine Estuary. In the foreground, a large MSC container ship is sailing on the water, carrying a load of colorful containers. To the left, a lighthouse is visible on a small island. The background shows the city of Le Havre and the harbor area. The image is overlaid with a grid of semi-transparent colored squares in shades of blue, green, and grey.

LE HAVRE- SEINE ESTUARY  
**Territorial  
overview**

TERRITORIAL OVERVIEW

# At the entrance of Northern Europe



# Main features

## ■ A leading european port

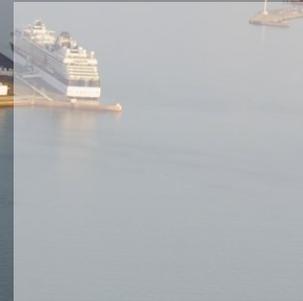
- ▲ HAROPA : 5<sup>th</sup> biggest port in Northern Europe
- ▲ 2<sup>nd</sup> French port in terms of tons carried
- ▲ 1<sup>st</sup> French port for container traffic
- ▲ Linked to 600 ports worldwide

## ■ A major industrial platform

- ▲ 31,000 jobs – 1,200 sites
- ▲ 1<sup>st</sup> French petrochemical complex
- ▲ The 2 biggest French refineries on the territory
- ▲ 1<sup>st</sup> European area for fertilizer production



LE HAVRE- SEINE ESTUARY  
**CO<sub>2</sub> capture:  
from research  
to industry**



CO<sub>2</sub> CAPTURE: FROM RESEARCH TO INDUSTRY

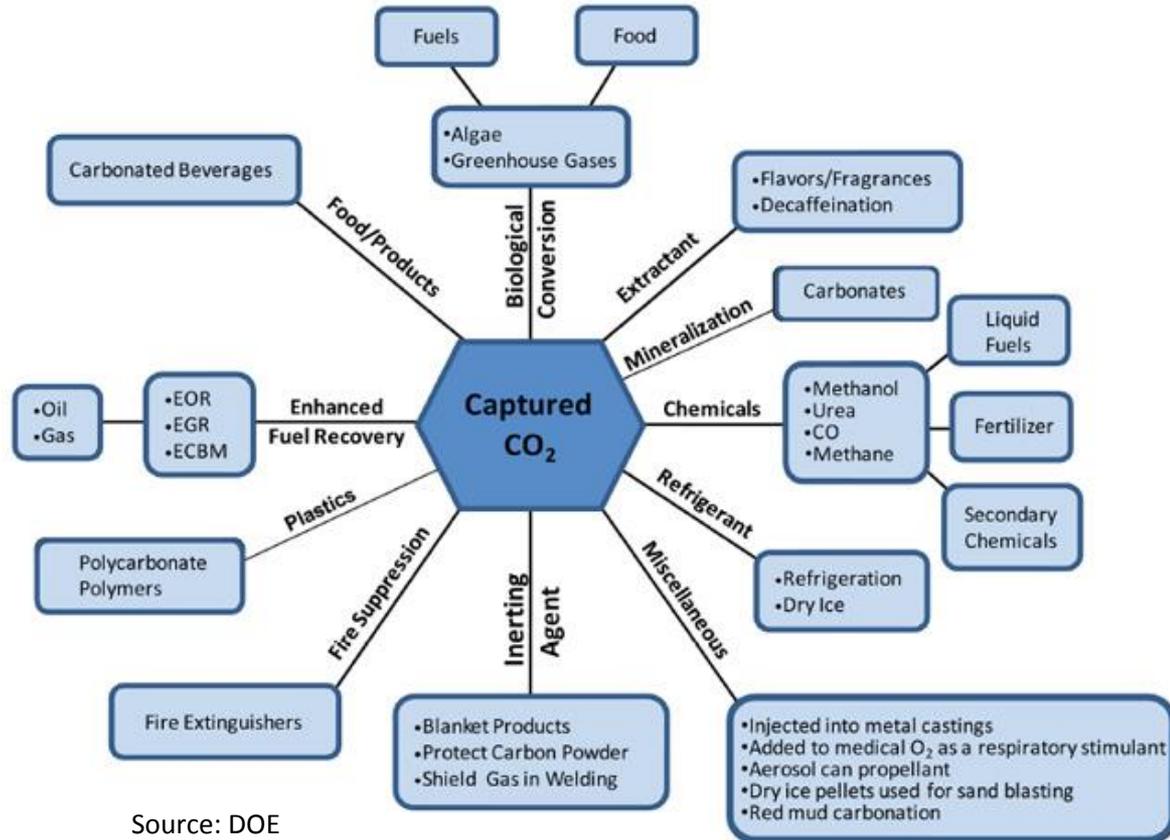
# An area concerned by CO<sub>2</sub> emissions

- More than **10 Mt of CO<sub>2</sub> / yr** emitted by 24 sites
  - About **15 sites under quotas**
  - **Issues for the territory**
    - ▲ Environment and health
    - ▲ Economic activities
- **A need for the territory to find solutions**



# What solutions to explore?

1. CO<sub>2</sub> emissions capture
2. Which CO<sub>2</sub> emissions routes ?

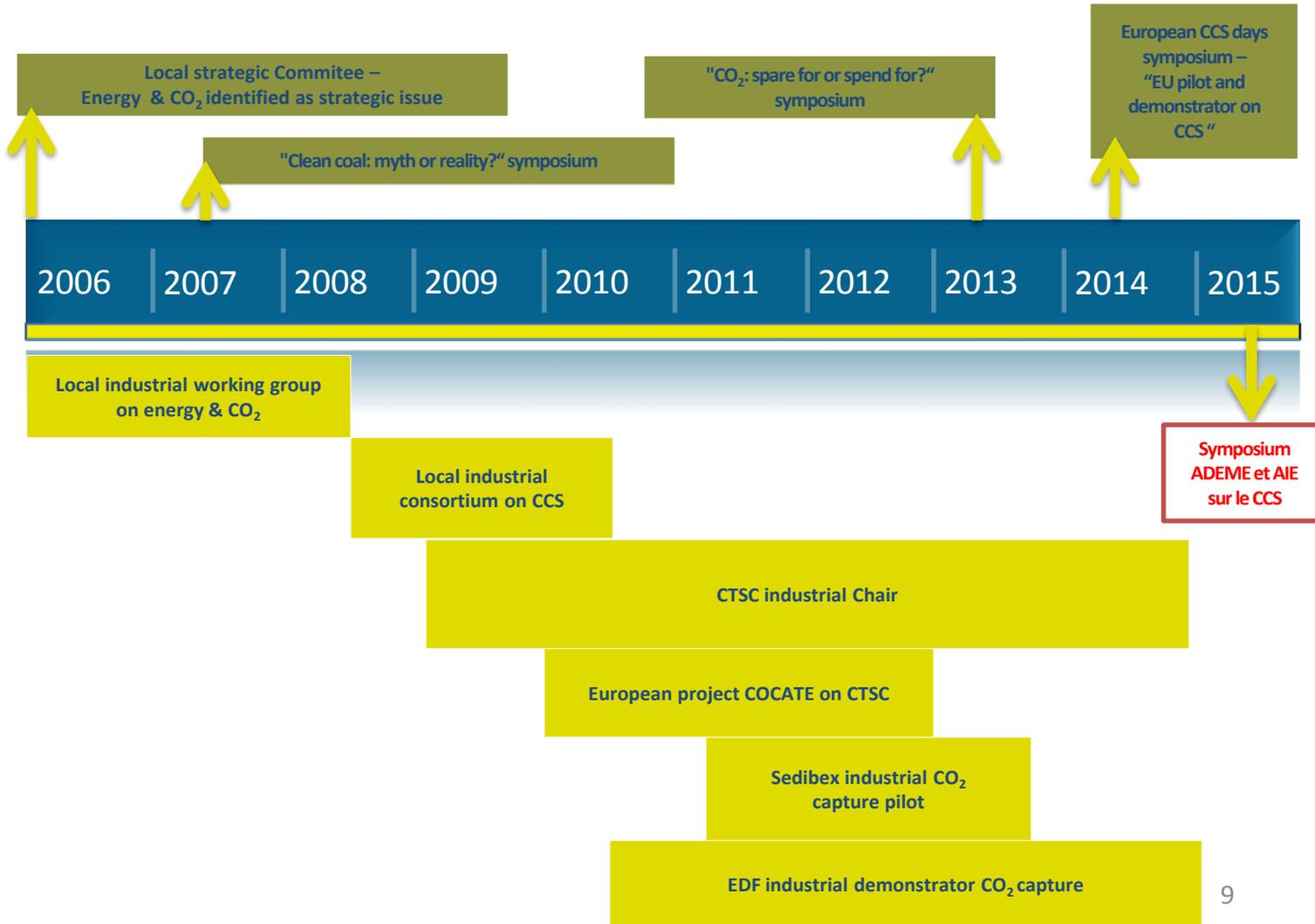


Source: DOE



CO<sub>2</sub> CAPTURE: FROM RESEARCH TO INDUSTRY

# 10 years of mobilization



CO<sub>2</sub> CAPTURE: FROM RESEARCH TO INDUSTRY

# CTSC industrial chair



- R&D CO<sub>2</sub> chair (2010 – 2015)
- Created by the University of Le Havre and the Ecole des Mines Paristech
- Objectives
  - ▲ Develop knowledge about Capture, Transport and Storage of CO<sub>2</sub> (CTSC)
  - ▲ Inform policy choices to come
- Seminars, publications, presentation at international conferences and the start of a dozen PhD theses



CO<sub>2</sub> CAPTURE: FROM RESEARCH TO INDUSTRY

# European project COCATE



- Large-scale CCS Transportation Infrastructure in Europe (2010-2012)
- 5 countries involved: France, Denmark, Norway, Netherlands, South Africa
- €4,5 M research project funded by the European Community under FP7 (EC contribution: €3 M)
- Objectives
  - ▲ Develop a collecting network of small emitters fumes
  - ▲ Study a CO<sub>2</sub> network composed of pipelines, intermediate storage and / or boats will transport the CO<sub>2</sub> gathered to the storage sites (off or on-shore)



CO<sub>2</sub> CAPTURE: FROM RESEARCH TO INDUSTRY

# Industrial pilot and demonstrators

## ■ CO<sub>2</sub> capture pilot (2011 – 2013)

- ▲ Conception of a **CO<sub>2</sub> post combustion capture pilot** based on the amine technology
- ▲ Pilot installed in the Sedibex **hazardous waste incinerator plant**
- ▲ Research program PLACID-EIDA
- ▲ Industrials and universities partnership
- ▲ Capacity : **1 kg CO<sub>2</sub> / h**



# Industrial pilots and demonstrators

- CO<sub>2</sub> capture demonstration unit (2010 – 2014)
  - ▲ Unit built in the EDF coal thermal power plant
  - ▲ **Amine-based** post-combustion CO<sub>2</sub> technology
  - ▲ Capacity: **7,500 t CO<sub>2</sub> / yr**
  - ▲ Total investment: **€ 22 million**



# Industrial achievement: Cryocap™

## ■ Cryocap™ H<sub>2</sub> industrial unit (2011 – 2016)

- ▲ Unit built in the biggest “Air Liquid” French hydrogen production plant
- ▲ Patented “Cold CO<sub>2</sub> capture” technology
- ▲ **Capacity: 100 kt CO<sub>2</sub> / yr**
- ▲ Air liquid investment: about **€ 30 million**
- ▲ Additional public financial **grant : € 9 million**
- ▲ Industrials and universities partnership



# Industrial achievement: Cryocap™

## ■ Cryocap™ technology:

- ▲ 1st CO<sub>2</sub> capture technology using a cryogenic process
- ▲ Capture of CO<sub>2</sub> emissions of NG reforming
- ▲ Improve hydrogen production yield (until 20%)

## ■ Use of CO<sub>2</sub> after purification:

- ▲ 70% agro-industries (carbonation of sparkling, beverages, food preservation and reezing, etc.)
- ▲ 30% other industries (water treatment, remineralization, chemical reagent...)





LE HAVRE - SEINE ESTUARY  
**Next steps**

NEXT STEPS

# What next ?

- **Offer other solutions to industrials of the area**

- ▲ Issue: maintain industrial activities on site

- **Unique R&D ecosystem to federate & promote**

- ▲ Scientific excellence on CO<sub>2</sub> capture and reuse
- ▲ Lab-pilot of CO<sub>2</sub> capture
- ▲ Industrial pilot of CO<sub>2</sub> capture: 1kg/h
- ▲ Industrial demonstrator of CO<sub>2</sub> capture: 1t/h

→ **The territory offers CO<sub>2</sub> capture R&D solutions from research to process development and scale-up**

→ **To be combined with CO<sub>2</sub> reuse R&D installations**



NEXT STEPS

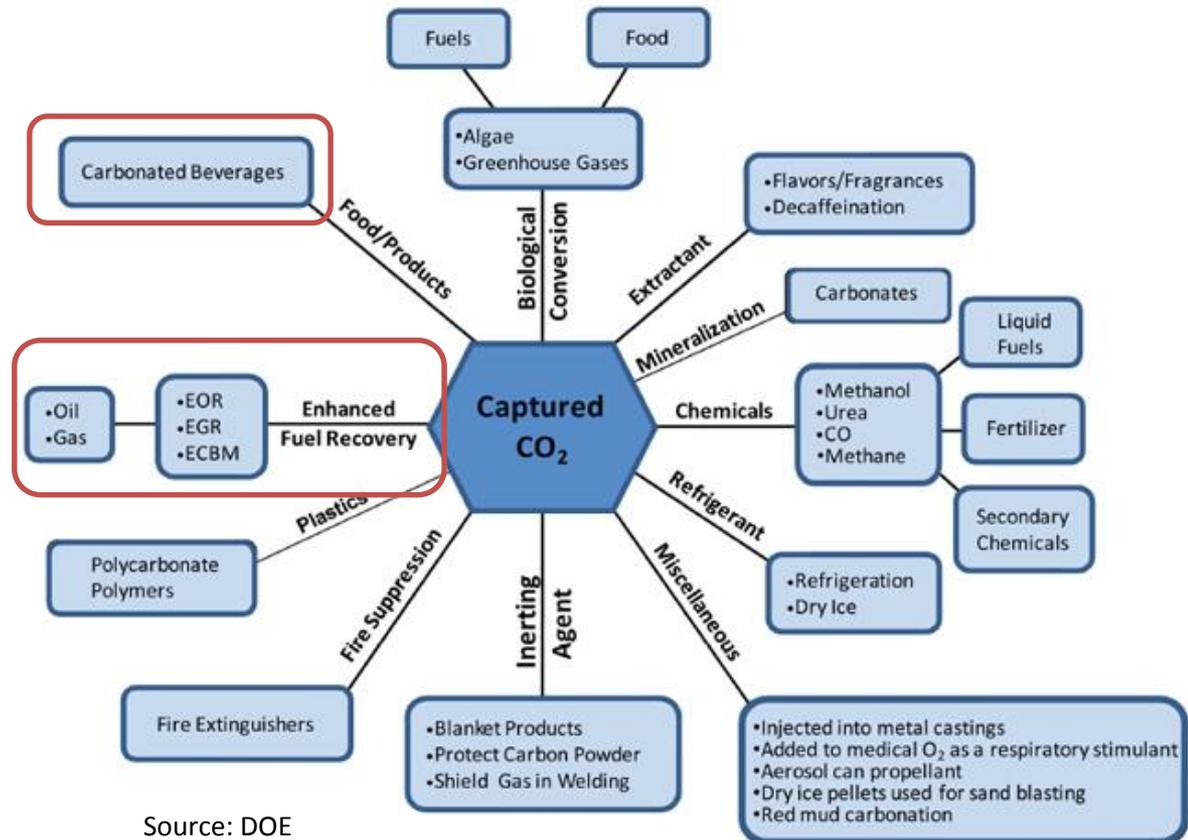
# What next ?

- Other CO<sub>2</sub> emission routes to explore  
→ other industries and project to implement



Cryocap

COCATE



Source: DOE



Le Havre region  
economic  
development  
agency



Frédéric  
**BERNARD**  
Industrial  
development  
Manager

Tel. +33 (0)2 76 40 23 20  
[f.bernard@havre-developpement.com](mailto:f.bernard@havre-developpement.com)

[www.havre-developpement.com](http://www.havre-developpement.com)

FROM RESEARCH TO INDUSTRIAL UNITS: OUR EXPERIENCE IN CO<sub>2</sub> CAPTURE

# What our territory can offer to the CO<sub>2</sub> valuation project

- Great CO<sub>2</sub> **emitters**
- **Real-estate opportunities** near CO<sub>2</sub> emitter who master CO<sub>2</sub> capture technologies
- Industrial & scientific **expertise** of CO<sub>2</sub> capture and reuse
- Knowledge of **large-scale CCS transportation** infrastructure
- **Support of local stakeholders** for CO<sub>2</sub> industrial development
- Know-how of **European projects**

