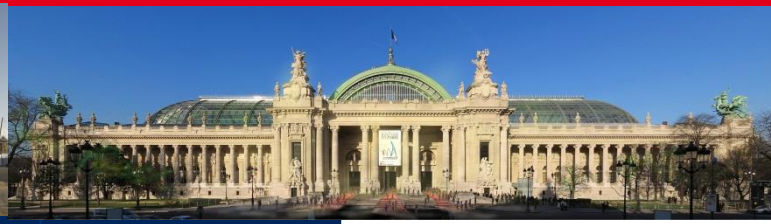
26th World Gas Conference

1 – 5 June 2015, Paris, France



Overview of Carbon Capture and Storage (CCS) Development towards a Sustainable Gas Industry

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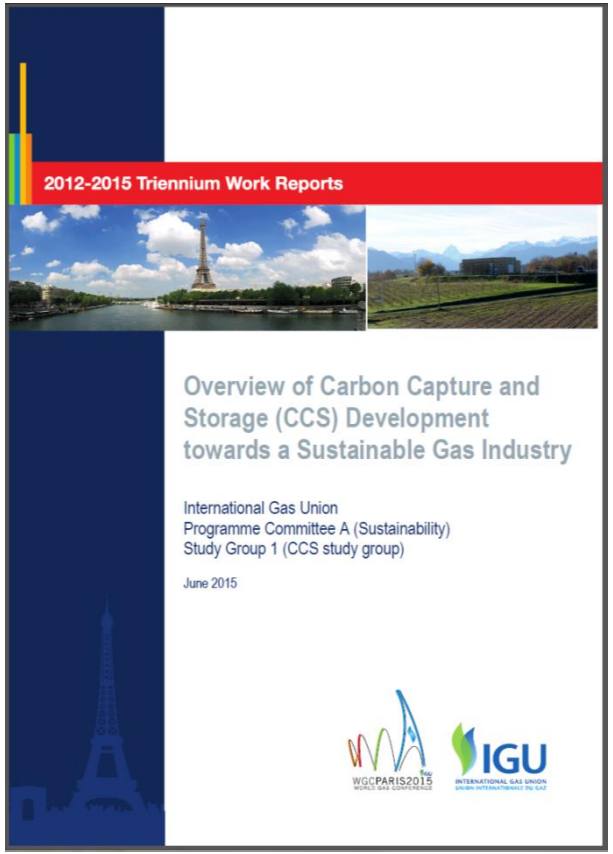
About our CCS report



- This report was prepared by Study Group 1 (CCS) in IGU PGC-A.
- This report is the second CCS report by IGU and is the achievement of intense discussion among the members from the following organizations during 2012-15.

  Tokyo Gas (Japan), Statoil (Norway), TOTAL (France), Petronas (Malaysia), Sonatrach (Algeria), PTT (Thailand), NIGC (Iran)

Contents

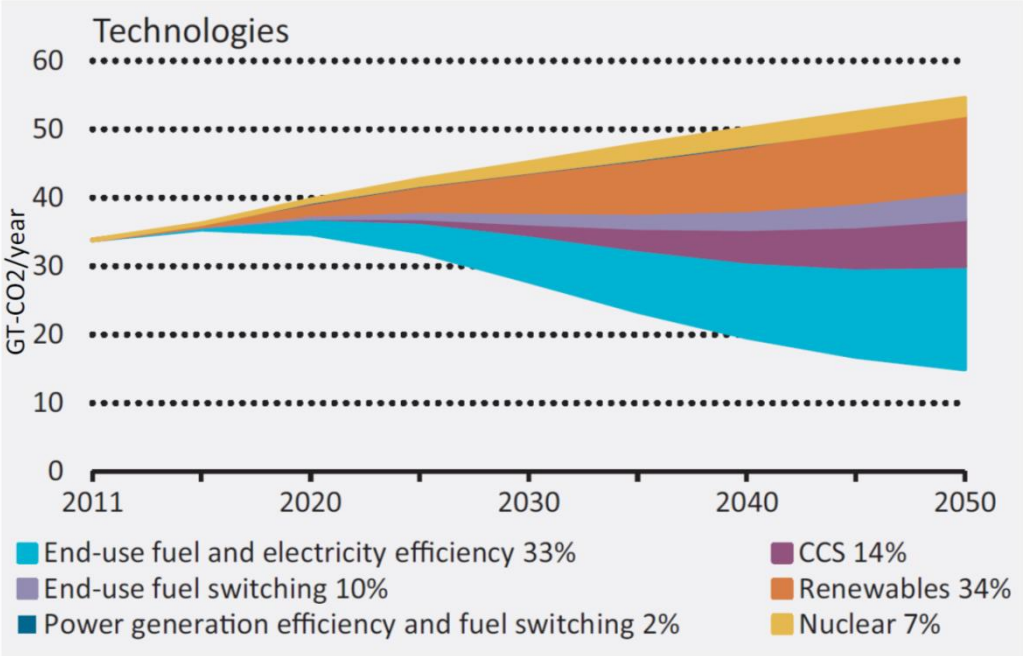
1. Introduction
2. Why is CCS important for a sustainable gas industry?
3. Status of CCS around the world
4. Legal and regulatory framework for CCS
5. Public perception on CCS
6. Perspective on CO_2 utilization
7. Conclusion

1. Introduction

- There is an urgent need to mitigate GHG emissions, including those related to energy production and consumption.
- CCS is one of the most viable technologies currently available to mitigate GHG emissions from fossil fuel usage.
- The main challenges for the expansion of the CCS are;
  - Lack of commercial incentives
  - The high cost of implementing CCS
  - Difficulty of public acceptance of CCS
  - Underdeveloped legal and regulatory framework
- Although CCS from coal has generally received most attention, CCS with gas can enhance natural gas' advantage of the low carbon emission.

2. Why is CCS important for sustainable gas industry? (1)

Contribution of various measures to annual emission reduction

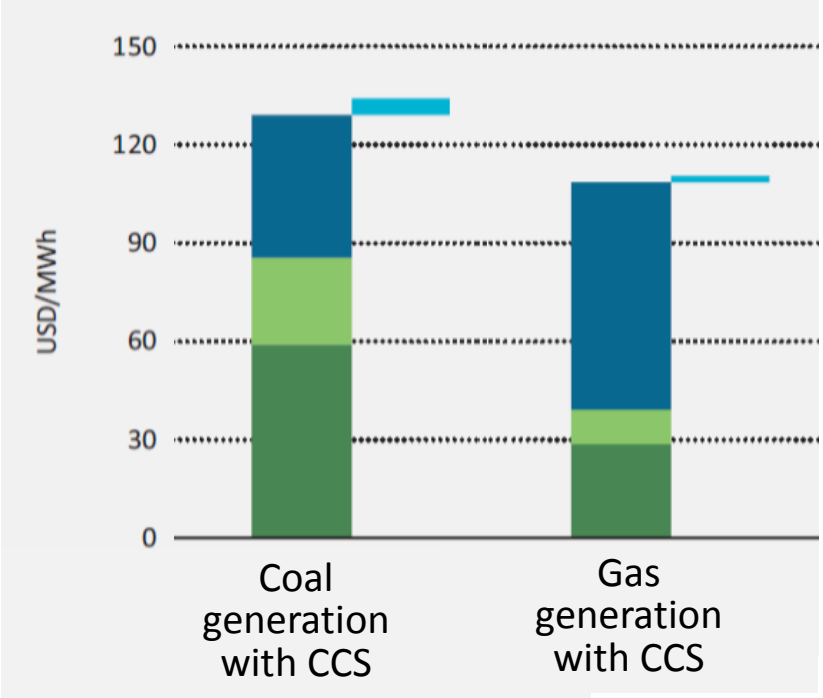


Source: IEA, ETP2014

CCS is expected to play a major role in various measures against global warming, accounting for 14% CO_2 reduction in 2050 to limit the expected temperature increase to less than 2 degrees Celsius.

2. Why is CCS important for sustainable gas industry? (2)

Levelized cost of electricity in IEA's 2DS scenario in 2020

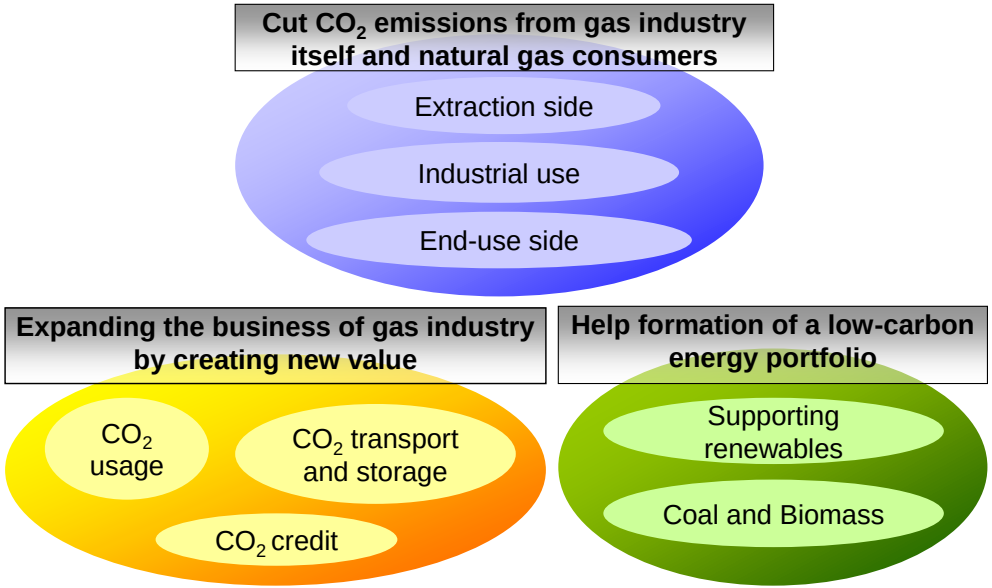


Source: IEA, ETP2014

- CO_2 emission factor per MWh from gas generation is much lower than that from coal.
- Gas-fired generation with CCS can be more competitive than the coal-fired equivalent if certain conditions of fuel and CO_2 prices are met.

2. Why is CCS important for sustainable gas industry? (3)

Three roles of CCS system for a natural gas supply system



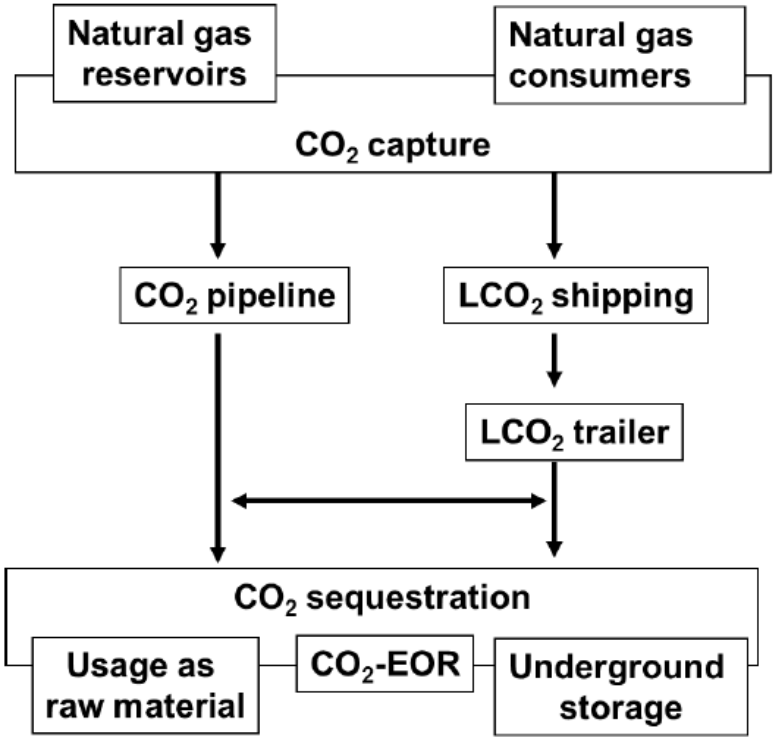
Source: IGU, 2012

CCS can contribute to gas industry by

- cutting CO_2 emissions from gas industry and consumers.
- expanding the business by creating new value.
- helping formation of low-carbon energy portfolio.

2. Why is CCS important for sustainable gas industry? (4)

CCS system for natural gas supply system



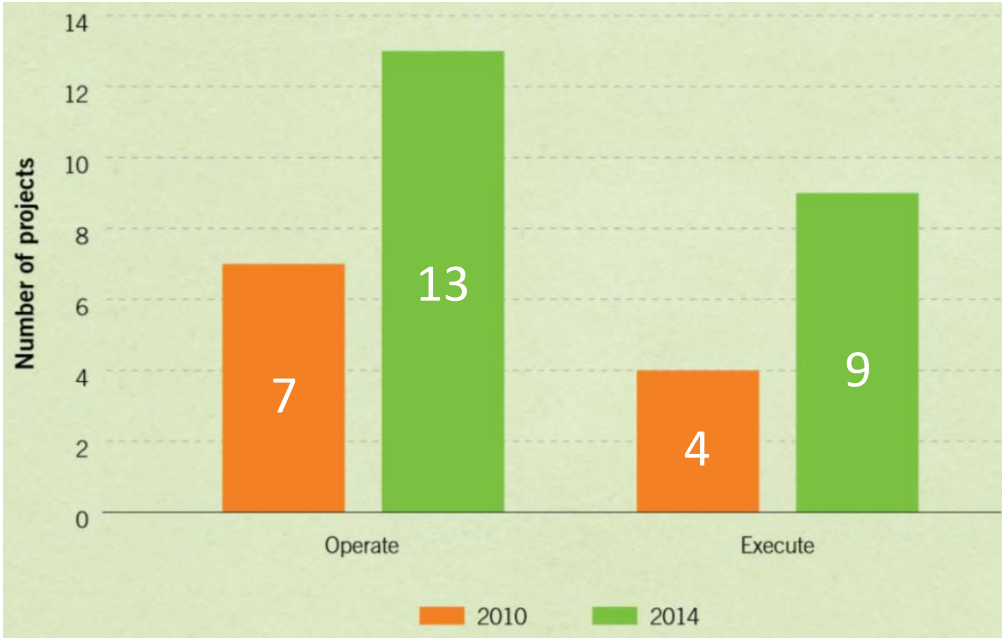
- In the CCS system, generated CO_2 is captured at the extraction site and at the natural gas consumption side.
- Captured CO_2 is transported through pipeline or as liquid CO_2.
- Transported CO_2 is utilized as raw material or stored in geological formations.

2. Why is CCS important for sustainable gas industry? (5)

- CCS from natural gas will account for a significant part of the global CCS industry, as it will deal with the CO_2 emissions associated with production of CO_2 contained in gas reservoirs, with natural gas liquefaction, and with industrial applications.
- Gas industry has developed knowledge, operational skills, and infrastructure that will contribute to develop CCS;
  - CO_2 separation technology from produced natural gas
  - Gas transport infrastructure by liquefied and by pipeline
  - The knowledge of geosciences to estimate CO_2 storage capacity

3. Status of CCS around the world (1)

Number of large-scale CCS projects in operation and under construction

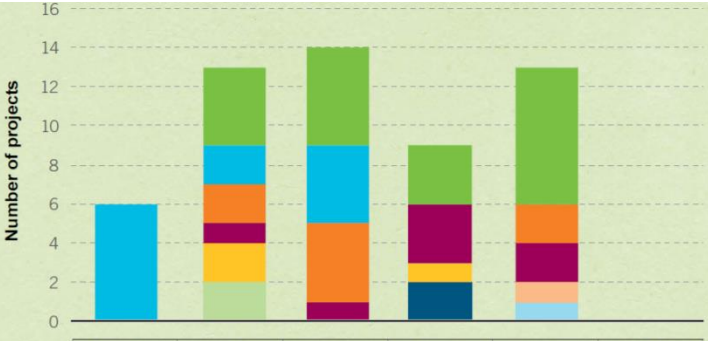


- The number of large scale CCS projects has almost doubled in four years.
- The year 2014 might signal the beginning of a historic period for the spread of CCS
- The world's first CCS project in the power sector commenced operation at the Boundary Dam in Canada in October 2014.

Source: GCCSI, 2014

3. Status of CCS around the world (2)

Large-scale CCS projects by lifecycle and region/country



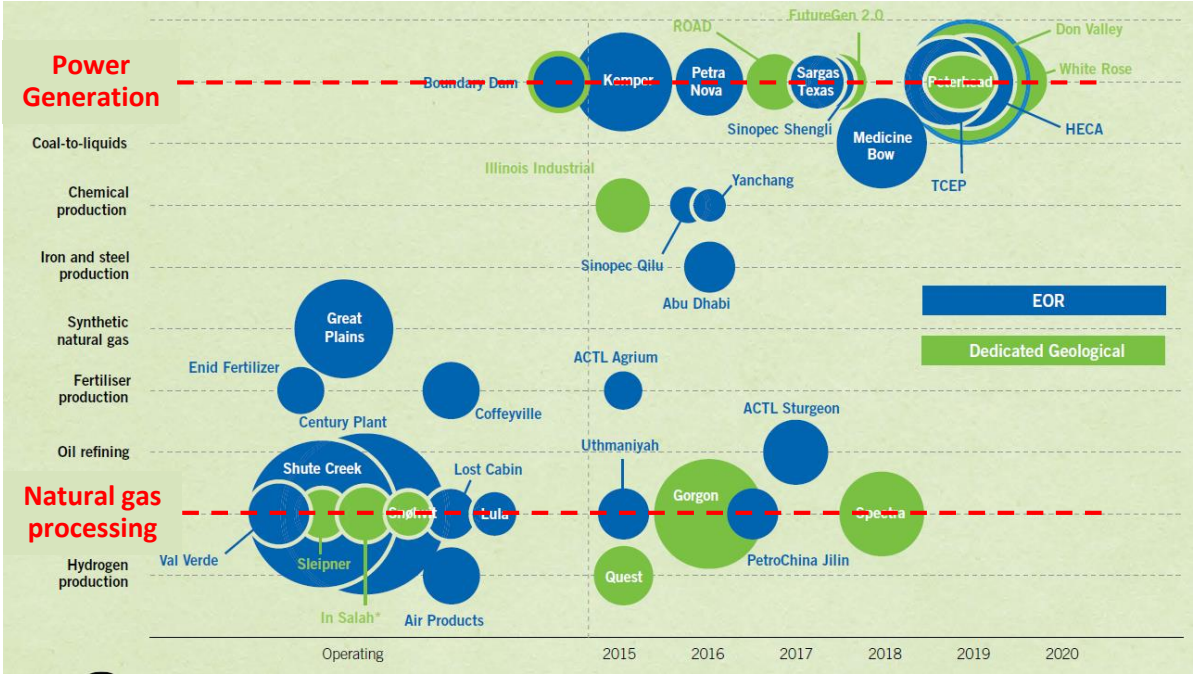
	Identify	Evaluate	Define	Execute	Operate	Total
United States	0	4	5	3	7	**19**
China	6	2	4	0	0	**12**
Europe	0	2	4	0	2	**8**
Canada	0	1	1	3	2	**7**
Australia	0	2	0	1	0	**3**
Middle East	0	0	0	2	0	**2**
Other Asia	0	2	0	0	0	**2**
South America	0	0	0	0	1	**1**
Africa	0	0	0	0	1	**1**
Total	**6**	**13**	**14**	**9**	**13**	**55**

Source: GCCSI, 2014

- North America accounts for nine of the 13 operating projects, 6 of 9 under construction.
- China, UK and Norway have more than one project in operation, construction or advanced planning.

3. Status of CCS around the world (3)

CCS projects by industry and storage type

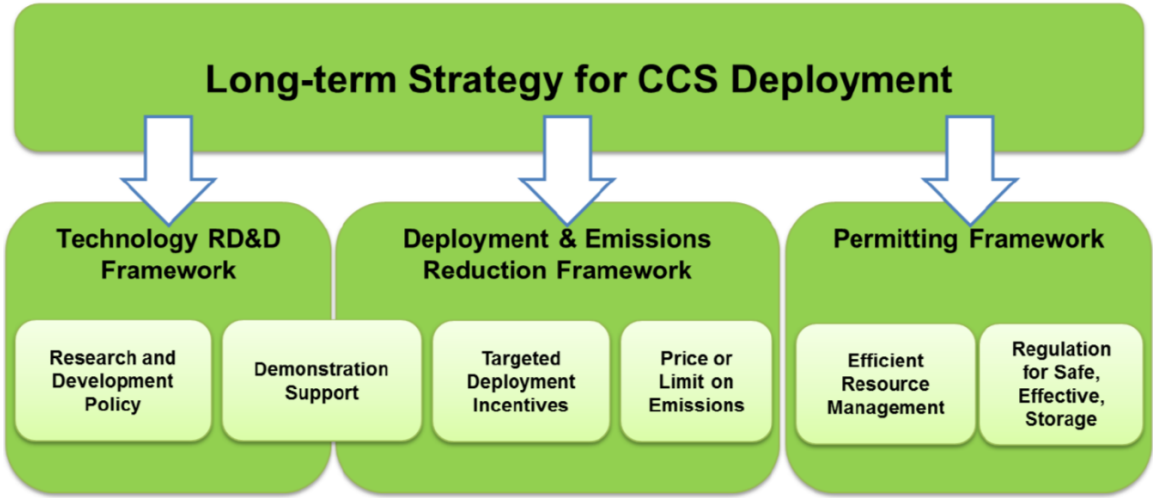


- Two projects, Sargas and Peterhead, adopt post-combustion CO_2 capture from natural gas power generation.
- This represents very important progress for the gas industry.

Source: GCCSI, 2014

4. Legal and regualatory framework for CCS (1)

Key elements of a comprehensive CCS policy framework

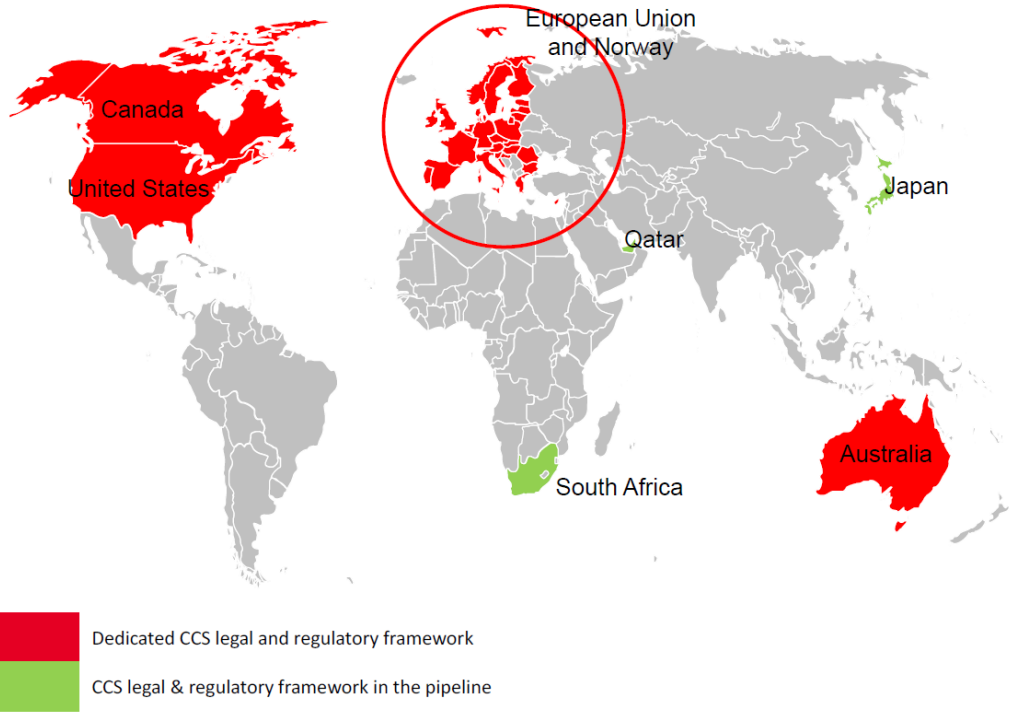


Source: IEA, 2014

- Legal and regulatory framework for CCS should cover long-term strategy for R&D, deployment and emission reduction as well as the permitting framework.
- National policies on climate change, carbon trading or pricing and incentives for R&D are also seen as components for enhancing CCS.

4. Legal and regualatory framework for CCS (2)

Status of the development of CCS legal and regulatory framework



- Only several countries and regions have established legal and regulatory framework to facilitate CCS.
- However, EOR in many instances can already be conducted under existing legal and regulatory pathways.

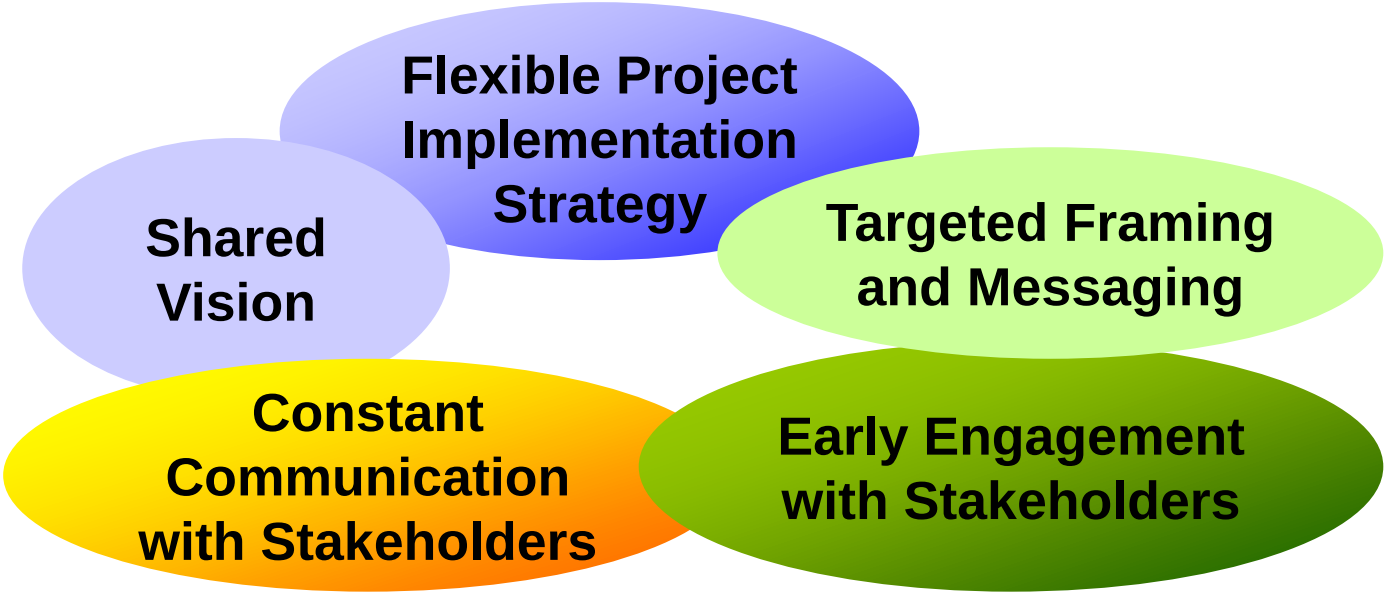
4. Legal and regualatory framework for CCS (3)

Conclusion

- The necessary CCS legal and regulatory framework is established only in some developed nations.
- However, some of the issues are not explicitly covered in the existing legal and regulatory model.
  - Post-closure long-term liabilities and financial responsibility.
  - Monitoring and verification.
  - Ownership and property rights.
  - Emerging health and safety issues arising from CO_2 storage.
  - Stakeholder management.
- A robust framework is vital for expanding CCS as part of climate change mitigation strategy.

5. Public perception on CCS (1)

The public communication, engagement, and acceptance are central to project success.



Five pertinent elements of public engagement

5. Public perception on CCS (2)

The ROAD project in Rotterdam (success example)

- The project proponent made substantial investment in their public outreach plan including; individual presentations by stakeholders, a project brochure and project website, town hall meetings, working visits, press release, regional advisory committee, etc.

5. Public perception on CCS (3)

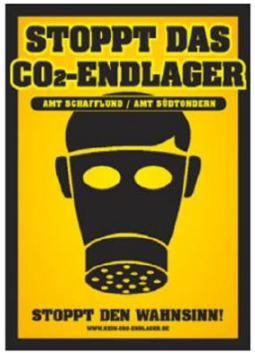
CCS integrated Lacq project (success example)

TOTAL developed and implemented a method to foster understanding among stakeholders by;

- Launching a stakeholder consultation
- Creating a local information and monitoring commission
- Forming a scientific committee
- Informing local inhabitants

5. Public perception on CCS (4)

Opposition campaigns against Jänschwalde CCS Demo Project

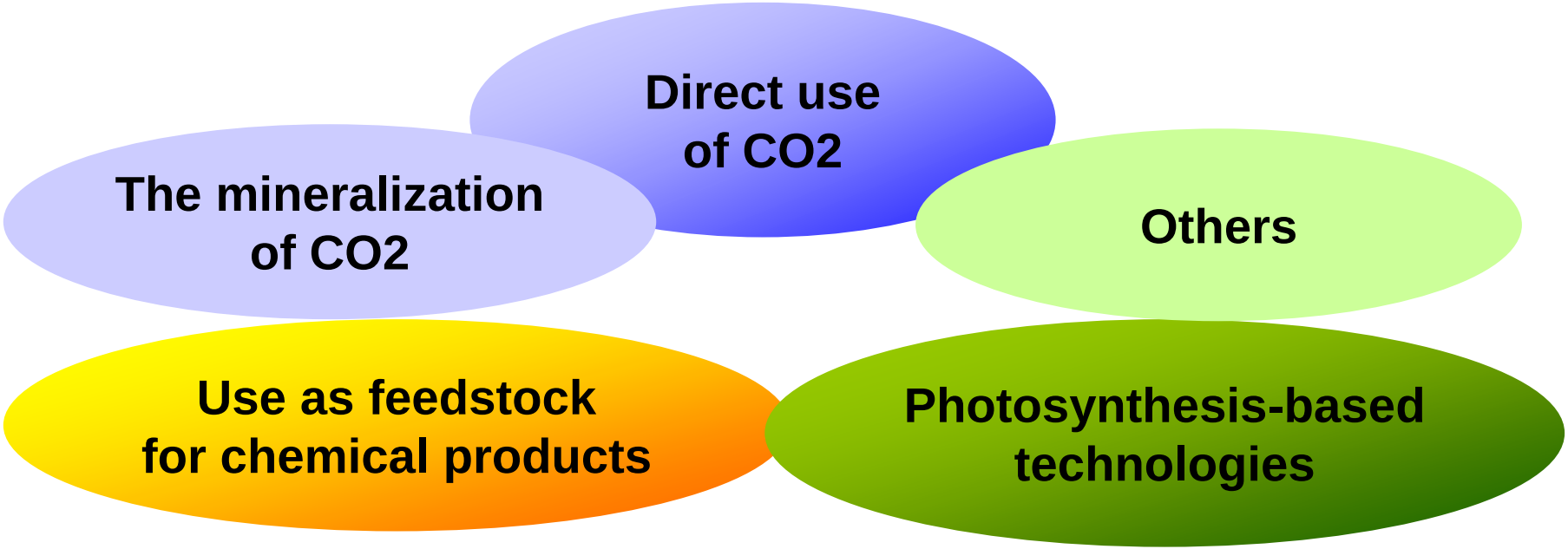


- The project was cancelled in December 2011.
- This provides clear evidence that there is a great need for CCS legislation to support CCS projects and give assurances to local communities on the health, safety and environmental issues.

5. Public perception on CCS (5)

- Public acceptance of CCS projects has been identified as a critical factor in successful development and deployment.
- Some of the key lessons learned are;
  - Integration of stakeholder engagement and communication functions
  - Develop a good rapport with all stakeholders to gain trust
  - Communicate accurate information in a timely manner
  - Communication with stakeholders needs to take place prior to the official announcement
- It is important to note that there is no single strategy to ensure successful public acceptance of a CCS project.

6. Perspective on CO_2 utilization



Five categories of CO_2 utilization technology

7. Conclusions (1)

- CCS is expected to be a major contributor to climate change mitigation, if fossil energy continues to be a significant part of energy mix.
- CCS from natural gas will account for a significant part of the global CCS industry, as it will deal with the CO_2 emissions associated with production of CO_2 contained in gas reservoirs, with natural gas liquefaction, and with industrial applications.
- Gas industry has developed knowledge, operational skills, and infrastructure that will contribute to develop CCS;
  - CO_2 separation technology from produced natural gas
  - Gas transport infrastructure by liquefied and by pipeline
  - The knowledge of geosciences to estimate CO_2 storage capacity

7. Conclusions (2)

- In addition to science, technology and infrastructure, at least three factors must be considered; economics, legal framework and public support.
  - CCS from gas-fired power generation can be more competitive than CCS from coal-fired power generation
  - An established legal framework is essential for the development of CCS
  - The support of the public is an absolute necessity. The development of robust and economical monitoring, measurement and verification process is necessary to achieve public support
- The gas industry is well placed to provide opportunities for the early developments of CCS, and to take a significant share of CCS activities.

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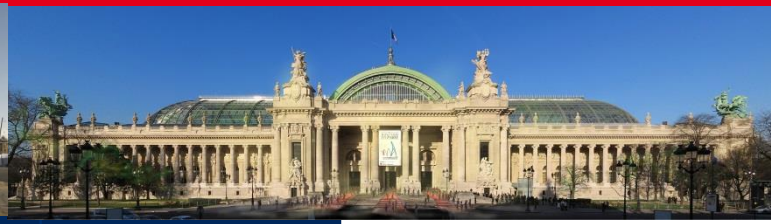

Thank you very much for your attention!

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