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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

Demonstrating Carbon Capture and Geological Storage (CCS) in emerging developing countries:

financing the EU-China Near Zero Emissions Coal Plant project

IMPACT ASSESSMENT

{COM(2009) 284 final}
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LIST OF ACRONYMS

APS: European Commission Annual Policy Strategy
CCS: Carbon capture and geological storage
COACH: **CO**operation **A**ction within CCS **CH**ina-EU
CCS: Carbon Capture and (Geological) Storage
CDM: Kyoto Protocol's Clean Development Mechanism
CCT: clean(er) coal technologies
CERs: Certified Emissions Reductions (under the CDM)
COM: European Commission
EIB: European Investment Bank
EIF: European Investment Fund
ENRTP: Environment and Natural Resources Thematic Programme of the European Commission
EOR: enhanced oil recovery
EP: European Parliament
(ETP) ZEP: European Technology Platform for Zero Emission Fossil Fuel Power Plants
GALILEO: The European satellite navigation project
GHG: greenhouse gas(es)
IEA: International Energy Agency
IGCC: Integrated Gasification Combined Cycle
IPCC: Intergovernmental Panel on Climate Change
IPR: Intellectual Property Rights
ITER: International Thermonuclear Experimental Reactor
JU: Joint Undertaking
MOST: Chinese Ministry of Science and Technology
MS: Member States
NZEC: Near Zero Emission Coal
PC: pulverised coal
SET-Plan: European Strategic Energy Technology Plan
SICAV: *société d'investissement à capital variable*
SIF: Specialised Investment Fund
SPV: Special Purpose Vehicle
STRACO2: Support to regulatory activities for carbon capture and storage
UNFCCC: United Nation Framework Convention on Climate Change

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Introduction

This document summarises the impact assessment for the Commission Communication on 'Demonstrating Carbon Capture and Geological Storage (CCS) in emerging developing countries: the EU-China Near Zero Emissions Coal Plant project' (item 2009/ENV/010 of the Commission's Legislative Work Programme). This Communication will provide input to the international climate negotiation process leading to the Copenhagen Climate Change Conference at the end of 2009, therefore timely adoption is important. It supplements a forthcoming Communication on financing low carbon technologies[1] by covering in greater detail carbon capture and storage technologies and focusing on China as a case study for cooperation with emerging developing countries.

The expected contribution from the Community Budget to the policy analysed in this Impact Assessment comes from the Environment and Natural Resources Thematic Programme (ENRTP). As such, the procedures associated with this programme are in line with the Financial Regulation.[2]

Time is of the essence. Under the EU-China Climate Change Partnership established at the EU-China Summit in 2005, both sides committed 'to develop and demonstrate, in China and the EU, advanced 'zero-emissions' coal technology' by 2020 and have begun negotiations to bring this date forward to 2015. Phase I of this 'Near Zero Emissions Coal' (NZEC) project ends in 2009. The aim is to have a financing vehicle in place as soon as possible after Phase II commences in 2010 (see Annex II).

In 2008, the G8 supported a recommendation by the IEA that '20 large-scale CCS demonstration projects need to be launched globally by 2010, taking into account varying national circumstances with a view to supporting technology development and cost reduction for the beginning of broad deployment of CCS by 2020.'[3] (For more information on the general context to this policy initiative, see Annex IV).

This Communication specifically concerns implementation of the Near Zero Emissions Coal (NZEC) project with China, which is a concrete example of technological and financial cooperation between developed and developing countries in the context of the international climate change negotiations.

The work with China set out in the Communication is complemented by capacity building and feasibility studies in cooperation with a number of emerging developing countries under the 2009 Annual Action Plan of the Environment and Natural Resources Thematic Programme (ENRTP, see Annex III).

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1 Item 2008/TREN+/050 in Commission Legislative Work Programme will build on the Commission Communication 'A European Strategic Energy Technology Plan' (SET-Plan) (COM(2007)723', covering a wider spectrum of technologies and focusing mainly on financing in Europe.

2 Commission Regulation (EC, Euratom) No 2342/2002 of 23 December 2002.

3 Joint Statement by G8 Energy Ministers, Aomori, Japan, 8 June 2008.

1.2. Organisation and timing

The consultation was conducted in a manner proportionate to the type and scope of the Communication. Minimum standards of consultation have been met. The Commission has consulted and informed other services via the existing Inter-Service Group on International Climate Change and via an informal inter-service working group (principally AIDCO-ENV-RTD-TREN) on NZEC. Meetings took place on 2 September 2008 and 16 February 2009. The attendance and the main issues discussed are set out in Annex I.

1.3. Consultation and expertise

When compiling this document and conducting the analysis, the Commission drew on expertise from the European Investment Fund (EIF) and the European Investment Bank (EIB) regarding a possible financial vehicle and on the work of the COACH, UK-NZEC and STRACO2 projects (see Annex VI) for other input specific to CCS in China. Cost data on CCS was sourced from the PRIMES model database, which was used for the impact assessment of the Directive on the Geological Storage of Carbon Dioxide,[4] and available literature such as McKinsey&Company, Climate Change Capital and the International Energy Agency and work by the Joint Research Centre of the European Commission.[5] Stakeholders were consulted on cooperation with emerging economies and developing countries on clean carbon technologies and CCS and options for combining public and private financing (further details in Annex I). The Commission conducted an internet public consultation on 'Capturing and storing CO_2 underground — should we be concerned?' in February 2007, which covered issues such as level of information, public perception, acceptability as a CO_2 mitigating solution, acceptable increase in the cost of electricity generation and in the price of electricity. A specific consultation of the general public on financing CCS demonstration in emerging developing countries was not held, due to the limited nature of a single demonstration project. However, interested NGOs and industry were consulted on an ad-hoc basis.

Stakeholders were most concerned about the potential of funding being diverted away from energy efficiency and renewables. Regarding the potential for attracting private investors to finance CCS demonstration plants in China, the main concern was the lack of a reliable revenue stream, given that CCS is currently not eligible under the Kyoto Protocol's Clean Development Mechanism (CDM) and that the potential to secure revenue from enhanced oil recovery (EOR) is uncertain and depends on the selected site. Member State representatives at the Zero Emissions Technology Platform's (ZEP) government group were interested to learn of the plan to develop an investment fund or special purpose vehicle (SPV) and thought this could make the project more attractive to the private-sector. The need to build the first CCS demonstration plant in China was questioned. It was perceived by some as undermining future European competitiveness in building CCS plants. Nevertheless, most stakeholders — including industry members of the ZEP and the Berlin Fossil Fuels Forum — recognised that it is important to address the issue, especially considering the increasing amount of GHG emissions from coal-based energy in emerging developing countries.

1.4. Response to the Opinion of the Impact Assessment Board

The Impact Assessment Board requested the following changes to the impact assessment:

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4 SEC(2008) 55.
5 JRC-IE, The cost of carbon capture and storage (CCS) demonstration projects in Europe, 2009.

- Clarification of the objectives of the financial mechanism: the extent to which the model proposed was meant for a single demonstration or for more extensive deployment. This is addressed in Chapter 3. The relevance of this model to the international climate change negotiations is addressed in Section 1.1;
- Detail of the sources of financing and of the financing mechanism. This is addressed in Section 1.1, Chapter 6 and Annex VIII;
- Analysis of the potential impact on Chinese local conditions. This is addressed in Sections 2.3 and 7.4. The issue of new/retrofitted CCS plants is addressed in Annex VIII;
- Clarification of the stage of development of the CCS technology and its overall significance to reduce greenhouse gas emissions. This is addressed in Section 2.1 and Annexes IV and V;
- Specification of procedures regarding stakeholder consultation, the role of the EU-China partnership on climate change and next steps. These issues are addressed in Sections 1.3, 2.3 and Chapter 9 respectively.

The detailed comments from the Board were taken into account when this impact assessment was re-drafted.

2. PROBLEM DEFINITION

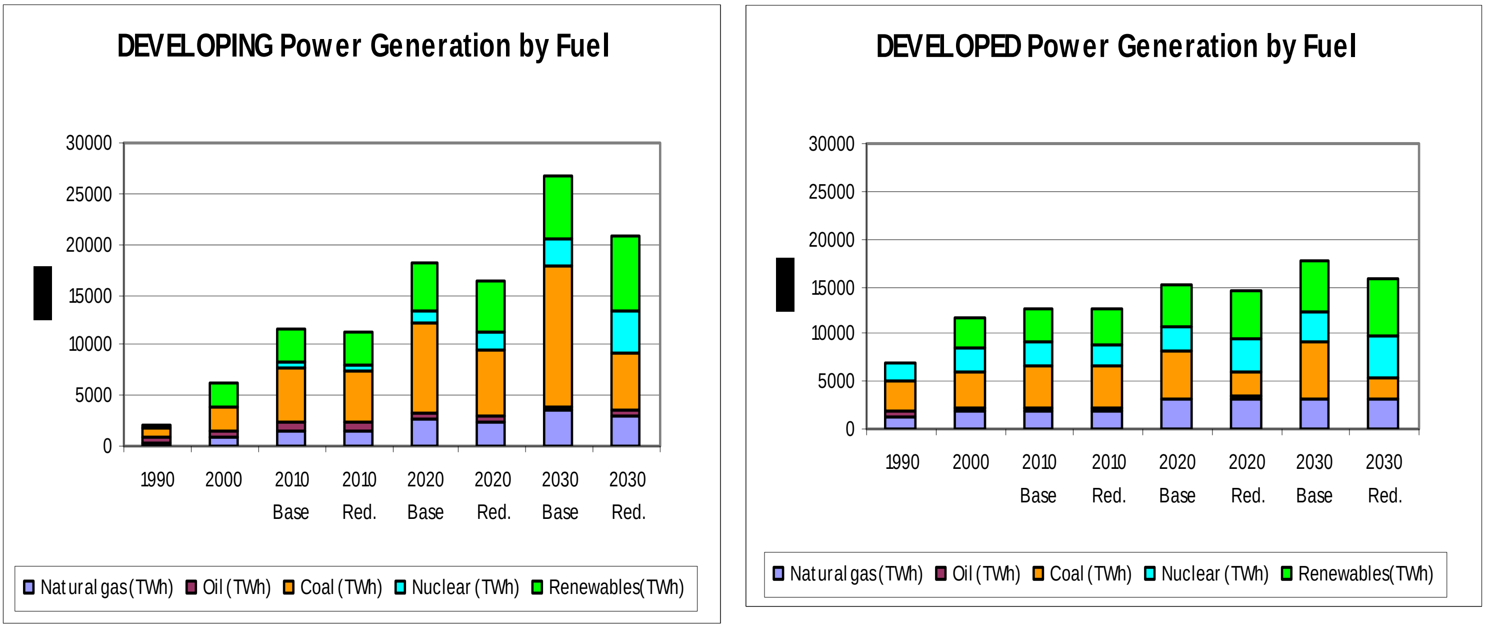
CCS deployment in fossil-fuel dependent emerging developing countries has the potential to significantly help achieve global sustainable development. However, in a business-as-usual scenario (i.e. without additional assistance from the public sector and without an international agreement or national policies establishing a carbon market price), CCS would not be demonstrated at commercial scale outside of OECD countries and would therefore — even if it were proven as a viable technology — not be economically viable for global deployment on a timescale commensurate with the need for GHG emission reductions. Without global development, demonstration, dissemination and deployment of CCS, the fight against climate change could be significantly more expensive.[6]

2.1. Power generation from coal and emission reductions from CCS

Coal is an important fuel for the generation of electricity worldwide, in particular in the emerging economies of China, India and South Africa, which have significant coal reserves. Figure 1 illustrates power generation by fuel type in developed and developing countries. It shows that power generation is going to significantly increase in developing countries and that coal will be the predominant type of fuel in a business-as-usual scenario, contributing to over half the power generated in 2030, compared to 34% for developed countries. According to a reduction scenario following the path to stay within the 2ºC objective, developing countries will still use coal for 38% of power generation in 2020 and for 27% in 2030.

[6] Further background on the Problem Analysis is contained in Annex V.

Figure 1: Power Generation by fuel type in developed and developing countries



Source: JRC, IPTS, POLES (from Copenhagen Communication IA modelling)

EU action alone will not be sufficient to limit the global temperature increase to 2ºC above pre-industrial levels. By 2020, developing country emissions will exceed those of the industrialised world.[7] A wide portfolio of mitigation options will be required to achieve the emission reductions needed. The analysis conducted for the Communication 'Towards a comprehensive climate change agreement in Copenhagen'[8] indicates that CCS is expected to make a significant contribution to emissions reductions and that very fast deployment of this technology would be necessary. Figure 2 illustrates the contribution of different measures to reducing CO_2 emissions, where CCS is expected to deliver about 3% of necessary emission reductions in 2020 and more than 10% in 2030. This translates to 1935 Mt of emission reductions due to CCS in 2030. While energy efficiency and renewable energies are in the long term the most sustainable solutions both for security of supply and for the climate, EU and global CO_2 emissions cannot be reduced by 50% by 2050 if other options such as carbon capture and storage are not used. CCS can be considered a bridge technology.

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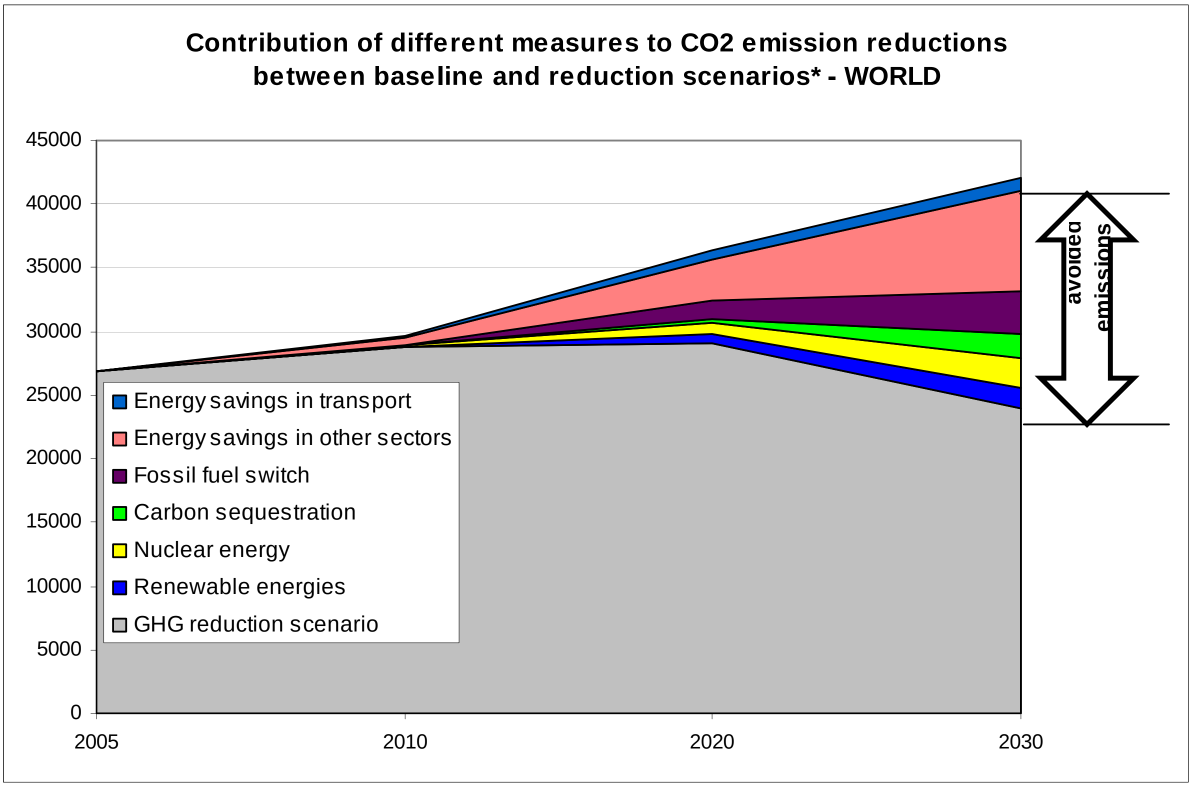
7 See Annex V, Figure 10 for more information.
8 SEC(2009) 101.

Figure 2: Contribution of different technologies to reducing CO_2 emissions



Source: DG JRC, IPTS, POLES (from Copenhagen Communication IA modelling)

According to the business-as-usual scenario, the penetration of CCS with respect to fossil fuelled power plants by 2030 is virtually zero, while the reduction scenario[9] shows a significant share (around 18 %) of fossil fuel power generation with CCS in 2030, rising to around 85 % of fossil fuelled power plants to be equipped with CCS in developing countries by 2050 (see Figure 3). This shows the importance of this technology to achieve a sustainable carbon emission path at global level and emphasises the need to start large-scale CCS demonstration without delay.[10] In addition, a recent IEA report found that achieving a 50 % reduction in CO_2 emissions by 2050 without using CCS would increase the cost by 71 %.[11]

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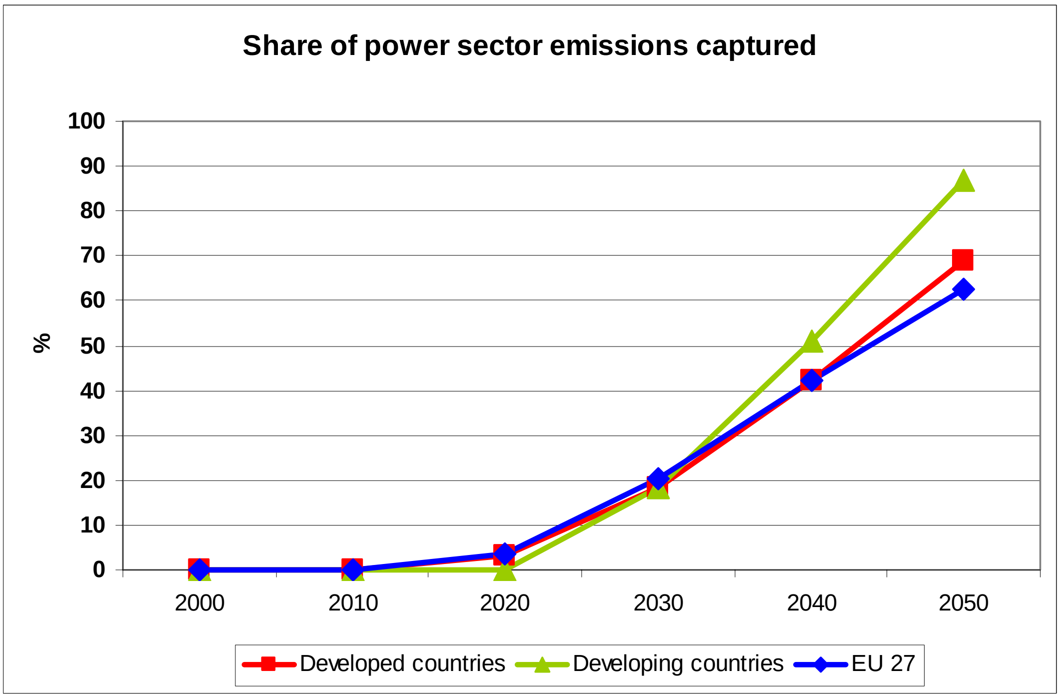
9 According to this scenario, GHG emissions in developed countries will decrease by 20 % in 2020 compared to 1990. GHG emissions from developing countries will continue to rise in the 'appropriate global action scenario' up to 2020, then peak between 2020 and 2030.

10 SEC(2009) 101.

11 'CO_2 Capture and Storage — A key carbon abatement option', IEA 2008.

Figure 3: Share of power sector emissions captured through Carbon Capture and Storage



Source: DG JRC, IPTS, POLES (modelling for the Copenhagen communication)[12]

Both the International Energy Agency and the IPCC conclude that the various components of the CCS process are already operational, but the challenge is to combine all these elements to enable commercial deployment of CCS in the power sector. There are currently only four large-scale CCS demonstration projects in the world: none based on a coal-fired power plant, and none in coal-dependent emerging economies. (See Annex IV for further information on the state of the art of CCS).

Several international initiatives either specifically support CCS or have it as one aspect of broader technology support. These include the Carbon Sequestration Leadership Forum, International Energy Agency implementing agreements; the World Bank Clean Technology Fund and the Asia-Pacific Partnership on Clean Development and Climate (see Annex IV for more details). However, none of these initiatives has yet succeeded in pooling sufficient resources to finance large-scale CCS demonstration projects, let alone in emerging developing countries, where no benefits can yet be monetised through carbon markets.

To gauge the true global mitigation potential of CCS and to save significant time in demonstrating, deploying and disseminating CCS technologies worldwide, coal-dependent emerging economies and developing countries also need to play their part. Therefore, a viable financing model must be found for large-scale CCS demonstration projects and an international agreement made to reinforce the market-based incentives that create a carbon price.[13] Given the EU's leadership role in the international climate change negotiations, a number of domestic companies with relevant knowledge and technologies and bilateral

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12 SEC(2009) 101.

13 European Commission proposed a minimum size of 250 MW for CCS demonstration plants eligible under the European Economic Recovery Plan support. For the purpose of this document, the cost analysis undertaken in Annex VIII is based on a 400 MW plant (net capacity).

partnerships on which specific technology cooperation can be built, the EU is in an excellent position to facilitate the initial demonstration of CCS technologies in key emerging developing partner countries.

2.2. Barriers to demonstrating and deploying CCS technologies in emerging developing countries

Both the International Energy Agency and the IPCC conclude that the various components of the CCS process are already operational, but the challenge is to combine all these elements to commercially deploy CCS in the power sector. This chapter analyses the barriers to CCS demonstration and deployment in developing countries.

2.2.1. Market failure for developing CCS

The increased cost of electricity generation due to the additional capital and operating costs of the capture, transportation and storage installations compared to conventional power plants is one of the major barriers for CCS uptake, both in Europe and internationally. The CCS process itself requires additional energy use, resulting in a so-called energy penalty, which either takes the form of additional fuel required to maintain a power plant's output or less output for the same fuel input.

The underlying root of the problem is the failure of the market to reflect the real cost to society of externalities caused by using fossil fuels to generate electricity. The use of coal-fired power stations, while providing the energy needed to develop an economy, causes significantly greater GHG and classical air pollutant emissions than alternative fuel sources. In addition, coal mining itself has negative environmental and social impacts. In countries with abundant coal reserves, in the absence of a price for such externalities and without an economic incentive to cover incremental CCS costs (by fiscal or other market measures like emissions trading), coal will continue to be used to generate electricity. CCS represents an opportunity to continue to use coal (which is often attractive due to cost/location factors) while mitigating the negative environmental impacts.

Even if policy frameworks become increasingly conducive to CCS, it cannot be assumed that the private sector will finance CCS investment. The problems underlying the financing gap are complex but mainly concern risk capital.[14] This financing gap is common for technologies that move into the pre-commercialisation stage, when they are 'weaned off' grant support and face high-cost activities such as initial and secondary prototype development and testing, site development, supply chain formulation, construction and grid interconnection.

Mobilising private-sector finance is essential to channel sufficient finance into sustainable energy investments. Private-sector returns do not take account of public benefits. Investments in CCS demonstration are typical public goods that produce substantial local and global benefits, such as zero or low greenhouse gas emissions and low pollutant emissions. They also promote local employment and generate income, including through the provision of energy for productive use. These positive externalities are not reflected when private investors calculate the additional costs of CCS demonstration plants.

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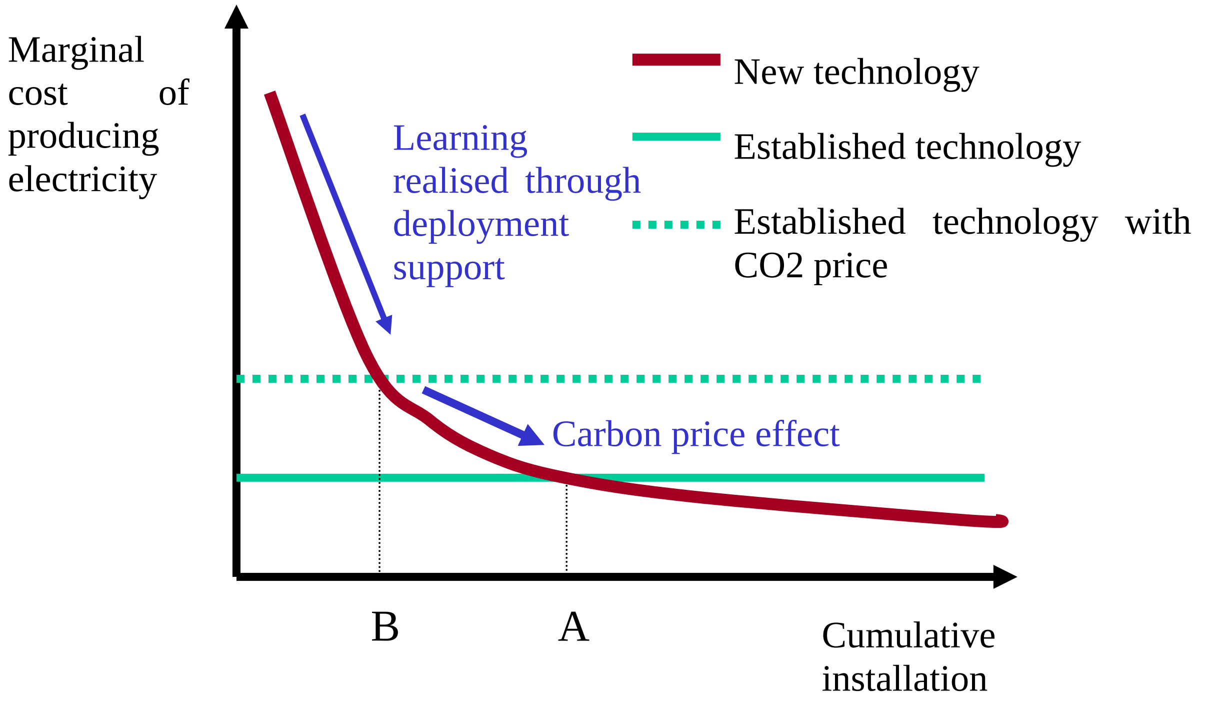
[14] For a summary and more details on the nature of the financing gap: UNEP-SEFI. 2005. Public Finance Mechanisms to Catalyze Sustainable Energy Growth.

Experience from previous technology development shows that costs substantially fall with increased deployment. Learning benefits and potential first-mover advantages could be positive factors attracting private investors. The learning curve at Figure 4 illustrates that new clean energy technologies need public financial support in the early stages of development to drive down the marginal costs of electricity production. However, for some technologies like CCS, some form of support (e.g. over and above the CO_2 price, if existing) may also be needed at the initial development stage, depending on prevailing market conditions. In emerging and developing countries, the CDM (pending the inclusion of CCS as a permissible methodology) or some other carbon market mechanism could provide limited carbon financing, but there will still be a gap to fill in terms of incentivising CCS demonstration over and above the use of established (dirtier) technologies. In the longer term, a price on carbon will help incentivise broader CCS deployment.

Figure 4: Illustrative learning curve for CCS development



Source: Stern Review, 2006, p 350, as presented in EU Technology Think Tank meeting 16-17 April 2007

Up-front public funding can provide this incentive and enable progress along the learning curve, which should drive down costs and exploit economies of scale over time, particularly in an economy such as China, where labour costs are significantly lower and power sector investment is increasing rapidly. These can lead to global benefits in addition to the knowledge spill-over benefits related to testing CCS as a viable large-scale mitigation option and the individual technological and geological options in combination.

2.2.2. Institutional and governance issues

The absence of national regulations or international agreements that put a price on greenhouse gas emissions is a disincentive for the private sector to cover incremental CCS costs. In addition to increased costs, there are other barriers to CCS development and deployment in emerging developing countries. They mainly relate to the lack of appropriate regulatory, planning and permitting frameworks to create the conditions conducive to such investment. There is a need to develop a legislative framework for planning and permitting CCS plants, safe transport and storage of CO_2 and greater protection of the intellectual property of foreign technology companies. Offering financial support for a CCS demonstration project can incentivise the recipient country to draft the regulatory, planning and permitting frameworks needed for large-scale deployment, and could even be attached as a condition to the provision of such finance, as could an appropriate IPR framework.

2.2.3. China

In 2007, China overtook the United States as the world's largest emitter of energy-related CO_2 accounting for around 20% of global energy-related CO_2 emissions. This is due to the high carbon intensity of the fuel mix in China, where coal constituted around 90% of power generation in 2006.[15] China built the equivalent of one 500MW coal-fired power plant every two and a half days in 2007.[16] Without the application of CCS, this represents an increase of around 4 megatons of CO_2 a week in Chinese emissions from coal-fired power generation alone.[17] With plant lifetimes of around 30 years or more, the potential for carbon lock-in is enormous.

China adopted a National Climate Change Programme (CNCCP) in June 2007, which aims to optimise the energy mix by developing low-carbon and renewable energy. It specifically mentions the development of technologies for CCS. If fully implemented, the full range of measures in the CNCCP could lead to a reduction of up to 950Mt of CO_2. Specific CCS technology guidelines are planned for publication in 2009.

The development and deployment of CCS in emerging economies would be significantly delayed without assistance from developed countries. The EU's commitment, coupled with technological and financial assistance, would help maximise the potential for CCS in emerging economies.

Among emerging developing countries, EU cooperation on CCS technologies is most advanced with China, notably through the Near Zero Emissions Coal project (see Annex VI) under the EU-China Climate Change Partnership (see Annex II for more details), where the EU has committed to developing and demonstrating advanced 'zero-emissions' coal technology using CCS technologies in China and the EU. In addition, under the Partnership agreement, the EU and China have committed to significantly reducing the cost of key energy technologies and promoting their deployment and dissemination. Given the volume of Chinese greenhouse gas emissions due to its coal-intensive power generation sector (global CO_2 emissions from coal combustion increased by 4.5% in 2006. China contributed most to this increase with a 9% increase in 2006, whereas in the rest of the world coal combustion emissions increased by 2%[18]), the political commitment between the EU and China and the

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[15] IEA World Energy Outlook 2008.

[16] IEA, Cleaner Coal in China, 2009.

[17] Dr Nick Riley from the British Geological Survey, oral evidence to the UK House of Commons Science and Technology Select Committee (http://www.publications.parliament.uk/pa/cm200506/cmselect/cmsctech/578/57805.htm#note18).

[18] Netherlands Environmental Assessment Agency, 2007. See: http://www.pbl.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition.html.

advanced stage of existing cooperation on CCS, China was chosen as the location for the first CCS demonstration plant supported financially by the EU.[19]

Several European companies are already present in Chinese clean technology markets. Many of these are members of the European Technology Platform for Zero Emissions Fossil Fuel Power Plants[20] and are key stakeholders for EU-China cooperation. Furthermore, cooperation between European and Chinese industry stakeholders will be supported by the EU-China Clean Energy Centre, agreed at the 2007 EU-China Summit and due to be established in Beijing.[21]

At the 3rd Meeting of the EU-China NZEC Steering Committee on 1 April, Chinese government representatives expressed their satisfaction with the EU-China cooperation on CCS, and identified useful expected outcomes of the Phase I projects and some lessons to be learned for future cooperation work. They also briefed the European side on the increasing prominence of CCS in Chinese technology, energy and climate change policies, noting its mention in the 2007 National Climate Change Programme and the Outline for National Medium and Long-term Science and Technology Development Plan towards 2020. They also indicated that a Guide for CCS Technology Development would be published in mid 2009.

2.3. Conclusion

The Commission Communication, 'Towards a comprehensive climate change agreement in Copenhagen,'[22] acknowledges the need for developing countries to receive financial and technological support to limit the increase in their emissions. Significantly increased financial resources will be needed to support the action needed in developing countries. Contributions from developed countries and the global carbon market will be required to implement action resulting in incremental costs that cannot be sustained by the country itself. Many of these investments will have both short- and long-term benefits in terms of climate change and economic recovery. In any case they will cost less than inaction.

In conclusion, EU public financing can help overcome some of the barriers outlined above and trigger private financing, which would not otherwise be available for large-scale CCS demonstration projects. Demonstration projects improve our understanding of the technical, methodological, political, legal and financial issues involved and therefore help us estimate the extent to which it will be possible to rely on CCS as one of the key future mitigation technologies. A successful demonstration project will reduce perceived risk, facilitate further demonstration on the path to deployment and dissemination and help lower the cost of this technology.

For these reasons, this impact assessment examines the options for a financial vehicle to support the construction and operation of a CCS demonstration plant in one emerging economy, China.

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[19] Whereas the cost figures associated with this Impact Assessment (Annex VIII) are estimated for China, the financial vehicle described could potentially be applied to a demonstration plant in any emerging economy.

[20] See: http://www.zero-emissionplatform.eu.

[21] See: http://www.eu-in-china.com/download/EC2.pdf.

[22] COM/2009/0039 final**.**

3. OBJECTIVES

3.1. General policy objective

- To limit the increase in global mean surface temperature to 2 °C compared with pre-industrial levels, which in turn requires that global greenhouse gas (GHG) emissions peak by 2020 at the latest, fall by at least 50 % compared with 1990 levels by 2050 and continue to fall thereafter.

3.2. Specific objective

- To facilitate early demonstration of CCS technology in emerging developing countries to **maximise the public benefits of these technologies (GHG emissions reductions, improved air quality) as they move from demonstration to deployment, to increase experience and economies of scale and drive down costs**, initially using China as a case study.

3.3. Operational objectives

- Identify the additional financing needed for a large-scale CCS demonstration plant in China, in the absence of a global carbon price or other incentive, to complete the demonstration project sooner than might otherwise be the case under normal market conditions.

- Provide financing using a viable financing model for CCS demonstration in China, which brings together public and private financing as a concrete example of technology and financing cooperation between developed and developing countries in the context of the international climate change negotiations.

- Given limited resources from the Community budget,[23] **calculate how to split public/private financing** to maximise the leverage of public funding, to be explored further when designing the above-mentioned vehicle.

This project is in line with the European Commission's Sustainable Development Strategy, the objectives of the 2008 Climate Change and Energy package and the Lisbon Strategy. In combination with the EU's own Demonstration Programme, this initiative can help develop a competitive advantage and new markets for European companies active in relevant sectors.

4. POLICY OPTIONS

According to IEA estimates, $22 trillion of investment will be needed for global energy supply infrastructure. Around $3.7 trillion of this is required in China alone. The way this

[23] The European Commission has earmarked €60m for cooperation on cleaner coal technologies and carbon capture and storage with emerging economies. Most of this finance is earmarked for the design and construction of a CCS demonstration plant in China. The first tranche of €10m (2009-2010) is earmarked to build capacity for CCS and other clean coal technologies in other emerging economies (about €3m) and for the second phase of the EU-China NZEC project (about €7m). Provided there is continued political support from China and satisfactory progress with the NZEC project, a second tranche of up to €50m could be made available for Phase III of NZEC, i.e. the construction and operation of a CCS demo plant in China.

investment is deployed will determine Chinese and global energy use patterns and CO_2 emissions for decades to come. The latest available figures are for 2006, when, according to the IEA, China increased capacity at coal-fired power stations by 100 GW over the course of the year.[24] Even this scale of power facility expansion is not sufficient to meet soaring demand, and estimates suggest that 1260 GW of new power stations will come on line in China by 2030, 70% of which will be coal fired.[25] Over the same period, Europe is expected to build 850 GW of new power stations to replace ageing stock.

4.1. Option 0: No EU involvement in financing CCS demonstration in emerging economies

Unless existing and new technologies are developed and deployed, the potential for carbon lock-in is significant. Therefore, Europe and China have a unique opportunity to work together to develop and demonstrate CCS technologies for future deployment in both regions to avoid the bulk of carbon lock-in and find innovative solutions to coal dependency. The EU already cooperates with China on various substantive aspects of climate change policies and research (see Annex II).

The aim should be to develop, demonstrate, disseminate and deploy CCS technologies globally to move along the learning curve and down the cost curve as quickly as possible. Without EU technological and financial assistance, deployment of CCS in China and other emerging economies could be significantly delayed. This would represent a missed opportunity for emissions abatement and for facilitating the progress of international negotiations on climate change. If large-scale deployment of CCS is delayed, combating climate change could be significantly more expensive. China builds capacity comparable to the entire UK power grid each year.[26] Without the application of CCS, this represents around 4 megatons of CO_2 a week increase in Chinese emissions from coal-fired power generation alone,[27] and with plant lifetimes of around 30 years or more, considerable potential for carbon lock-in. Developing CCS technologies in Europe and then exporting them at a later date to developing countries does not fit with the EU's policy aim of limiting global climate change to 2ºC. Furthermore, developing countries reject this form of technology dissemination. CCS technologies must be developed in partnership with developing countries to determine and then maximise the true potential of CCS.

The funding gap for CCS demonstration is well documented. Under the EU Emissions Trading System (emissions stored are not emitted), the New Entrants Reserve of the EU ETS (300 million allowances have been set aside to support EU CCS demonstration plants and renewable energy projects) and the European Economic Recovery Plan (€1.05bn is planned for selected demonstration projects), the EU incentivises demonstration within Europe. However, as explained above, action in the EU alone will not bring CCS to market in the timescale commensurate with the problem. For this reason, additional public financing is required for cooperation with developing and emerging economies. The Commission plans to promote information exchange between the NZEC project and European demonstration

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24 Fred Pearce in New Scientist, 23 April 2008.

25 Chatham House/E3G report: Changing Climates, November 2007.

26 'The Future of Coal', Massachusetts Institute of Technology, 2007.

27 Dr Nick Riley from the British Geological Survey, oral evidence to the UK House of Commons Science and Technology Select Committee (http://www.publications.parliament.uk/pa/cm200506/cmselect/cmsctech/578/57805.htm#note18).

projects through the CCS project network, which is currently being established.[28] Furthermore, many members of the European Technology Platform for Zero Emissions Fossil Fuel Power Plants[29] are key stakeholders in EU-China cooperation.

The EU has a commitment to China and has indicated its intention to expand CCS cooperation to other partners. A lack of EU action could delay eventual dissemination of CCS technologies globally and lead to further carbon lock-in. This option is not commensurate to the problem and would be a missed opportunity for the EU's Climate Change and Energy policy. Therefore, this option is discarded.

4.2. Option 1: Public grant funding

This option would mean fully financing the additional cost of CCS by public grant funding. In the current economic climate, it would be difficult to mobilise the level of funding required for a commercial-scale demonstration plant. Furthermore, if financing a CCS demonstration plant relies solely on public grant financing, the donor/recipient dynamic might prevent the establishment of the structures and relationships required to position the first demonstration in a broader strategy for large-scale CCS deployment. For these reasons this option is discarded.

4.3. Option 2: Public-private partnerships

To share ownership and risk, pool sufficient funds and deploy them effectively, it will be necessary to develop a **public-private partnership (PPP)**. The partnership must be designed to inform and garner support from EU and EEA Member States, China, International Financial Institutions and private investors. The EU has experience with the following three basic models, which are analysed in further depth here:

Option 2a) Joint Undertaking

Option 2b) Ad-hoc International Treaty

Option 2c) A Special Purpose Vehicle

It should be noted that, as further experience is gained during NZEC phase II, other options may be considered. These three options are not exclusive, but represent what are considered to be the most likely options at present.

5. COMPARING THE PUBLIC-PRIVATE PARTNERSHIP OPTIONS

5.1. Option 2a: Joint Undertaking

The legal basis for establishing a Joint Undertaking (JU) is the EC Treaty, Title XVIII 'Research and Technological Development', Article 171: 'The Community may set up joint undertakings or any other structure necessary for the efficient execution of Community research, technological development and demonstration programmes'.

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28 See: http://europa.eu/rapid/pressReleasesAction.do?reference=IP/08/1315&format=HTML&aged=0&language=EN&guiLanguage=fr.

29 See: http://www.zero-emissionplatform.eu.

Article 171 of the EC Treaty does not define joint undertakings in more detail nor does it define fields of application in terms of research areas. The only clear condition set for a JU is that it has to be necessary for the efficient execution of Community programmes for research, technological development and demonstration.

It has previously been applied to projects with a significant budget line including a large share of Community financing, such as GALILEO,[30] which also involves non-EU countries, and SESAR.[31] The GALILEO Joint Undertaking (GJU) oversees the establishment of a public-private partnership to manage the Galileo Programme and mobilise the required funds. A competitive tendering process is used to select the private consortium that will be awarded the Galileo concession. While it is highly flexible with regards to participation, as it allows for funding from both private and public sources, one of the potential downsides is the time involved in establishing such a mechanism. At present, JUs have been set up through the adoption of a Council Regulation, which would take a minimum of two years. In addition, the GALILEO model is not sufficiently flexible to bring in financing from the carbon market, which will be crucial in the future to ensure dissemination and deployment of clean energy technologies such as CCS.

5.2. Option 2b: ITER (International Thermonuclear Experimental Reactor)

The bespoke model for ITER was used in the absence of an off-the-shelf model for the purpose of bringing together various international partners (EU and non-EU country governments) to collaborate on the design and construction of an experimental fusion reactor. In effect, new international law was created to fit the purpose. This underpins the organisational structure of a 'Joint Implementation Agreement', which covers issues as diverse and potentially politically sensitive as information and intellectual property, privileges and immunities, public health, safety, licensing and environmental protection, liability, decommissioning, and peaceful uses and non-proliferation. This structure was lengthy to establish (taking over 5 years), and does not allow the private sector to be directly involved. The private sector contributes via contracts awarded by the member governments. This model does not pool public and private interests in the way envisaged for this project and is over-complex for the purposes of funding a CCS demonstration plant in China. There are existing structures where the Commission has experience and competence, therefore it is not necessary or appropriate to create new international legal structures in this case.

5.3. Option 2c: Special Purpose Vehicle (SPV**)** or other investment vehicle

A Special Purpose Vehicle (SPV) is a legal entity created to achieve (a) specific objective(s). SPVs have no purpose other than the transactions for which they were created, and they can make no substantive decisions; the rules governing them are set down in advance and carefully circumscribe their activities. This mechanism limits the financial risk to the investor. SPVs are suited to transferring assets to finance a large project achieving a narrow set of goals while limiting the risk to the investing entity. Hence an SPV or other similar vehicle can offer several advantages and can be tailored to suit the needs of the CCS demonstration project.

30 See: http://ec.europa.eu/transport/galileo/index_en.htm.

31 SESAR (Single European Sky ATM Research) is the technological wing of the Single European Sky. The aim of the SESAR Joint Undertaking is to modernise the European air traffic management system by coordinating and concentrating all relevant research and development efforts in the Community.

Potential to build on existing structures

The Commission and the EIB have experience in channelling support via public-private partnerships in general, including SPVs. SPVs are highly flexible in that they can be designed for a one-off project and have a relatively light legal and managerial structure, which means that they can be established quickly and with minimal overheads.

Involving the private sector

The advantage of a PPP — either a Fund or an SPV — is that public-sector donors can set out investment policies to ensure full coherence with public policy objectives. A specified investment policy provides an investment platform combining public and private finance. Being set up as a private investment fund or SPV with a public objective, the vehicle would be managed in an efficient and financially viable way with a view to attracting funding from private capital markets.

Achieving policy objectives

A further advantage of the governance structure of an SPV is the opportunity to attach policy objectives to the investment decisions, such as the deployment of a new technology.

5.4. Summary and conclusion

Table 1 compares the three public-private partnership options according to a set of criteria.

Table 1: Assessment of the proposed public-private partnership options

Issue	a) Joint Undertaking (e.g. GALILEO)	b) Ad-hoc international treaty (e.g. ITER)	c) Special Purpose Vehicle (SPV) or other investment instrument
Decision-making procedure	Council Regulation agreed with the opinion of EP	COM receives a negotiating mandate from Council	The EC indicates its intention to act, e.g. via a Commission Communication. Commission Financing Decision to commit EC funding
Timeframe	Experience shows that a minimum of 2 years is realistic	ITER took 5 years to negotiate (2 of these spent on location issue)	6-12 months is ambitious but feasible
Contribution of non-EU parties	No particular type of participation provided for: flexibility of Article 171 allows for various possibilities. Third countries participate in GALILEO.	For ITER, all parties (governments only) are equal, although France has a key role due to location, and Japan has some advantages due to location trade-off (but ad-hoc nature means this can be decided)	Non-EU parties — both public and private — could contribute to the vehicle

Role of private sector	No particular role is specified: flexibility of Article 171 allows for various possibilities. Allows for public-private cooperation.	ITER is entirely inter-governmental — private sector involvement is arranged through contracts with governmental parties	Allows for public-private cooperation with direct private investment.
Split of public/private-sector funding	Nothing is specified: flexibility of Article 171 allows for various possibilities.	ITER is entirely publicly funded at present.	Both private and public investors could participate by lending or taking equity in an SPV or by buying shares of an investment fund.

Given the absence of a functioning commercial-scale CCS demonstration plant globally, there is no specific experience to draw on to ascertain the best financial vehicle to achieve the second operational objective. However, the EU has experience in bringing public and private bodies together in large research/demonstration projects through the above three types of public-private partnerships. Therefore, while all three options would build on previous experience, neither option 2a) nor 2b) seem feasible regarding the timescale as both options would entail lengthy inter-institutional legal procedures. If the assumption is made that the contribution from the Community budget is fixed regardless of the chosen cooperation model, the cost to the Community remains constant. A key issue is that option (b) does not involve the private sector financially. Options (a) and (b) are therefore discarded. Option (c) and its resulting impacts are assessed in more detail below.

6. SPECIAL PURPOSE VEHICLE (SPV) OR OTHER INVESTMENT VEHICLE

As the technologies are at the demonstration stage and not yet commercially viable, private investment in CCS is only attractive if there are prospects for a revenue stream either from the carbon market or from enhanced oil recovery. This chapter analyses different financing options and gives examples of rates of return on investment in a CCS project on an IGCC and pulverised coal plant.

The figures used in this example derive from initial cost estimates presented in Annex VIII. Specific costs depend on the location (country and site) and the technology selected. Cost estimates for CCS demonstration projects at the pre-feasibility stage are generally considered to have an uncertainty range of +/- 40%. For the EU-China NZEC Project, during the second feasibility and design phase (see Annex III), more accurate cost analyses will be conducted based on choices (technology, site, storage type and location) to be made by the Chinese government. The most accurate cost estimates will be made during the pre-construction Front End Engineering Design (FEED) study.

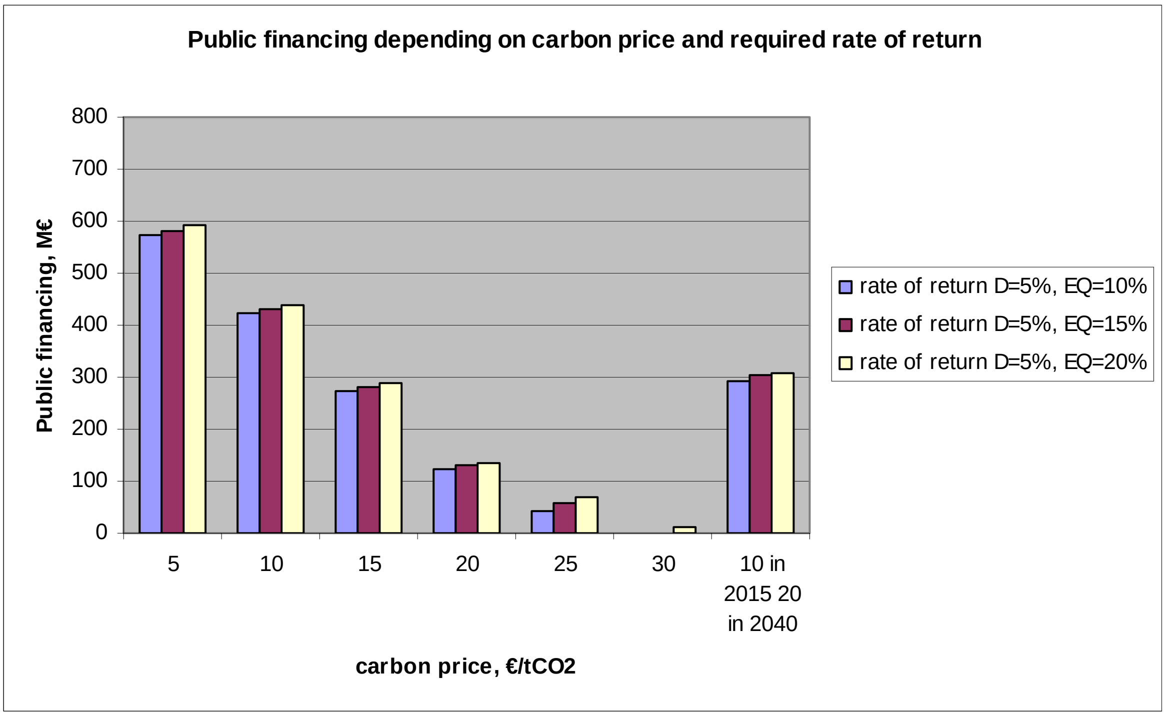
6.1. Financing with revenue from the carbon market

The future eligibility of CCS for CDM or another carbon market mechanism (such as sectoral crediting) would generate a revenue stream that could make investment in the technology attractive to private investors. Particularly interesting in this regard is the sectoral crediting mechanism currently being discussed in the context of negotiations on a post-2012 global climate change agreement. In the Chinese power sector, for example, this approach could allow emissions reductions to be credited beyond a certain baseline. Thus, only action which is additional to business as usual is credited and companies would have an incentive to take more costly mitigation action in return for financing through the carbon market. This could facilitate the uptake of more expensive technologies such as CCS, over and above other cleaner coal and efficiency technologies, which are cost neutral or even negative over time.

Figure 5 shows the public financing needed for the Integrated Gasification Combined Cycle (IGCC) plant, depending on the carbon price and required rates of return by private investors for a base plant. (D=debt; EQ=equity).

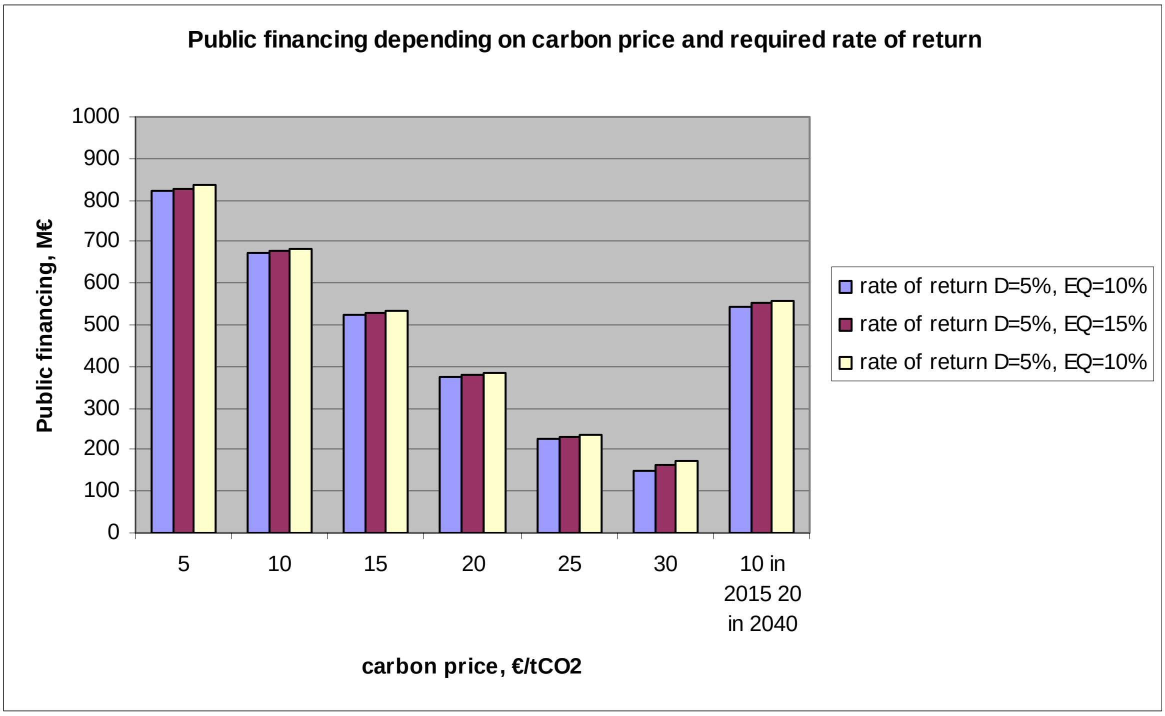
Figure 6 does the same for the Pulverised Coal (PC) plant. The amount of public financing needed is estimated with the assumption that it is in the form of subsidy (no revenue). Public financing for capital investment is set at a rate that leaves private investors indifferent as to whether to invest in plants with or without CCS. Public financing for operational costs covers additional CCS costs that are not covered by revenue from carbon credits. The carbon value is set at different levels and assumed to be constant throughout the plant operation (2015-2039), the last scenario assumes the value of carbon will gradually increase from € 10/tCO_2 in 2015 to € 20/tCO_2 in 2040. It is important to note that assumptions on the carbon value are hypothetical, without pre-judging the policy instrument used to achieve this value (such as a sectoral crediting mechanism, carbon tax or domestic emission trading system). As shown in Figures 6 and 7, the financing gap depends to a large extent on the assumed carbon value.

Figure 5: Public financing for IGCC plant



(D = debt; EQ = equity)

Figure 6: public financing for PC plant



(D = debt; EQ = equity)

It is uncertain whether and at what time CCS in emerging developing countries will be eligible for carbon market revenue. Therefore, public funding — with no or very low expectations for a return on investment — will be required to reduce the risk for private investors and to allow for a sufficiently high rate of return.

If the value of carbon increases gradually from € 10/tCO2 in 2015 to € 20/tCO2 in 2040, the amount of public financing needed to cover the additional CCS cost is estimated at around € 550 million for the PC plant and around € 300 million for IGCC plant. It is important to note that these cost estimates are based on the assumptions made in Annex VIII. A full sensitivity analysis on other parameters is summarised in Annex VIII.

6.2. Financing with revenue from enhanced oil recovery

It may be possible to source revenue from enhanced hydrocarbon recovery (oil or coalbed methane), in addition to revenue from the carbon market.

Enhanced oil recovery (EOR) denotes a variety of processes to increase the amount of oil removed from a reservoir, typically by injecting a liquid (e.g., water, surfactant) or gas (e.g. nitrogen, carbon dioxide). The income from applying EOR to the storage site can be significant. The CO_2 value is estimated by the US Department of Energy at $ 25-35 per ton for EOR.[32] A price of around € 15/tCO_2 in EOR would cover up to half of the additional cost of CCS at the IGCC plant above. However, the economic benefit of enhanced oil recovery

[32] McKinsey&Company: Carbon Capture and Storage: Assessing the Economics, 2008.

depends very much on oil prices. IPCC suggests that, for example, oil at US$ 50/barrel could justify a credit of US$ 30/tCO_2.[33]

Such estimates should be treated with caution as, firstly, the applicability of EOR is highly dependent on the profile of the specific site, its age and level of depletion and, secondly, on the oil price and on the ability to ensure a constant supply of CO_2. However, in the absence of a carbon price or eligibility of CCS for CDM, EOR would be the only potential additional stream of revenue from equipping a power plant with CCS.

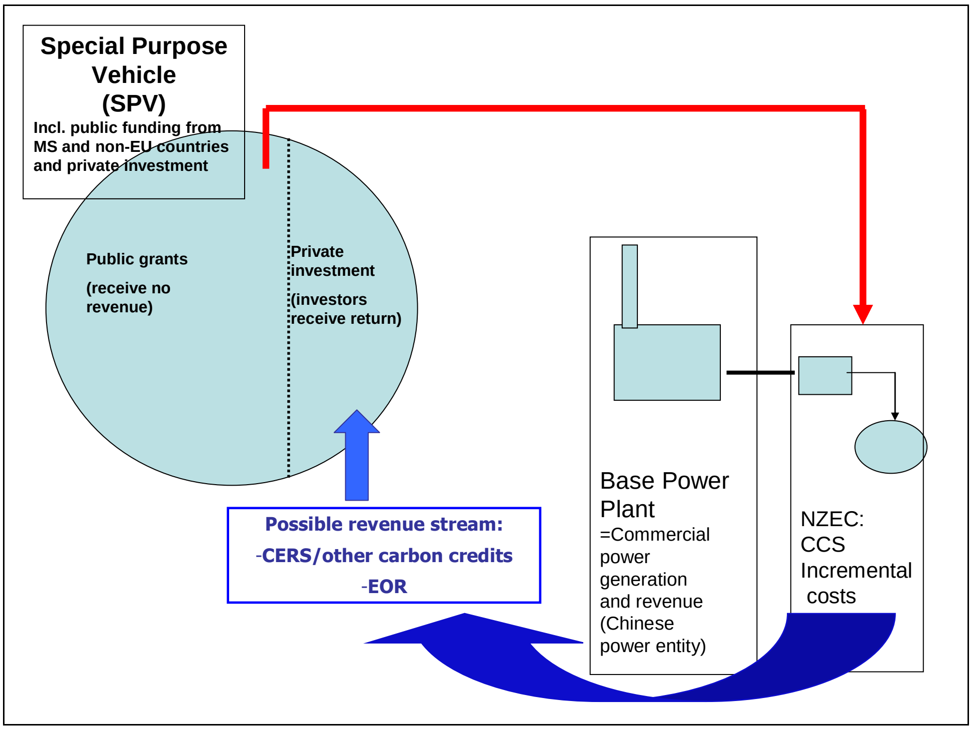
In practice, CO_2-EOR use will be limited to power plants close to oil and gas fields to keep transport costs down. Although the potential for EOR in China is limited to the relatively low number of oil fields, developing CO_2-EOR could jump-start the transport infrastructure required for full CCS deployment in some regions.

An assessment of the EOR potential in some regions of China is made by NZEC Phase I projects, which are investigating the scope for applying CO_2-EOR for CCS projects in China. COACH is looking at the Bohai basin (Shandong Province), which contains the Dagang and Shengli oilfields. This site was selected by the Chinese partners, indicating a potential interest in EOR. Results will be available in the second half of 2009. If EOR is an option, this would considerably ease the financing of a CCS commercial scale demonstration plant.

6.3. Financial flows

Figure 7 illustrates the flows of finance in the investment scheme described above.

Figure 7: Illustration of Special Purpose Vehicle investment and returns



33 Herzog et al. (2005): Chapter 8: Costs and economic potential. In IPCC Special Report on Carbon Dioxide Capture and Storage.

A likely scenario is that private investment will come from two sets of investors: International Financial Institutions or public banks, such as the EIB, essentially providing advantageous loans and seeking a low return (e.g. 5 %) and private investors seeking a higher return (e.g. 10-20 %). One way to reduce the size of the initial investment required is through a competitive bidding process for the construction and operation of the plant, where partner companies in the consortium may bid at cost or reduced rates to gain first-mover and learning advantages from being in the first commercial scale CCS demonstration plant in China.

To make the proposal attractive to private investors, public investors need to be willing to underwrite some of the risk.

Several issues remain for negotiation with Chinese partners. The assumption is that the Chinese will at least invest in the construction of the base power plant. Chinese investment in the incremental costs of CCS could reduce the risk for private investors and increase Chinese buy-in to the project and development of the technology. This could ensure a greater chance of Chinese ownership and familiarity with the technology and increase the likelihood of further deployment.

Figure 5 shows that the target amount of public funding under the Special Purpose Vehicle or other investment vehicle would be around €300 million for an IGCC plant or €550 million for a pulverised coal plant.[34] This is subject to slight changes, depending on the rate of return required by private investors for the base plant and, to a larger extent, on the carbon price and possible revenue streams from enhanced oil recovery. In addition, the target amount of public funding under the Special Purpose Vehicle or other investment vehicle depends on the number of years of operation during which the CCS plant would receive public financial support.

If public contributions from the EU Member States provide advantages to certain companies operating in the EU and more generally qualify as State aid, they may need to be notified to the Commission under the State aid rules.

7. ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF CCS DEMONSTRATION IN CHINA

This analysis focuses on the impact of policy options on the process of CCS demonstration on an industrial scale in emerging developing countries, particularly in China. The construction of one CCS demonstration plant is not likely to lead to a major immediate improvement in the climate or to immediate economic benefits. Also, direct social and employment impacts are likely to be limited due to the scale of CCS demonstration projects.

However, the individual policy options differ in their impact on the extent and timing of demonstration projects and their likely results. This in turn can be decisive in bringing CCS swiftly to market and will have much more substantial implications for the global climate and for the local environmental, economic, social and employment situation in emerging developing countries.

[34] This figure is based on the assumptions in Annex VIII, which also summarises the results of the sensitivity analysis on the main parameters.

7.1. Environmental Impacts

A full Environmental Impact Assessment for a specific CCS project site will be conducted as part of the ENRTP project referred to in Annex III. Furthermore, environmental and technical guidelines will be drafted for the design, construction, operation and monitoring of CCS demonstration plants. The more general environmental impacts of CCS can be classified as:

7.1.1. Risk of physical leakage

The IPCC Special Report on CCS estimated that the fraction of CO_2 retained in appropriately selected and managed geological reservoirs is very likely (i.e. with probability of 90-99 %) to exceed 99 % over 100 years and likely (i.e. with probability of 66-90 %) to exceed 99 % over 1000 years.[35]

The storage site selection stage is key to ensuring zero or near-zero seepage. With suitable site profiling, selection and management, this practical experience supports the notion that the long-term risk of seepage is low. These levels of confidence and the assurance of permanence to be confirmed by ongoing projects, support the presumption of long-term CO_2 retention in well-selected and managed sites (i.e. a permanent emission reduction).

7.1.2. Air Pollution

As set out in the impact assessment for the Communication on Sustainable Power Generation from Fossil Fuels,[36] the penetration of sustainable coal technologies including CCS is likely to reinforce the positive impact of recent improvements in coal-fired power generation through the application of cleaner coal technologies. These have so far led to significant reductions in the most critical air pollution agents, notably sulphur dioxide (SO_2) and nitrogen oxides (NOx). These pollutants are major contributors to ocean acidification, eutrophication and ground-level ozone. In general, SO_2 emissions plummet (by more than 90 %) regardless of the technology, whereas depending on the CCS technology used, NOx emissions may increase slightly (up to 20 % for Natural Gas Combined Cycle (NGCC) or Pulverised Coal (PC) technologies, or fall by 81 % for Integrated Gasification Combined Cycle (IGCC) plants.

Aerosols and particulate matter have serious adverse impacts on human health and have been estimated to be responsible for up to 800 000 deaths worldwide per year.[37] They are also believed to be a significant forcing agent for major local and global climate effects which are still being investigated. Although some aerosols occur naturally, sulphur dioxide from the combustion of coal is the precursor of sulphate aerosol, especially in urban areas, and although legislation has succeeded in controlling emissions in the US and Europe, they are increasing in Asia.[38] Therefore, a reduction in SO_2 emissions as described above can also have a positive impact on anthropogenic aerosol production. Black carbon (soot) is the result of incomplete combustion of fossil fuels or biological matter and global emissions increased threefold between 1950-2000, largely driven by economic growth in China and India.[39]

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35 IPCC Special Report on Carbon Dioxide Capture and Storage (2005), 5.7.3.5 (p.246).

36 SEC (2006) 1722.

37 International Risk Governance Council paper 'the linkages between air quality and climate policies' (2008) quoting WHO figures.

38 IPCC WGII, 2007: From 1980-2000, sulphur dioxide emissions reduced from 18 to 4 mega tonnes p.a. in Europe and from 12 to 8 Mt in the US. In Asia, emissions increased to approx. 17 Mt p.a.

39 IRGC, 2008.

Nitrate aerosol can also derive from fossil fuel combustion. Accumulated organic and anthropogenic aerosols can travel thousands of kilometres, across national borders and can remain in the atmosphere for long periods. They also contribute to large-scale hazes, such as that seen in the Indo-Asian region. The application of large-scale CCS in this region would have a positive impact on several aspects of air quality.

7.1.3. Greenhouse Gas Emissions

CCS technologies applied to a modern conventional power plant provide scope for reducing CO_2 emissions to the atmosphere by approximately 80-90 % compared to a plant without CCS.[40]

There is a wide range of estimates for the global potential of CCS, but some sources place it as high as 600-700 GW (half of which with coal), at more than 1/3 of the Chinese market and 10 % of the market in Europe.[41]

In terms of achieving the 2 degrees objective, CCS could contribute around 10 % of global reductions required (as described in Section 2.1).

7.1.4. Availability of sufficient storage capacity

Work is currently being undertaken as part of Phase I of NZEC to map storage capacity in China. The final selection of a storage location and site will be made by the Chinese government. Further site-specific work will be undertaken as part of Phase II, supported by the ENRTP.

7.2. Social Impacts

The social impact of a single demonstration plant is obviously limited, but if the demonstration leads to large-scale deployment, this may create new jobs.

7.3. Economic and health benefits

7.3.1. Economic Impacts

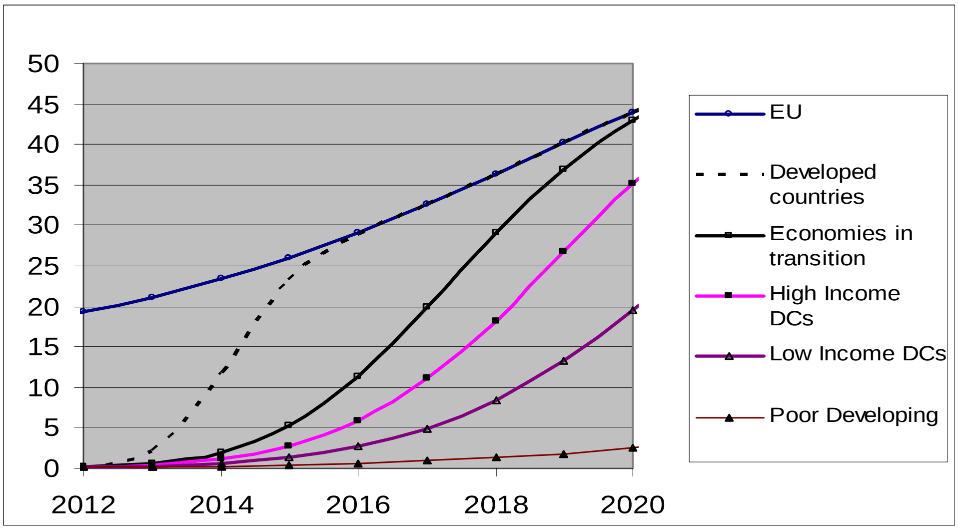
In countries with abundant coal reserves, coal will continue to be used to generate electricity. Capturing and storing CO_2 has economic benefits, which are not captured in the cost analysis presented in Annex VIII. A carbon price, set by the level of emissions reduction to be achieved, indicates the value of reducing CO_2 emissions for society. However, in the absence of a carbon price in emerging markets, the failure of the market to reflect the real cost to society of external costs caused by the use of fossil fuels to generate electricity means that CCS technologies are not economically viable in the pre-demonstration phase. Therefore, the CCS demonstration project and corresponding SPV or other investment vehicle are designed with the assumption that there will be a carbon price in China and other emerging developing countries in future that will reflect the social price of carbon. Figure 9 depicts the assumptions about carbon price developments in the global carbon market. Energy intensive sectors in developing countries would be exposed to a low carbon price in 2012, simulating the limited

40 IPCC SR on CCS, 2007.

41 From the impact assessment produced for the CCS Directive, paragraph 223 based on the result of the POLES model, IPTS (DG JRC), for the 2 degrees Communication (COM/2007/0002 final).

penetration or visibility of a carbon price for all individual firms through policy instruments such as the CDM. However, the differences in carbon price decrease over time as a result of improvements to the regulatory framework and the state of development of the economy. Between 2025 and 2030, these differences in carbon prices decreased for all groups of countries, apart from low-income countries. According to these assumptions, China will have a carbon price of € 20/tCO2 in 2020. This would imply that deploying CCS in China would become more attractive over time as the carbon price would be taken into account when making investment decisions.

Figure 9: Carbon price developments in the global carbon market



Source: DG JRC, IPTS, POLES (from Copenhagen Communication IA modelling)

7.3.2. Health benefits

The air quality impacts outlined above could have local health benefits, although these must be seen in the context of various factors, such as the range of local pollution sources and pollution control mechanisms.

As noted above, a single CCS demonstration plant will lead to limited local air quality benefits, but it could lead to large-scale deployment of CCS in this region. This could in turn have significant co-benefits, particularly in terms of health and reduced abatement costs. The impact assessment for the Communication 'Limiting Global Climate Change to 2 degrees Celsius: The way ahead for 2020 and beyond,'[42] estimated that reducing CO_2 emissions just by 10% compared to baseline emissions results in a decrease in health costs between €12bn per year to about €2.5bn per year by 2020 due to the reduction in abatement costs for traditional air pollutants.

Similar or greater co-benefits are anticipated from ambitious climate change policies in developing countries, where urban areas experience particularly high local air pollution levels. A study in Shanghai (China)[43] indicates that implementing an energy scenario with CO_2 tax could prevent more than 10 000 PM10-related avoidable deaths in 2020 and could also slash

42 SEC(2007) 8.
43 As cited in SEC(2007) 8.

the number of cases of other relevant diseases. A case study for the Beijing area[44] showed the huge potential for active energy policies to reduce pollutants. They estimate that an ambitious energy policy, to more than halve business-as-usual emissions of SO_2, NOx and PM10 by 2030 in the Beijing area, would also decrease business-as-usual CO_2 emissions by a third. Therefore large-scale CCS deployment could form an integral part of the overall climate change mitigation and air quality improvement strategy.

The impact assessment for Europe's 'Thematic Strategy on air pollution'[45] estimated that the health benefits alone of this strategy are valued at between €42 and 135 billion per year depending on the evaluation method used.[46] Premature deaths due to particulate matter would be reduced by 63 000 in 2020 compared with the status quo. This is equivalent to saving 560 000 life years per year. Lower income groups are expected to benefit more as they are generally exposed to higher levels of air pollution than those in higher income groups.

7.4. Risks

This impact assessment and the Communication which it supports were developed as input to the ongoing negotiations between the EU and third country partners, in particular China, on CCS and CCT cooperation. It will be important to ensure buy-in from European and Chinese partners and for them to play an equal role in the project, but it cannot be excluded that the parties fail to agree on the terms of this project.

It will be necessary to work closely with European companies and the Chinese government to ensure that all appropriate measures are taken to safeguard the intellectual property of European enterprises involved in these projects. This is one of the issues, along with other regulatory matters, relating to Foreign Direct Investment in China, and technical issues concerning the site, technology and storage type selection that will be addressed during Phase II of the NZEC Project (see Annex III for details of Phase II). As regards regulatory matters, it will be important for the Chinese government, building on the results of the STRACO2 project, to develop a regulatory regime for CCS demonstration. The EU has significant experience to offer here, including on matters such as Environmental Impact Assessment, liability and monitoring issues.

In addition, the success of the project will depend on its ability to mobilise additional financing, the extent to which possible revenue from the carbon market and/or enhanced oil recovery can be secured, and technological risks.

8. MONITORING AND EVALUATION

The performance of the financial vehicle would be subject to monitoring, risk management and compliance procedures to ensure it complies with the relevant laws and guidelines.

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44 Integrated Environmental Strategies, Energy Options and Health Benefit Beijing Case Study; Prepared by National Renewable Energy Laboratory; Department of Environmental Science, Singhua University; School of Public Health, Peking University; School of Public Health, Yale University; November 2005.

45 'Thematic Strategy on air pollution' COM(2005) 446 final was aimed at achieving 'levels of air quality that do not give rise to significant negative impacts on, and risks to human health and the environment'. To reach these objectives, SO_2 emissions needed to decrease by 82 %, NOx emissions by 60 %, VOCs by 51 %, ammonia by 27 % and primary PM2.5 by 59 % relative to emissions in 2000 by 2020.

46 The lower figure is based on the median value of a life year lost (VOLY) while the higher figure is based on the mean value of a statistical life (VSL).

Financial reporting will be in accordance with the requirement of the International Financial Reporting Standards that apply to financial intermediaries and the EC Financial Regulation. This could include quarterly un-audited financial statements, six-monthly financial statements and an annual report audited by certified public accountants qualified to audit financial institutions.

In addition to financial reporting, several other indicators will need to be monitored to follow the implementation of the demonstration project, such as:

- catalytic financing effects in terms of money leveraged from co-financiers;
- technical parameters of the CCS demonstration project, such as plant capacity, net energy efficiency, capture rate and capacity utilisation;
- construction time and sequence;
- investment and operating cost of carbon capture, transport and storage;
- volume of CO_2 avoided and stored by the CCS demonstration projects;
- amount and type of air pollutants avoided;
- creation of an enabling legal and regulatory framework in the country CCS is demonstrated;
- acceptance by the public of CCS technologies, particularly related to the geological storage of CO_2 and associated risks.

At the deployment stage, a list of indicators should be extended to include selected environmental, social and economic objectives, such as:

- number and type of CCS projects;
- amount of clean energy generated (MWh);
- extent of health benefits from avoided air pollution;
- number of jobs created.

In addition to regular monitoring as outlined above, an in-depth evaluation of the functioning of the financing vehicle for CCS demonstration should be carried out no later than after five years of operation. The evaluation should be carried out by an independent body, to be contracted and appointed by the European Commission in consultation with other donors and investors.

The scheme would have a governance structure that ensures that an appropriate body (either an Investment Committee or a Board of Directors) supervises the monitoring and implementation of the investment and investment decisions.

Cooperation with China on CCS under the auspices of the ENRTP will be monitored in compliance with the standard provisions under the development cooperation funding instrument. Performance monitoring will be detailed in the guidelines for ENRTP (see Annex

III). Furthermore, the action will be subject to EuropeAid's annual external monitoring exercise.

9. NEXT STEPS

This Impact Assessment supports the proposed Commission Communication on 'Demonstrating Carbon Capture and Geological Storage (CCS) in emerging developing countries: the EU-China Near Zero Emissions Coal Plant project.' Based on the analysis conducted for and presented in this impact assessment, working closely with European and Chinese stakeholders, the Commission proposes to:

i) determine with international financial institutions such as the European Investment Bank, World Bank and Asian Development Bank the setting up of an appropriate financial structure, such as an SPV, to support Phase III of the NZEC project in close cooperation with interested Member States, States of the European Economic Area and Chinese partners;

ii) invite Member States to pledge financial support. The target amount for public financing would be around €300 million for an IGCC plant or €550 million for a pulverised coal plant;

iii) secure further political support from the Chinese and ensure maximum value for European public money in negotiating the cost-sharing arrangements;

iv) engage in international negotiations on a post-2012 global climate change agreement in support of carbon financing for CCS technologies both during the first commitment period of the Kyoto Protocol (up to 2012) and under the new regime thereafter.

Several Member States and companies have expressed an interest in this project. The Commission also invites Member States, and interested EEA States to pledge financial and political support to this new initiative and invites the European Parliament to provide political support. Given that this is a new approach, the European Commission will continue to work on the details to implement the arrangement, together with entities expressing a formal interest in co-financing this initiative. Member States, EEA States and China will be kept fully informed of developments of this initiative.

In parallel, the Commission will take forward its plans on Phase II of NZEC and capacity building activities in other emerging economies, as outlined in the Project Outline attached in Annex III.

ANNEX I: Detailed information on consultation and expertise

The following groupings were consulted:

- Industry
  - Berlin Fossil Fuels Forum, 7 October 2008
  - World Coal Institute Conference, 4 November 2008
  - 2nd Joint Meeting of COACH, NZEC, STRACO2 (EU-China NZEC phase I projects), 4 November 2008
  - Ad-hoc discussions with industry contacts from October 2008 — February 2009.
- Member States:
  - ZEP government group, 30 September 2008
  - broader meeting on NZEC progress plus the Communication and Impact Assessment (21 November 2008);
  - MS consultation meeting, 17 February 2009
- China:
  - At a meeting on 2 June 2008 in Bonn to discuss the transition to subsequent phases of the EU-China Near Zero Emissions Coal (NZEC) project, the COM, the UK and representatives of the Chinese Ministry of Science and Technology (MOST) agreed to prepare Joint EU-China papers on the following issues (lead author in brackets):
  - – Costs of demonstration (UK)
  - – IPR framework (UK)
  - – Finance mechanisms (COM)
  - – Potential projects and timeframes for demonstration (China)
  - – Legislation and Regulation experience (COM).
  - At a follow-up meeting on 28 August, the European side had produced their papers, but the Chinese had not. To maintain the pace of discussions, the COM and UK agreed to condense the content of the COM/UK papers into one document to be discussed at the next meeting.
  - At bilateral meetings (in December 2008, April and June 2009), the Commission briefed Chinese representatives (chiefly from the Ministry of Science and Technology) on plans for a communication on financing the next stages of CCS cooperation with China. The Chinese colleague was enthusiastic about the

subsequent stages of the NZEC project and underlined the importance of learning lessons from Phase I. Furthermore, it was agreed that the Chinese side would consult experts on a model to examine IPR, set up a costs taskforce and examine regulatory issues and issues concerning plant selection.

The consultation was conducted in a manner proportionate to the type and scope of the Communication. The minimum standards of consultation were been met, namely:

- Consultation materials were clear and extensive use was made of PowerPoint slides to deliver messages in a comprehensible fashion;
- Relevant target groups (EU MS, European industry and the Chinese government) were consulted;
- Sufficient publicity was secured by making use of networks of officials and stakeholders to spread the word about the Commission’s plans;
- The consultation spanned a period of eight months;
- Written contributions were not received from external stakeholders and therefore were not published on the internet.

Through the Berlin Fossil Fuel Forum and the Zero Emissions Technology Platform, the European Commission has established reliable consultation fora with energy industry stakeholders on issues of security of supply for oil, natural gas (upstream) and coal and the options for improving the environmental sustainability of activities in these sectors. Member States representatives also take part in both groups. DG ENV presented an outline of the issue and the options set out in this impact assessment and discussed it at the Berlin Fossil Fuels Forum on 7 October 2008 and presented an update on 27 May. Some Member State representatives and stakeholders had also the opportunity to present their views on how to support the demonstration of CCS technologies. Strong support for the proposed policy was expressed by a number of industry stakeholders.

DG ENV presented an outline of the issue and the options set out in this impact assessment on 30 September 2008 to the Zero Emission Power (ZEP) government group, which represents energy companies, power plant operators, power plant equipments suppliers, research institutes and non-governmental environmental organisations.

Interservice consultation

Other Commission services were informed and consulted via the Inter-Service Group on International Climate Change. In addition, informal discussions were held with colleagues in other DGs, including in the informal inter-service working group (ENV-RTD-TREN) on NZEC. Meetings took place on 2 September 2008 and 16 February 2009. DG ENV received valuable support from JRC colleagues in the financial analysis presented in this impact assessment and from the EIB concerning the investment vehicle.

DGs AIDCO, ECFIN, ENTR, ENV, RTD, RELEX, SEC GEN and TREN attended the Informal Interservice Meeting of 16 February 2009. DG ENV presented the main findings of the Impact Assessment process and sought comments. The main comments related to:

– the need to ensure the figures for costs given in this Communication were consistent with those in ‘Financing Low Carbon Technologies’ being prepared by DGs TREN, RTD and ECFIN;

– the decision to focus in the Communication and impact assessment on cooperation with China and to take forward cooperation on CCT and CCS with other emerging and developing countries in the context of the parallel ENRTP project, and

– the need to ensure sufficient MS and Chinese engagement.

ANNEX II – EU and China Partnership on Climate Change

2 September 2005

EU and China Partnership on Climate Change

The EU and China today agreed a Partnership on Climate Change as one of the major outcomes of the 2005 China-EU Summit in Beijing. The Partnership will strengthen cooperation and dialogue on climate change and energy between the EU and China. One major objective of this Partnership is the development and demonstration of advanced, "zero emissions" coal technology based on carbon dioxide capture and geological storage. It will also promote other clean energy sources, as well as energy efficiency, energy conservation, and renewable energy.

The focus of the Partnership is on concrete action: the development and deployment of clean energy technology. It demonstrates the EU's determination to tackle climate change at the highest level and in concrete ways, as recently also announced at the G8 Summit in Gleneagles. It underlines our commitment to the implementation of the UN Framework Convention on Climate Change and its Kyoto Protocol. It also helps to strengthen the momentum for discussions of a multilateral climate change regime 'post 2012', which the Commission intends to kick-start later this year in Montréal.

The Partnership contains two concrete co-operation goals, to be achieved by 2020. The first is to develop and demonstrate, in China and the EU, advanced "zero-emissions" coal technology. This technology will allow for the capture of CO_2 emissions from coal-fired power plants and its subsequent storage underground, for example in exploited oil or gas fields or in sealed geological strata, thereby avoiding CO_2 emissions into the atmosphere. The second cooperation goal is to significantly reduce the cost of key energy technologies and promote their deployment and dissemination.

The Partnership will also support EU and Chinese efforts to reduce the energy intensity of their economies. China has set the goal of halving the energy intensity of the Chinese economy by 2020. In the recently adopted Green Paper on energy efficiency, the Commission has proposed to reduce the EU's energy consumption by 20% over the same period by increasing energy efficiency. These efforts will be strengthened through the involvement of the private sector, bilateral and multilateral financing instruments and export credit agencies, and the promotion of joint ventures and public-private partnerships.

The Partnership will also reinforce EU-China cooperation on the Kyoto Protocol's Clean Development Mechanism (CDM). It foresees a dialogue on the further development of this mechanism 'post 2012' in combination with an exchange of information and experience on the use of market-based mechanisms such as the EU emissions trading scheme. It furthermore foresees a number of joint research activities on the impacts of climate change.

Background

The EU and China have a history of close cooperation on environment and energy issues, including climate change. The EU-China Partnership on Climate Change provides a high-level political framework that will further strengthen this cooperation and which sets out concrete new actions. The Partnership covers the China-EU Action Plan on Clean Coal and the China-EU Action Plan on Energy Efficiency and Renewable Energies, both of which were agreed in March this year. The Partnership provides for a robust follow-up process, which will include a regular review of progress in the context of the annual EU-China Summits. The full text of the Partnership is set out in the Annex to this Press Release.

Both China and the European Union are parties to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The Parties to the UNFCCC and the Parties to the Kyoto Protocol will meet from 28 November to 9 December 2005 in Montreal, Canada, to discuss the implementation of existing obligations and develop further steps to address the global challenge that climate change represents.

Joint Declaration on Climate Change between China and the European Union

1 We underline our commitment to the objectives and principles of the UN Framework Convention on Climate Change and the Kyoto Protocol and in this context agree to set up a Partnership on Climate Change. This Partnership will strengthen cooperation and dialogue on climate change including clean energy, and promote sustainable development. Follow-up of the Partnership will be carried out regularly at a suitably high level through a bilateral consultation mechanism, including in the context of the China - EU Summits.

2 We will strengthen our dialogue on climate change policies and exchange views on key issues in the climate change

negotiations.

3 We will co-operate to realise our respective goals of significantly improving the energy intensity of our economies.

4 We will strengthen our practical co-operation on the development, deployment and transfer of low carbon technology, to enhance energy efficiency and promote the low carbon economy.

5 We agree on the following key areas for technical co-operation:

Energy efficiency, energy conservation, and new and renewable energy;
Clean coal;
Methane recovery and use;
Carbon capture and storage;
Hydrogen and fuel cells;
Power generation and transmission.

6 We will take strong measures to encourage low carbon technology development, deployment and dissemination and will work jointly to ensure that the technologies become affordable energy options. We will explore financing issues including the role of the private sector, joint ventures, public private partnerships, and the potential role of carbon finance and export credits. We will co-operate to address barriers to the development, deployment and transfer of technology.

7 We will aim to achieve the following co-operation goals by 2020:

To develop and demonstrate in China and the EU advanced, near-zero emissions coal technology through carbon capture and storage;
To reduce significantly the cost of key energy technologies and promote their deployment and dissemination.

8 We will enhance our existing co-operation and we welcome the following recent initiatives:

The China-EU Action Plan on Clean Coal to promote collaboration in the development of clean coal technologies in China;
The China-EU Action Plan on Industrial Co-operation on Energy Efficiency and Renewable Energies.

9 We will co-operate to strengthen the implementation of the Clean Development Mechanism (CDM), exchange information on CDM projects and encourage our companies to engage in CDM projects co-operation. We will engage in dialogue on improving and further developing the CDM. We will facilitate the exchange of information and experience on the design and practical implementation of other market-based instruments such as emissions trading and on assessing the costs and benefits of their use.

10 We will strengthen co-operation on adaptation to the impacts of climate change through:

Research and analysis on adverse effects of and vulnerabilities to climate change;
Research and analysis on assessing the socio-economic impacts and costs of climate change;
Enhancing the scientific, technical and institutional capacity to predict climate change and its impacts;
Research and development on technologies and measures to adapt to climate change;
Raising awareness of integrating vulnerability reduction and adaptation needs into sustainable development strategies and their implementation.

11 We will enhance our co-operation in capacity building and strengthening institutions, including through raising public awareness, exchange of personnel and training.

ANNEX III – Draft ENRTP Project Action Fiche

ACTION SHEET H

Title/Number	Under Priority 2 and 5 of the ENRTP: Cooperation on clean coal technology (CCT) and carbon capture and storage (CCS) with coal-dependent developing and emerging country partners (ref. 20539 + 20634)		
Total cost	Maximum EC Contribution **EUR 10 000 000**		
Aid method / Method of implementation	Project approach – centralised management		
DAC-code	32182	Sector	Technological research and development

DRAFT – NOT FOR QUOTATION

1. RATIONALE

1.1. Sector context

The EU demonstrates leadership domestically and internationally on climate change, but the sole action of the EU will not suffice to achieve our objective of limiting global climate change to less than 2°C. By 2020, developing country emissions will exceed those of the developed world, driven by the combustion of fossil fuels to meet soaring demand for electricity in emerging economies. Further greenhouse gas emission reductions are needed globally and the EU must actively help fossil-fuel dependent emerging economies and developing countries achieve their mitigation potential as well, in particular considering their increasing energy demand. Mitigating climate change will directly benefit all developing countries and especially the poorest that are likely to suffer most from climate change. This is important both politically and practically.

In a business-as-usual scenario, carbon capture and storage (CCS) would not be ready for global deployment on a timescale commensurate with the problems outlined above. CCS technologies and storage types and locations are not yet demonstrated in the power sector, even in developed countries, so developing countries are unable or unwilling to demonstrate/deploy without additional assistance. The lack of experience means additional uncertainty and risks associated with technologies and financing compared to other alternatives, particularly in the absence of a global carbon price/other incentive to encourage demonstration and deployment in emerging/developing countries. In some cases, the developing country enabling environment may not be considered suitable, and public acceptance and knowledge may be limited. However, given the potential for economies of scale and large-scale deployment following demonstration in certain key coal-dependent emerging economies, and the urgency of the climate change challenge, it is essential to demonstrate in those countries in parallel to demonstration in developed countries.

The EC committed itself in both climate change and energy packages (2007 and 2008) to stepping up existing cooperation on CCS with **China** and extending it to other key partners, such as **India** and **South Africa** (see COM(2006)843, paragraph 5.4). According to recent bilateral exchanges, other countries which might also have an interest in capacity building for CCT and CCS are **Russia** and **Ukraine**.

1.2. Lessons learnt

We have learned from bilateral discussions under the various climate change dialogues that one size will not fit all. We have learned from preparatory studies and research (COACH and NZEC projects) and the EU-China Climate Change Partnership the importance of ownership by the partner country and the importance of involvement of experts and stakeholders on an equal footing with the European partners. For these reasons, we plan to implement a differentiated approach, using a combination of a call for proposals and a tender to implement a number of activities at an appropriate level for the countries concerned.

1.3. Complementary actions

EC membership of the Carbon Sequestration Leadership Forum (CSLF) and increasing contact with the Australians in the context of their proposed CCS Centre of Excellence will enable us to exchange information and coordinate with the key partners and donors in this field. This activity is also directly complementary to DG RTD and DG TREN led activities with these partner countries. The potential for cooperation with the partners in the Asia-Pacific Partnership will be examined, as the Commission is aware of on-going work between Japan and China and Australia and China, and has been approached by i.a. Australia to exploit synergies between the different activities. [47]

This activity is complementary to EU activities, which concentrate on other energy technologies, eg the Global Energy Efficiency and Renewable Energy Fund (GEEREF). It is also complementary to the EU-China Energy and Environment Programme, which is looking at different aspects of energy policy with a focus on energy efficiency and renewable energies.[48]

1.4. Donor coordination

The full strategy and plans for extending the cooperation beyond the limited activities outlined below will be set out in a Commission Communication, due for adoption in Spring 2009. In the course of the stakeholder consultation for this Communication, outlines of planned activities were presented to Member States (MS), Norway, industry and the partners in the current EU-China work. Of the MS, the most interested are: UK, DE, NL, FR, IT.

[47] http://www.asiapacificpartnership.org/CleanerfossilenergyProjects.htm.
[48] http://www3.eep.org.cn/.

2. DESCRIPTION

"Cooperation on clean coal technology (CCT) and carbon capture and storage (CCS) with coal-dependent developing and emerging country partners"

2.1. Objectives

The objective is to build capacity and test feasibility for CCT and CCS technologies in coal-dependent emerging economies and developing countries, taking a partner-driven, differentiated approach.

2.2. Expected results and main activities

We propose to support two types of activities as follows.

a) capacity building and studies on clean coal technologies and CCS in developing countries and emerging economies targeting in particular coal dependent countries (eg. China, India, South Africa, Russia, Ukraine and other countries, as appropriate). Activities to be supported and selected via a call for proposals may include for instance:

- Support for national CCT and CCS capacity building and technology development centres;
- Capacity building in the form of internships on CCT and CCS for engineers and power sector managers from a limited number of heavily coal dependent emerging economies and developing countries to European companies.;
- Cooperation activities between interested groups in emerging economies and developing countries and those working on CCS demonstration plants in Europe, and
- Studies on preparatory activities for the possible demonstration, diffusion and deployment of clean coal and CCS technologies.

b) Global Expertise development: this component will include i) the support to the site-specific feasibility and design phase of the Near Zero Emission Coal (NZEC) project in China, including the transition to Phases II and III of NZEC; and ii) actions aimed at disseminating worldwide key information on roles and opportunities for CCS.

i) support to the site-specific feasibility and design phase of the Near Zero Emission Coal (NZEC) project in China, and the transition to Phases II and III of NZEC. Phase I of the NZEC consists of three research projects (UK-NZEC, and EC financed COACH and STRACO2 projects) that will set out a series of options in their final reports relating to i.a. capture technology options, storage potential, regulatory options and site selection, for assessment and implementation by the Chinese government.

This component includes the following three elements:

- A detailed **feasibility study** will be launched in Sept 2009. It will be the concrete follow up of the Phase I research work (to be completed in autumn 2009) and the adoption of the planned Commission Communication on CCS to be issued in spring 2009. The feasibility study will include the following activities:

  - Support to and analysis of the decision on which capture technology, storage site and plant type/size to use

  - An EIA of both the demonstration power plant, and the carbon storage site (transport included)

  - An assessment of the issues to be considered in the detailed design study for the construction of the demonstration plant (including transport), based on plant location and type

  - An assessment of the costs – construction and O&M

  - The identification of options for fully financing CCS demonstration plant in China

  - An assessment of the regulatory framework in China

- The preparation of the tender documents based on results of above mentioned feasibility study for the Phase III of NZEC – the construction phase of the pilot plant – (including assistance to the evaluation of participating bidders).

- Activities to facilitate the transition to Phase III of the NZEC project, including coordination with ongoing efforts, existing steering groups, with the Chinese government, the European Commission and Member States.

This kind of cooperation has the potential to underline the EU's credibility in the international climate negotiations and provide a model for technology cooperation and financing between developed and developing countries. In advance of the December 2009 Copenhagen climate negotiations, it will be politically important to start moving from the research to the implementation phase in relation to the commitments made by the EU at the Summit with China in 2005.

ii) Global Visibility Actions will aim at widely disseminating best practices, raising awareness on the role and potentialities of CCT/CCS in partner countries, eliciting support for the EU policies on CCT, and drawing together experts and exchange innovation on the subject. Activities will therefore include seminars, workshops and conferences; the publications of leaflets and booklets on specific subjects; participation in conferences; the set up and maintenance of a website where both project and wider CCT/CCS issues and research findings will be disseminated.

2.3. Risks and assumptions

The on-going climate negotiations for a post-2012 framework may affect the project(s) in a positive or negative way, as will the current negotiations on the Climate and Energy package, including on the modalities of the ETS review and the EU's CCS Demonstration programme. We are working on the assumption that a flexible approach will enable recipient country ownership of the activities implemented.

CCS in the power sector is at the demonstration stage. We need to demonstrate it globally in order to better assess the potential and risks of the technological and storage options in combination in the power sector. By working in partnership with developing countries, building on the research conducted under Phase I of the NZEC project, working with local institutions and bringing in international expertise to conduct a thorough feasibility study, we can minimise the risks and maximise the potential benefits of global deployment.

2.4. Crosscutting Issues

The objective of the project is environmental sustainability. By ensuring that all activities are done through cooperation lessons learnt in the EU on suitable forms of governance will be transferred.

2.5. Stakeholders

The key stakeholders are European and third country governments, research institutes and organisations and industry (primarily the engineering and power generation sectors). Initial consultations with industry (i.a. via the Zero Emissions Technology Platform (ZEP)) and MS have shown a positive response to our plans to cooperate on this issue with a range of developing countries, including China.

Local project partners will be able to participate in and implement projects as long as they are targeted at the appropriate level in line with the current state of the debate and the technology in any given country. This underlines the need for a differentiated approach. We have been consulting stakeholders in emerging and developing countries through the existing bilateral arrangements (eg. EU-China Climate Change Partnership, EU-India S&T cooperation, EU-S.Africa Working Group on coal, CCT and CCS). The South African Minister for Environment, Marthinus van Schalkwyk has recently written to Commissioner Dimas with details of S. Africa's CCS plans and requesting cooperation with the EC on this issue.

The cooperation with China stems from commitments made between the EU (represented by President Barroso for the Commission and Mr Blair as President of the European Council), at the EU China Summit in 2005.[49]

Consultations of the relevant EC delegations have taken place and consultation with partner governments is ongoing.

3. IMPLEMENTATION ISSUES

3.1. Method of implementation

i) Capacity building and studies on clean coal technologies and CCS in developing countries and emerging economies

Centralised management of contracts awarded via a call for proposals, which is open to participants from a limited number of heavily coal dependent emerging economies and developing countries including South Africa, India, Russia and Ukraine.

ii) Global Expertise development:

[49] http://ec.europa.eu/environment/climat/pdf/china/joint_declaration_ch_eu.pdf.

Direct centralised management of contracts awarded via a call for tenders. To that effect, a tender dossier for the feasibility study and detailed design of the CCS demonstration plant will be prepared. An international tender will be launched in September 2009.

3.2. Procurement and grant award procedures/programme estimates

1) Contracts

All contracts implementing the action must be awarded and implemented in accordance with the procedures and standard documents laid down and published by the Commission for the implementation of external operations, in force at the time of the launch of the procedure in question.

Participation in the award of contracts for the present action shall be open to all natural and legal persons covered by the DCI Regulation. Further extensions of this participation to other natural or legal persons by the concerned authorising officer shall be subject to the conditions provided for in articles 31(7) and (8) DCI.

2) Budget and calendar

The total budget is €10m, to be divided between results i and ii.. An indicative breakdown would be €3m for the CCT / CCS call for proposals and €7m for the work on global expertise development including an NZEC feasibility study in China.

The call for proposals should be launched after the adoption of the AAP, in May 2009. The tender procedure should be launched in the second half of 2009.

3.3. Performance monitoring

Proposals under the call will be required to include suitable performance monitoring arrangements following the detailed guidelines for the call. The detailed tender documents for the feasibility study specify monitoring and reporting arrangements.

Proposals under the call will be required to include performance indicators. Evaluation criteria for the tender for the feasibility study will be drawn up as part of the work under the framework contract.

Furthermore, the action will be subject to EuropeAid's annual external monitoring exercise.

3.4. Evaluation and audit

Details of evaluation and audit will be included in the call for proposals.

3.5. Communication and visibility

The contractor awarded the tender will conduct outreach, dissemination and awareness raising activities.

Standard clauses on visibility will form part of the call for proposals.

ANNEX IV — General Context

Engaging emerging economies and developing countries in the fight against climate change

The European Commission published a Communication in February 2005 entitled 'Winning the Battle against Climate Change'[50], which outlined key issues for the EU's post-2012 strategy. In their discussions of this Communication, EU Heads of State and Government at the European Spring Council in March reiterated the need to cooperate strategically with third countries, in particular with major energy-consuming countries, including emerging economies and developing countries. The European Parliament, in Resolution 2005/2161 (INI) on the need to encourage sustainable development, e.g. in China, 'recognises that rapid economic growth in China presents a huge challenge to global efforts to tackle climate change, with CO_2 emissions from coal-fired power stations set to double by 2030.'

The Commission has taken this mandate forward via a variety of strategic bilateral arrangements with a number of developed and developing country partners. Climate change partnerships or dialogues have been developed with emerging economies such as Brazil, India, China, S. Korea and South Africa.

On 10 January 2007, the European Commission set out proposals and options for keeping climate change to manageable levels in its Communication 'Limiting Global Climate Change to 2° Celsius: The way ahead for 2020 and beyond'.[51] The Communication, part of a comprehensive package of measures to establish a new climate change and energy policy for Europe, is a major contribution to the discussion on a global agreement to combat climate change after 2012, when the Kyoto Protocol's emissions targets expire. The Communication proposed a set of action by developed and developing countries to enable the world to limit global warming to no more than 2 °C above pre-industrial temperatures. This Communication was strongly endorsed by the 2007 European Council. Measures to implement the targets that the EU set itself were agreed by the European Parliament and Member States in December 2008. In January 2009, the Commission adopted a Communication entitled 'Towards a comprehensive climate change agreement in Copenhagen', which sets out the Commission's view on the elements needed to secure a global climate change agreement in Copenhagen in December 2009.

It is clear that even the most willing developing countries will need significant financial and technological assistance from developed countries to be able to contribute to a post-2012 regime, in line with the commitments under the UNFCCC.[52] At the meeting of the Parties to the Kyoto Protocol third session in Poznan December 2008, emerging economies such as China and India made this point absolutely clear.

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50 COM(2005) 35 final.
51 COM(2007) 2 final.
52 e.g. UNFCCC Article 4.5 and Article 11.5.

Box 1: Carbon capture and storage: essentials

What is carbon capture and storage?

CCS is a suite of technological processes which involve capturing carbon dioxide (CO_2) from the gases discarded by industry and transporting and injecting it into geological formations.

The major application for carbon capture and storage (CCS) in terms of GHG abatement is to reduce CO_2 emissions from power generation from fossil fuels, principally coal and gas, but CCS can also be applied to CO_2-intensive industries such as cement, refineries, iron and steel, petrochemicals and oil and gas processing. After capture, the CO_2 is transported to a suitable geological formation where it is injected, with the aim of isolating it from the atmosphere for the long term.

There are storage options other than geological storage, such as storage in a water column and mineral storage. Storage in a water column is considered to present a high environmental risk and the Commission's proposed directive on CO_2 geological storage bans it within the Union. Mineral storage is currently the subject of research. Any developments will be reviewed.

How does geological storage work?

There are four main mechanisms which trap CO_2 in well-chosen geological formations. The first is structural trapping, in the presence of an impermeable cap-rock which prevents CO_2 escape from the outset. The second is residual CO_2 trapping, where CO_2 is trapped by capillary forces in the interstices of the rock formation, which develops about 10 years after injection. The third is solubility trapping, where the CO_2 dissolves in the water found in the geological formation and sinks because CO_2 dissolved in water is heavier than normal water. This develops 10-100 years after injection. Finally, mineral trapping happens when dissolved CO_2 chemically reacts with the formation rock to produce minerals.

Why the need for CCS?

While energy efficiency and renewables are, in the long term, the most sustainable solutions both for security of supply and for the climate, EU and global CO_2 emissions cannot be reduced by 50 % by 2050 unless we also use other options such as carbon capture and storage.

Timing is crucial. About a third of existing coal-fired power capacity in Europe will be replaced within the next 10 years. Internationally, China, India, Brazil, South Africa and Mexico's energy consumption will lead to a major increase in global demand, which is likely to be met mostly by fossil fuels. The capacity to deal with these very substantial potential emissions must be developed as a matter of urgency.

Current CCS initiatives in the EU and the world

The European Commission and the Member States already support a range of programmes and measures on energy technology research, development, dissemination and deployment. Regarding research and development, the EU research framework programmes support projects on regulatory and technical aspects of carbon capture and storage (projects are listed in Annex VII).

EU leaders have committed to establishing a network of up to 12 demonstration plants by 2015, to maximise knowledge sharing and the range of technology and storage options demonstrated. The European Commission is considering the contribution that projects outside of the EU can make to the EU's demonstration network. The European Council and Parliament have agreed to a Directive setting out a legal framework for CCS[53] to enable the safe operation of CCS in Europe and to incentivise CCS demonstration i.e. through the EU Emissions Trading Scheme (CO_2 safely stored will not count as emitted) and through the EU ETS New Entrants Reserve (providing funding which can be used to co-finance CCS demonstration plants) as well as revised State aid rules. Several EU companies have announced demonstration plants to be completed in the EU over the next 5-10 years.

The Carbon Sequestration Leadership Forum (CSLF) was founded in 2003 at the initiative of the US. It has brought together policymakers in the 22 member countries, including several emerging economies, such as China, and aims to share knowledge and coordination on CCS. While the CSLF has provided some useful guidance on technical issues, it has fallen short of involving a wide range of stakeholders and, more importantly, it has not resulted in large-scale CCS demonstration projects.

The Internationally Energy Agency covers CCS in two of its Implementing Agreements: the Clean Coal Centre and the Greenhouse Gas R&D Centre, which is an important source of information on the capture and storage of CO_2. These agreements aim to pool resources and share costs, harmonise standards and hedge technical risks, but they have not resulted in CCS demonstration.

In 2005, Australia, Canada, China, India, Japan, Korea, and the United States launched the Asia-Pacific Partnership on Clean Development and Climate (APP) with the aim of promoting and creating an enabling environment for the development, dissemination, deployment and transfer of existing and emerging cost-effective, cleaner technologies and practices. It has eight task forces, including cleaner fossil energy with CCS as one of its priorities. It has carried out some research and capacity building initiatives, but no large-scale CCS demonstration projects.

There are currently only four large-scale CCS demonstration projects in the world: none based on a coal-fired power plant, and none in coal-dependent emerging economies. The projects are located in Norway (2), USA/Canada and Algeria. The Intergovernmental Panel on Climate Change (IPCC) estimates that CCS for gas, biomass and coal-fired electricity generating facilities will become a key mitigation technology to commercialise before 2030, with deployment generally starting around 2015.

The World Bank has established the Clean Technology Fund (CTF) with the aim of financing transformational action by providing positive incentives for accelerating and scaling-up the deployment, dissemination and transfer of low-carbon technologies, embedded in nationally appropriate mitigation actions by eligible countries. Financing will target investment that can achieve significant greenhouse gas reductions, which may include best available coal technologies ready to implement carbon capture and storage and therefore there may be future synergies in rolling out the technology once CCS gets beyond the demonstration phase.[54]

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[53] Directive 2009/31/EC of 5.6.09

[54] See:http://digital.library.unt.edu/govdocs/crs/permalink/meta-crs-10826:1 - http://siteresources.worldbank.org/INTCC/Resources/Clean_Technology_Fund_paper_June_9_final.pdf

Existing cooperation with developing countries on CCS

The European Commission has committed itself in both climate change and energy packages (2007 and 2008) to stepping up CCS cooperation with China and extending it to other key partners, such as India and South Africa.[55] Cooperation with China is the most advanced. The 2005 China-EU Summit agreed an EU-China Climate Change Partnership, a key element of which was cooperation on Near Zero Emissions Coal (NZEC), i.e. to research, develop and deploy clean coal and CCS technology in China and Europe. A Memorandum of Understanding was agreed between the European Commission and China on Phase I of the project.[56]

Phase I covers initial research to explore options for demonstrating CCS for coal-fired power generation in China and is nearing completion. Two complementary projects (one, COACH, funded by the Sixth Framework Programme (FP6) and the other, UK-NZEC, funded by the UK – in total approx. € 7m), managed by a Joint Steering Committee, are conducting the work under Phase I and are due for completion in early 2009. In addition, the EC-funded STRACO2 project is looking a regulatory issues on CCS in the EU and China (see Annex VI). Phase II (2010-2012) will examine site-specific requirements and Phase III will see the construction and operation of a commercial-scale demonstration plant in China.

The EP Report on Trade and Economic Relations with China (2008/2171 (INI)) calls on the European Commission specifically to speed up implementation of the EU-China Climate Change Partnership. At the 2007 Spring Council, the EU Heads of State and Government called for the 'strengthening [of the] partnership and cooperation building on the bilateral energy dialogues with the USA as well as with China, India, Brazil and other emerging economies, focusing on the reduction of GHG, energy efficiency, renewables and low-emission energy technologies, notably CCS.'

The UK and other Member States (e.g. Italy, France) as well as Norway are involved in cooperation with China in the fossil fuel power generation sector. This cooperation includes work with companies or agencies based in those Member States, and is often under a broader umbrella of climate change/energy cooperation.

55 See COM(2006)843, paragraph 5.4, 'While making efforts to accelerate the ongoing European collaboration with China in the demonstration of CCS (bringing the operation date from 2020 significantly forward), the Commission will look for opportunities to extend cooperation on demonstration projects to other key emerging economies (such as India, South Africa) and will seek to stimulate the creation of enabling policy and regulatory framework in those countries. The Commission will examine options for co-financing such projects and for close coordination of demonstration projects in the EU and in third countries.' Also COM(2008) 13 final, Section 4: 'Given the importance of CCS on the global scale, it will be important to include an international dimension, by developing and accelerating the ongoing European collaboration with China on CCS demonstration and expanding to other key emerging economies. Of equal importance will be a systematic cooperation with other advanced economies developing CCS technologies for use in power generation.'

56 Summit Declaration. During the meeting, a Joint Declaration on Climate Change between China and the EU was issued, which confirmed the establishment of a China-EU partnership on climate change. The two sides were determined to tackle the serious challenges of climate change through practical and results-oriented cooperation. This partnership will fully complement the UN Framework Convention on Climate Change and the Kyoto Protocol. It will strengthen cooperation and dialogue on climate change including clean energy, and will promote sustainable development. It will include cooperation on developing, deploying and transferring low carbon technology, including advanced near-zero-emissions coal technology through carbon capture and storage. (See Annex II).

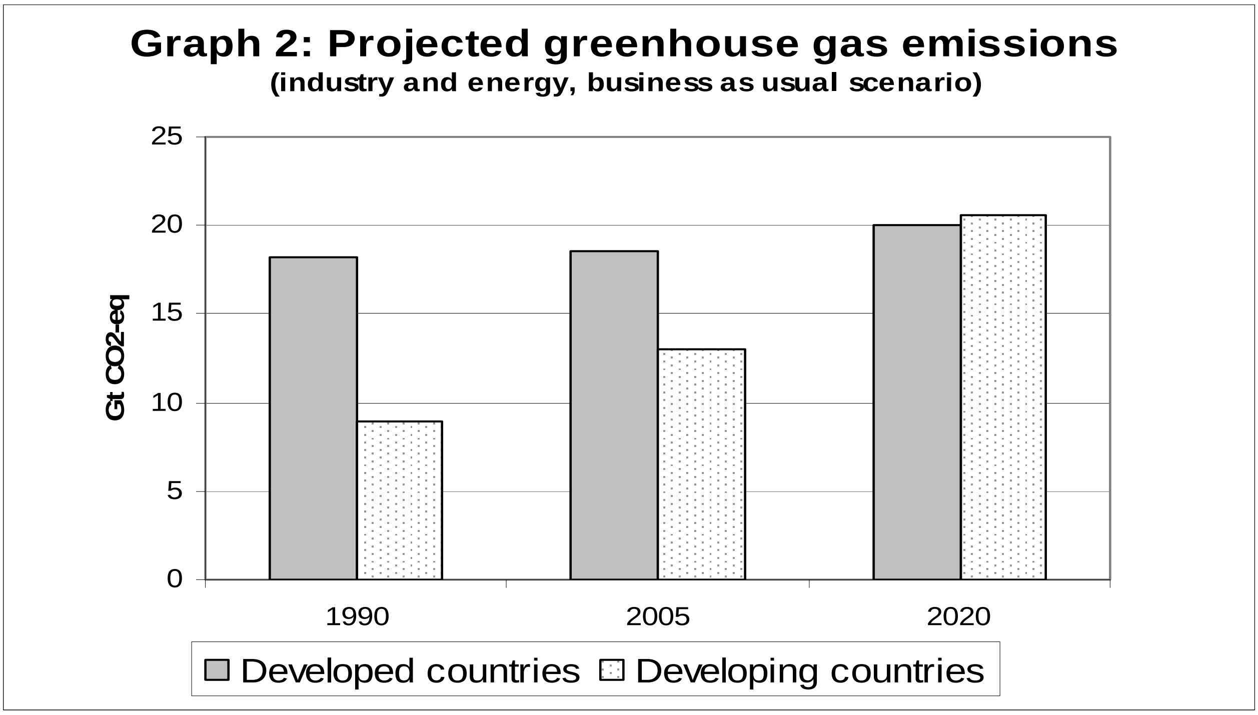
ANNEX V: Problem analysis: further background

Unless a way is found to tackle the projected emissions from coal-dependent emerging economies, the EU will not meet its headline objective of limiting global climate change to 2ºC above pre-industrial levels.

The fundamental problem is to reconcile the need for urgent global action on climate change with security of supply and economic growth/competitiveness concerns. The EU has set itself the target of limiting global climate change to 2ºC, which is commensurate with the urgency and scale of the challenge and is necessary to limit the expected impacts. Global emissions will need to peak within the next 10 to 15 years, followed by substantial global emission reductions of up to 50 % by 2050 compared to 1990, to ensure that global average temperature increases do not exceed pre-industrial levels by more than 2 °C.

Action by the EU alone will not solve the problem. By 2020, developing country emissions will exceed those of the industrialised world (see Figure 10 below).

Figure 10: Projected greenhouse gas emissions



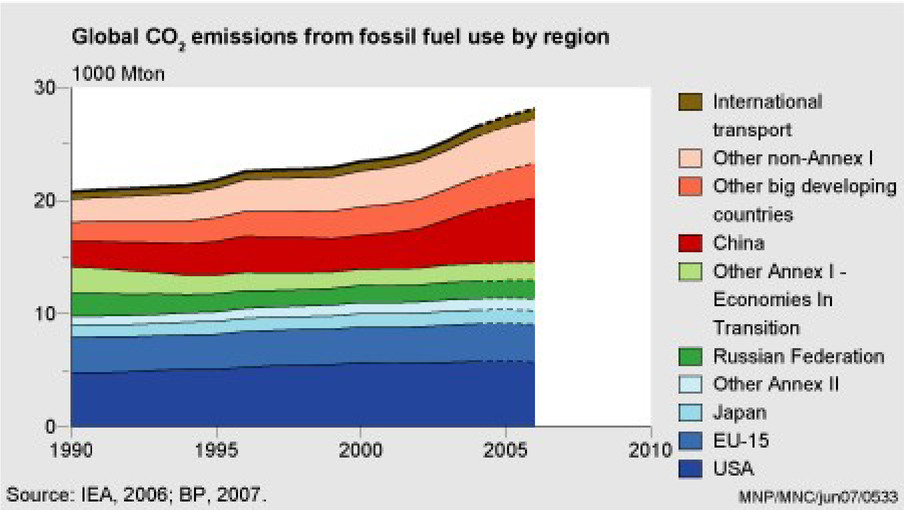
Source: COM(2007) 2 final

The IEA World Energy Outlook 2007 projected that, instead of decreasing by 2030, global CO_2 emissions from energy use are currently set to increase by 55 %. China and India alone account for 45 % of this increase. 84 % of the additional energy demand will be met from fossil fuels, leading to a 73 % increase in global coal use. The world is not only using more energy, but generating it in a less climate-friendly way.[57]

Coal is the most abundant fossil fuel in terms of known reserves and is an important fuel for the generation of electricity worldwide, in particular in the emerging economies of China, India and South Africa, which have significant coal reserves. But traditional technologies used to generate electricity from coal give rise to serious environmental concerns, such as emissions of NO_x and SO_2, which have implications for human health and the public healthcare budget, and CO_2, a major greenhouse gas.

The Environment Council of 20 October 2008 noted that 'on the basis of information provided by the IPCC, keeping the 2 °C objective within reach implies that developing countries in many regions will need to make a substantial deviation of their emissions from baseline by 2020, and notes that recent scientific research indicates that developing countries as a group, in particular the most advanced among them, would have to reduce their emissions by 15 to 30 % below business as usual, respecting the principle of common but differentiated responsibilities and respective capabilities, in order to be consistent with the global emission reduction goal.'[58]

Figure 11: Global CO2 emissions from fossil fuel use by region



Source: MNP[59]

Given the high reliance of emerging economies on coal to meet their increasing energy demand, it will be essential to ensure that they begin to shift to lower levels of CO_2 emissions from fossil-fuel based power generation and ultimately zero-emissions power plants, as we are doing in the EU. Developing and deploying technologies for zero-emission power generation from coal using CCS technology is the ultimate objective, but given the heterogeneous (and often low) levels of efficiency in coal-fired power plants in developing countries, it will be necessary to take a differentiated approach, with some countries first

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57 Raupach, M. et al (200&) Global and regional drivers of accelerating CO2 emissions. Proceedings of the National Academy of Science, NAS-USA.

58 Conclusions of the 2898th ENVIRONMENT Council meeting, Luxembourg, 20 October 2008 (paragraph 15).

59 Source: MNP.

increasing the efficiency of their power plants by deploying advanced clean coal technologies before moving to more advanced technologies such as CCS.

The Stern Review[60] estimates that, even with robust action on renewables and other low-carbon technologies, fossil fuels may still account for half of the world's energy supply by 2050. Failure to develop viable CCS technology, Stern argues, risks locking in a high emissions trajectory. Stern estimates that CCS could contribute some 20 % of all reductions needed by 2050, and that the technology, if proved effective, may allow many economies to maintain the role of fossil fuels in providing secure and reliable energy, whilst addressing rising CO_2 emissions.

The IPCC projected in its Working Group III Report 'Mitigation of Climate Change' that, in the absence of any additional policies, CO_2 emissions from energy use are expected to rise between 2000 and 2030 by 45 to 110 %. Two thirds to three quarters of that growth will come from non-Annex I regions. But the IPCC also confirmed that their low emissions scenarios can be achieved by deploying a portfolio of technologies that are currently available and that are expected to be commercialised in coming decades. While energy efficiency is expected to be the largest potential source of greenhouse gas reductions, the use of low-carbon energy sources, including the global deployment of CCS technologies, will need to be substantially increased.

In the context of the international climate change negotiations in the UNFCCC, the EU has endorsed the view that demonstration needs to take place in both developed and developing countries if we are to achieve the ultimate objective of the UNFCCC, which is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

At the Toyako G8 Summit in July 2008, leaders strongly supported 'the launching of 20 large-scale CCS demonstration projects globally by 2010, taking into account various national circumstances, with a view to beginning broad deployment of CCS by 2020.'

In the context of the UNFCCC, developed countries have committed to assisting developing countries in achieving sustainable development. Of particular relevance here are the obligations in the Convention on technology transfer and financing:

Article 4.1.(c) Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors.

Article 4.5. The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other

[60] Stern Review on the Economics of Climate Change, in particular Chapter 16, page 368.

Parties and organisations in a position to do so may also assist in facilitating the transfer of such technologies.

Article 11.5. The developed country Parties may also provide and developing country Parties avail themselves of, financial resources related to the implementation of the Convention through bilateral, regional and other multilateral channels.

Furthermore, stronger commitments and material evidence of technology transfer and financing will be essential to encourage emerging economies and developing countries to engage in the international negotiations on the post-2012 climate change regime. In the recent UN Climate Change conference in Bali, emerging economies such as China and India made absolutely clear that acceptance of their own need to contribute to the solution was dependant upon increased flows of finance and technology from developed countries.

ANNEX VI — Phase 1 of NZEC

COACH

Full partner list at: http://c.martin.atanor.free.fr/en/partners/

Includes (private sector) Shell, Greengen, Statolhydro, BP, Alstom and Air Liquide.

The emphasis in this project is to prepare for large-scale use of coal for poly-generation with CCS. Work Package 1 aims to enhance knowledge sharing and capacity building in China, organise workshops, CCS summer schools, create a public website and implement mobility schemes. WP2 will deliver concept studies of coal power plants, an inventory of different technical capture options such as gasification, poly-generation and IGCC and will benchmark post-combustion options in China and CO_2 transfer conditions. WP3 is analysing storage capacity within the Bohai basin (selected by the Chinese) and mapping geology and point emission sources plus improved methodologies for capacity assessment and site selection. WP4 will identify specific poly-generation/IGCC demonstration options for further development. There are common partners with UK NZEC. In COACH, all WPs are co-led by Chinese and EU partners. In WP6, COACH will interface with other EU projects such as MOVECBM, STRACO2 and EUGEOCAPACITY to share non-confidential information on CCS in China.

UK NZEC

NZEC is funded by the UK's Department of Energy and Climate Change (DECC), and is being taken forward in partnership with the People's Republic of China Ministry of Science and Technology (MOST). The NZEC project has 9 UK partners and 20 Chinese partners from industry and academia. The contract was signed in February 2008 and will end in autumn 2009 to align completion with the COACH project.

WP1 consists of Capacity Building, a website set up in both languages and technical exchanges for Chinese participants to be trained in the EU. WP2 will work on the future energy technology perspective role of CCS in China in the future energy scenarios. WP3 is looking at capture scenarios, and case studies will be done on pre-combustion, oxy-fuel, post combustion and a study on transport. In WP4, CO_2 storage studies will be undertaken on 3 basins on aquifers, EOR and ECBM. WP5 is a cross-cutting package and will include a consultation on stakeholder perception, a study on socioeconomic impact assessment and sustainability assessments. These will be brought together with the technologies in a report.

Within the UK and Europe, the following are project partners:

- AEA (Project Managers, WP1, WP2 & WP5 Leaders)
- Alstom Power
- British Geological Survey (WP4 Leaders)
- BP
- Doosan Babcock
- Heriot Watt University
- Imperial College (WP3 Leaders)
- Shell
- The following are the Chinese partners:

- ACCA21 (the Administrative Centre for China's Agenda 21, Project Managers and WP1 & WP5 Leaders)
- Chinese Academy of Sciences (Institute of Geology and Geophysics)
- Centre for Energy and Environmental Policy (CEEP)
- China University of Petroleum Beijing (WP4 Leaders)
- China University of Petroleum Huadong
- Department of Environmental Sciences and Engineering at Tsinghua University (DESE TU)
- Department of Chemical Engineering at Tsinghua University (DCE TU)
- Department of Thermal Engineering at Tsinghua University (DTE TU)
- Energy Research Institute (ERI)
- Greengen (WP3 Leaders)
- Institute of Engineering Thermophysics, Chinese Academy of Sciences (IET)
- North China Electric Power University (NCEPU)
- BP Tsinghua University Clean Energy Research and Education Centre
- Thermal Power Research Institute (TPRI)
- 3E Institute Tsinghua University (WP2 Leader)
- Wuhan University (WHU)
- Zhejiang University (ZJU)
- PetroChina
- Jilin Oilfield

STRACO2

The Support to Regulatory Activities for Carbon Capture and Storage (STRACO2) — Project is designed to support the development of a regulatory framework for CCS in the European Union. By supporting a CCS regulatory framework inside the EU, STRACO2 will be instrumental in establishing best practice standards globally.

By incorporating the Administrative Centre for China's Agenda 21 (ACCA21), the Project is part of the EU-China Partnership on Climate Change and aims to ensure that the solutions developed are applicable to rapidly developing economies outside Europe, which will be crucial in fighting CO_2 emissions and climate change. The programme started in January 2008 and will run for 18 months.

Members:

» Bureau de Recherches Géologiques et Minières (BRGM)
» DEVELOPMENT Solutions Europe Ltd. (DS)
» Netherlands Organisation for Applied Scientific Research TNO
» Mälardalen University (MU)
» The Royal Institute of Technology (Kungliga Tekniska Högskolan) (KTH)
» The World Business Council for Sustainable Development (WBCSD)
» The Administrative Centre for China's Agenda 21 (ACCA21)
» The Institute of Engineering Thermo-physics, of the Chinese Academy of Science (IET)
» The Institute of Policy and Management of the Chinese Academy of Sciences (IPM)

ANNEX VII — List of EU CCS research projects

Carbon dioxide thematic network (CO2NET2) (2002-2005) NORWAY

Carbon dioxide capture and sequestration in geological storage technology network development programme (2000-2002) UNITED KINGDOM

Promotion of an Integrated European and National R&D Initiative for Fossil Energy Technologies towards Zero Emission Power Plant (FENCO) (2003-2004) GERMANY

Initiative for Fossil Energy Technologies towards Zero Emission Power Plant (FENCO-ERA) (2005-2009) GERMANY

Network of Excellence on Geological Sequestration of CO_2 (CO2GEONET) (2004-2009) UNITED KINGDOM

International Cooperation actions on CO_2 capture and storage (2004-2007) FRANCE

Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage (DYNAMIS) (2006-2009) NORWAY

Carbon Dioxide Capture and Hydrogen Production from Gaseous Fuels (CACHET) (2006-2009) UNITED KINGDOM

CO_2 capture and storage networking extension to new member states (CO2NET EAST) 52006-2009) CZECH REPUBLIC

Cooperation Action within CCS China-EU (COACH) (2006-2009) FRANCE

CALCIUM CYCLE FOR EFFICIENT AND LOW COST CO_2 CAPTURE IN FLUIDISED BED SYSTEMS (C3-CAPTURE) (2005-2008) GERMANY

Advanced separation and storage of carbon dioxide: Design, Synthesis and Applications of Novel Nanoporous Sorbents (DESANNS) (2006-2008) FRANCE

Assessing European capacity for geological storage of carbon dioxide EU (GEOCAPACITY) (2006-2008) DENMARK

CO_2 capture using amine processes: International cooperation and exchange (CAPRICE) (2007-2008) NETHERLANDS

Support to regulatory activities for carbon capture and storage (STRACO2) (2008-2009) FRANCE

Enabling advanced pre-combustion capture techniques and plants (DECARBIT) (2008-2011) NORWAY

ANNEX VIII — Preliminary Cost Estimates, Sources of Funding and a Possible Financial Vehicle for a Demonstration Plant in China

Preliminary cost estimates

Modelling work[61] conducted for the impact assessment for the Directive on the geological storage of carbon dioxide[62] provides reference values for capital and operational costs for different technology vintages. For this impact assessment, the technology vintage for 2010 is used, which results in additional specific capital investment costs of € 545/kW for CCS in integrated gasification combined cycle coal (IGCC) plants and € 1025/kW for pulverised coal (PC) plants. The reference values for capital investment costs are broadly consistent with the figures given in other sources (see Table 2), however they are on the conservative side and very close to the reference values suggested in the Second Strategic Energy Review, which results in additional specific capital investment costs of € 550/kW for CCS in IGCC plants and € 985/kW for PC plants. Since these figures are for the EU, a region-specific cost multiplier of 0.6 for China is used in this Impact Assessment.

Table 2: Specific capital investment for coal power plants with and without CCS

Source	Reported values	Converted values ($€_{2005}$/kW)[63]
Second Strategic Energy Review[64]		
IGCC	1400-1650 €/kW	
IGCC CCS	1700-2400 €/kW	
Additional CCS capital costs	300-750 €/kW	
Pulverised Coal Combustion	1000-1440 €/kW	
Pulverised Coal Combustion with CCS	1700-2700 €/kW	
Additional CCS capital costs	700-1260 €/kW	
CC Capital		
IGCC	1079-1483 €/kW	

61 PRIMES model database.

62 SEC(2008)55.

63 Converted values indicated where values were reported in other units than 2005 Euros.

64 SEC(2008) 2872 'Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport' provides the specific capital investment costs for the state-of-the-art power generation technologies based on available literature: E. Rubin et al: Use of experience curves to estimate the future cost of power plants with CO2 capture. International Journal of GHG control, 1 (2007) 188-197, 2007; IPCC: Special report on carbon capture and storage, 2005; IEA GHG: Potential for improvement in gasification combined cycle power generation with CO2 capture. Report 4/19, 2003.

IGCC CCS	1361-2001 €/kW	
Additional CCS capital costs	282-518 €/kW	
Pulverised Coal Combustion	1056-1400 €/kW	
Pulverised Coal Combustion with CCS	1484-2330 €/kW	
Additional CCS capital costs	428-930 €/kW	
IEA		
Coal, steam cycle	1500-2200 $/kW	1176-1725
Coal, steam cycle with CCS	2250-3200 $/kW	1764-2509
Additional CCS capital costs		588-785
Coal, IGCC, Selexol	1600-2300 $/kW	1255-1804
Coal, IGCC, Selexol with CCS	2300-2800 $/kW	1804-2196
Additional CCS capital costs		392-549
MIT		
Pulverised Coal Combustion	1280-1360 $/kW	1029-1093
Pulverised Coal Combustion with CCS	2090-2270 $/kW	1680-1825
Additional CCS capital costs		651-732

Source: SEC(2008)2872; Climate Change Capital: ZEP Analysis of funding options for CCS demonstration plants, 2007; IEA: CO2 Capture and Storage — A key carbon abatement option, 2008; MIT: The Future of Coal, 2007; McKinsey&Company: Carbon Capture and Storage: Assessing the Economics, 2008.

In addition to extra capital investment costs, there are additional fixed and variable operating and maintenance costs associated with CCS that include the cost of fuel, other materials, personnel, etc. Additional annualised operational and management costs for CCS plants are taken from the PRIMES model database for the 2010 technology vintage[65] and are summarised in Box 2.

There is a high degree of uncertainty in estimating the costs for CCS demonstration plants due to the novelty of the technologies in combination. Even though some CCS components, such as CO_2 transport via pipelines, are tested in different applications, there is currently no large-scale CCS coal power plant in operation. This means that all the figures above are estimates, based on scaling up smaller components or expert judgment on experience with near-proven technologies.

65 Energy Systems Analysis of CCS technology: PRIMES MODEL SCENARIOS (http://ec.europa.eu/environment/climat/ccs/pdf/primes.pdf).

The cost of a CCS demonstration plant depends on the particular type of technology used, fuel type and composition, plant size and lifetime, capture rate, process efficiency and the construction site. Plant efficiency also affects capital costs: since CCS plants will be less efficient than conventional plants, they need to be designed and constructed with a larger fuel input than conventional power plants to achieve the same net electricity output. Therefore, the size, and hence the cost, of components for a CCS plant will depend on plant efficiency for a predefined net power output. Finally, capital costs will vary depending on the terrain and location of the plant, which mainly affect transport and storage costs.[66]

Transport costs depend on the length of the pipeline required between capture and storage sites, the local terrain, and the volume of CO_2 to be transported, as well as whether the infrastructure is already available. Storage costs depend on the type and shape of the geological formation, the depth and the storage process, which will affect the type and number of wells that will be drilled and monitoring techniques. The size of the storage site can play an important role in reducing the storage cost per tonne of CO_2. Storage costs for a large field that can service two commercial-scale plants simultaneously could be roughly one third lower than for a one-to-one situation.[67]

As shown above, transport and storage costs are site-specific. Other costs, such as materials and labour, will also greatly depend on where the CCS demonstration plant is built. These are issues to address during Phases I and II of the NZEC project in China. More precise site-specific cost figures will be obtained using detailed conceptual designs of CCS power plants under the ENRTP project outlined in Annex III. It is also uncertain as to how costs will develop with time, given both the wide possible range of learning rates and scale benefits, and the variability of input costs, such as steel, engineering and fuel development. Capital expenses per unit are expected to decrease with increasing installed capacity, due to potential economies of scale on some components.

The calculations given in this impact assessment were made for a newly built CCS plant. For the NZEC demonstration, the decision on retrofitting vs. new build will be made together with the Chinese government on the basis of output from Phase I. Given the rate at which China constructs new coal-fired power plants, new build is a safe assumption. Literature suggests that retrofitting existing power plants would bear considerably higher costs (up 30% higher than for newly built CCS plants). This is due to several reasons. Firstly, a retrofitted power plant will have a shorter economic life than a newly built one; therefore the investment would be spread out over fewer years, making it more expensive per ton of CO_2 abated. Secondly, reconstructing existing plants could be more difficult than building a new CCS plant due to space and other inherited constraints. Thirdly, retrofitting existing plants may result in a higher efficiency penalty leading to higher fuel costs. And fourthly, one has to take into account the opportunity cost from closing down the plant for retrofitting as opposed to continued operation.

Figure 1 depicts China's emission reduction cost curve for the power sector, which indicates that the lowest cost option is coal-based new CCS with enhanced oil recovery, next is new coal-based CCS, followed by coal-based CCS retrofit, gas-based new CCS and finally gas-based CCS retrofit is the most costly CCS option for the power sector.

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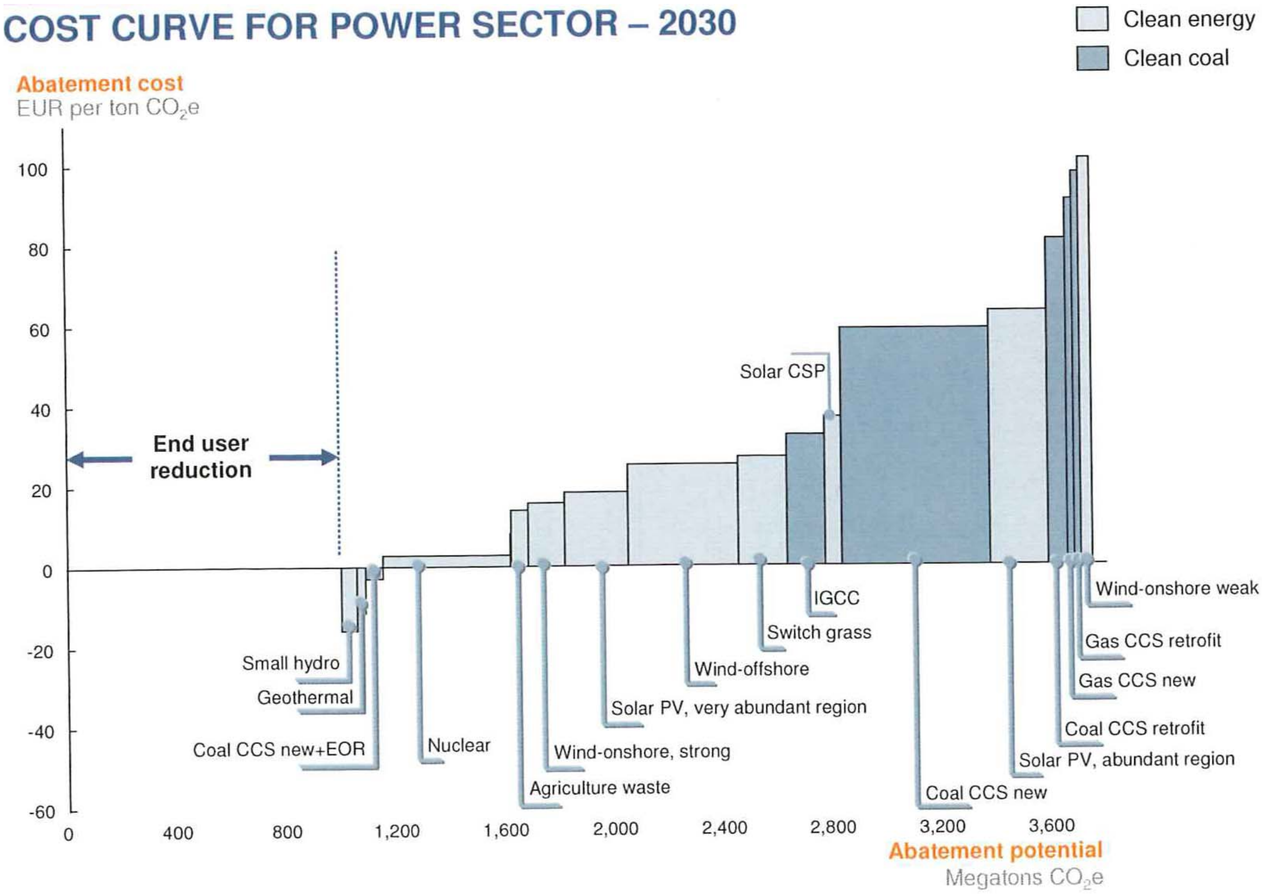
66 JRC-IE, The cost of carbon capture and storage (CCS) demonstration projects in Europe, 2009.

67 McKinsey&Company: Carbon Capture and Storage: Assessing the Economics, 2008.

Figure 12: abatement cost curve for power sector in China



Source: McKinsey analysis[68]

Based on the assumptions in Box 2 below, the costs were calculated for the CCS demonstration plant and a conventional coal plant with the same electricity output for two types of technologies: Integrated Gasification Combined Cycle and Pulverised Coal.

Box 2: Assumptions used in the CCS plant cost calculations

Plant size (net): 400 MW Economic lifetime: 25 years Construction time: 4 years Construction sequence: 16% of total amount invested 1st year, 28% in each of remaining 3 years Capture rate of CCS plant: 87.7% for PC plant and 88.7% for IGCC plant (approximately 2.6 mt CO_2 captured and 1.8 mt CO_2 avoided per year) Capacity utilisation: 80% Fuel costs for coal (€/GJ): 2.1 in 2015; 2.3 in 2020; 2.5 in 2025; 2.7 in 2030; 2.8 in 2035; 3.0 in 2040 Plant efficiency without CCS: 44.8% for PC plant and 46% for IGCC plant Plant efficiency with CCS: 33% for PC and 37.8% for IGCC Specific investment cost without CCS: 1320€/kW for PC, 1655 €/kW for IGCC

68 McKinsey&Company 'China's green revolution: Prioritising technologies to achieve energy and environment sustainability'.

Specific investment cost with CCS: 2344€/kW for PC, 2200€/kW for IGCC Fixed costs without CCS: 40€/kW for PC, 45€/kW for IGCC Additional fixed costs for CCS plant: 8€/kW for PC, 11€/kW for IGCC Non-fuel variable costs without CCS: 2.5€/MWh for PC, 4.9€/MWh for IGCC Additional non-fuel variable costs for CCS plant: 0.5 €/MWh for PC and IGCC Transport and storage costs: 7€ per ton of CO_2 stored Region-specific cost multiplier: 0.6 for capital investment and Operation&Management costs[69] Coal emission factor: 98.3t/TJ Interest rates (net of inflation and taxes): Private Lending Interest Rate: 5.5% Equity Rate of Return on Capital: 12% Public support rate of return on capital: 0% Public sector borrowing interest rate: 2.5% WACC[70]: 7.5% for conventional plant 9% for CCS plant Carbon value for scenario with gradual increase of carbon revenue (e.g. from CDM, sectoral crediting or avoided costs in case of carbon tax): 10€/tCO_2 in 2015 gradually raising to 20€/tCO_2 in 2040

The required additional financial need for the CCS demonstration plant is split between a subsidy for capital investment and a subsidy to cover operating costs. Public financing for the capital investment costs are assumed at 100% of the additional CCS costs (i.e. the private entity is indifferent as to whether to build a conventional plant or a plant with CCS).

The operating financial gap is calculated to cover additional operating costs so that the cost to the operator of producing electricity would be the same for a CCS as for a conventional plant. Both subsidies are discounted according to public sector borrowing interest rate (2.5%) to obtain the total amount of subsidy in 2010. This is the value that could be paid from public sources to the special purpose vehicle if they are to cover all additional CCS costs in the absence of a carbon price. A separate scenario calculates the financial gap assuming that operator receives a compensation for CO_2 avoided due to CCS according to the CO_2 price schedule in Box 2. Moreover, the amount of public financing will depend on the number of years during which CCS operation will be supported.

An estimate of the additional financial need to cover additional costs of a CCS plant compared to the equivalent plant without CCS is given in Table 3. The costs are expressed in present value in 2010 over the four-year period of construction and 25 years of operation based on social discount rate. The additional costs are estimated assuming that at a certain point of time, there is a choice between building a conventional coal plant or an equivalent coal plant equipped with CCS. These estimates would differ from the costs of installing CCS to an existing plant, which would be potentially higher (see above text on retrofitting). Table 4

69 According to World Bank analysis, regional cost factor for conventional power plant is 0.6 for India (Study of Equipment Prices in the Power Sector, The International Bank for Reconstruction and Development/The World Bank Group, 2008) and a similar value is assumed to apply for China. This is consistent with the judgement of energy experts working on China.

70 Weighted Average Cost of Capital is an overall return that must be achieved to meet the requirements of all its investors. Assuming a lending rate is 5.5% (real) and the rate of return on capital is 12% (real), the risk free WACC is 7.5% with weight of 0.3 for equity and 0.7 for debt. In the case of CCS demonstration plant, additional risk factors exist (technical, infrastructure, political), so WACC includes a risk premium of 1.5% (differential from standard sector's risk factor) which adds to the weighted sum of rate of return on capital and a lending rate. So the total WACC for CCS becomes 9%.

summarises the financing need assuming a carbon value and the option to support operation of CCS.

A recent McKinsey study posted significantly higher cost estimates of an additional € 60-90 per ton of CO_2 avoided for a CCS demonstration plant. The background data presented in the report is not sufficiently detailed to carry out a full assessment of the differences in costs. Nevertheless, due to the uncertainty, the McKinsey figures could be considered as the upper boundary of costs. Therefore, in the sensitivity analysis below, two upper cases are considered, of 50 % higher capital investment costs and 50 % higher operational and investment costs.

Table 3: Estimated incremental costs of CCS compared to an equivalent coal plant without CCS for 25 and 10 years of operation, respectively

	Pulverised coal		IGCC	
	€ M (25 years of operation)	€ M (10 years of operation)	€ M (25 years of operation)	€ M (10 years of operation)
Capital costs	232	232	124	124
Transport and storage costs[71]	300	284	264	251
Operating costs	445	192	342	147
TOTAL	**977**[72]	**708**	**730**	**522**

Table 4: Additional financial resources needed to cover incremental costs of a CCS plant compared to an equivalent plant without CCS, with a carbon value (for 25 years of operation)

	Pulverised coal	IGCC
Capital financing need	232	124
Operating financing need (including transport and storage)	317	175
TOTAL	**549**[73]	**299**

Conclusion: based on these assumptions, the total financial need in 2010 to cover the additional CCS costs is on average about € 730 – 980 million over a plant lifetime of 25 years, depending on the technology used. This results in about € 30-40/tCO_2 avoided. Assuming a carbon value of € 10/tCO_2 in 2015, gradually raising to € 20/tCO_2 in 2040, the need for additional financing from the other sources is reduced to € 550 million for a pulverised coal plant and € 300 million for an Integrated Gasification Combined Cycle (IGCC) plant. Should support only run for 10 years of CCS operation, the financing gap is estimated at € 520 million for a IGCC plant and € 710 million for a pulverised coal plant.

Sensitivity analysis

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71 It is assumed that transport and storage costs are broken down in 90% capital costs and 10% operational costs. Therefore, total transport and storage cost is lower for the 10 year scenario..

72 To express the financing gap in €/tCO2, public support is set to zero and the 'goal seek' function can calculate the constant compensation that operators need for every ton of CO_2 avoided by CCS, which results in € 41/tCO2 for PC and € 29/tCO2 for IGCC.

73 The carbon price is € 10/tCO2 in 2015, gradually raising to € 20/tCO2 in 2040.

As explained above, the assumptions used for estimating the costs of CCS have a major impact on the figures. The range of cost estimates will narrow once the CCS technologies are demonstrated, but until then the estimates remain uncertain. Therefore the following sensitivity levels of the key variables determining the additional CCS costs were evaluated to assess their impact on the results:

(1) High fuel costs for coal: € 4.16 /GJ from 2015 to 2040[74]

(2) Low fuel costs for coal: € 0.97 /GJ from 2015 to 2040[75]

(3) 50 % higher capital costs for CCS

(4) 50 % higher capital, fixed operational and management, and non-fuel variable operational and management costs for CCS

(5) High transport and storage costs of € 15/tCO_2[76]

(6) 15 % lower capital costs for CCS

(7) 15 % lower capital, fixed operational and management, and non-fuel variable operational and management costs for CCS

(8) No cost multiplier for China

The results of the sensitivity analysis are displayed in Table 5 and Figure 13:

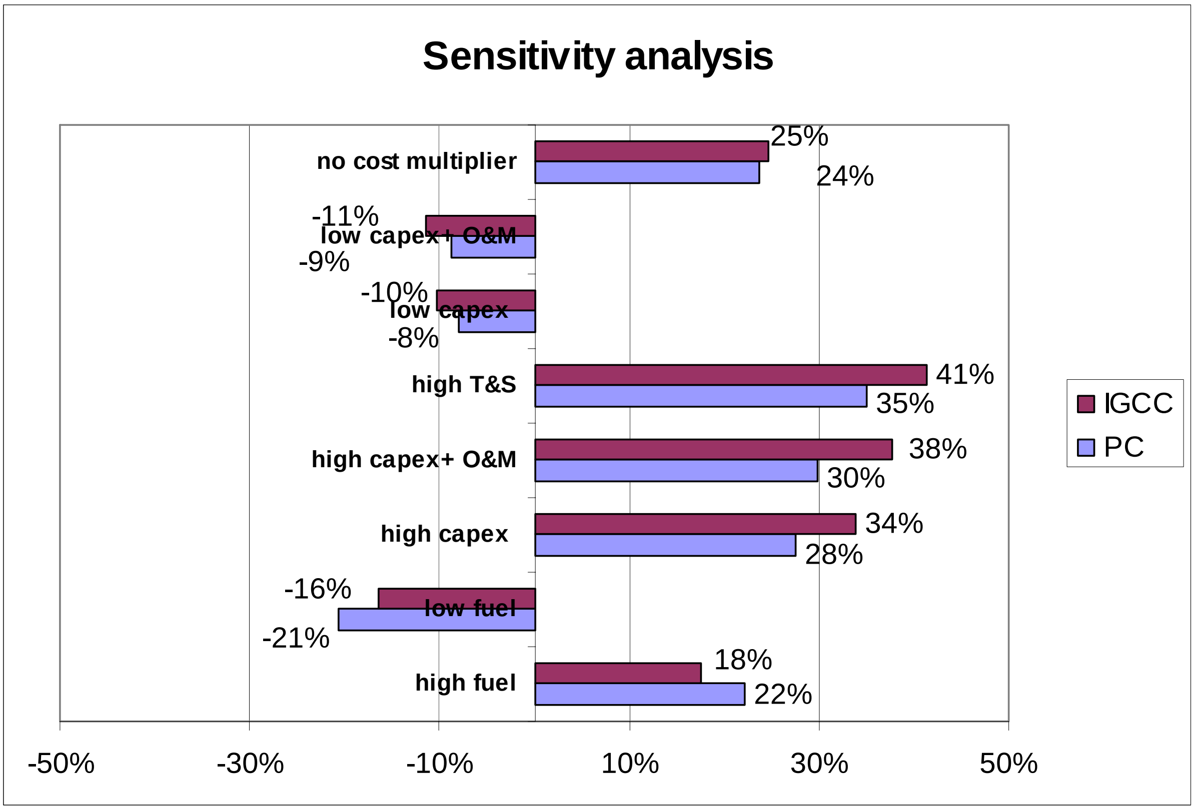
Table 5: Sensitivity analysis: impact of key variables on the additional CCS costs for pulverised coal plant and IGCC plant expressed as NPV

		additional CCS costs		€/tCO_2 avoided		% change in additional costs compared to the base case	
		PC	IGCC	PC	IGCC	PC	IGCC
0	base	977	731	41	29	0 %	0 %
1	high fuel	1193	858	48	33	22 %	18 %
2	low fuel	775	611	34	25	-21 %	-16 %
3	high capex	1246	978	59	46	28 %	34 %
4	high capex+ O&M	1268	1006	60	47	30 %	38 %
5	high T&S	1320	1033	53	39	35 %	41 %
6	low capex	1065	655	36	24	9 %	-10 %
7	low capex+ O&M	898	647	35	23	-9 %	-11 %
8	no cost multiplier	1208	911	54	38	24 %	25 %

74 Corresponds to $ 150/t, IPTS scenario.
75 Corresponds to $ 35/t, IPTS scenario.
76 As assumed in the PRIMES.

This shows the relative importance of capital costs, transport and storage costs on the additional CCS cost estimates. In this analysis, a 50 % increase in the capital costs of the CCS power plant results in a 28 % increase in the NPV of additional CCS costs for PC plants and 34 % for IGCC plants. This is due to the fact that a large proportion of the additional costs are operational costs and a carbon value of zero is assumed. Another important factor is transport and storage costs: increasing these costs from € 7 to 15 per ton of CO_2 stored creates a 35 % increase in NPV differential for PC and 41 % for IGCC plants. Operational and management costs have a moderate influence on additional CCS costs. The costs described above are purely incremental CCS costs.

Figure 13: Sensitivity analysis: impact of key variables on the NPV of additional CCS costs expressed for IGCC and PV plants



In conclusion, the main assumptions of the economic lifetime of the plant, carbon value, transport and storage costs as well as capital investment costs significantly influence cost estimates. Using different scenarios, the difference between the net current value of the CCS demonstration plant compared to the corresponding conventional coal power plant widens to € 300 – 1320 million over a plant lifetime of 25 years, depending on the technology used, and € 25-60 /tCO_2 avoided.

Potential sources of funding

At current cost estimates, possible revenue streams would not cover the total incremental costs of CCS; hence the perceived need for public grant funding – at least for the capital expenditure.

At present, the Commission has earmarked € 60m for cooperation on cleaner coal technologies and carbon capture and storage in emerging developing countries under the

Environment and Natural Resources Thematic Programme (ENRTP) over the period 2009-2013. Further Community funding is currently not planned, as support agreed under the 2008 EU Climate and Energy package only applies to demonstration within the EU. Some MS have expressed an interest in supporting NZEC's work, but need evidence of a firm Commission commitment (in the form of the Communication) to begin inter-ministerial discussions.

The CDM offers an opportunity for developing country companies and governments to invest in clean development projects in developing countries and use the resultant Certified Emissions Reductions (CERs) for their own compliance purposes. At present, CCS is not permissible in the CDM. If CCS were covered by a carbon price in the future, e.g. carbon credits in the light of an ambitious post-2012 agreement, these could serve to offset some of the additional costs and/or create a revenue stream. A further potential revenue stream is enhanced hydrocarbon recovery (using the captured CO_2 to force additional hydrocarbons, i.e. oil or gas, from the field in which the CO_2 will then be stored), depending on circumstances.

Chinese investment in the incremental costs of CCS will be essential to increase China's buy-in to the project and the development of the technology ensuring a greater Chinese ownership, familiarity with the technology and an increased likelihood of further deployment.

Box 3: Potential financing sources

Private sector

Private-sector involvement falls into two categories: active equity investors (operators, contractors, equipment suppliers) and passive equity investors (investment funds, institutional investors). The base plant may be funded through private-sector investment (e.g. on a project finance or corporate finance basis). Private-sector investors may also take on some of the additional CCS costs or provide in-kind support if they can see potential incentives.

Several European companies are already present in Chinese clean technology markets. Many of these are members of the ZEP and are key stakeholders in EU-China cooperation. Cooperation between European and Chinese industry stakeholders will also be supported by the EU-China Clean Energy Centre, agreed at the 2007 EU-China Summit and due to be established in Beijing.[77]

Carbon finance

Currently, CCS is not eligible for carbon finance (e.g. through the Clean Development Mechanism, CDM, which is a project-based approach offsetting developed country emissions through clean development projects in developing countries). It may, however, be eligible for post-2012 carbon financing, e.g. through a sectoral crediting mechanism (i.e. a mechanism to credit emissions reductions at sector level) or through a specific CDM scheme for CCS demonstration plants in emerging/developing countries.

Enhanced Fossil Fuel Recovery

Depending on the nature of the plant, a revenue stream could come from enhanced oil recovery (EOR).

[77] See: http://www.eu-in-china.com/download/EC2.pdf.

Public financing

Contributions from the public budget would be required to co-finance additional CCS costs. A number of potential sources could be leveraged:

- EC budget
- EU or EEA Member States national budgets[78]
- concessional loans from public investment banks

Public finance could be used in the following ways:

– subsidies

– loan guarantees

– guarantee for private-sector return (to guarantee price or regulatory risk)

– investment (with limited expected return)

[78] If these public contributions qualify as State aid, they may need to be notified to the Commission under the State aid rules.