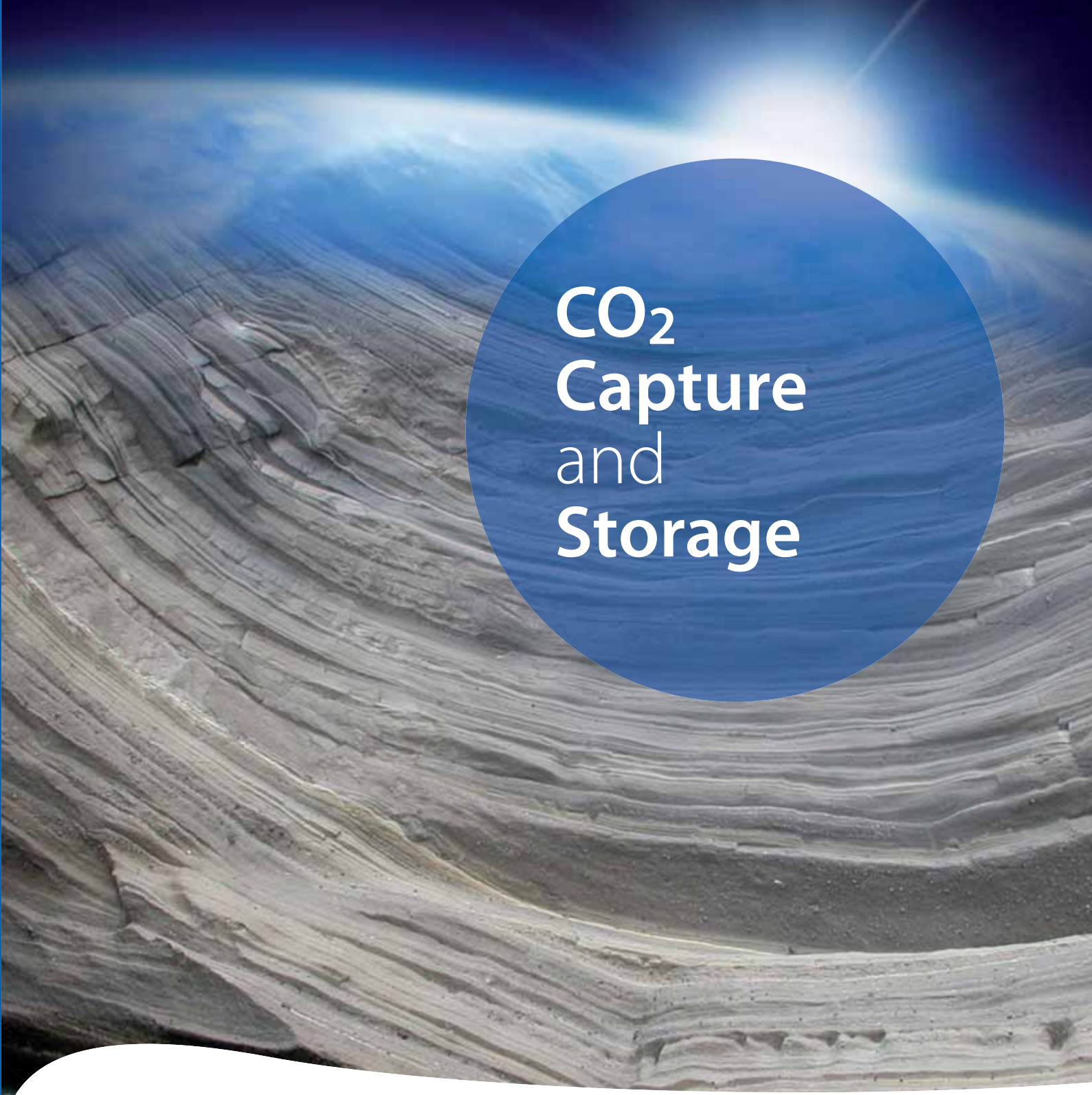


CO_2 Capture and Storage

Directorate-General for Energy and Transport

EUROPEAN COMMISSION

DECARBONISING ENERGY FROM FOSSIL FUELS

CCS can be the second most effective measure for reducing European CO_2 emissions after energy efficiency and before renewables. By 2030, 10% of EU emissions could be avoided by using CCS.

(International Energy Agency, 'CO_2 Capture and Storage: A Key Carbon Abatement Option', 2008)

- The EU is serious about controlling climate change and therefore promotes CO_2 Capture and Storage (CCS) – the technologies for capturing and permanently storing CO_2 from industrial processes.
- EU leaders have agreed on the need to demonstrate this technology in industrial conditions at the earliest opportunity: up to 12 CCS-equipped power plants are to be operational in the EU by 2015.
- The European Commission is spearheading the efforts jointly with the Member States and industry, making the EU the world leader in the field.

Helping Europe **tackle climate change through CCS**

Europeans have been quick to realise that if they are serious about controlling climate change, electricity generated in the EU needs to be decarbonised. To limit global warming to 2 °C, greenhouse gas emissions worldwide will have to be cut significantly by 2050. As the world continues to rely heavily on fossil fuels, there is global consensus that delivering the necessary emissions reductions efficiently will require the capture and permanent storage of CO_2 from industrial processes.

The urgency of the climate challenge has pushed a number of countries to pursue CCS. At present, the EU is widely recognised as a global leader in the field due in part to more than 10 years of European R&D. Maintaining this global position and stepping-up to commercialisation of CCS technologies will create jobs as well as new commercial opportunities for European businesses.

To bring forward the commercialisation of CCS, the technology first needs to be demonstrated and proved effective in large-scale power plants. This will pave the way to extending CCS to other energy-intensive industries, including steel, cement and chemicals.

In 2007, leaders agreed that the EU should aim to have up to 12 such demonstration projects by 2015. An EU portfolio of demonstration projects is the first initiative of its kind to unite public and private efforts towards the common goal of advancing the deployment of CCS.

Demonstrating CCS in Europe has two main objectives:
- to show the feasibility of a full CCS chain in power generation and other industries;
- to help drive down the cost of electricity produced with CCS.

Inset:
Instead of being released to the atmosphere, CO_2 is captured during the generation of energy

A combination of technologies

CCS is composed of three phases, each of which can be achieved through a number of technologies.

Capture

CO_2 can be captured wherever large industrial plants burn fuels such as coal, oil, gas or biomass. Using technologies such as chemical absorbents, around 90 % of the CO_2 produced can be extracted from the flue gases resulting from fossil fuel combustion. Using the alternative technology of 'pre-combustion capture', the CO_2 is extracted from gases resulting from the conversion of solid fuels into hydrogen.

Transport

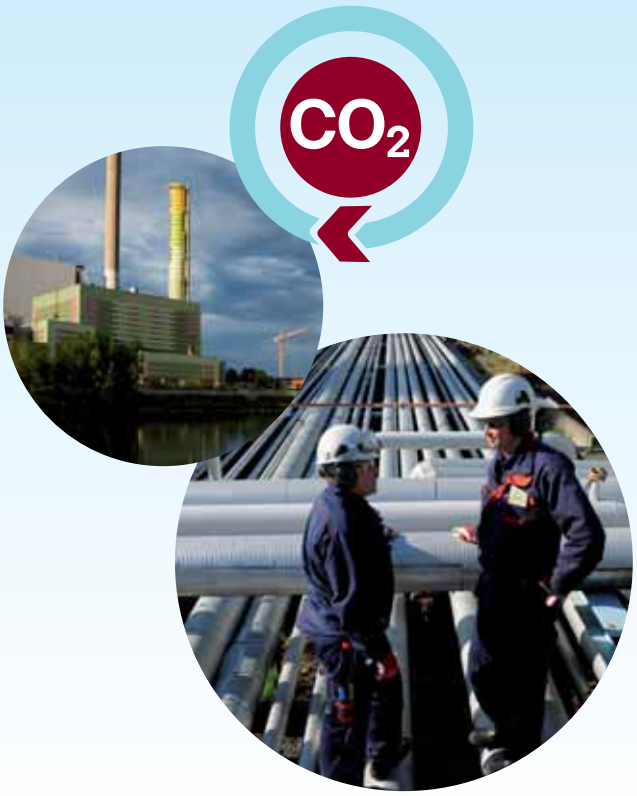
Pipelines to transport CO_2, over distances even greater than 500 km have been in operation for over 30 years. CO_2 is an unreactive, non-explosive gas, which can be easily transported under pressure in a state where it behaves as a liquid; this makes its piping technically rather simple, safe and reliable.

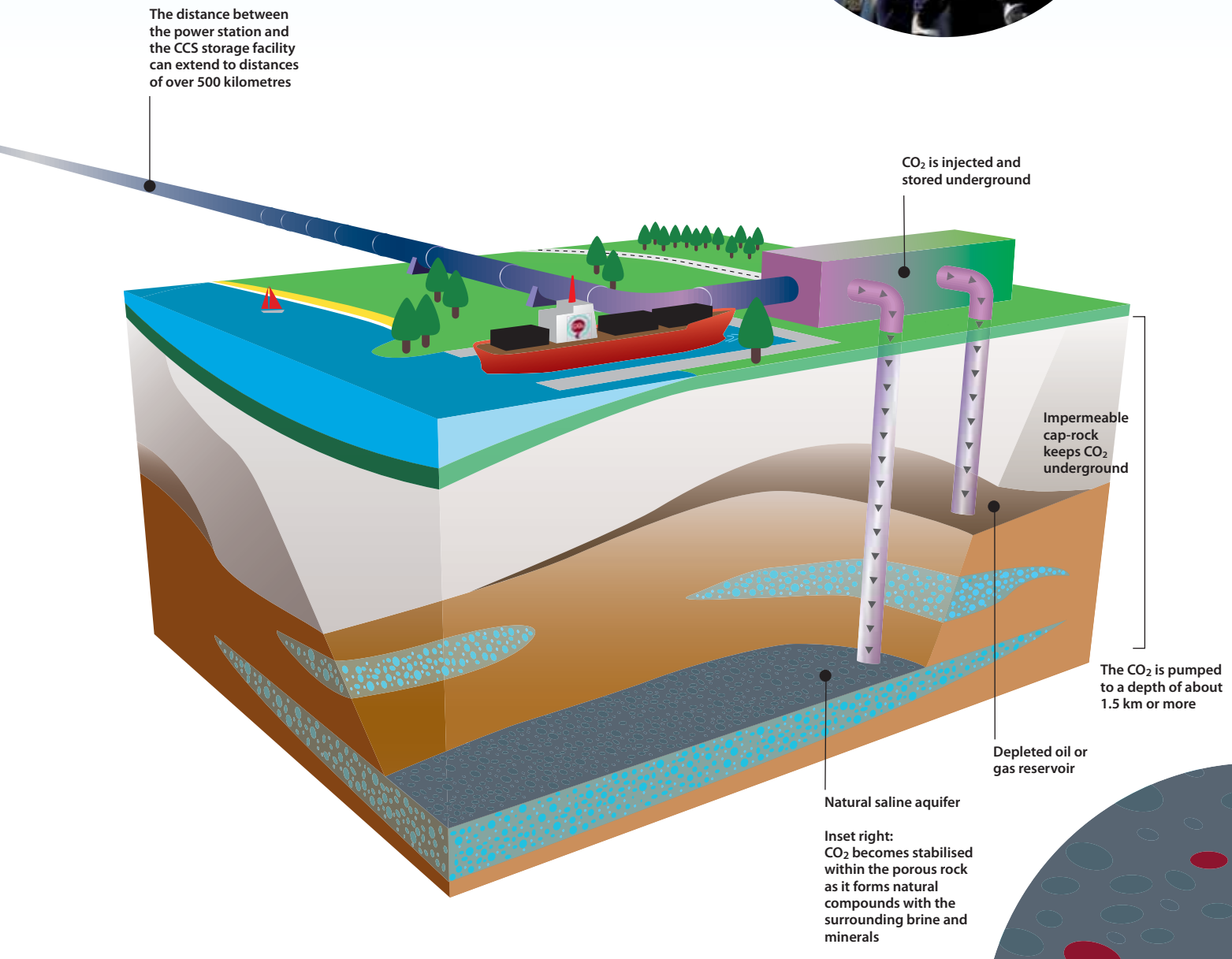
Shipping could offer a flexible transport alternative in certain cases. Several ships already exist that are certified for CO_2 transport.

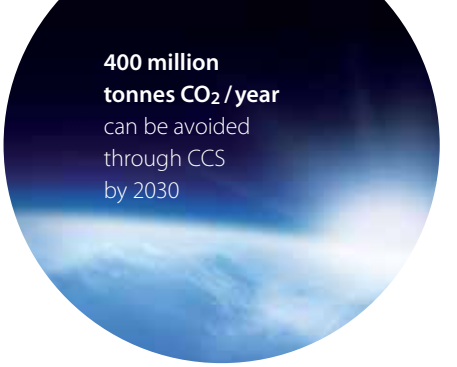
Storage

CO_2 can be stored either onshore or offshore (under the sea-bed) at depths of several kilometres. Two geological formations can be used: saline aquifers or depleted oil and gas fields.

Generally deeper, saline aquifers are the storage option of choice for most EU demonstration projects in progress today. They are already used for temporary storage of natural gas.







CCS – a way to reduce costs of combating climate change

The EU will be emitting some 4.2 billion tonnes of CO_2 annually by 2030 under a 'business-as-usual' scenario. Significant reductions will be necessary for climate stabilisation. The IEA *Technologies Perspectives 2008* shows that in scenarios without CCS, the costs for achieving climate stabilisation in 2050 are at least 70 % higher than scenarios that include CCS (1). The IEA shows that EU emissions can be reduced by **400 million tonnes CO_2/year** through CCS. This is less than energy efficiency (500 million tonnes CO_2/year) but before renewables (200 million tonnes CO_2/year). By 2050, CCS could reduce EU emissions by up to 1.7 billion tonnes CO_2/year, depending on the extent of use of CCS.

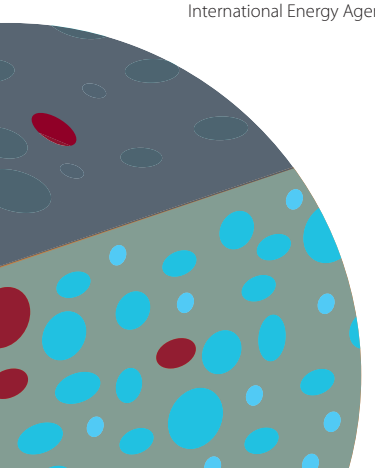
The global leader in CCS

For over 10 years the EU has been funding R&D in CCS, focusing on projects that will improve performance and enable electricity produced with CCS to be no more expensive than electricity from most other low-carbon sources.

Since 2009, EU legislation on geological storage of CO_2 is in place. This provides the necessary regulatory framework and ensures that CO_2 will be safely and permanently stored underground. The EU legislation now needs to be transposed into national laws in Member States.

Recent developments in the Emissions Trading Scheme (ETS) rules bring about two important changes: CO_2 captured and reliably stored can now be considered as not emitted and, after 2013, stronger economic incentives will exist for industrial operators to prefer low-emission technologies. This creates conditions to move CCS closer to economic viability and makes investments in the technology a good business decision.

(1) *Energy Technologies Perspectives 2008 – Scenarios and Strategies to 2050,* International Energy Agency, 2008.



CCS – how safety is ensured

The EU Directive on the geological storage of carbon dioxide requires that all CO_2 is stored 'safely and permanently'. This is achievable with existing technology. In a sense, CO_2 storage in hydrocarbon fields is like injecting gas back into the same spaces in the ground where it was safely stored for millions of years before being pumped out. These are not large, hollow spaces, but porous rocks that trap the CO_2 in networks of microscopic cavities.

European industry already has extensive experience with CO_2 storage; since 1996, 1 million tonnes of CO_2 per year have been injected into Norway's Sleipner gas f ield with no trace of leakage.

Once the CO_2 has been injected into a rock formation, chemical processes begin that continue for thousands of years. In the geological environment CO_2 reacts with the surrounding minerals, stabilising it over time and making it more difficult for it to migrate underground. Top European geologists (CO2GeoNet) have therefore concluded that 'the safety of a CO_2 storage site tends to increase with time.'

CCS – ready to be launched

The technology for capturing CO_2 from industrial emissions is not new – its various components have been around for years. The technologies have been used by the oil, gas and chemicals industries for over 40 years. Long-distance CO_2 transport through pipelines is already in use for Enhanced Oil Recovery (EOR) and has proven to be environmentally safe and commercially feasible. Deposition of gases (including CO_2) in geological environments underground has also been safely practised for many years. Now the processes need to be integrated into a full value chain, including power generation.

It is projected that between now and 2070 the EU will need to store about 20 billion tonnes of CO_2. European storage capacity is estimated to be 120 billion tonnes, and not smaller than 40 billion tonnes. This means that the minimum storage estimate is twice as large as the storage capacity needed up to 2070.

The next steps…

EU support for cleaner coal and CCS research has more than doubled under the current Seventh Framework Programme compared with previous periods. The momentum needs to be sustained so that R&D builds on the experiences from the first demonstration projects to create improvements to CCS components and reduce costs further.

Large-scale demonstration is the next milestone. EU financing is now available: € 1.05 billion for up to seven CCS demonstration projects is secured through the European Energy Programme for Recovery; additional financing in the order of several billion euros will come by 2013 from the New Entrants Reserve (NER) of the EU ETS. Industry and Member States are also needed to provide additional project financing.

After 2020, pipeline networks should allow industrial facilities to be linked to optimal storage sites, even if they are hundreds of kilometres apart. The European Commission has initiated studies investigating how pipeline systems could be installed in the most economic and sustainable manner, whilst maximising benefits for EU business and citizens.

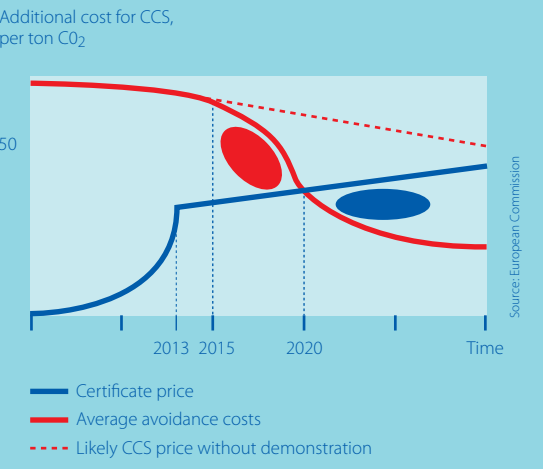
For the EU to remain a world leader in CCS, and to accelerate deployment worldwide, international CCS partnerships will be crucial. It is the only way to fully exploit the potential of CCS at a global level so that it helps limit climate change. Existing EU engagement with other important players such as China, Australia, US, India, South Africa, and major international bodies, will be strengthened.

Funding CCS demonstration – good value for your money

At present, CCS-equipped power plants could not produce electricity at costs that would make them profitable. This is because the cost of avoiding CO_2 emissions using the current CCS technology is higher than the price paid for emitting CO_2. The first CCS demonstration projects would operate in the red oval in the chart (right) and face a 'financing gap' of at least € 25 - € 55 per tonne CO_2.

It is estimated that with continuous technological improvements, the costs can be halved by 2020. This should ensure that CCS plants can in the future operate within commercially feasible parameters in an environment governed by a robust CO_2 price (blue oval in the chart). Successful early demonstration will guide further technology improvements and therefore merits temporary public funding. Industry, however, also needs to contribute.

Public funds can give the EU and the world at least a seven year head-start compared with the likely case without public intervention. This could equate to 90 gigatonnes of avoided CO_2 emissions worldwide, equivalent to over 20 years of current overall EU CO_2 emissions.



1. The first CCS demonstration projects will likely have CO_2 abatement costs between €60 and €90 per tonne of CO_2 – higher than the projected carbon price under the EU ETS. They will operate in the red oval and face a 'financing gap' of €25 - €55 per tonne CO_2.

2. Successful early demonstration will guide further research into CCS that will reduce costs. It is estimated that with continuous technological improvements, the costs can be halved by 2020 and ensure that CCS plants will operate within commercially feasible parameters in an environment governed by a robust CO_2 price (blue oval).

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The Project Network

The European CCS Project Network, launched in 2009, will bring together the demonstration projects that are underway in Europe. Projects in the Network will benefit from each other's experience and interact effectively with international developments in CCS.

The goal of the European CCS Project Network is to create a prominent community of large-scale projects with the shared goal of commercial viability of CCS by 2020. The Network will foster knowledge-sharing amongst the demonstration projects. This will accelerate learning and build a critical mass across Europe to ensure that CCS will safely fulfil its full potential both in the EU and worldwide. The Network is coordinated by the European Commission.

To find out **more** about…

…how CCS fits into the EU's strategy for sustainable energy – **www.ec.europa.eu/energy**

…the European CCS Project Network, where you will find more information on how the European Commission is coordinating and learning from the demonstration projects – **www.ccsnetwork.eu**

…the European Technology Platform for Zero Emission Fossil Fuel Power Plants, a multi-stakeholder initiative involving industry, governments and NGOs – **www.zeroemissionsplatform.eu**

…the European Network of Excellence on Geological Storage of CO_2, which comprises over 150 researchers engaged in assessing the safety and potential of CO_2 storage – **www.co2geonet.com**

…the EU GeoCapacity project, which has been assessing the European capacity for geological storage of CO_2 since 2006 – **http://www.geology.cz/geocapacity**

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