Low Carbon Green Growth Roadmap for Asia and the Pacific

FACT SHEET

Carbon capture and storage

Key point

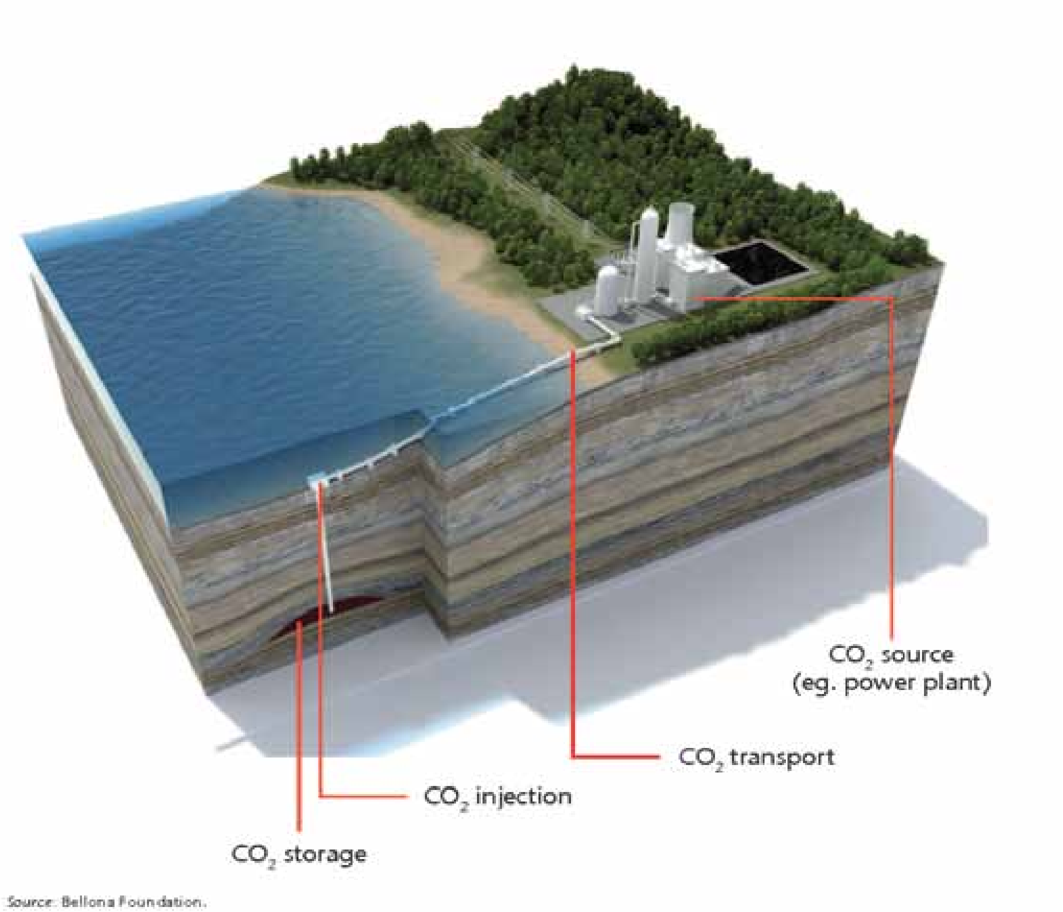
- ***Carbon capture and storage can potentially mitigate greenhouse gas emissions from large-scale fossil fuel use, although the technology is not yet ready for commercial-scale application.***

Carbon capture and storage explained

According to the International Energy Agency (IEA), carbon capture and storage is a system of technologies that integrates three stages: CO_2 capture, transport and geological storage (figure 1):[1]

1) **CO_2 capture:** Catch CO_2 from such sources as fossil fuel, power plants, industrial facilities and steel, concrete and fertilizer plants.
2) **Transport:** The transport of the captured CO_2 through high-pressured pipeline networks or via ships, trucks and trains for regions that do not have adequate storage.
3) **Geological storage:** After transporting the CO_2 to the storage site, it is injected deep into a well where it is then trapped in the geological formations below the surface. Three options for geological storage are saline formations, oil and gas reservoirs and deep un-minable coal seams.

Figure 1: Carbon capture and storage process



Source: Bellona Foundation extracted from International Energy Agency (IEA), *Technology Roadmap: Carbon Capture and Storage* (Paris, IEA and OECD, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

Climate change mitigation potential

Carbon capture and storage (CCS) is considered the "only technology available to mitigate greenhouse gas emissions from large-scale fossil fuel usage in fuel transformation, industry and power generation", according to the IEA *Technology Roadmap: Carbon Capture and Storage*.[2]

The IEA *Energy Technology Perspectives 2010: BLUE Map Scenario* "sets the goal of halving global energy-related CO_2 emissions by 2050 (compared to 2005 levels) and examines the least-cost means of achieving that goal through the deployment of existing and new low-carbon technologies".[3] In this BLUE map scenario, the introduction of carbon capture and storage in power generation, fuel transformation and industry is expected to reduce an estimated 19 per cent of global CO_2 emissions.[4]

In parallel to the introduction of carbon capture and storage, which should be considered as an interim necessity, a variety of innovative low-carbon technologies for alternative sources of energy and energy efficiency will also be needed to reduce global CO_2 emissions.

How it works

The individual technologies that are used for carbon capture and storage are relatively mature, but the integration and the scaling up of all the technologies to a commercial scale still needs further research and demonstration. According to a working paper by the World Resources Institute, CO_2 separation and capture technology has been applied at the commercial scale in the food and beverage sector and for other industrial uses. In terms of CO_2 transport by pipeline technology, it is a mature industry used in such places as the United States. Technologies for storage selection, injection and monitoring are well developed across the petroleum industry. However, further research and experience are required in terms of storage locations and on leakage issues, which has safety implications. Power plant integration of all the carbon capture and storage technologies still needs further research.[5]

Because the integrated technology is not yet mature, carbon capture and storage requires retrofitting fossil fuel plants and building capture-ready plants so that the technology can be installed when it becomes commercially viable.

Although industrialized countries have more experience in research, development and demonstration of carbon capture and storage, developing countries with their unique geological characteristics can demonstrate the technology. Developing countries can work together with experienced countries and donors on such projects through international cooperation and innovative partnerships. The IEA expects that from 2020 onwards, carbon capture and storage will pick up in developing countries.[6] In addition to the energy security perspective, carbon capture and storage's potential for reducing CO_2 emissions is considered highly viable for countries that depend on coal as a major source of their energy.

[1] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[2] ibid, p. 5.

[3] International Energy Agency, *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050* (Paris, 2010), p.47. Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part1.pdf (accessed 1 March 2012).

[4] ibid., p. 81.

[5] F. Almendra, L. West, L. Zheng and S. Forbes, "CCS Demonstration in Developing Countries: Priorities for a Financing Mechanism for Carbon Dioxide and Capture and Storage", Working Paper (Washington, D.C., World Resources Institute, 2011). Available from http://pdf.wri.org/working_papers/ccs_demonstration_in_developing_countries.pdf (accessed 5 September 2011).

[6] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

Regulatory frameworks

To introduce carbon capture and storage technology into developing countries, several conditions are required. For instance, because the major player is the private sector, governments need to provide policy certainty and incentives through long-term policy signals that promote private sector investment and minimize the associated risks. This is especially important because of the long-term investment cost that is required.

Legal and regulatory frameworks that contribute to an enabling policy environment are needed. In parallel, existing laws should be reviewed and amended in order to carry out the demonstration projects. There also may be a need for a comprehensive framework if amendments of the law prove insufficient.[7]

Some of the carbon capture and storage specific regulations that may need to be introduced at the national level include, but are not limited to, the following:[8]

- Oil and gas legislation
- Mining legislation
- Waste legislation
- Health and safety legislation
- Property rights
- Transport legislation
- Groundwater legislation
- Environmental impact assessment legislation.

Financing for carbon capture and storage

The IEA estimates under its BLUE map scenario, that 10 gigatonnes of CO_2 emissions need capturing in 2050 to reduce global CO_2 emissions by half from the 2005 level. This translates, for example, to a total of 21 carbon capture and storage projects in India and China by 2020 and 950 projects by 2050.[9] That level of deployment in India and China will incur an additional cost of US$7.6 billion by 2020 and US$1.3 trillion by 2050.[10] Total investment requires US$19 billion by 2020 and US$1.17 trillion by 2050.[11]

Due to the high costs associated with carbon capture and storage, financing is the primary obstacle – not only for developing countries but even for industrialized countries. Currently, carbon financing is one of the main funding sources available to developing countries for reducing their CO_2 emissions. During the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) 17 negotiations in Durban, country delegates decided that carbon capture and storage would be eligible as a project activity under the Clean Development Mechanism. This COP decision opens opportunities for projects to be financed in developing countries in the future – but not in the immediate future (see the following box).

Other possible sources of funding that developing countries may access in the future are multilateral funds, bilateral funding and emissions trading schemes. Although donor support may facilitate carbon capture and storage technology introduction, financing and partnership agreements between the public and private sector will be necessary because the amount of investment is too high for the private sector to take on alone, especially for upfront costs.

[7] ibid.

[8] ibid.

[9] The IEA BLUE Map scenario estimates that globally a total of 100 carbon capture and storage projects need to be deployed by 2020 and a total of 3,400 projects need to be deployed between 2010 and 2050 to reduce CO_2 emissions by half by 2050 from the 2005 levels; International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[10] Additional cost – the annualized expenditure for solely the CCS part of a facility. It reflects the incremental costs incurred to operators compared with the operating costs of a facility without CCS; International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[11] Total investment – the amount of financial capital needed to build a complete CCS facility; International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

BOX: Carbon capture and storage and the UNFCCC negotiations

In the context of the UNFCCC negotiations, carbon capture and storage was first considered in 2005 as a possible option in the portfolio of mitigation actions. In 2009, the business sector advocated that such technology is necessary to halve emissions by 2050. In 2010, the UNFCCC COP 16 Parties in Cancun agreed that carbon capture and storage in geographical formations is eligible as a project activity under the Clean Development Mechanism, provided that such issues as project boundaries, liability, measurement, reporting and verification, environmental impacts, safety and long-term permanence are resolved in a satisfactory manner. During the COP 17 negotiations in Durban, South Africa in December 2011, the Parties agreed that carbon capture and storage would be eligible as a project activity under the Clean Development Mechanism. However, details of the specific procedures and modalities are to be discussed in future UNFCCC negotiations.

Source: Earth Negotiations Bulletin, *Summary of the Cancun Climate Change Conference: 29 November – 11 December*, vol. 12, No. 498 13 (Winnipeg, International Institute for Sustainable Development, 2010). Available from www.iisd.ca/download/pdf/enb12498e.pdf (accessed 12 March 2012).; and United Nations Framework Convention on Climate Change, *Carbon Dioxide Capture And Storage In Geological Formations As Clean Development Mechanism Project Activities*, draft conclusions proposed by the Chair, Subsidiary Body for Scientific and Technological Advice, Thirty-fifth session, Durban, 28 November to 3 December 2011 (FCCC/SBSTA/2011/L.24). Available from http://unfccc.int/resource/docs/2011/sbsta/eng/l24.pdf (accessed 12 March 2012).

Governments will need to find financial incentives for attracting private sector investment as well as allocating domestic funding, such as loan guarantees, tax breaks, risk sharing of investments with government and special financial assistance for retrofitting plants.

Public awareness and support

Carbon capture and storage facilitation will entail building public awareness in order for governments to allocate huge investments in demonstration projects. Governments must provide appropriate information and create channels in which reliable data can be accessed by the public. Consultations will be required for site selection and ensuring safety measures, especially regarding storage issues.

Current status of integrated commercial-scale projects in operation

According to the World Resources Institute, there are seven fully integrated, commercial-scale carbon capture and storage facilities around the world (table 1).[12]

Table 1: List of integrated commercial-scale carbon capture and storage projects in operation

Location	Site name	Start date	Type
USA/Canada	Weyburn	2000	Capture: Coal gasification plant; pre-combustion Transport: Pipeline (330 km) Storage: Enhanced oil recovery (2.4 Mt per year)
North Sea, Norway	Snohvit	2007	Capture: Liquefied natural gas plant, natural gas processing Transport: Pipeline (160 km) Storage: Offshore deep saline formation (0.7 Mt per year)
North Sea, Norway	Sleipner	1996	Capture: Offshore platform, natural gas processing Transport: Pipeline in same site Storage: Offshore deep saline formation (1Mt per year)

12 Almendra, Zheng and Forbes, op. cit.

Algeria	In Salah	2004	Capture: Natural gas processing plan Transport: Pipeline (14 km) Storage: Deep saline formation/gas field (1.2 Mt per year)
USA	Salt Creek	2006	Capture: Natural gas processing plants Transport: Pipeline (132 km) Storage: Enhanced oil recovery (1Mt per year)
USA	Val Verde CO_2 pipeline	1998	Capture: Five natural gas processing plants Transport: Pipeline (132 km) Storage: Enhanced oil recovery (11Mt per year)
USA	Rangley EOR project	1986	Capture: Natural gas processing Transport: Pipeline (285 km) Storage: Deep saline formation/gas field (1 Mt per year)

Source: Extracted from F. Almendra, L. West, L. Zheng and S. Forbes, "CCS Demonstration in Developing Countries: Priorities for a Financing Mechanism for Carbon Dioxide and Capture and Storage", Working Paper (Washington, D.C., World Resources Institute, 2011). Available from http://pdf.wri.org/working_papers/ccs_demonstration_in_developing_countries.pdf (accessed 5 September 2011).

Examples

Countries such as Australia, Canada, Japan, Norway, United Kingdom and United States and the European Union have provided assistance towards financing carbon capture and storage R&D, demonstration and deployment.[13] In the emerging developing countries in the Asia-Pacific region, preliminary work includes studies ongoing in China, India and Indonesia with international assistance.[14]

Australia: In Australia, a member-based Global CCS Institute was launched in June 2009 to accelerate the deployment of technologies globally, foster cooperation on projects and technologies and to share information.[15] The Australian Government committed A$2 billion dollars to fund large-scale carbon capture and storage demonstrations domestically.[16]

Norway: Since 1991, Norway has applied an offshore CO_2 tax on gas and oil companies to reduce their emissions. This scheme has helped owners to finance the application of the CCS technology, such as the Sleipner CO_2 injection project.[17] The Norwegian Government plans to allocate 1.2 billion krone for other projects.[18]

South Africa: In March 2009, the South African Centre for Carbon Capture and Storage was established with financial support from the Government through the South African National Energy Research Institute, the Norwegian and United Kingdom governments, Agence Francaise de Development (AFD) and South African industries. The Centre pursues R&D and capacity building to prepare for a safe and reliable CCS demonstration plant in South Africa in the future.[19]

13 International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

14 Almendra, Zheng and Forbes, op. cit.

15 Commonwealth of Australia, Department of Resources and Energy and Tourism website, "Global Carbon Capture and Storage Institute". Available from www.ret.gov.au/resources/gccsi/Pages/default.aspx (accessed 29 January 2011).

16 International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

17 Global Carbon Capture and Storage Institute website, "Projects: Sleipner CO_2 Injection". Available from www.globalccsinstitute.com/resources/projects/sleipner-co2-injection (accessed 7 September 2011).

18 International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

19 South African Centre for Carbon Capture & Storage website, "About Us". Available from www.sacccs.org.za/about-us/ (accessed 7 September 2011).

Further reading

CCS Demonstration in Developing Countries: Priorities for a Financing Mechanism for Carbon Dioxide Capture and Storage (Washington, D.C., World Resources Institute, 2011). Available from http://pdf.wri.org/working_papers/ccs_demonstration_in_developing_countries.pdf

Technology Roadmap: Carbon Capture and Storage (Paris, International Energy Agency, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf