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Carbon Capture & Storage Association

Suites 142-152
Grosvenor Gardens House
35/37 Grosvenor Gardens
London SW1W 0BS

t +44 (0)20 7821 0528
f +44 (0)20 7828 0310
e info@ccsassociation.org
www.ccsassociation.org

CCSA Position Paper

CCS in an international post-2012 climate change agreement

KEY MESSAGES

- CCS can safely and permanently prevent carbon dioxide from reaching the atmosphere on the scale necessary to address climate change and must be recognised and supported by the future UNFCCC agreement as a crucial greenhouse gas mitigation technology. Only through CCS can required mitigation targets be met whilst the inevitable use of fossil fuel reserves continues. The IEA estimates that, to meet required mitigation pathways, 100 CCS projects must be in operation worldwide by 2020 and more than 3000 by 2050.

- To achieve this level of development by 2020, the IEA calculates that $130bn extra capital will need to be deployed, 73% of it from OECD Governments. Although all component elements of CCS technology are proven, development of commercial scale power projects is at an early stage and attracts high up-front capital costs. The UNFCCC agreement must allow for both public financing and ongoing market incentives to support an ambitious demonstration programme of commercial scale power plants fitted with CCS in key developing countries.

- Crediting of CCS projects in international carbon markets – through a reformed Clean Development Mechanism (CDM), sectoral crediting or other means – must be made possible post-2012 to enable the development of low-cost CCS opportunities. However, market mechanisms alone are insufficient to drive early stage development of CCS in the power sector where the technology will be needed the most.

- The UNFCCC agreement must allow for large-scale public finance to be channelled into CCS development to overcome high initial capital costs. This could be through carbon market levies, bilateral agreements, including Nationally Appropriate Mitigation Actions (NAMAs) or other means.

President: Lord Oxburgh KBE
Registered in London
Company number 5650208

- There are some large, low-cost, early climate gains to be taken from storing CO_2 from natural gas production, ammonia plants and coal-to-liquids. Steel and cement production has no other practical option to minimise emissions than CCS because of the intrinsic process emission of CO_2. Combining biomass energy production with CCS actually results in removal of CO_2 from the atmosphere.

- CCS can be safely regulated globally through a robust international governance structure. This should focus on establishment of an accreditation standard for project certification and development of clear monitoring, reporting and verification (MRV) protocols. The IPCC guidelines for national greenhouse gas inventories provide a workable model for this. Suitable geological storage site characterisation and selection is key to safe CCS and must be a part of the process.

CONTENTS

SUMMARY

The widespread deployment of CCS will be a necessary component of any environmentally and cost effective international response to climate change. It is therefore of vital importance that Carbon Capture and Storage (CCS) is included in the future international climate change agreement and mitigation effort after 2012. Special financing channels must be established by the international community to ensure successful early deployment of the technology.

To bring CCS projects to fruition internationally, funding for CCS must come from both the carbon market and from international funding sources as part of the UNFCCC. The public finance is necessary to implement demonstration projects internationally. Over the long-term the carbon market is expected to be able to support CCS without extra financing.

This paper puts forward options for how CCS could be supported internationally in a post-2012 climate change agreement. It explains CCSA views on the implications of each potential scenario but does not explicitly support any particular option. The paper discusses how likely each option would be to provide sufficient financial support to allow CCS demonstration projects to be developed by the private sector internationally.

An international regulatory model is required to ensure safe operation of international CCS projects and to address some of the non-technical barriers and concerns often raised in opposition to international deployment of CCS. A model for this is described.

Options for leveraging large scale international finance under the UNFCCC process are discussed and scenarios are compared. In addition, the various models currently being considered for the future structure of carbon markets post-2012 are briefly analysed in the context of CCS development.

The paper concludes that both recognition of CCS as a mitigation technology to be credited in international carbon markets AND large scale international public financing will be required to bring CCS to fruition in developing and developed countries.

1. Introduction

1.1. The importance of CCS

Fossil fuels remain a vast energy resource and are widely available around the world. Coal in particular is in abundance in regions with large existing or projected energy demand. CCS can allow countries to continue using fossil fuels without emitting damaging levels of carbon dioxide. CCS can capture approximately 90% of the CO_2 produced in electricity generation and then transport and store it securely and permanently in deep geological formations – rather than releasing it to the atmosphere. In future, CCS will also be vital to decarbonise other industrial sectors, many of which have few other options for large-scale emissions reductions apart from CCS.

Many countries are heavily dependent on coal for energy generation. With leadership and support from the developed world, developing countries can decarbonise their growing economies and support efforts to tackle climate change globally. CCS needs to be recognised as a critical mitigation technology. A post-2012 global settlement to be agreed at the UNFCCC meeting in Copenhagen in 2009, must include CCS as a key technology for delivering global greenhouse gas (GHG) reductions, particularly in order to incentivise deployment in the developing world. The IEA has recently assessed the importance of CCS to achieving required emissions reductions. The resulting roadmap concludes that 100 CCS plants must be operational by 2020, with 38 of these in the power sector. This needs a large acceleration from the current situation, as shown in figure 1.

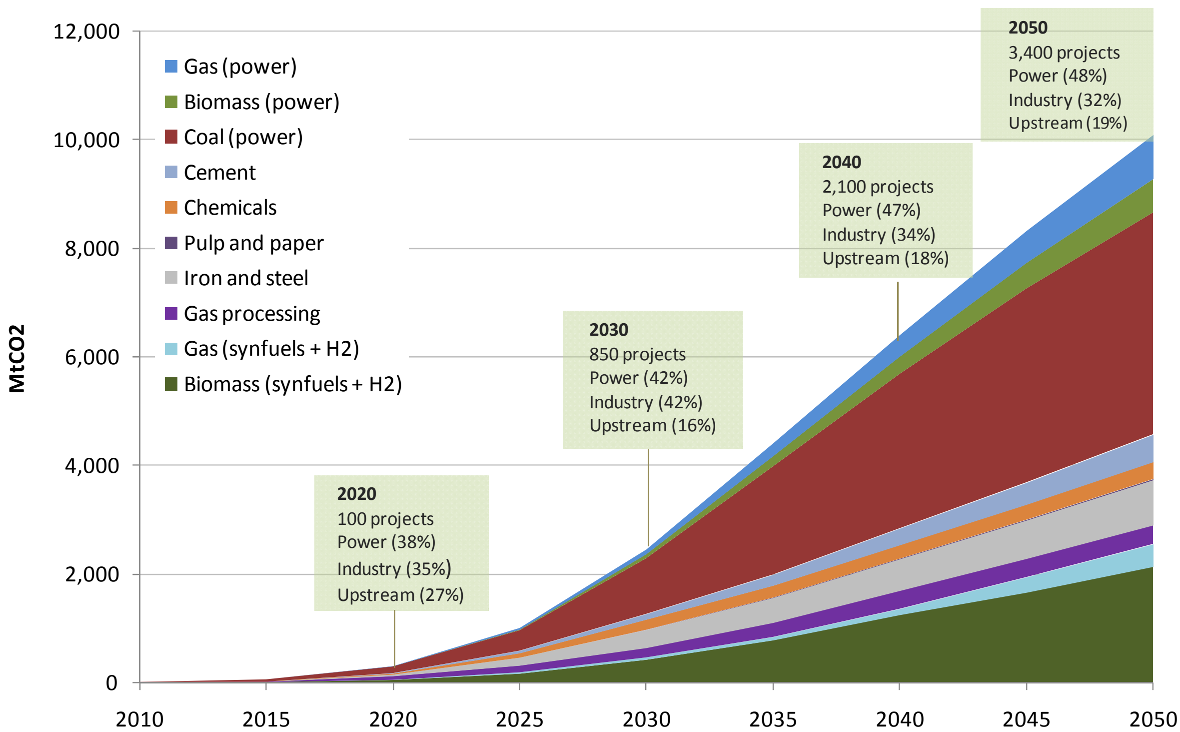

Figure 1 – Global deployment of CCS 2010-2050 by sector, according to IEA roadmap[1]

[1] Source: IEA-GHG. *:* project numbers are calculated on the basis of $MtCO_2$ captured/yr data under IEA's BLUE Map (adjusted for capture rates and plant efficiency losses) and ranges of typical projects sizes within each sub-sector.

A CCS industry has begun to take shape in some parts of the world, including projects associated with hydrocarbon processing and more recently in power generation. However all large scale projects are currently supported through regional funding programmes, either through direct government support (for example in the USA) or linked to GHG mitigation through climate change legislation (for example through extra European Emissions Trading Scheme (EU-ETS) allowances). There is not as yet any international incentive or extensive financial support for CCS project development. This paper looks at the options for developing such an incentive structure within a post-2012 international climate change agreement in order to achieve deployment at the rate required by the IEA roadmap.

1.2. Unpacking CCS technology

The term CCS is often used loosely as a descriptor as though it represents only one form of abatement technology. In reality CCS covers a wide range of technologies at all stages of the CCS chain including capture, transport, injection and storage. Furthermore these technology options can be applied to a diverse array of different emissions sources. The design of financial incentives and public funding for CCS will differ for specific types and application of technology.

1.2.1. Applications of CCS

Power generation

The most prominent potential application of CCS is in electric power generation. This is most often associated with capture of emissions at coal-fired power generation units because of the high CO_2 emissions intensity of all coal units and the abundance of remaining coal reserves in regions of the world with high or growing energy demand. However in the medium to long term, the level of abatement required by climate change science will require development of CCS applications on other forms of power generation, notably natural gas and biomass-fired installations. CCS with biomass combustion is an important concept because there is a potential for such projects to be 'CO_2 negative', removing CO_2 from the atmosphere. The CO_2 captured at the point of combustion and subsequently stored will have already been removed from the atmosphere during the cultivation phase, if the biomass is sourced in a sustainable manner. Currently such CCS projects would not qualify for benefits under the EU-ETS and it is important that any forthcoming international agreement is flexible enough to allow support for such projects.

Oil and gas processing and refining

Natural gas processing, where the gas has a naturally high CO_2 content that must be stripped prior to injection to a gas grid, provides a relatively cost-effective application for CCS. Although common practice is to vent the CO_2 after stripping, the resulting pure CO_2 stream can be relatively easily captured and stored. The Sleipner project in Norway has

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These range from small pilot CCS projects within the power sector to large CO_2 reinjection projects in high-CO_2 natural gas fields.

now been operating for more than 13 years and is an example of an industrial scale CCS project that stores CO_2 stripped from natural gas. This application of CCS can be relatively cheap and incentivised at current carbon prices and much CCS experience might quickly be gained if all opportunities were developed.

Most petroleum refineries boast a number of high concentration or pure CO_2 streams that can offer cost-effective capture options, especially if combined with a local transport network.

Heavy industry

Any heavy industry with a large CO_2-intensive combustion or production process can provide a potential application for CO_2 capture and subsequent storage. The precise capture process will depend on the industry. The cement and iron and steel sectors, both industries with few realistic other abatement options, are in particular exploring options for CCS. Another industrial source is from ammonia production where a pure CO_2 waste stream is produced.

1.2.2. CCS technology options

Capture

When fossil fuels are burnt CO_2 can be stripped out from the other gases produced in the generation process. This can be done in at least three different ways: 'post-combustion', 'pre-combustion' and 'oxyfuel combustion'[2]. For power generation projects, most studies estimate CO_2 capture will account for up to 75% of the total cost of CCS, measured in cost per tonne stored. Part of this cost is due to the energy required by the capture process itself.

Transport and storage

The CO_2 must be transported by pipeline or ship for storage at a suitable site. Carbon dioxide is already transported for commercial purposes by road tanker, ship and pipeline. The likely quantities to be transported from source to storage site are so large that it is most likely that local and regional infrastructures of pipelines will ultimately be developed, although there will be an important place for shipping CO_2 in the early adoption of CCS and where there are long distances between source and store.

CO_2 can be stored in depleted or declining gas and oil fields, deep saline formations or unmineable coal seams. CO_2 is injected under pressure into typically microscopic spaces in porous rocks – the gas is held within the rock and gradually binds chemically into the rock. The porous material in which the CO_2 is contained is bounded by an impervious layer above. It is the same process that has kept oil and natural gas secure under the ground for millions of years. The storage sites are typically several kilometres under the earth's surface.

[2] For more information on capture technologies please see the CCSA International Manifesto

There is already much experience with transporting CO_2 in pipeline networks and injecting it deep underground: it has been used for over 30 years in Enhanced Oil Recovery Projects. Storage sites will be carefully selected and monitored. All existing evidence, for example from Norway's Sleipner project, with 13 years' of operational experience, suggests CO_2 will be completely locked into geological formations in a properly characterised and monitored site.

1.3. Current position of CCS in international climate policy

CCS is recognised under the Kyoto Protocol as an important greenhouse gas mitigation technology that promotes sustainable development. CCS is crucial to enabling developing countries to meet their development goals in an environmentally sustainable manner.

Nevertheless, a number of Parties to the UNFCCC have continually resisted the inclusion of CCS within the Kyoto Protocol's key flexible mechanisms, notably the Clean Development Mechanism. This means that to date the UNFCCC process has not provided any incentive for CCS technology. The opposition to CCS in the UNFCCC process has often been focused purely on the inclusion of CCS in CDM rather than opposing CCS as a climate change mitigation technology. The arguments put forward cite technological, legal and methodological issues but are often backed by other drivers concerning the purpose of CDM and the distribution of benefits arising from it.

The UNFCCC has been debating the merits of crediting CCS in CDM since gas processing projects were put forward in 2005. The topic has passed from the CDM Executive Board (CDM EB) to the UNFCCC Conference of the Parties but no significant progress has been made despite extensive technical analysis. Experts are currently preparing a report for the CDM EB and this is intended to inform the next session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) which coincides with the Conference of the Parties in December 2009.

The goals of the CCSA in this context are recognition of the GHG mitigation potential of CCS in the future international agreement, leading to incentives for both market mechanisms and public financing for demonstration of higher cost applications. This paper puts forward mechanisms by which this funding could be generated in future. The agreement to be signed in Copenhagen MUST recognise the mitigation potential of CCS AND develop the incentive mechanisms that can enable CCS to be deployed in developing countries.

2. The case for CCS market support

Widespread deployment of CCS is needed to achieve the levels of GHG mitigation that a strong international agreement will require. However, the hurdles of early implementation will not be overcome without significant and distinct financial support mechanisms in addition to the incentives provided by the international carbon market. This has been recognised in many OECD countries where Governments are offering upfront capital finance from public funds through a variety of means such as competitions, grants or revenue from sale of ring-fenced emissions allowances in Europe. To encourage development of early-stage plants in advanced developing countries seeking to deploy CCS will require international support through the UNFCCC system. There are a number of reasons why this is likely to be the case in the early stage of CCS development up to at least 2020.

High costs at demonstration stage: The use of CCS technology fitted to commercial-scale power stations is still at the demonstration phase and is therefore at its most expensive. Most studies suggest that CCS projects, applied to both power generation and industry, will be cost competitive with other low carbon technologies once project development moves into an early commercial phase and costs have been reduced through experience and learning-by-doing. This means that if a regional or global carbon market has been established driven by strict GHG reduction targets, the prevailing value of carbon should be sufficient to make CCS a preferred GHG mitigation option, the business case made attractive by the carbon value of each tonne stored. Before this time, CCS projects applied to power generation will require capital financing over and above that provided by the carbon market, although the long-term nature of the required investments means that ongoing carbon value support is also necessary even at this early stage. As CCS costs fall with increasing deployment and if, as anticipated, the market value of CO_2 increases as caps become tighter and more sectors are regulated for GHG emissions, then at some point in the future the CO_2 price alone will justify construction of economic CCS plants. This shifting dynamic is illustrated schematically in figure 2, although cost ranges and timescales are approximate.

At this early stage on the cost curve, the financial markets have no experience of CCS project development and so no means to reliably quantify the commercial risks of developing projects. Demonstration projects will require public financing, either directly from Governments or through international funds via the UNFCCC or otherwise, in order to attract private finance.

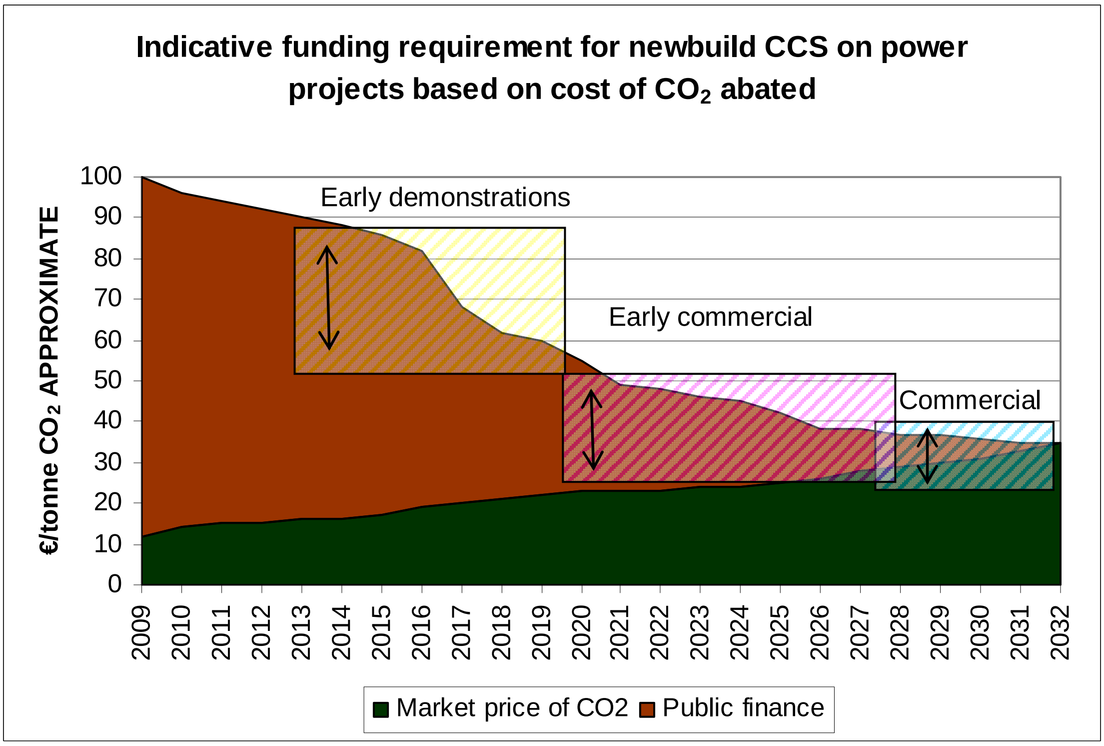

Figure 2: Funding gap between early stage CCS power projects and expected carbon price support (approximate cost ranges from *CCS: Assessing the economics* by McKinsey & Co.[3])

Tendency for very large scale: As well as being at demonstration phase and not yet tried at commercial scale, CCS will be most cost-effective as a very large scale technology applied to the largest industrial installations and power generators. In this way the first commercial scale plants face particularly steep capital cost challenges, greater than for most abatement technologies. This cost hurdle will be impossible to overcome without carbon value, and even this is likely to be insufficient for the first projects in the power sector.

Provide assurance on permanence: As CCS is a sequestration technology rather than an avoidance technology, issues concerning possible impermanence and long-term liability for the stored CO_2 need to be addressed. Whilst geology experts are agreed that with correct site selection there is very low risk of leakage to atmosphere from underground storage sites, early CCS projects will require particularly stringent monitoring during design and construction phase, as well as during operation, and this will also add to upfront cost requirements.

Capacity building and sustainable development: It is likely that the first commercial scale CCS power projects will be developed in Annex I countries, just as the first oil and gas processing projects were mostly in Annex I countries. This means that if the UNFCCC system provides sufficient incentive for projects to be implemented in developing countries, this could be seen as special form of technology transfer where a particular technology might be seen to be 'imposed' by its favourable position in the

[3] www.mckinsey.com/clientservice/.../ccs_assessing_the_economics.pdf

market. This could be overcome by an enhanced host country approval system further to the current CDM approval process. A host country Government would therefore be at liberty to approve projects and the technology source.

As the CDM has matured, there has been an increasing emphasis to support projects that bring strong social development benefits. Whilst this integration of GHG mitigation and social development is very important, the primary goal of climate change policy is to mitigate climate change and the potential of CCS to reduce GHG emissions on a massive scale means that it is essential to meet required levels of GHG reductions and so should be supported despite its industrial nature. In addition, the implementation of CCS projects in a region will provide opportunities for local employment and capacity development within that country and can provide improvements in local air quality.

3. Regulation of CCS internationally

For CCS projects to be recognised and financially supported under an international climate change agreement, robust international regulation and monitoring of CCS technology and implementation will be required. This section analyses what is required of an international regulatory structure and proposes the basics of a model for governance.

3.1 Addressing non-technical barriers and risks

3.1.1 Environmental security through site selection and MRV

Many of the fears and concerns relating to support of international CCS projects centre on uncertainty over the environmental performance of the projects over the medium to long term. Environmental integrity can be assured through robust international procedures addressing the following key points:

- Selection of storage sites that exhibit excellent trapping mechanisms;
- Assessment and suitable management of the risk of CO_2 leakage;
- Allocation of responsibility for monitoring and reporting;
- Allocation of responsibility for any environmental damage caused (local and global).

The recommendation in the 2006 IPCC guidelines for national greenhouse gas inventories[4] – the latest protocol by which countries should calculate their national emission inventories – is that CCS projects report using a project-by-project Tier 3 methodology and this provides a framework to address these points.

The single most important factor for long-term environmental stability is the selection of storage site. CCS experience to date and geology research shows that well-chosen sites

[4] Intergovernmental Panel on Climate Change guidelines for national greenhouse gas inventories, available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm

would be very unlikely to ever leak CO_2 to the atmosphere or even to the water column. Other commonly quoted fears include unpredictable subsurface CO_2 movement and the possible impact of seismic events. Again, thorough site-selection would minimise unpredictability and effective monitoring of CO_2 plumes would allow for early corrective action in the event of any unexpected CO_2 migration.

An internationally accepted Monitoring, Reporting and Verification (MRV) protocol for CCS would provide control for other environmental concerns surrounding the capture, transport and injection aspects of CCS and the possibility of local environmental impacts including specific concentrated CO_2 leaks and general impacts from construction and operation of plant. Existing experience with CO_2 transport and handling, including 30 years of experience of Enhanced Oil Recovery operations, show that these hazards can be avoided through regulation of operating procedures with suitable safety standards.

3.1.2 A legal framework backed up by Governments

Concerns over legal complications and sovereignty issues are also often quoted as barriers to CCS development. One issue is the process for transfer of long-term liability for stored CO_2 to the national government at an agreed time after the injection process has been completed and sealed. The operator will be responsible for the site during operation and post-closure, up to a period where there is no realistic expectation of any leakage from the site. However the long term integrity of storage – including future corrections to national CO_2 balances in the event of any leak – can only be guaranteed where long term responsibility for the storage site is transferred to the government. Related to this are concerns regarding the definition of project boundaries when sub-surface storage sites may cross international frontiers or when stored CO_2 may migrate within a storage complex from one defined storage site to another. This is also covered under the IPCC reporting guidelines, and the existence of an internationally recognised CCS standard to be adhered to by national governments and their institutions and certification companies would facilitate the setting of precedent and the resolution of such cases through mutual confidence.

3.1.3 Public and political acceptance

Other non-technical concerns are mostly driven by political opposition to using public finances and policy to support CCS development in a particular country or region. Often the issues raised are not backed up by credible evidence or justification. These include opposition based on the premise that implementation of CCS in developing countries with international support may lead to calls for mandatory CCS to be imposed on governments, or a view that as CCS is not yet proven in developed countries, should be demonstrated in Annex I countries before being transferred. Furthermore the novel and industrial nature of CCS means that, without well targeted public communication, there could be negative public perception of proposed projects.

Although there is no immediate apparent solution to these concerns, an acceleration of CCS project development around the world will help to dispel myths and demonstrate that these concerns are often without grounding. All low carbon energy conversion technologies carry a cost premium but CCS is likely to be particularly cost effective.

3.2 A model for international CCS regulation

Many of the identified issues could be solved by introducing a single international system for overseeing the assessment of international projects with the collaboration of competent national authorities.

This could function through the accreditation of existing or new certification companies that can prove competence in the very specific skills required for CCS storage site. Accreditation would be assessed against an international standard that could be developed by an international institution such as the Global Carbon Capture and Storage Institute in Australia or the International Performance Assessment Centre for CCS (IPAC-CO_2).

A critical aspect of the standard would be in the assessment of storage sites because the suitability of the storage site is the single most important factor in establishing the long-term environmental integrity of the project. The body could potentially also be required to oversee the entire supply chain involved in CCS projects, including capture, transport and injection operations as well. However, the more conventional nature of these operations mean that assessment would be best carried out by other institutions suited to particular support mechanisms.

With site selection carefully controlled by accredited competent certification companies, an international protocol for Monitoring, Reporting and Verification could be developed. The procedures outlined in the 2006 IPCC GHG Inventory Guidelines would provide a useful framework for developing this, as described above.

Funding for the development of the standard and assessment process could come directly from CCS project developers or through the UN via a levy on CCS projects.

The EU has already tackled many of these issues in its regulations and guidelines for qualifying CCS projects for EU allowances under the Emissions Trading Scheme, including the proposed introduction of a Scientific Committee to oversee storage site selection.

4. CCS financed through special funds.

Applying a global carbon price to the CO_2 stored in CCS projects will help incentivise lower cost CCS opportunities and will provide ongoing support suitable to the long-term nature of CCS investment. However carbon prices in the near to medium term are expected to be insufficient to bring CCS projects into fruition, especially in the case of large scale demonstration of CCS in the power sector. Additional funding will be necessary as has been implemented in Europe through the provision of double allowances in the EU-ETS and extra funding from the economic recovery package. Other special arrangements to kick start CCS investment exist in UK, USA, Canada and Australia. On a global scale, it is important that this funding be linked to the international agreement on climate change for post-2012.

A number of ways that this funding could be structured are explored here. This is a qualitative assessment of the principles behind various proposed market mechanisms for CCS support and does not aim to quantify the likely effectiveness of each potential option.

4.1 Central fund options

4.1.1 Levy on international carbon transactions

This could operate in a similar fashion to the adaptation fund established by the UNFCCC and would effectively be an international tax on all UN-supported carbon credit transactions. This would be used to finance specific CCS projects in designated countries and could then be allocated to projects in a number of possible ways:

- Through a reverse auction bid process whereby the UNFCCC agrees to allocate funding per tonne stored for a verified CCS project. A fixed price would be offered, for example €40/tonne, and projects could bid to receive it, on top of standard carbon credits, if developers think that the support will be sufficient. The offered price could be made flexible and decreasing over time as technology costs fall, with a varying quantity of finance available at different price levels.

- Through a contract-for-differences type of procedure where project developers apply for an extra carbon support based on the expected shortfall between the ‘normal’ global carbon price and the revenue level required to make each project viable; this could possibly be demonstrated using an investment analysis similar to current CDM practice.

4.1.2 Global Climate Change Fund

This would comprise a central fund financed by developed countries in place of or in addition to accepting deeper targets than they anticipate being able to achieve through domestic abatement. Payment into the fund would replace direct purchase of offsets from developing countries in the way that a deep target would currently be expected to be met via the Kyoto flexible mechanisms. In this case the fund could then be used to either purchase and remove credits from the system generally, or could be used to finance demonstration projects in large-scale innovative technology, such as CCS, which could have a ring-fenced proportion of the funds to help finance very early-stage demonstration projects. This could also be linked to the Sequestration Unit currency described in Section 5.3 below, should that option gain international support.

4.2 UN recognition of bilateral or multilateral funding

Public finance for specific CCS projects could also be provided through bilateral agreements between Governments or through finance from multilateral organisations and development banks. In most cases these funds will be competing with other climate change actions and so recognition of CCS projects by the UNFCCC as legitimate recipients of financing of mitigation effort could be crucial to ensuring that worthwhile CCS projects receive funding. If such projects are not seen to qualify as part of rich countries' obligations to fund mitigation actions in developing countries under the agreement, then funding may well be channelled elsewhere to ensure that those commitments to the UNFCCC are met.

4.2.1 Bilateral agreements

A likely pillar of any agreement at Copenhagen will be an agreement on how to finance and account for so-called Nationally Appropriate Mitigation Actions (NAMAs) undertaken by developing countries with rich country support. A number of bilateral agreements for large climate change mitigation projects have been proposed between richer countries under Annex I of the UNFCCC and specific developing countries. One example is the possible further development of the NZEC (Near Zero Emission Coal) project between the EU and China. Recognition of the latter stages of this project as a bilateral NAMA under the future UNFCCC agreement would have a triple effect: counting towards the respective commitments of both the EU and China under the climate deal AND securing significant public financing for a major CCS project in an advanced developing country. This could also provide a workable model for future projects.

4.2.2 Financing from multilateral institutions and development banks

Another potential channel for large-scale financing for CSS is through development banks including the World Bank and regional entities such as the Asian Development Bank (ADB). For example, the ADB recently announced a $21.5m fund with GCCSI in Australia[5]. Although this small fund is intended for studies and capacity building to facilitate the deployment of CCS in Asia, future larger agreements for CCS project financing through the Development Banks could also be recognised as contributing to mitigation efforts under the international climate change agreement.

[5] http://www.environmental-expert.com/resultEachPressRelease.aspx?cid=27279&codi=59126&lr=1

5. Recognising CCS in the global carbon market

In addition to the public financing sources outlined above, CCS must also be recognised as a GHG mitigation option that qualifies under future international carbon market frameworks. Although this will not be sufficient to finance early demonstration CCS projects in the power sector, it could bring forward immediate projects in the oil and gas sector and is crucial to the long-term future of CCS as an abatement option and must be in place as soon as possible to build up confidence in the market.

5.1 Inclusion of CCS projects within a reformed CDM

In a reformed CDM, CCS projects would earn carbon credits such as Certified Emissions Reductions for each verified tonne of CO_2 stored. Allowing CCS to be credited in international carbon markets raises some particular issues in addition to those identified in Section 3 above. This section looks briefly at possible solutions to the issues raised and what modifications to CDM would be required to implement those solutions.

None of the issues identified provides an insurmountable barrier to crediting CCS within a CDM-type project-based carbon credit system and we envisage the basics of a reformed project-based CDM offset mechanism that can comfortably credit CCS projects should carbon credits make enough difference for project economics to become viable.

Supply and demand of credits

An issue sometimes raised is that the size of potential CCS projects could mean that, were they to be credited with fully fungible international carbon credits, there could be a destabilising effect on the carbon market with a large increase in supply but no increase in demand from buyer countries and companies. This fear is largely unfounded. A comprehensive study by the IEA[6] has shown that the market effect is likely to be minimal. In the long-term after 2020, caps on buyer countries could be tightened to allow increasing numbers of CCS projects to enter the market.

Demonstrating 'additionality'

A key concept in current CDM is project-by-project proof that emissions reductions are additional to business as usual. This concept would need to be redefined post-2012, not only for CCS but in order to reduce crippling bureaucracy and ever increasing transaction costs for all project types. The CCSA recognises that CDM overall needs reform to make it more efficient and effective. The prohibitive costs of CCS projects, and particularly power sector projects, mean they are unequivocally additional.

Development of eligible technology lists per region would allow certain technologies to qualify for CDM without individual project additionality analysis. For CCS, this would remove the problem of perverse incentives for inefficient power generation because the specification of power generating equipment could be stipulated in the stipulated technology list.

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[6] http://www.ieagreen.org.uk/glossies/2008-13.pdf

Business-as-usual baselines are also calculated on a project-by-project basis which is often laborious and may prevent the scale-up of the CDM and extension to sectors such as CCS. In a reformed CDM, baselines could be pre-calculated based on the whole sector in a certain country and any project improving on this performance level would be considered as demonstrating an additional emissions reduction. This approach maintains a direct incentive on individual projects, in contrast to the full sectoral crediting proposals described below.

Certification and Monitoring, Reporting and verification

These issues are discussed under governance in section 3 above. As with all carbon credit projects, CCS projects would have a burden of proof to show that each credit received correctly accounts for one tonne of CO_2 equivalent avoided. In any CCS project, the total CO_2 stored would not be the same as the total CO_2 avoided, as a full carbon balance calculation would be carried out to account for emissions occurring in the capture, transport and injection process, through energy use and potential minor leakage. In this respect CCS projects would be no different to any other CDM project

Long-term value of carbon credits

The small chance of CO_2 escaping from a long-term storage site has been raised as a particular concern in the context of crediting stored CO_2 for its carbon value. If CO_2 escapes that was credited some years previously, it may be hard to hold the project operator or owner accountable for the leak that in effect devalues the carbon credits that were issued earlier. Long-term liability for the storage site rests with the national Government in their national inventory. In the highly unlikely event of such a leakage occurring after responsibility has passed back to the Government, the balance of credits could be made up from the national account. Although this places greater administrative and legal burden on the host country, it also ensures maximum clarity on liability and ensures that should any seepage occur, these emissions will remain in a future national inventory. It is conceivable that funds could be made available to facilitate this process in developing countries through the public financing mechanisms described in Section 4.

A reformed CDM should not deal with CCS by issuing temporary CERs or inflating or deflating the number of CERs allocated relative to each tonne of CO_2 safely stored. Such a step away from the concept of all tonnes being equal would be very detrimental to the integrity, transparency and user-friendliness of the carbon market. The severe lack of registered forestry projects in the CDM to date highlights that temporary CERs (tCERs) have been shown to be largely unworkable in a market situation.

Conclusion on reformed CDM

This brief analysis of CDM issues shows how reform to the CDM process could allow CCS projects to be credited under a project-based CDM system should this be the enduring international carbon credit mechanism after 2012. An approach based on current CDM but using sector-wide pre-established baselines could be a particularly effective option.

However, the cost of CCS demonstration projects in the power sector means that CDM finance alone will be unlikely to provide sufficient support to make projects economically viable. An exception to this could be the application of CCS to natural gas processing projects in developing countries – these projects could fit with the proposed selection criteria described and carbon credit sales could in some cases make projects financially attractive to industrial developers.

5.2 CCS credited within a sectoral mechanism

There are a number of proposals currently being considered in the UNFCCC process for how emissions reductions could be encouraged through sector-specific approaches.
The proposals are not covered in detail here as extensive analysis has been carried out elsewhere, for example by the IEA[7]. This paper focuses on how the approaches could lead to crediting of CCS projects; CCS is an unusual case because it is not limited to a single industry sector as likely to be defined by the UNFCCC. The different applications of CCS described in Section 1 cut across many sectors and the technical and financial challenges facing CCS differ greatly between these sectors.

Although the definition of sectoral boundaries is complex and not yet clearly established, it is unlikely that CCS should be considered as a sector in itself. As such CCS could be treated differently under different sectors which may be an effective way to provide different levels of support to CCS given the heterogeneity of the cost and specification of CCS across different applications.

Sectoral approaches to valuing emissions reductions can be mapped on two basic axes: the metric for measuring emissions (emissions intensity or absolute emissions) and the type of crediting process (either *ex ante* allocation of allowances or *ex post* issuance of credits). This paper looks at the position of CCS within two types of sectoral approach: emissions intensity with *ex post* sectoral crediting and absolute emissions with *ex ante* allocation and trading. The latter is akin to a cap-and-trade scheme such as the EU-ETS or the proposed Carbon Pollution Reduction Scheme (CPRS) in Australia.

5.2.1 Sectoral crediting mechanism based on emissions intensity and *ex post* credits

This system would involve establishing an intensity metric for each sector based on a key unit of output, such as tCO_2e/MWh or tCO_2e/tonne production. A projected baseline would then be set on a national or regional level using historical data and a stretch target defined for an agreed reduction in emissions intensity for the sector as a whole. If the sector as a whole exceeds the target, credits would be allocated to the Government to distribute amongst good performers within the sector. The target would be set at a level that goes beyond improvements attributable to current policies and measures, and could be set at an even tougher level that goes beyond further measures in which the host country would be supported through international finance. In this way the scheme goes beyond offsetting; business-as-usual emissions performance must be bettered *before* any international credits can be sold.

[7] http://www.oecd.org/dataoecd/8/7/42875080.pdf

The target level in each sector determines volume of credits available to the sector as a whole, but the price, and therefore total funding level, will be set by demand for credits arising from global markets. Assuming that credits between sectors are fungible, this will be outside of the control of any particular Government or sector.

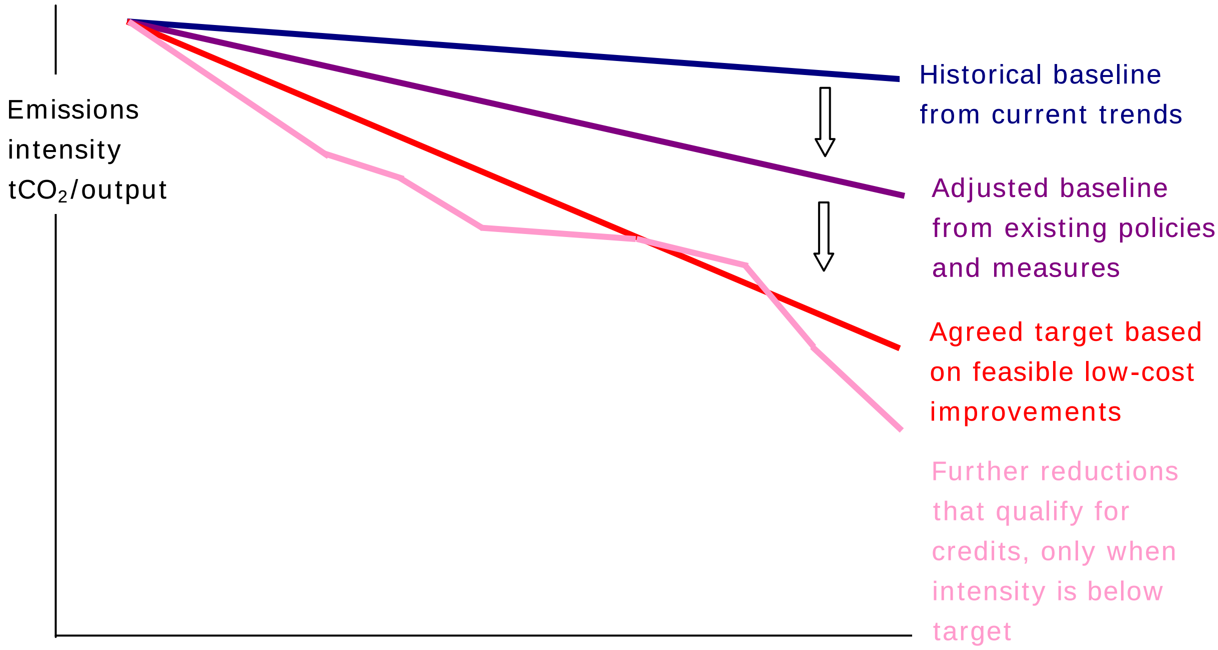

Figure 3: Illustrative representation of sectoral crediting targets, adapted from IEA 2009[8]

Advantages of such an approach are that targets can be politically acceptable because of their ‘no-lose’ nature and that the approach provides a clear path for a transition from current CDM to future sectoral caps. A key disadvantage is that the central crediting of Governments takes away from private businesses the visibility of a direct incentive and in some cases bad performers in a sector will neutralise any actions taken by progressive installations. In addition there is an onerous data requirement from the entire sector if a single sectoral performance figure is to be calculated. This also requires historical data to be available for calculating the projected baseline.

However, the impact of these disadvantages will vary significantly by sector, and the benefits to CCS under such a proposal would also depend very much on the sector involved.

Power Sector

Power sector benchmarks would be set as tCO_2/MWh of electricity produced and could be fixed or dynamic and weighted more towards existing or new plant performance. In many countries the power sector comprises mainly large installations, often under state ownership, which means that data availability may be stronger. This also mitigates the risk of the credit supply being controlled by the Government, because the smaller number

[8] http://www.oecd.org/dataoecd/8/7/42875080.pdf

of players means there will in most cases be more visibility over how well the sector as a whole is performing, how many credits will be available in total, and how those credits should be allocated by the Government once they are issued. However, the setting of the baseline and no-lose target will likely be a contentious issue and subject to international negotiation.

Key supply-side mitigation options in the power sector are fuel switch, new build and, potentially, retrofit of CCS to existing stations. The sectoral target would be designed to ensure that low- or negative-cost abatement options do not benefit from carbon credits when they may be economically viable without support. However, actions that do not fall into existing national policies cannot be easily categorised under such a scheme. Unless the Government were to guarantee funding in advance – if it were confident that the sector as a whole would exceed the target and therefore credits would be available – then there would be no guarantee to potential investors that carbon finance will be available to any particular project. This is particularly important for large-scale, high-cost technologies such as CCS. The volume of credits available and the international price of credits would both be critical. The former cannot be guaranteed because it depends on the performance of the entire sector in the country in question. The latter cannot be guaranteed because it depends on demand for credits on world markets.

CCS in the power sector is such an expensive abatement option at the current time that it would be very unlikely to be applied to power generation, either new build or retrofit, under such a no-lose sectoral crediting system. In the future, post-2020, if CCS costs have fallen into line with other abatement options then at that time CCS could be stimulated by sectoral crediting in the power sector. However, by 2020 many countries are expected to have moved beyond sectoral crediting to a sectoral trading system as described in section 5.2.2.

Energy-intensive industries

Application of CCS to heavy industry is also a very high-cost, though effective, mitigation option. It is therefore likely to suffer the same problems as for the power sector above, with the added complication that the performance of the sector is likely to be much harder to predict because of the larger number of installations and diverse range of mitigation possibilities. The twin problems of data and finance uncertainty therefore make industrial CCS very unlikely to be stimulated by such a crediting mechanism in the near-term.

Oil and gas sector

Natural gas processing projects are one example of a CCS application that may be viable through such a sectoral crediting mechanism. Mitigation options in the upstream oil and gas production sector are relatively limited and there is likely to be reasonably good visibility of participants in the sector. Furthermore and as described in the CDM section above, the projects are likely to be closer to financial viability and so developers may accept greater levels of risk if carbon finance is not guaranteed in advance due to uncertainty in the sector's performance as a whole.

5.2.2 Sectoral trading mechanism based on absolute emissions and *ex ante* allowances

Under this mechanism a country will set a fixed cap on the absolute emissions of a specific sector, or a number of sectors, and distribute allowances to individual installations accordingly. This is a similar concept to current cap-and-trade schemes such as the EU-ETS. The outlook is very different to sectoral crediting. Emissions permits become an asset to be managed in advance of investment decisions. The volume of 'spare' allowances that will be made available through mitigation options can be calculated based on the allocation plan and the expected performance of each mitigation action within the installation.

The impact on CCS would therefore be similar to that in the EU-ETS for European companies, depending on the allowed level of offsets in the sectoral scheme in question – i.e. if the capped sector can buy credits from outside of the cap to reduce its requirement for domestic abatement. Assuming that most capped sectors will allow for a certain level of offsets, it is unlikely that a trading scheme alone would be sufficient to incentivise CCS in the power or heavy industry sectors, as has been the case in Europe. The only exception to this would be if there was a general high confidence in a long-term carbon price significantly higher than currently expected, which is an unlikely scenario. Again, it is difficult to see how a sectoral trading scheme alone could provide sufficient incentive to stimulate high-cost CCS demonstration projects in the power or heavy industry sectors before 2020. Natural gas processing projects could prove viable such as has been shown in Norway with the Sleipner project guaranteed by a strong carbon price in the form of a tax.

5.3 CCS credited by an "avoided CO_2" mechanism

This mechanism would be designed specifically for CCS projects. It would allow the incentive to be based on CO_2 permanently *stored* rather than CO_2 *abated* which could then allow definitions to be specifically applied to the unique challenges of CCS, such as those described above. This would also mean that qualification criteria could be designed that would not require CCS to go through elaborate additionality and other proofs to qualify for CCS-specific crediting. It would be a means of guaranteeing the effective long-term storage of CO_2 by demonstrating adherence to international standards.

A new credit unit would therefore be introduced based on a unit of stored CO_2. This could then be used in a number of ways to link to the international carbon market. It could be used simply as a guarantee of reliable permanent storage. In this way normal carbon credits would be issued to the project based on the net carbon abated – through CDM or a successor – and special carbon storage certificates would be allocated for each tonne stored, purely as an indication of safe storage. This would then be attached to the carbon credits and would be traded with them as a guarantee. The benefit of this system is that the specific burden of proof for safe storage of CO_2 is kept separate from the standard UN carbon credit system.

Alternatively, projects that are not financed by carbon credits but which are subject to regulation – such as emissions performance standard (EPS) – could purchase the special carbon storage certificates on the international market in order to meet their EPS requirement; a similar system could be used where entities within an EPS could only purchase carbon storage units from other organisations within the same regulated system. This would be one way to maintain the EPS as a plant-level obligation, rather than a portfolio average obligation, but to facilitate the use of CCS within the network by allowing trading of carbon storage certificates.

Disadvantages of this system would be the added complication and confusion of a new carbon unit and the need for a new certification system to guarantee the integrity of the CO_2 stored; this could be achieved through a new certification body such as that described under the CDM section above. Furthermore the carbon storage units may need to be restricted to the power sector to avoid the linking system becoming prohibitively complex. Stringent domestic policy must also be designed to ensure that there is no perverse incentive to generate more CO_2 for storage.

The system would likely require a new certification process, with operators holding specialist skills in CCS, to oversee the award of storage certificates. This could be developed under the governance model proposed in Section 3 above.

6. Conclusions and CCSA recommendations

The above analysis draws two broad conclusions for required action if CCS is to fulfil its potential as a major international greenhouse gas abatement technology:

- The high development costs for early-stage CCS demonstration projects in most sectors means that CCS **must** attract further funding from the UNFCCC system, be it through structured funds, levies or special allocation of national allowances
- CO_2 stored through CCS **must also** be credited as emissions reductions in a post-2012 climate change agreement, be this through a modified project-based mechanism, a sectoral mechanism or other approach

Many of the barriers to implementing internationally-supported CCS projects could be mitigated through the existence of a strong international regulatory system for CCS technology. This could be developed through establishment of a strong monitoring, reporting and verification (MRV) protocol based on the existing IPCC GHG reporting guidelines and development of a new accreditation standard for CCS technical competency which would be used to develop an international network of accredited certification companies. The establishment of such a system should be a priority for the international CCS community.

Whichever mechanisms prevail from the international negotiation process running up to and beyond Copenhagen, CCSA would like to draw the attention of policy makers to the implications that the various options may have on successful CCS deployment and its potential contribution to global GHG mitigation. As the new agreement takes shape the analysis will be further refined following discussions with industry participants, national delegates and UN representatives.

The view expressed in this paper cannot be taken to represent the views of all members of the CCSA. However, they do reflect a general consensus within the Association.

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