GLOBAL CCS INSTITUTE

MAKING THE CASE FOR FUNDING CARBON CAPTURE AND STORAGE IN DEVELOPING COUNTRIES

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Key messages

1. Approximately US$100 million has been contributed by the United Kingdom (UK) and Norwegian Governments to finance carbon capture and storage (CCS) pre-investment and enabling activities in developing countries[1] in response to a call for $150-200 million[2] made at the April 2012 London CEM 3.
2. A further $50-100million is needed to fulfil the call for funding for CCS pre-investment and enabling activities in developing countries.
3. Nevertheless, there is more than $112 million available for pre-investment and enabling activities from CCS specific Trust Funds and capacity development programs; which is particularly relevant for developing countries with large fossil fuel based emissions.
4. In the medium term $5 billion will be needed for the incremental CCS costs of construction and operation of initial demonstration projects in developing countries. Funding contributions to this $5 billion may increasingly come from donor governments' development aid budgets, highlighting the need to identify the development impacts of CCS funding.
5. Investment in CCS demonstration projects is needed now to facilitate widespread deployment in the future so as to reap the benefit of deep emissions cuts, and therefore contribute to avoiding catastrophic impacts of climate change on the world's poor.

This report provides an update for CEM Ministers regarding the progress of recommendations made in the report *Funding Carbon Capture and Storage in Developing Countries* tabled at the April 2012 London Clean Energy Ministerial (CEM). It includes a 'Template Business Case' that identifies the links between funding for CCS and development impacts, which may be a useful reference document for donor countries.

Background

At the Abu Dhabi Clean Energy Ministerial (CEM) in April 2011, the Carbon Capture Use and Storage Action Group (CCUS AG) tabled a report with eight recommendations. Recommendation 2 was "to identify and advance appropriate funding mechanisms to support the demonstration of large-scale CCS projects in developing economies".

Following the 2011 CEM meeting the Global CCS Institute (the Institute) agreed to coordinate with the World Bank, Asian Development Bank (ADB) and World Resources Institute (WRI) to investigate the CCUS AG's Recommendation 2. This work was undertaken in consultation with the Clinton Climate Initiative, International Energy Agency (IEA) and UK and Australian Governments.

This Working Group tabled the report *Funding Carbon Capture and Storage in Developing Countries*, at the 2012 CEM meeting. The recommendations put forward in that report were:

SHORT TERM

1. **Donor countries to provide funding in the order of $150-200 million primarily for CCS enabling and pre-investment activities in developing countries, through topping up existing dedicated CCS funding programmes.**

   Existing dedicated funds and programmes which are able to easily accommodate such funding include:

   - Asian Development Bank's *Carbon Capture and Storage Trust Fund;*

1 For this report, the term 'developing countries' will be used to refer inclusively to all Non-Annex I countries under the United Nations Convention on Climate Change (UNFCCC).

2 Unless otherwise stated all dollar references are in US dollars.

- Carbon Sequestration Leadership Forum's *Capacity Building Fund;*
- Global CCS Institute's *Capacity Development Program;* and
- World Bank's *CCS Capacity Building Trust Fund.*

2. **Donor countries seek to lift the exclusion of CCS in the Clean Technology Fund.**
3. **Donor and developing countries to engage in bilateral and/or multilateral project support.**
4. **Developing countries to seek complementary funding for capacity building activities under the Global Environment Facility.**

MEDIUM TERM

1. **Donor countries to provide dedicated CCS funding in the order of $5 billion for the 'extra' CCS costs of construction and operation of demonstration projects in developing countries.**

   The Working Group has identified a number of potential vehicles through which funding can be channelled (listed below). Given the aim is to consolidate $5 billion of funds, it is therefore important that there is consensus between donor countries on which funding vehicle is preferred:

   1. Dedicated CCS funding window within the Green Climate Fund (noting that this is ultimately a decision for the Green Climate Fund Board).
   2. Portfolio approach to funding a range of technologies within the Green Climate Fund, with CCS included as a component of the portfolio (noting that this is ultimately a decision for the Green Climate Fund Board).
   3. Establish a new dedicated CCS Fund with its own governance arrangements, but which counts towards a country's climate funding commitments.
   4. Top up existing dedicated CCS trust funds or programmes and make any changes to criteria to accommodate project support funding, and ensure it counts towards a country's climate funding commitments.

In order to justify funding contributions in response to these recommendations, donor governments need a strong business case, or intervention justification. It is anticipated that increasingly funding for climate change will come from development aid budgets. Therefore the donor governments' business case, or intervention justification, will need to make the link between deep cuts in emissions that CCS can deliver and the resulting longer term developmental impacts.

If the basis for funding can be established, questions then arise on the preferred form/s of such funding, which sources should be used, which funding vehicles should be utilised, and how to help developing countries gain awareness of and access to such funds: issues that were raised for further action in the *Funding Carbon Capture and Storage in Developing Countries* report.

In response to this, the Global CCS Institute, drawing on consultation with CCUS AG governments and Working Group members, was asked to address the following themes in this follow-on report:

- <u>progress against the recommendations</u> made in the Working Group report, including mobilising funding (addressed in 'Progress against Recommendations' section);
- <u>a template 'business case'</u> to assist in mobilising funding which includes how CCS impacts sustainable development goals (addressed in the 'Template Business Case' section);
- <u>identify any impediments to either providing or receiving funds</u>, with recommendations on how to overcome such impediments including guidance for both donors and recipients (addressed in the 'Impediments to Funding' section); and
- <u>progress on improving access for CCS to international funding vehicles</u> (also addressed in the 'Progress Against Recommendations' section regarding the Clean Technology Fund and Global Environment Facility).

Progress against recommendations

Short term recommendations

1. *Donor countries to provide funding in the order of $150-200 million primarily for CCS enabling and pre-investment activities in developing countries, through topping up existing dedicated CCS funding programmes.*

In response to this recommendation the UK announced £60 million (~US$97 million[3]) for CCS in developing countries at the London CEM meeting. The Norwegian Government made an additional contribution of NOK15 million (~US$2.66 million) in December 2012, adding to their two previous contributions to the World Bank CCS Trust Fund. The UK has channelled its contribution through the ADB (£35 million, ~US$57 million) and the World Bank (£25 million, ~US$40 million).

However, it should be acknowledged that since 2009 a number of governments and organisations have collectively contributed or allocated hundreds of millions of dollars to current and future activities in developing countries to support CCS knowledge sharing, capacity development, and project development in some form. Organisations and countries that have contributed significant funds in this space include the European Union (EU), the Australian Government, the Global CCS Institute, the Norwegian Government, the UK Government and the United States (US) Government. These funding contributions have been channelled through:

- the Global CCS Institute, where all activities are either directly or indirectly aimed at knowledge sharing, capacity development, project development or raising awareness and advocating for CCS, particularly in international forums;
- bilateral and multilateral projects; or
- contributions to organisations that in turn undertake CCS outreach activities, such as: Asia-Pacific Economic Forum (APEC); Bellona; Clinton Climate Initiative (CCI); Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC); Energy Research Centre of the Netherlands (ECN); International Energy Agency (IEA); and United Nations Industrial Development Organisation (UNIDO).

$138 million of this funding has been contributed to CCS Trust Funds or capacity development programs to support pre-investment and enabling activities as detailed in Table 1 below.

Table 1: Funding allocations for CCS in developing countries

FUND/PROGRAM	CONTRIBUTORS	ALLOCATED CONTRIBUTIONS (US$)[1]	FUNDS STILL AVAILABLE (US$)[2]	FUNDING FOCUS
Asian Development Bank (ADB) CCS Trust Fund	• Global CCS Institute • UK Government	74 million	67 million	The ADB fund focuses on China, India, Indonesia, and Viet Nam.
Carbon Sequestration Leadership Forum (CSLF) – Capacity Building Fund	• Global CCS Institute • UK Government • Norwegian Government • Canadian Government	2.96 million	514,000	The CSLF Fund focuses on the emerging economy CSLF member countries including: Brazil, China, India, Mexico and South Africa.
EuropeAid Grant Programme for Cooperation on clean coal technology (CCT) and carbon capture and Storage (CCS)	• EU Government	Up to 4 million	0 (call for proposals closed)	The Grant Programme targets India, Indonesia, Kazakhstan, the Russian Federation, South Africa and Ukraine.

[3] Exchange rate from 17 December, 2012 utilised, but actual amount will depend on the date money is transferred, which may be done in tranches.

Global CCS Institute Capacity Development Program	• Global CCS Institute • US Government	3 million[3]	Program ongoing	The Global CCS Institute's capacity development countries of focus include: China, India, Indonesia, Malaysia, Mexico and South Africa. In addition capacity development support has been provided to Brazil and Trinidad and Tobago.
The World Bank Group CCS Trust Fund	• Norwegian Government • UK Government • Global CCS Institute	54 million	$44 million	To date support has been provided to: Botswana, China, Egypt, Jordan, Kosovo, Maghreb, Mexico and South Africa.

1. Actual final amounts are subject to exchange rate variation, so these should be considered as rounded estimates.
2. As at March 2013. These figures should be considered as rounded estimates, and it should be noted that there are projects in the pipeline that will call on some of these available funds.
3. For the Global CCS Institute Capacity Development Program funds shown are only those expended (but not funds allocated to out-years).

The UK's £60 million (~US$97 million[4]) and Norway's NOK15 million (~US$2.66 million) represent the key contributions in response to the call for $150-200 million of funding in the *Funding Carbon Capture and Storage in Developing Countries* report. It was recommended that the focus of this funding be on pre-investment and enabling activities. Pre-investment and enabling activities can take a number of years to develop; much of them are country-specific and it is essential to undertake them in advance of large scale demonstration projects.

While the contributions from the UK and Norwegian Governments in response for the call for further funding are a very generous on-going commitment, a further $50-100 million is required to fulfil the recommendation.

2. Donor countries seek to lift the exclusion of CCS in the Clean Technology Fund.

As was stated in the *Funding Carbon Capture and Storage in Developing Countries* report, CCS is currently not eligible for Clean Technology Fund (CTF) co-financing because it has been deemed as being in the pre-commercial stage. The report goes on to note that a case could be made for making amendments to allow CCS to qualify for CTF funding, especially given CCS has been proven at scale, has now been accepted as an eligible low emissions technology in the Clean Development Mechanism (CDM), and is also recognised as an essential low emissions technology by the IEA and the Intergovernmental Panel on Climate Change (IPCC).

Although CCS is not excluded explicitly from obtaining CTF funding, to date only renewable energy and energy efficiency investment proposals and projects have been approved by the CTF. Allowing CCS to obtain funding under the CTF may stimulate some early-mover pilot or demonstration scale projects, in advance of similar levels of financing under the Green Climate Fund. In addition making amendments to include CCS under the CTF could set an important precedent in ensuring CCS is provided the same funding opportunities that other low emission technologies have enjoyed.

The World Bank, which administers the CTF on behalf of the donors, has advised that the request for reassessing the current status of CCS in the CTF would have to come from one of the Member countries.

It is therefore suggested that one or more governments which are members of both the CCUS Action Group and the CTF, approach other CTF country representatives regarding a re-consideration of CCS within the CTF.

[4] Exchange rate from 17 December, 2012 utilised, but actual amount will depend on the date money is transferred, which may be done in tranches.

3. Donor and developing countries to engage in bilateral and/or multilateral project support

This recommendation was made to recognise a viable alternative to providing funding through topping up existing and dedicated CCS funding programs in the short term. Some countries have already adopted this approach. For instance:

- the China-Australia Geologic Storage of CO_2 (CAGS) project developed CCS technical skills in both Australia and China through a number of capacity building and research programmes which were completed in 2012 (Geoscience Australia, 2012);
- the Cooperation Action within CCS China-EU (COACH) project is aimed at preparation for implementation of "large-scale polygeneration energy [CCS] facilities with options for coal based electric power generation as well as production of hydrogen and synthetic fuels" (COACH, 2007);
- the EU has provided financial support for the TREC-STEP Capability Leverage Programmes in Clean Coal Technologies and CCS in India. This project aims to organise a series of knowledge sharing activities aimed at the Indian thermal power players, policy makers, entrepreneurs and innovators, and academics (TREC-STEP, 2011);
- China Huaneng Group built its first experimental carbon capture pilot plant capturing 3000 tonnes of CO_2 a year at the Huaneng Beijing Thermal Power Plant. This was a project under the Sino-Australia Clean Coal Working Group, specified in the Joint Declaration on Climate Change and Energy between the Chinese and Australian governments signed in 2007. The Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) provided technical support for this project. Based on this success, the Australia-China Joint Coordination Group on Clean Coal Technology has recently allocated further funding to undertake a feasibility study for an industrial-scale post combustion capture project with storage in China;
- UK-China Near Zero Emissions Coal (NZEC) the objective of which is to demonstrate advanced, near zero emissions CCS coal technology through a three stage approach: 1) exploring options and capacity building, 2) investigate storage and capture options and 3) construct a demonstration plant (AEA Group, 2007);
- in November 2009 the US and China entered into a bilateral joint research and development program called the US-China Clean Energy Research Centre. This includes, among other research projects, development of CCS technology (Energetics Incorporated, 2013);
- in 2011 the Research Council of Norway provided NOK 18 million for clean energy and CCS projects between Norwegian and Indian partners, under the auspices of the Large-scale Programme Clean Energy for the Future (RENERGI) (Olsen C.R. and Lie, E., 2012);
- Natural Resources Canada (NRCan), the Mexican Ministry of Energy (SENER), and the US Department of Energy (US DOE) collaborated to produce the North American Carbon Storage Atlas (NACSA), which was produced under the leadership of the North American Carbon Atlas Partnership (NACAP) (NRCan et al, 2012); and
- the South African Centre for Carbon Capture and Storage (SACCCS) was established to drive CCS activities in South Africa. "It undertakes CCS research and development and capacity building (both human and technical) to attain a state of country readiness for the implementation of CCS in South Africa." SACCCS has received financial support from both the UK and Norwegian Governments, as well as the South African government and other company sponsors (SACCCS, 2013).

More recent bilateral collaborations include the following:

- the Japanese and Indonesian governments have indicated their intentions to collaborate on enhanced oil recovery (EOR)-CCS as a way to contribute to mitigating Indonesia's greenhouse gas emissions (RITE, 2011);
- in addition, "Mitsubishi Heavy Industries, Ltd. (MHI) and Mitsubishi Corporation (MC) have agreed with the Indonesian government to collaborate in a large-scale substitute natural gas (SNG) synthesis project utilizing Indonesia's abundant low rank coal (LRC) which is conducted by MHI/MC and Indonesian partners (government institution and private company), as a follow up of Indonesia-Japan Energy Round Table held in November 2010. A feasibility study (F/S) has already gotten under way with support from the Indonesian and Japanese governments" (Mitsubishi Corporation, 2011); and

- an announcement has been made on a US-India Low Carbon Growth Working Group, which reportedly includes "further cooperation in the utilisation of carbon dioxide, released through carbon capture and sequestration (CCS) in alternative uses, such as fertiliser manufacture, enhanced oil recovery (EOR) and other such methodologies in order to make CCS commercially viable" (Kumar, A., 2012).

These bilateral and multilateral arrangements indicate that these two approaches remain a viable option for supporting CCS in developing countries. Donor countries have to weigh the benefit of these approaches against the benefit of other funding approaches, such as consolidating funding in CCS specific Trust Funds or programs.

4. *Developing countries to seek complementary funding for capacity building activities under the Global Environment Facility.*

As reported in the *Funding Carbon Capture and Storage in Developing Countries* report, CCS was initially listed as an eligible technology for funding under the Global Environment Facility (GEF), but is no longer listed. However, this does not necessarily preclude CCS. The Renewable CO_2 Capture and Storage from Sugar Fermentation Industry in Sao Paulo State (RCCS) project in Brazil sought GEF funding, however this did not eventuate.

Feedback suggests that the GEF is well structured to deal with projects championed by developing country governments, and not as well structured to deal with projects championed by the private sector. This feedback indicates that smaller capacity development projects championed by governments are perhaps better suited to GEF funding. However, given that there are other CCS-specific Funds or Programs for capacity development where the managers are well versed in CCS (such as the ADB CCS Trust Fund, CSLF Capacity Building Fund, Global CCS Institute Capacity Development Program, World Bank CCS Trust Fund) developing countries may find it easier to seek funding from these CCS-specific funds.

Medium term recommendation

5. *Donor countries to provide dedicated CCS funding in the order of $5 billion for the 'extra' CCS costs of construction and operation of demonstration projects in developing countries.*

This is a medium-term recommendation and funding for 'extra' (or incremental) costs of CCS construction and operation should follow funding for pre-investment and enabling activities. However, it may be the case that funding allocated in the short term, for the pre-investment and enabling activities, could be utilised for some aspects of project demonstration. For instance, funding from the ADB and World Bank CCS Trust Funds can be utilised for pilot scale projects.

The Template Business Case (discussed below) focuses on providing generic justification for funding CCS costs that donor countries might find useful to make the case for contributing to this $5 billion for CCS in developing countries.

Template business case

Donor countries seeking funding for CCS in developing countries, in response to the recommendations above will need to make a 'business case' to justify the expenditure. Both the UK and Norway have already developed business cases to secure funding for CCS capacity development and pre-investment activities for their contributions to the ADB and World Bank CCS Trust Funds. The UK Department of Energy & Climate Change has published their *Business Case and Intervention Summary: Carbon Capture and Storage Accelerating Developing Country Deployment* in March 2013 (DECC, 2013).

The Template Business Case found at **Appendix 1** is therefore provided as a generic justification for funding the extra costs of construction and operation of CCS demonstration projects in developing countries (linked to the medium-term recommendation above). However, some arguments may also be relevant for justifying funding for CCS pre-investment and enabling activities.

Donor countries will have their own formats and funding criteria that they will need to address for their own business case/funding justification requirements. For instance, a donor country Treasury may require a 'benefit cost ratio' analysis that is aimed at 'monetising' the benefits (e.g. impact of demonstration on wider deployment of CCS, poverty alleviation through avoidance of climate change,

CO_2 emissions avoided, energy security, skills development, job creation or job preservation) to compare against the proposed cost. This benefit cost ratio analysis could be done for an example CCS demonstration project, and would require detailed modelling. Translating environmental, policy and social impacts into a monetary equivalent is challenging. This is especially the case given that the quantified benefits of a CCS demonstration project will be very site specific and therefore hard to generalise, and experience suggests the analysis is very sensitive to discount rates used. This approach is nevertheless a useful decision-making tool.

The Template Business Case found at Appendix 1 can provide some arguments or considerations that may be informative for donor countries when developing their own business cases. The UK International Climate Fund format has been used for this Template Business Case on the basis that it likely covers many aspects or issues that will be relevant to other donor countries.

Overseas development assistance

Increasingly, significant funding for climate change activities (such as CCS) will come from donor governments' development aid budgets. For instance, a number of international contributions to the United Nations Framework Convention on Climate Change (UNFCCC) Fast Start Finance (the precursor to the Green Climate Fund) came from aid budgets. If funding comes from aid budgets, donor governments will most likely want to 'count' this funding in their official aid contributions. The Organisation for Economic Co-operation and Development (OECD) calls this official aid contribution 'overseas development assistance' (ODA). An OECD committee called the Development Assistance Committee (DAC) monitors (among other functions) the reporting of ODA to ensure an international standard of reporting.

The OECD DAC has provided Development Co-operation Guidelines on 'Donor Assistance to Capacity Development in Environment'. This includes donor country assistance for climate change, and therefore for CCS. Donor assistance for *CCS capacity building* (as a climate change mitigation technology) seems to clearly fall within the OECD's Guidelines as counting toward ODA. Both Norway and the UK consider their contribution to CCS capacity building as complying with these Guidelines.

However, the medium-term recommendation for funding in the order of $5 billion for the costs of CCS *construction and operation* of demonstration projects is clearly beyond just capacity building. This has posed the question for some donor countries: can funding for capital and operational expenses for CCS projects be counted as eligible under ODA budgets? This is ultimately a decision for the OECD DAC. Nevertheless, it appears that there is a *prima facie* case that donor country funding for actual CCS projects would be eligible to be counted as ODA.

The DAC defines ODA as "those flows to countries and territories on the DAC List of ODA Recipients and to multilateral institutions which are":

i. *provided by official agencies*, including state and local governments, or by their executive agencies; and

ii. each transaction of which:

a) is administered with the promotion of the **economic development and welfare of developing countries** as its main objective; and

b) is **concessional in character** and conveys a grant element of at least 25 per cent (calculated at a rate of discount of 10 per cent) (OECD, 2013).

On this basis as long as:

- the donor country official agency/agencies provided the funding (which is likely to be the case);
- the funding is administered with the economic development and welfare of the developing country as the main objective (for which a strong argument can be made);
- funding goes to eligible developing country recipients (most developing countries that have indicated an interest in CCS are on the list, with the notable exception of Trinidad and Tobago); and
- there is a grant element of at least 25 per cent (which will need to be specified in the governance arrangements);

then funding for CCS projects should be eligible to be counted as ODA.

The arguable aspect is whether CCS funding for demonstration projects has "economic development and welfare of the developing country as its main objective". A strong case can be made that funding for CCS

demonstrations *is* in the best interest of the developing country. In fact targeting countries that have significant emissions from large point sources (and emissions that are expected to increase from fossil fuel use) is not only for the benefit for the specific developing country, but has a global benefit — given the nature of climate change. This case can be made through CCS's contribution to making deep emission cuts that will help to avoid the devastating impact of climate change in developing countries. There is a number of reports which describe the impact that climate change will have on the economic development and the welfare of developing countries if left unmitigated. The World Bank's report *Turn Down the Heat: Why a 4° World Must be Avoided* is one such report.

The OECD DAC has previously provided advice on a related topic of the Clean Development Mechanism. This advice (below) highlights some important principles:

> We [OECD DAC] confirm our commitment to the Marrakesh agreement as the basis for our consideration. We note that it is the host party's prerogative to confirm whether a CDM project assists it in achieving sustainable development, and that the recipient country will need to approve each project including its source of financing. We agree that the value of any [certified emissions reductions] CERs received in connection with an ODA financed CDM project should lead to a deduction of the equivalent value from ODA, irrespective of whether the CERs are sold or retained by the donor. We also rule out the possibility of counting as ODA funds used to purchase CERs *(DAC, 2004).*

Donor countries could therefore not count any CERs as ODA, and the advice suggests that an important principle will be the host country's view on whether the project contributes to achieving sustainable development.

The Institute suggests that an opinion be sought from the OECD DAC on the eligibility of counting funding for CCS capital expenses as ODA. In addition, donor countries should also seek feedback from recipient countries on utilising ODA budgets for climate change strategies, and CCS projects specifically.

Because donors may prefer their funding contributions for CCS in developing countries to count as part of their ODA commitments, the Template Business Case was prepared with a view to identifying links between the impacts of funding for CCS and development aims.

However, there has been very little research undertaken on the economic and social benefits of CCS in areas such as employment, infrastructure, education and community development. In fact, the only report identified directly on this topic is still in press. It is being undertaken for SACCCS and is entitled *Impacts of Carbon Capture and Storage on South African National Priorities other than Climate Change*. This report will no doubt provide useful suggestions regarding indicators linked to economic and social benefits as well as ways of measuring them. There are, however, a number of reports linking climate change with aspects of the millennium development goals (refer Literature Review Appendix 2).

Impediments to funding

To date only six donor countries have contributed funding to CCS in developing countries, as indicated in the *Progress Against Recommendations* section (recommendation 1) above. These are: Australia; Canada; the European Union (EU); Norway; the UK; and US.

Phone interviews were held with officials from both lead CCS agencies and relevant aid agencies from the Australian, Canadian, Norwegian and UK governments to determine any institutional or other barriers to providing funds[5]. Donor government representatives identified a number of impediments to seeking funding for CCS. These fell into two categories as outlined below.[6]

The following are impediments to seeking CCS funding, but are not *specific* to CCS:

a) *time and effort required to seek interagency sign-off*: large funding contributions generally require interagency approval, and/or Ministerial approval. The process to seek the necessary approvals can take time and effort, usually the preparation of a detailed business case or justification, which can in

5 Semi-structured interviews were utilised for these phone interviews, i.e. officials were asked the same set of questions depending on whether they were from a lead CCS-agency or an aid agency; follow-up questions were adapted to the responses to the initial set of questions. Note that an aid agency official was not interviewed from the UK as part of this process.

6 The impediments were identified by at least one donor government representative. Given the small population of donor countries, all impediments raised have been recorded, noting that not all impediments were experienced or raised by all donor governments.

turn require commissioning special reports. Often large funding contributions come from dedicated programs, where at least the approval process and required justification is known;

b) *commitment to climate change*: the commitment of donor governments to addressing climate change in general will have an impact on funding available to address climate change in developing countries more specifically;

c) *global financial crisis*: the global financial crisis has reduced budgets for overseas spending and may make it more difficult to justify overseas spending domestically; and

d) *climate change not 'priority aid'*: climate change funding is not always regarded by aid agencies as 'priority aid'. Other more immediate development priorities (such as food security, emergency relief, health and education) often overshadow climate change projects. The larger the funding amount being sought (and CCS projects will require large amounts of funding), the greater competition it will face with other aid priorities. The development impacts of climate change projects generally have long lead times and the benefits of one specific project can be difficult to quantify, especially when compared to outputs like food provision, vaccinations, and emergency relief.

Funding for projects that are political or Ministerial priorities tend to be implemented more quickly – assuming the funding is already available, perhaps under an existing program. Identifying 'new' funding can often take a lot of time, and may need to be included in a national budget through a new policy proposal, or require Cabinet level sign-off.

The following are impediments that are specific to CCS:

e) *CCS not a familiar technology*: often large funding commitments need approval from Finance or Treasury Departments, and depending on where the funding budget originates, from Aid Agencies. CCS may not be as familiar to officials in these departments as other low-emission technologies, such as renewables, and therefore may require 'more convincing' or additional evidence. This is particularly since there are common misconceptions regarding CCS, for example around perceived risk and permanence of storage, which these officials may also hold and therefore must be overcome;

f) *focus on 'least developed countries':* there is an increasing focus on 'least developed countries' for climate change funding. These are not the developing nations most likely to be first movers in implementing CCS, nor are they most likely to benefit from large scale deployment of CCS (i.e. they are likely to have fewer large point sources of emissions compared to other developing nations);

g) *CCS may not be identified in mitigation strategies*: some donor countries may require developing countries to have identified CCS as part of their climate change strategies/policies, or as a development priority. Some developing countries will already be able to satisfy this requirement; other countries may not yet have identified CCS formally in their mitigation strategies even though they may be well placed to host a demonstration project if funding were available; and

h) *difficulty in quantifying outcomes from specific donor contributions given real value is cumulative and long term*: it is hard to evaluate the effectiveness of a specific donor country contribution, especially as the donor contribution *alone* will unlikely achieve the desired long term impacts (e.g. of making CCS more economically viable for larger scale deployment). The donor contribution in *conjunction* with contributions from other donor countries and willingness to innovate from the private sector will be needed to achieve the desired impacts. It is also hard to evaluate how funding may be 'additional' i.e. that developing countries would not themselves invest in the technology (especially in the higher income developing countries).

Some of these impediments are wide reaching and addressing them goes far beyond CCS alone, such as the extra challenge/s that the global financial crisis has imposed. However, there are some lessons that can be drawn from being cognisant of these impediments for interested donor countries.

Addressing impediments

Time and effort required to seek interagency sign-off: donor countries are invited to utilise the Template Business Case as a reference for arguments or considerations for funding costs of CCS construction and operation of demonstration projects. In addition to this report, there is a wide range of existing reports on many aspects of CCS that can be utilised to inform business cases. There are, for instance, over 520 knowledge sharing reports available on the Institute website, a number which is constantly growing.

Climate change not 'priority aid': as noted in the Template Business Case, the single biggest threat to perpetuating and deepening poverty in the medium-to-long term is climate change. There is a large body

of evidence that supports this claim (some useful reports are listed in Appendix 2). This body of evidence is a specific subset of information that can be drawn upon to make the case for climate change funding broadly, and for CCS more specifically as a key mitigation technology as part of the portfolio of mitigation technologies.

CCS not a familiar technology: if required (depending on funding approval requirements) CCS lead agencies should seek opportunities to share knowledge with officials from their Finance, Treasury and/or Aid Agencies about CCS, and the significant role it can play in emission reductions. The first step is to identify the right people in these departments or ministries. Discussing support for CCS in the Green Climate Fund may be a good catalyst for raising awareness in these agencies, as CCS is the only technology that has, to date, been specifically recognised as being eligible in the Green Climate Fund (Transitional Committee for the design of the Green Climate Fund, 2011).

CCS may not be identified in mitigation strategies: developing countries should be encouraged to utilise existing funding (identified in Table 1) for CCS pre-investment and enabling activities. A key enabling activity is to identify how CCS can contribute to a country's low emission strategy and developing a policy and legal framework for the introduction of CCS. This will pave the way for future funding for demonstration projects.

Difficulty in quantifying outcomes from specific donor contributions: like many government policies across a range of issues - not just climate change - the impacts of funding for demonstration projects will not be known for ten, twenty or even thirty years in the future. This creates a significant challenge for governments justifying funding for CCS in the present. Like any long term policy, they can utilise appropriate shorter term 'proxy' indicators for these long term impacts. Suggested metrics have been included in the Template Business Case.

Nevertheless, further research could be undertaken to estimate the short and long term impacts of CCS on social and economic indicators, and the development of a methodology to undertake a 'benefit cost ratio' analysis that aims to 'monetise' the varied and diverse benefits to compare against the costs.

Summary of suggested actions

1. One or more governments which are members of both the Clean Technology Fund and the CCUS Action Group should approach other CTF country representatives regarding a re-consideration of CCS within the CTF.
2. Donor countries should utilise the Template Business Case and Literature Review list as a reference for arguments or considerations for funding costs of CCS construction and operation of demonstration projects in developing countries.
3. One of the donor countries active in CCS contributions to developing countries should seek an opinion on the eligibility of counting funding for CCS capital expenses as ODA from the OECD DAC.
4. CCS lead agencies should seek opportunities to share knowledge with officials from their Finance, Treasury and/or Aid Agencies about CCS, and the significant role it can play in emission reductions.
5. Developing countries are encouraged to utilise available funding to investigate how CCS could fit within their low emissions strategies and develop policy and regulatory frameworks.
6. Further research should be undertaken and methodologies developed to quantify the social and economic benefits of CCS.

APPENDIX 1

TEMPLATE BUSINESS CASE

Funding for carbon capture and storage in developing countries

Summary

What support will the funds provide?

The [donor country] will provide $X million over X-many years for the planning and pre-investment activities and capital and operational costs for large scale carbon capture and storage demonstration projects in developing countries.

This funding should ideally be consolidated with funding from other country's contributions through utilisation of [a preferred funding mechanism].

The Global CCS Institute defines a large-scale CCS project as one which captures at least 800,000 tonnes of CO_2 annually for a coal-based power plant, and at least 400,000 tonnes of CO_2 annually for other emission-intensive industrial facilities (including natural gas-based power generation).

(The rest of this 'What support will the funds provide?' section is drawn from a unpublished Background Paper: Carbon Capture and Storage Demonstration Fund, prepared by Ashok Bhargava from the Asian Development Bank, July 2011.)

Funding support would be made available for offsetting the incremental costs for integrating CCS (i.e. not for the 'base' cost of the host project), including for:

- geological site characterisation;
- engineering studies, such as pre-feasibility, and Front-End Engineering and Design studies required for a project;
- transaction costs for assessing Clean Development Mechanism (CDM) credits;
- environmental impact assessments;
- Capital costs, including for:
    - equipment;
    - labour; and
    - preparation of legal, technical and risk advice for a project.
- Operating costs, including for incremental operational costs associated with:
    - periodic administrative costs for CDM credits;
    - loss of electricity revenue or cost of additional fuel consumption due to the energy penalty;
    - unexpected down time/switch off due to CCS operations;
    - monitoring and verification costs; and
    - down time or loss of revenue associated with retrofit.

Funding would be provided upon reaching agreed 'milestones' relevant to the above activities. The scale of funding provided for each project would depend on the magnitude of the economic gap of the project, based on all revenue streams (e.g. including CDM credits) and access to other funding sources and instruments. In order for funding to be 'additional' it should be likely that the project would not go ahead without donor funding support (as evidenced by an economic gap from other funding sources).

One important milestone might be a requirement for a percentage of the funding contribution not to be made until the project has successfully injected CO_2.

A variety of financing instruments should be available to offset these incremental or 'extra' CCS costs. These financial instruments could include:

- **Grants:** are likely to be used for storage site characterisation and front-end engineering and design (FEED) studies.

  (*The donor country may want to stipulate that CCS Ready requirements are also eligible for funding.)*

- **Debt financing:** the concessional loan product with a significant grant element such as low interest rate and long tenure including long grace period could be provided for the project to achieve an overall competitive financing profile.

- **Blending:** entails a combination of market (or concessional) loans with grant (or grant equivalent) components which may be in various forms:
  - direct investment grants;
  - equity investment;
  - interest rate subsidies;
  - loan guarantees;
  - technical assistance; and
  - risk mitigation, guarantee and equity instruments, etc.

It should be noted that for contribution to count towards a donor country's overseas development assistance (ODA), there will need to be a grant element of at least 25 per cent.

[Actual funding mechanisms available may depend on the preferred funding vehicle.]

Why is [donor country] support required?

CCS is needed as part of a portfolio of mitigation technologies if the world is to achieve its emissions reductions goals. The IEA projects that the cumulative investment in non-OECD countries between now and 2050 will need to be at a level sufficient to account for 70 per cent of all stored CO_2 over that period (IEA, 2012b).

If CCS is not part of the climate change mitigation solution, then it is likely that there will be:

- difficulty in reaching global emission reduction targets;
- a potential to lead to an overall increase in emissions; and
- an overall increase in the cost of abatement, even assuming alternative low emission technologies could replace fossil fuel power generation.

The market failure to a) put a price on carbon and b) resolve the imbalance between 'risk and reward' for first-movers provides a rationale for [donor country] funding to help overcome these market failures at this demonstration phase.

[Donor country] funding contribution consolidated with contributions from other donor countries is needed to overcome these market failures and help move CCS from the 'demonstration' to 'deployment' phase.

Given the current low number of CCS demonstration projects in developing countries it is expected that without international funding for the incremental CCS costs that developing countries would not invest in these CCS demonstration projects – not until demonstration helps bring the costs down. It is expected that the [donor country] funding is additional (i.e. providing funding that would not otherwise be provided by the private sector) and catalytic.

What are the expected results?

The [donor country's] funding aims to:

a) provide funding support for X-many projects [*dependent on the amount of funding being provided*];

b) avoid at least X-tonnes of CO_2 a year from entering the atmosphere over X-many years [*this will be dependent on the amount of projects that the funding can be expected to support and the expected timeframes of these projects. The definition of large scale projects – at least 800,000 tonnes of CO_2 a year for a power project and 400,000 tonnes CO_2 a year for an*

industrial project - can be used to estimate the minimum amount of GHG avoided];

c) develop in-country CCS capacity that can be applied to other CCS projects and further contribute to greenhouse gas emission reductions of up to X-tonnes of CO_2 avoided [a statistic that could be based on potential contribution of CCS to a country, region or globally]; and

d) contribute to the goal of reducing CCS costs and energy penalty by learning-by-doing, to make CCS more economically viable to be deployed on a larger scale.

Avoiding a rise in temperature due to emission reductions in greenhouse gases (in this case CO_2) will greatly contribute to poverty alleviation in the longer term, compared to what would otherwise be the case. If left unchecked, the impact of climate change on the world's poor will be unprecedented. CCS has the ability to deliver deep cuts in emissions that can ultimately contribute to the development goals of poverty alleviation, through:

e) access to low-emission energy measured by X-number of people/households with access to low-emission energy [this is relevant if power projects are expected to be supported]; and

f) economic prosperity measured by X-number of construction jobs contributing to economic prosperity and X-number of operational jobs [and potentially an 'economic multiplier' of the direct and indirect jobs of the CCS-aspect of the project].

BUSINESS CASE

Strategic case

Strategy

Rationale

The need for CCS as part of the portfolio of mitigation technology options to combat climate change is well documented. The world agreed at the 2010 climate change talks held in Cancun to strive to hold the global average temperature rise to 2°C relative to pre-industrial levels to avoid dangerous climate change. This is dependent on a revolutionary scale of mitigation that could see CCS contribute between 15 per cent and 55 per cent of the required abatement to the year 2100 (IPCC 2005).

Demand for fossil fuels is on the rise, especially in developing countries where a significant percentage of the population currently has no access to electricity. Of the world's energy-related CO_2 emissions, electricity sourced from fossil fuels accounts for more than 40 per cent (IEA 2011a). Another 25 per cent comes from large-scale industrial processes such as iron and steel production, cement making, natural gas processing and petroleum refining (Global CCS Institute 2011). Although fossil fuel use as a *percentage* of overall energy consumption is expected to decline in the coming decades, the *absolute* volume of fossil fuel use is expected to increase (IEA 2011b). This increase in fossil fuel volume is driven by global population growth and industrialisation. The fact that energy infrastructure (e.g. pipelines, port facilities, power stations, transmission lines, meters) is already in place in most countries makes "rapid shift to other [large-scale] energy sources extremely difficult" (Almendra 2011).

Given fossil fuel currently accounts for approximately 65 per cent of CO_2 emissions today, and the volume of fossil fuel use is expected to increase in many countries in the coming decades, the need to reduce emissions from fossil fuels is essential if the world is to achieve its emission reduction targets. As of 2012, CCS remains the single largest option available to mitigate greenhouse gas (GHG) emissions from fossil fuel use in fuel transformation, industry and power generation.

Modelling by the IEA concludes that CCS will need to contribute 17 per cent of the necessary emissions reductions by 2050 to achieve stabilisation of GHG concentrations in the most cost-effective manner (IEA 2012b). Of this, almost 50 per cent is estimated to be CCS associated with power generation, and 50 per cent is estimated to be CCS associated with industry.

In addition to power and industrial applications of CCS, when bio-energy is combined with CCS (known

as BECCS) this can lead not only to reduced emissions, but a net removal of CO_2 from the atmosphere – or negative emissions.[7] While more work is required to quantify the potential of BECCS solutions, the resulting negative emissions could play an important role in the fight against climate change.

The $X million provided by [donor country] is expected to contribute to the development of X-many CCS demonstration projects – thereby directly supporting the development of CCS and its contribution to GHG emissions reductions.

Given the relatively high cost of CCS compared to more conventional technologies and the current low number of CCS demonstration projects in developing countries (1 operational project)[8] it is expected that without funding for the incremental CCS costs, that investment in CCS from developing countries would be limited, and not enough to achieve climate change goals. It is therefore expected that the [donor country] funding is both additional and (with its ability to make deep emission cuts) catalytic. [*Donor countries may wish to ensure that funding is indeed 'additional' through selection criteria.]*

What happens if CCS is not deployed?

If CCS is *not* part of the climate change solution there are three potential consequences:

- difficulty in reaching global emissions reduction targets;
- potential to lead to an overall increase in emissions; and
- an overall increase in the cost of abatement, even assuming alternative low emissions technologies could replace fossil fuel power generation (noting that there are no alternatives to fossil fuel use in some industrial sectors).

Given that the volume of fossil fuel use will increase (even though as an overall percentage it may decrease) it is questionable whether global targets can be met *without* CCS as part of the portfolio of technologies. That is, the world cannot have fossil fuel use in the order of 65 per cent, and in some countries increasing *volumes* of fossil fuel use, and meet emissions reduction targets without reducing emissions from that fossil fuel use. It is important to note that while there might be alternatives to fossil fuel power generation, there are *not* alternative technologies to fossil fuel use in many key industrial sectors. As noted above, CCS combined with bio-energy has the potential to provide *negative emissions*.

Given the vast quantities of CO_2 that CCS can prevent from entering the earth's atmosphere, if CCS is *not* part of the climate change mitigation solution, this puts greater pressure on other mitigation technologies to 'fill the gap'. These mitigation technologies are already going to have to deliver very ambitious outcomes to fulfil global targets, and there are real constraints on how much additional emissions abatement these technologies could contribute to fill a gap left by CCS. For instance, hydroelectricity, wind power, and even solar power, require a suitable local environment.

If CCS is *not* part of the climate change mitigation solution then there is potential that this will lead to an overall increase in emissions. In the absence of CCS associated with traditional coal and gas plants, the next most likely climate change friendly alternative is a switch to combined-cycle gas turbine plants. Even assuming this switch to combined-cycle gas turbine plants, the IEA estimates that this could "lead to an increase in CO_2 emissions of over 140 Mt in 2035 – equivalent to the annual emissions of around 65 million cars in Europe today – and a cumulative increase of 1 GT of CO_2 emissions over [2010-2035]" (IEA 2011b). That is, even though combined-cycle gas turbine plants produce fewer emissions than traditional coal and gas plants, traditional coal and gas plants *with* CCS would provide extra emissions abatement.

If CCS is *not* part of the climate change mitigation solution, then the global cost of abatement increases. The IEA estimates that without CCS, the cost of global abatement will increase by US$3.1 trillion. (Based on figures from IEA, 2012b)

Market failure

There are two main reasons why private sector financers will not invest in CCS at this demonstration

[7] For more information on BECCS refer to the 'Bio-energy with CCS Factsheet'; http://cdn.globalccsinstitute.com/sites/default/files/publications/25921/fact-sheet-3-bioccs-v4.pdf

[8] It is possible that a few CCS projects in developing countries will be implemented despite this funding. However, to fulfil the goals of supporting demonstration projects - i.e. driving down costs and learning by doing - more than a few projects need to be implemented. It is also the case that many CCS projects that move through the planning phases, though technically viable, do not proceed to a final investment decision because of lack of capital. This funding could facilitate projects already in the pipeline move to a final investment decision.

stage. The first reason is a current lack of policy incentives or policy requirements to invest in CCS in most, if not all, developing countries. The second is the high risks of a CCS project compared to a 'business as usual' project.[9]

This lack of commercial or market based incentives to justify the extra costs and risks of CCS are due to market failures. [Donor country] funding will help address these market failures during this 'demonstration' phase of CCS. There are two main market failures: the first is the failure of the market to put a price on carbon, the second is an imbalance between risk and reward for 'first movers'. In short, first movers take on all the risk, but it is the second and third movers that reap most of the reward when the technology costs come down.

It is also important to note that funding for CCS in developing countries has been at a disadvantage compared to other low-emission technologies, because it has been either not eligible, or actively excluded, from existing climate mitigation funding mechanisms. It has only been since the Seventeenth Conference of Parties (COP 17) held in December 2011, that CCS has become eligible to generate tradable carbon credits under the CDM.

Evidence

The different parts of the CCS chain (CO_2 capture, compression, transport, injection and storage) have been utilised commercially for decades. However, integrating the CCS chain for the purposes of long-term isolation of emissions from the atmosphere, at scale, is still in the *demonstration* stage.

Nevertheless, CCS has been proven at a large scale. There are currently eight large scale CCS projects in operation (storing over 23 million tonnes of CO_2 a year). There are currently nine in construction, including two commercial coal-fired power stations (Global CCS Institute, 2013).

Providing direct funding especially for the additional capital and operational cost projects is expected to have a measurable impact on the deployment of CCS in developing countries.

Feasibility

The fact that there are 72 large-scale CCS projects globally currently in the planning or operational stages, including eight in operation and nine under construction, is testament to the feasibility of implementing CCS projects. Of these 72 large-scale projects in the planning or operational phases, 17 are in developing (i.e. non-Annex I) countries:

- Algeria – 1 (in operation)
- China – 11
- Korea – 2
- United Arab Emirates – 3

There are in fact 19 developing countries that have engaged in some CCS activity – although much of this is at the early 'scoping out the opportunity' stages (Global CCS Institute, 2012b).

In addition to those developing countries that have or are planning a CCS project, there are at least three other countries of note that have moved beyond the 'scoping' phase, including:

- Mexico – which has already undertaken a country wide storage atlas, is currently undertaking a regional analysis, and is scoping out a demonstration project;
- South Africa – South Africa's Government have endorsed a CCS Roadmap, and work is underway to implement a test injection project; and
- Brazil – has commercial CO_2 EOR operations and pilot scale CO2-EOR projects, which could become CCS projects with the right monitoring and verification methods. They have also undertaken a country-level storage analysis.

This CCS activity in developing countries suggests that existing capacity development efforts are having a positive effect in raising awareness and in some cases creating an enabling environment for CCS. The majority of this activity in developing countries has been linked with capacity development support of some description from the Asia Pacific Economic Cooperation, Asian Development Bank, Carbon Sequestration Leadership Forum, Energy Research Centre of the Netherlands, Global CCS Institute, and/or the World Bank.[10]

[9] For more information on what these risks are, refer to Global CCS Institute Status Report 2010.

[10] For more information on the status of CCS in developing countries please refer to 'Global Status of CCS: 2012' Chapter 5.

Impact and outcome
The following outlines suggested Impacts, Outcomes and Outputs (tangible good or activities as a result of the funding) to be achieved through donor funding. The section also suggests measurement indicators, the key risk associated with each Impact/Outcome/Output and a key mitigation action. *These indicators are captured in Figure 1 - 'Theory of Change' diagram (terminology used by the UK Government) or 'Results Chain' diagram (terminology used by the ADB).*
IMPACTS
Improve economic and technical viability of CCS – through improved affordability and accessibility to the technology: The ultimate aim of funding demonstration projects is to support the technology in this pre-commercial phase to help drive down costs and support learning by doing. It is only by large scale implementation that step-change improvements in the technology and cost reductions can be made. *Measurement metric*: Costs of CCS technology reduced (long term measure). *Potential Risk:* Viability of CCS not improved through demonstration. *Mitigation Actions:* • portfolio of capture technologies supported; and • innovative projects preferred (where stakeholders demonstrate interest and ability to not only implement but improve technology).
Additional CCS projects deployed – contributing to avoidance of catastrophic climate change A vital medium-to-long term impact is that CCS expertise developed during development of demonstration projects can be applied to the development of additional CCS projects in-country, especially as the technology becomes more economically viable (which will only happen with demonstration). The more CCS projects deployed, the more CO_2 emission reductions are achieved – i.e. demonstration projects could have a 'multiplier effect' on potential emissions reductions in a country. *Measurement metric*: Number of additional CCS projects following implementation of demonstration project (long term measure). *Potential risk*: CCS expertise not applied to additional CCS projects in country. *Mitigation action*: Countries with large fossil fuel emissions where CCS can be replicated are preferred.
Link to development goals
Poverty alleviation: • in the short term through job creation; and • in the long term through avoidance of catastrophic climate change. The single biggest threat to perpetuating and deepening poverty in the medium-to-long term is climate change. "The Stern Review found that the negative impact of climate change could be equivalent to a fall in global per capital consumption of 5-20 per cent now and forever. This is as a result of adaptation costs (such as increased heating and cooling bills, and flood defences) and impacts which cannot be adapted to (such as health impacts and increased flood damages). In comparison it is estimated that the long-run costs of global action to stabilise atmospheric CO_2e and avoid catastrophic climate change to be around 1-2 per cent of per capita consumption by 2050. Given negative impacts will be felt disproportionately in developing countries mitigation is net beneficial and pro-poor" (DECC, 2013). The World Bank report, *Turn Down the Heat: Why a 4° World Must be Avoided*, provides a compelling description of what the world would be like if warmed by 4°C, a distinct possibility without concerted policy changes and mitigation action. The 4°C scenarios are devastating: the inundation of coastal cities; increasing risks for food production likely leading to higher malnutrition rates; many dry regions becoming dryer, wet regions wetter; unprecedented heat waves in many regions, especially in the tropics; substantially exacerbated water scarcity in many regions; increased frequency of high-intensity

tropical cyclones; and irreversible loss of biodiversity, including coral reef systems. The following are snapshots of just seven of the development impacts taken from the report to illustrate the effects of climate change on the world's poor:

> Negative effects of higher temperatures have [already] been observed on agricultural production, with recent studies indicating that since the 1980s global maize and wheat production may have been reduced significantly compared to a case without climate change (World Bank, 2012, page xiv).

> An example of a recent extreme heat wave is the Russian heat wave of 2010, which had very significant adverse consequences. Preliminary estimates for the 2010 heat wave in Russia put the death toll at 55,000, annual crop failure at about 25 per cent, burned areas at more than 1 million hectares, and economic losses at about US$15 billion (1 per cent gross domestic product (GDP)) (World Bank, 2012, page xiv).

> A substantial increase in ocean acidity has [already] been observed since preindustrial times…. The regional extinction of entire coral reef ecosystems, which could occur well before 4°C is reached, would have profound consequences for their dependent species and for the people who depend on them for food, income, tourism, and shoreline protection (World Bank, 2012, page xv).

> For small island states and river delta regions, rising sea levels are likely to have far ranging adverse consequences, especially when combined with the projected increased intensity of tropical cyclones in many tropical regions, other extreme weather events, and climate change–induced effects on oceanic ecosystems (for example, loss of protective reefs due to temperature increases and ocean acidification) (World Bank, 2012, page xvi).

> Large-scale extreme events, such as major floods that interfere with food production, could also induce nutritional deficits and the increased incidence of epidemic diseases. Flooding can introduce contaminants and diseases into healthy water supplies and increase the incidence of diarrheal and respiratory illnesses (World Bank, 2012, page xvii).

> The projected impacts on water availability, ecosystems, agriculture, and human health could lead to large-scale displacement of populations and have adverse consequences for human security and economic and trade systems (World Bank, 2012, page xvii).

> As the scale and number of impacts grow with increasing global mean temperature, interactions between them might increasingly occur, compounding overall impact. For example, a large shock to agricultural production due to extreme temperatures across many regions, along with substantial pressure on water resources and changes in the hydrological cycle, would likely impact both human health and livelihoods. This could, in turn, cascade into effects on economic development by reducing a population´s work capacity, which would then hinder growth in GDP (World Bank, 2012, page xviii).

Investment in low-emissions mitigation technology, especially one that can deliver deep cuts to emissions like CCS, therefore can contribute to the long-term impact of poverty alleviation; poverty that would otherwise be perpetuated or deepened by the effects of climate change. In the short term, like any large infrastructure projects, it can deliver jobs and the associated multiplier effect on the economy.

Measurement metric: Decrease in country or regional emissions (long term measure).

Potential risk: CCS not deployed on a large scale.

Mitigation action: Offsetting this risk is the very reason that funding is being provided in the first place; to avoid the possibility that CCS is not deployed on a large scale, and thereby not contributing to significant emission reductions. If CCS is not part of the portfolio of mitigation options, then this will mean that a) the world does not achieve global mitigation goals leading to negative climate change impacts, or b) the cost of mitigation will be more expensive.

OUTCOMES

CCS contributes to global CO_2 emissions reductions

The ultimate aim of demonstration projects is to facilitate large-scale deployment. However, even a few

CCS demonstration projects can make a significant contribution to global emissions reductions. For instance, the eight large-scale CCS projects in operation today are storing approximately 23 million tonnes of CO_2 each year. With a further nine projects currently under construction (including two in the electricity generation sector), this figure will increase to over 36 million tonnes of CO_2 a year by 2015 (Global CCS Institute, 2012b).

This is a significant contribution to emission reductions in just eight projects – more than all the combined electricity generation sector abatement efforts in Australia in 2010.[11]

Measurement metric: Avoid X-many tonnes of CO_2 a year from entering the atmosphere over X-many years from demonstration projects.

Potential risk: The stored CO_2 leaks thereby 'undoing' emissions reductions.

Mitigation actions:

- robust site characterisation will mitigate the risk of leaking; and
- robust MMV requirements will enable proper management to avoid health and safety issues in the unlikely event (assuming robust characterisation) of a leak.

CCS expertise developed in-country

On a global basis the IEA estimates that CCS will need to contribute 17 per cent of emissions reductions by 2050. More specifically, the IEA estimates that CCS will need to contribute:

- 17 per cent of reductions in China;
- 17 per cent of reductions in India;
- 14 per cent of reductions in ASEAN;
- 11 per cent of reductions in Mexico;
- 13 per cent of reductions in Brazil; and
- 14 per cent of reductions in South Africa

(IEA, 2012a)

These deployment statistics represent a significant need for investment in CCS expertise in these countries. A key outcome of the demonstration projects is 'learning-by-doing'. Capacity development activities (such as workshops, study tours, courses) are essential to get a good base understanding of the technology. However, it is only by actually building a large scale CCS project that relevant experts (e.g. engineers, geologists, project managers) will develop the expertise needed in order to replicate it.

Measurement metric: X-many skilled professionals engaged in project.

Potential risk: CCS expertise unable to be developed (perhaps for lack of 'base' engineering and geological expertise).

Mitigation action: Countries with suitable expertise to build upon should be preferred.

Increased understanding of regional geology, storage and potential and sites

The CO_2 once captured and compressed, cannot be stored just anywhere. Permanent and safe storage requires suitable permeable rock with a suitable cap rock layer more than 800 metres below ground level. Identifying these sites requires extensive 'geological characterisation' which can take a number of years. Characterisation often starts at a country-level with the development of a 'storage atlas', and then becomes increasingly more focused, moving to basin level characterisation, then finally specific site characterisation.

The time and cost of characterisation within any one country will depend on how much data has already been acquired about a country's geology. Characterisation usually starts with desk top analysis of existing data, but will eventually need to move towards primary acquisition of data (e.g. through seismic, well cores) which can be expensive.

[11] This statement is based on emission abatement statistics for Australia in 2010 published in Productivity Commission (2011) Carbon Emission Policies in Key Economies

Identification of suitable storage sites is essential before any CCS project can commence. Storage characterisation on a country, basin, then site level (particularly multiple site level) can be utilised by other project proponents for additional projects in the future.

Measurement metric: X-many geological storage studies.

Potential risk: Suitable geological storage sites not found.

Mitigation action:

- pre-investment activities ideally undertaken for more than X-number of target demonstration projects – so a pipeline of potential projects created; and
- pre-investment activities undertaken so other opportunities can be identified (e.g. through source-sink mapping, techno-economic analysis).

Link to development goals

Improved access to <u>low-emissions</u> energy

The capture and compression phase of CCS requires a lot of energy. In fact, it can currently take in the order of 20 per cent of a power station's energy production to capture and compress up to 90 per cent of the CO_2 being produced by the power station. This has become known as the 'energy penalty', and can account for 60-85 per cent of the cost of CCS. For this reason, some developing countries argue that CCS undermines 'access to energy' – i.e. it uses significant amounts of energy that would otherwise be provided to the grid, to be used by households and businesses in desperate need of the energy. Reducing the energy penalty is a key reason why demonstration projects are needed.

However, what is not often acknowledged is that the energy that is produced is 'low-emissions' energy – and embedded in this concept is the development benefit that 'low-emissions' can deliver. That is, low-emissions energy can (cumulatively) avoid catastrophic climate change with its devastating impacts on the world's poor. Because CCS is associated with base-load coal or gas power stations (that can produce large amounts of power, e.g. 500MW-1500MW or more) a CCS-power station can still deliver significant amounts of energy even with the energy penalty, and significant amounts of emissions reductions compared to a business as usual scenario.

Much of the devastating impacts of climate change on the world's poor will be in the future, although we are already beginning to see these negative impacts now. Clean energy projects have beneficial development impacts which are not immediate, and developmental benefits which although large, are hard to quantify for any one specific project, thus making it difficult to compete with aid projects (and aid funding) that provide immediate benefits such as food provision, vaccinations and emergency relief.

Nevertheless, as per the discussion above on 'poverty alleviation', the aid relief and community development that donor countries are investing in now will be undermined if countries do not also invest in greenhouse gas mitigation. The aid requirement in the future will be much larger if they do not invest in mitigation now.

Measurement metric:

- X-many MW of installed low-emissions energy; and
- X-many households (or people) with access to low-emissions energy;

Potential risk: Demonstration projects do not reach operational phase.

Mitigation action:

- select suitable funding vehicle – see Appraisal Case; and
- ensure suitable project selection criteria.

OUTPUTS
Pre-investment activities Funding is being provided for the pre-investment activities needed to ensure a suitable, safe and secure CCS project e.g.: • geological site characterisation; • engineering studies, such as pre-feasibility, and Front-End Engineering and Design (FEED) studies required for a project; • transaction costs for assessing Clean Development Mechanism (CDM) credits; and • environmental impact assessments. *Measurement metric:* • X-many geological site characterisations; • X-many engineering studies; and • X-many project related reports (e.g. providing legal, technical and risk advice). *Potential risk*: Lack of interest from developing countries for funds. *Mitigation action*: Fund manager works with in-country stakeholders to help identify suitable projects and encourage interest. Fund manager with regional presence therefore important.

Demonstration projects
The demonstration projects underpin the desired outcomes and impacts. Funding is being provided for the 'additional' CCS capital and operating costs, e.g.:
• Capital costs, including for:
  ○ equipment
  ○ labour; and
  ○ preparation of legal, technical and risk advice for a project.
• Operating costs, including for incremental operational costs associated with:
  ○ periodic administrative costs for CDM credits;
  ○ loss of electricity revenue or cost of additional fuel consumption due to the energy penalty;
  ○ unexpected down time/switch off due to CCS operations;
  ○ monitoring and verification costs; and
  ○ down time or loss of revenue associated with retrofit.
Measurement metric:
• X-many projects received funding for capital or operational expenses;
• X-many CCS demonstration projects commenced deploying X-many different capture technologies.
Potential risk:
• pre-investment activities do not lead to demonstration project;
• lack of donor commitments (i.e. necessary scale of funds not achieved); and
• projects stalled due to lack of regulatory environment or public opposition.
Mitigation actions:
• pre-investment activities ideally undertaken for more than x-number of target demonstration projects – so a pipeline of potential projects created;
• pre-investment activities undertaken so other demonstration opportunities can be identified (e.g. through source-sink mapping, techno-economic analysis);

- pre-investment and demonstration projects identified in countries that have or are developing regulatory frameworks; and
- public engagement plans form integral part of project plans.

Link to development goals

Project/s contributes to economic and productivity benefits

The CCS aspect of the project will create additional jobs in manufacturing (some which may be in the host country, some which may be in other developing countries), construction, and operation. In addition, a key concept identified in the South African Centre for CCS report *Impacts of CCS on South African National Priorities other than Climate Change* (in press) is that CCS can help to preserve jobs in high-carbon industries that may not be able to compete in a low-carbon future, especially following the introduction of a price on carbon. This is a long term measure and may be hard to measure.

The abovementioned report also identifies that, like any large investment project, a CCS project is likely to have economic 'multiplier effects' for the host country economy.

Measurement metric:

- X-many jobs created;
- X-many jobs preserved; and
- $X generated from multiplier effects from investment in CCS.

Potential risk: Demonstration projects do not reach operational phase.

Mitigation action:

- pre-investment activities ideally undertaken for more than X-number of target demonstration projects – so a pipeline of potential projects created; and
- pre-investment activities undertaken so other opportunities can be identified (e.g. through source-sink mapping, techno-economic analysis).

Capacity development indicators

Knowledge sharing between stakeholders and countries occurred

Measurement metric: X-number of knowledge projects or events.

CCS policies or strategies introduced

Measurement metric: X-number of policies or strategies announced (e.g. legislation, formal policy documents, inclusion of CCS in NAMAs).

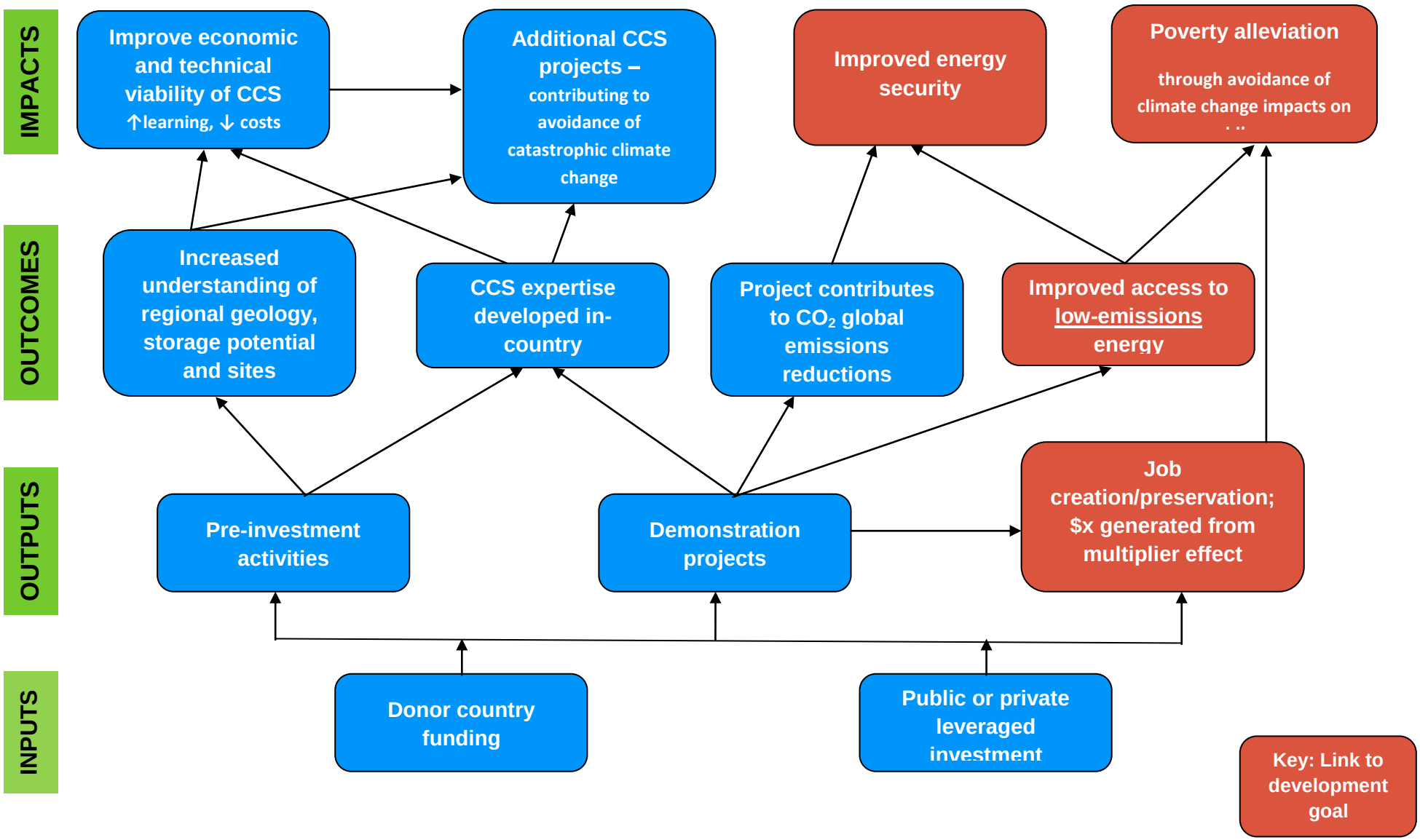

Figure 1: Theory of Change Diagram

Appraisal case

Feasible options

What are the feasible options that address the need set out in the Strategic Case?

Different funding options and high level pros and cons were identified in the report 'Funding Carbon Capture and Storage in Developing Countries' March 2012 and are provided below. Donor countries may wish to assess the feasible options (or a combination of these options) in the 'Appraisal Case'.

FUNDING VEHICLES	PROS/CONS
Dedicated CCS funding window within the Green Climate Fund (GCF).	This option has the advantage of dedicated CCS funding, but sits within what is likely to become the largest climate funding facility. Contributions to the GCF will clearly count toward a country's climate change contributions. Saudi Arabia has already supported this approach at the COP17 negotiations. It may be easier to leverage private sector funds under the GCF in time. It is ultimately the GCF Board's decision to have dedicated funding windows, and they may decide not to take this approach, preferring all technologies to 'compete equally' against a common set of criteria. It should be noted however, that CCS has been at a disadvantage by being excluded from existing mechanisms, until recently.
Portfolio approach to funding a range of technologies within the Green Climate Fund, with CCS included as a component of the portfolio.	This option has the advantage of working within what is likely to become the largest climate funding facility, and will clearly count toward a country's climate change contributions. It also avoids the possible concern of CCS not 'competing equally' with other technologies, but ensures that some CCS projects do get funded under the GCF. Ultimately this is the GCF Board's decision.
Establish a new dedicated CCS trust fund with its own governance arrangements, but which counts towards a country's climate funding commitments.	This option has the advantage of not being dependent on potentially lengthy negotiations and establishment of governance arrangements required for the GCF. Interested donor countries can more quickly and easily establish a dedicated CCS Fund, identifying governance arrangements and selection criteria tailored specifically to CCS. Donor countries can choose how the dedicated funding will be administered. However, a new fund will take time to establish when there are available alternatives.
Top up existing dedicated CCS Trust Funds and make any changes to criteria to accommodate project support funding, ensure it counts towards a country's climate funding commitments.	This option has the advantage of utilising existing mechanisms and by-passes the need for establishing new governance arrangements etc. This may mean that 'new' donor countries have less flexibility in establishing governance arrangements of their choosing.

Bilateral or multilateral project support.	These projects have the advantage of focusing on projects that are in the mutual interest of all countries involved, and can be taken forward without having to go through a potentially long selection process. These tend to have a greater administrative cost to donor countries, who may or may not have the expertise to manage a complex CCS project.
Existing UNFCCC climate change funds (e.g. Clean Technology Fund, Global Environment Facility).	These are existing funds. However, as it currently stands these Funds are not well placed to facilitate a CCS project (refer *Funding Carbon Capture and Storage in Developing Countries*, March 2012). It is understood that the Green Climate Fund is being positioned to become the main global climate fund and therefore may be better positioned to fund CCS.

Existing funding mechanisms include the following:

FUND	Description
Asian Development Bank (ADB) – Carbon Capture and Storage Trust Fund	CCS Trust Fund under the ADB's Clean Energy Financing Partnership Facility. Includes support for capacity building, and scope for directly supporting demonstration projects (e.g. FEED studies). Activities currently in China, Indonesia, Philippines, Thailand and Vietnam: • a selection of projects based on assessment against criteria (identified by donors) and approved within ADB governance arrangements; and • $69.3 million in contributions from the Global CCS Institute and UK Government.
Carbon Sequestration Leadership Forum (CSLF) – Capacity Building Fund	For CCS capacity building in emerging economy members of the CSLF. Activities supported in Brazil, China, Mexico and South Africa: • proposals reviewed by CSLF Capacity Building Taskforce and funding approved by CSLF Capacity Building Governing Council; and • $3 million in contributions to date to the Fund from UK, Canadian, Norwegian Governments and Global CCS Institute.
Global CCS Institute – Capacity Development Program and Project Support	The Institute works with 'countries of focus' to undertake a capacity development assessment and helps develop and deliver a tailored capacity development program of activities for those countries. Activities currently in China, Brazil, India, Indonesia, Malaysia, Mexico, South Africa and Trinidad and Tobago. In addition, the Institute supports other international capacity building efforts: • the Institute has contributed over AU$25 million to capacity development activities including to the ADB, CSLF and World Bank funds; and • $3 million of Institute and US Government funding to delivery of Institute capacity development program.

World Bank Group – CCS Capacity Building Trust Fund	Dedicated CCS Fund focusing on capacity building and knowledge sharing, pre-investment support, and carbon asset creation services. Activities currently in Botswana, China, Egypt, Jordan, Kosovo, Maghreb, Mexico and South Africa: • a selection of projects based on assessment against criteria (identified by donors) and approved within World Bank governance arrangements; and • $44.3 million in contributions to date to the CCS Trust Fund from Norwegian and UK Governments and the Institute.

In addition to these options is the 'business as usual' option (or the do-nothing option).

Appraisal of options

Donor countries have identified the following issues as important when considering which funding mechanism is the most appropriate. Donor countries may wish to undertake an assessment for each option of interest, against all or just some of the issues below:

- ***Leverage**: ability of funding mechanism to leverage and be combined with additional financial support either from other donor countries and/or private sector.*
- ***Alignment of goals**: what are the goals and selection criteria of the funding mechanism? Do they match the goals and criteria of the donor country (e.g. of the climate change fund or development aid fund where the money is being sourced from?) If so, how well?*
    - *Is there any ability to include specific governance, selection criteria of the donor country, or has this already been set by the funding vehicle organisation?*
- ***Timing and ability to disperse funds**: how quickly does the funding have to be allocated and/or expended? This may impact the choice of funding mechanism. Some funding vehicles are able to approve projects more quickly than others.*
    - *does the funding vehicle have projects in the pipeline? This will facilitate expenditure and also diversify risk (i.e. if one project does not go ahead, funds can be allocated to other projects); and*
    - *is the mechanism accepting funds (e.g. the Green Climate Fund is not yet in a position to receive funds).*
- ***Governance mechanisms**: is the funding mechanism already established, and does it therefore have existing governance arrangements? Negotiating these from the outset can take significant time and effort.*
- ***Track record**: what is the track record of the funding mechanism? Channelling it through an established fund with a good track record will give confidence that the funding will achieve the outcomes desired.*
- ***International commitments**: will the funding be spent in a way that gets recognised as meeting the donor country's commitment to climate funding? Could it be counted as overseas development assistance (ODA) funding?*
- ***Alignment with developing country policies**: is the money being allocated in accordance with developing country's needs, e.g. is it aligned with developing countries policies or strategies (e.g. their NAMAs goals, which was a key principle agreed in the Copenhagen Accord).*
- ***Ability to implement and manage projects**: does the funding vehicle organisation have good relationships with developing country governments, companies and other relevant stakeholders (e.g. NGOs). Good relationships with in-country stakeholders will facilitate identification and development of project proposals and implementation.*

- *What is the geographical coverage of the funding vehicle organisation? Do they have in-country or regional presence or offices which allow them to target developing countries of interest?*

- ***Flexibility:*** *does the funding vehicle offer flexibility in the type of projects it can support and funding amounts (e.g. smaller projects may be vital to facilitating CCS deployment, but may need to seek funding quickly).*
- ***CCS expertise****: does the funding vehicle organisation have CCS specific expertise to help identify, develop and manage the projects?*

Comparison of options

Which option, on balance, is assessed as the most suitable, following the considerations outlined above?

It may be useful to use a matrix or a table to summarise and compare the considerations.

Measures to be used to address value for money

Possible measures and considerations for value of money may include:

- *CO_2 avoided – i.e. the more CO_2 emissions avoided the greater contribution to a key climate change outcome.*
- *Cost of CO_2 avoided – this may be a more suitable monetary measure. However, consideration needs to be given to what this measure would be compared against. It could be compared against other low emissions technologies or possibility some pre-defined benchmark; however this may be misleading given the purpose of the funding is to demonstrate CCS technologies in part to help reduce cost of CO_2 avoided. It is not necessarily the case that the lowest cost projects would fulfil this impact.*
- *Investment leveraged – from other donor countries or potentially also from private sector. Private sector investment in CCS would be difficult to measure accurately, given this may be confidential information. However, estimates could be made based on estimated total cost of project, minus donor country contributions.*

  However, it should be kept in mind that the funding is being provided because it is expected that the developing country's private sector would not invest without this funding.
- *X-many demonstration projects supported by funding. Given it is unlikely that large numbers of CCS projects will be vying for funding, then this might be an appropriate measure to ensure a key funding objective is met.*
- *Benefit cost ratio – of demonstration projects funded. This analysis attempts to 'monetise' the benefits to compare to the cost, and aims to have a benefit-cost ratio greater than one. (It should be noted that fund managers will likely have their own cost-benefit analysis approach that they utilise to review each project proposal.)*

Commercial case

Value for money through procurement

The value for money will depend on what funding vehicle or mechanism the donor country decides to channel their funding through. Considerations that may impact on value for money evaluation may include:

- *the fee structures of the preferred funding vehicle;*
- *the procurement policies and procedures; i.e. do these procurement policies and procedures ensure a competitive, transparent, and fair approach to organisations tendering for the work, compared on cost and quality of output?; and*
- *risk management of funding vehicle organisation? How do they identify and manage risk?*

Financial case

How much will it cost?
This is dependent on the donor country's intended funding contribution.
How will it be funded?
This is dependent on where the donor country expects to source the funds from (e.g. established programs, climate funding, or overseas development aid budget).
How funds will be paid out?
This is dependent on what funding vehicle or mechanism the donor country decides to channel their funding through.
How will expenditure be monitored, reported and accounted for?
This is dependent on what funding vehicle or mechanism the donor country decides to channel their funding through and what governance arrangements are already in place or can be negotiated.

Management case

Oversight
This is dependent on what funding vehicle or mechanism the donor country decides to channel their funding through. *The existing funding vehicles listed above all have existing governance arrangements either in existence (e.g. ADB, Global CCS Institute, World Bank) or in development (e.g. Green Climate Fund). There may be some flexibility to negotiate specific governance or oversight arrangements that are important to the donor country to ensure donor objectives are achieved and/or tracked.*
Management
The organisation managing the funding vehicle (e.g. ADB, Global CCS Institute, World Bank) will have existing management structures that can be described. It is likely that there will be a process by which project submissions are accepted, reviewed and approved or not. The donor country may or may not require involvement in that process.
Conditionality
The donor country may or may not require specific conditions to be met by recipients to access this funding, e.g. ensure that the funding is 'additional' and funding contribution unlikely to be met through another means. *The preferred funding vehicle may or may not impose their own conditions (e.g. CCS be a part of their national climate change policies), and may or may not have the flexibility to include specific conditions of the donor country.*
Monitoring and Evaluation
Existing funding vehicles listed above have - or in the case of the GCF will have - existing monitoring and evaluation frameworks. There may be some flexibility within some of those funding vehicles to negotiate specific monitoring and evaluation measures that align with the measures outlined in the 'Impact and Outcome' section above. *Donor countries may wish to ensure there are:* • *progress reporting – against agreed indicators or measurement approaches;* • *progress review – e.g. half way into the expected disbursement period, which could focus on how*

the funds are tracking against indicators, identifying any problems and suggesting improvements; and

- *evaluation – usually at the end of disbursement, or possibly even later to try to identify if any of the impact goals have been achieved.*

Risk assessment

It is likely that established funding vehicles will have identified risks and mitigation strategies associated with its particular approach. It is likely that each project or initiative to be funded will also be subject to its own risk assessment as part of the evaluation and sign-off process.

Risks for CCS funding and some high-level mitigation strategies have been identified in 'Impacts and Outcomes' section. Donor countries may wish to expand on these risks and mitigation strategies through identification of probability and consequence analysis.

In addition there are some administrative risks (as identified by the UK Government and outlined in their Business Case and Intervention Summary):

- *delay in dispersing funds and therefore achieving funding goals;*
- *negative stakeholder views on CCS projects;*
- *a demonstration project is unable to be completed despite funding (e.g. due to issues with company, not enough funding etc);*
- *risk of fraud/corruption in administered funding;*
- *insufficient human resources to effectively manage interventions through preferred funding mechanism; and*
- *CCS interventions are not deemed to be overseas development aid by the OECD Development Assistance Committee.*

Results and benefits management

Reporting against the Monitoring and Evaluation framework (which would ideally include Impacts and Outcomes identified above) would provide the basis of the results and benefits management.

APPENDIX 2

Literature review

The following reports and documents were reviewed in an attempt to identify the economic and social benefits of CCS interventions and links to development goals.

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