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WHAT IS CCS?

Carbon capture and storage (CCS) is a greenhouse gas emissions reducing option that involves an integrated process of three distinct steps: capture, transportation and long-term storage. Technologies needed to implement the various components of CCS have been utilised in the oil and gas industry for decades; a challenge remains in scaling up the technology for commercial use.These technologies are currently available but have not been integrated at commercial scale.

CCS involves capturing the carbon dioxide in fossil fuels either before or after combustion, and storing it for the long-term in formations such as depleted natural gas fields, deep saline aquifers and unmineable coal seams. CCS technology can reduce carbon dioxide emissions from large industrial sources and coal-fired power stations by approximately 85 per cent. As such, it is a key technology within a suite of low carbon solutions for tackling climate change.

SUMMARY

Recent efforts by the Global CCS Institute, in collaboration with the International Energy Agency (IEA), and Carbon Sequestration Leadership Forum (CSLF) to establish a definition for Carbon Capture and Storage Ready (CCSR), highlights increasing recognition of its potential to facilitate CO_2 mitigation in the future.

In addition, many governments around the world are now considering how CCSR can play a role in broader climate change policies.

The introduction of CCSR policy anticipates a future transition to broader carbon capture and storage (CCS) deployment. It acts as a signalling mechanism by indicating that governments are willing to mandate a technology still in development if there is perceived to be an environmental benefit. CCSR is an option for governments seeking to facilitate any future transition to CCS deployment.

THE ROLE OF CCSR IN FOSSIL FUEL ENERGY GENERATION

The United Nations International Panel on Climate Change (IPCC) estimates that about 69 per cent of all CO_2 emissions and 60 per cent of all greenhouse gas emissions are derived from stationary energy sources[1].The IEA projects that energy sector CO_2 emissions will almost double between 2007 and 2050 with nearly all of this increase to occur in non-OECD countries[2]. This increase is occurring at a time when large amounts of existing plants in developed countries are reaching the end of their commercial life and require replacement.

The challenge of planning for a low carbon future is exacerbated given the 30-50 year operating lifecycle of fossil fuel plants.

CCS is a key technology available to mitigate CO_2 emissions from fossil fuel based energy generation facilities. The IEA Energy Blue Map analysis forecasts that CCS could contribute almost one fifth of the necessary emissions reductions required to achieve stabilisation of greenhouse gas concentrations in the least costly manner. However, in the absence of appropriately priced CO_2 emissions, CCS is unlikely to attract the necessary investment without government support.

A range of policy measures can be implemented to prompt the design, permitting and construction of CCS projects. One of the ways that governments can prepare to transfer to a more environmentally sustainable development path while maintaining reliable energy supply, is to implement CCSR requirements for new build fossil fuel energy generation plants.

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CCSR provides governments and project proponents with low opportunity costs to reduce potential carbon lock-in, or stranded assets, in a future where CCS is

CARBON LOCK-IN occurs when plants continue to emit CO_2 as CCS is not feasible due to technical or economic constraints.

A STRANDED ASSET is where a plant is shut down before the end of its planned operational lifetime, as it is uneconomic to retrofit CCS.

TECHNOLOGY LOCK-IN occurs when a developer designs a facility for a particular capture technology which then proves to be either uneconomical or not technically viable at the time of retrofit.

[1] IPCC (2007) Climate Change: Mitigation of Climate Change, Contribution of Working Group III to the Fourth Assessment Report (B. Metz et al, Eds), Cambridge University Press.

[2] IEA (2010) Energy Technology Perspectives: Scenarios & strategies to 2050, Paris.

available on a commercial basis in competition with other low emission technologies.

HOW CCSR CAN PROVIDE OPPORTUNITIES FOR CCS RETRO-FIT

CCSR policies can work to incentivise CCS retrofit once the appropriate economic and policy drivers for mitigating CO_2 emissions are in place. The recently established CCSR definition underlines this point by stating that 'a CCSR facility is a large scale industrial or power source of CO_2 which could and is intended to be retrofitted with CCS technology when the necessary regulatory and economic drivers are in place…'.

Recognising that the necessary financial and legislative drivers required to support CCS deployment are not available, CCSR offers an interim option by anticipating a transition to full CCS once these drivers are in place. Where a plant is constructed with or without CCSR facilities, and a carbon cost or regulatory action is subsequently introduced that penalises emissions, an owner has the option of continuing to emit CO_2 into the atmosphere and pay for carbon offsets, pursue a CCS retrofit or, shut down the plant before the end of its economic life.

A CCSR policy requires project proponents to expend upfront costs to carry out engineering and cost estimate studies as well as undertaking storage assessments. As a guide, the Government of the United Kingdom estimates that the overall costs of a CCSR requirement per new combustion power station is equivalent to less than 0.1 per cent of the capital cost of a 1600MW coal fired power station and about 0.3 per cent of the capital cost of an 800MW gas fired power station[3]. By investing earlier in making a plant CCSR this potentially lowers plant adaptation costs in the future, and leads to lower total costs overall.

However, some caution is required as the benefits of taking action decrease over the project's life cycle. CCSR policies are most effective when the drivers toward CCS are expected to come into force during the earlier years of operation, so that future savings are not discounted to the extent that CCS retro-fit is uneconomic[4].

One of the drivers for the development and uptake of CCSR is its potential to facilitate CO_2 mitigation in the future, especially in developing countries where fossil fuel energy generation sources are expected to provide a reliable source of energy supply.

A CCSR facility is a large scale industrial or power source of CO_2 which is intended to be retrofitted with CCS technology when the necessary regulatory and economic drivers are in place.

While the additional upfront costs may be an initial deterrent for developing countries, there may be some justification in introducing a CCSR policy for exceptionally large energy facilities for environmental reasons. The Government of South Africa for example has taken a project specific approach by requiring the 5400MW Kusile project be constructed CCSR.

CCSR AS A MEANS OF ACCELERATING CCS DEPLOYMENT

The introduction of CCSR policy anticipates a future transition to broader CCS deployment. This is made clear in the CCSR definition which states that 'CCSR ceases to be applicable in jurisdictions where the necessary drivers are already in place, or once they come into place'. As such, the introduction of CCSR requirements developed in concert with broader CCS policies will provide a consistent approach to policy development. For example, many of the legal and regulatory issues relating to CCS such as permitting requirements, property and storage rights and long term liability will need to be addressed under a CCSR policy as proponents will require regulatory certainty in order to plan for future retrofit.

An additional benefit to implementing CCSR policy is that by obliging companies to consider CCS retrofit during their planning and design phases, the corollary skills and capability of both developers and the regulators required for broader CCS deployment are also developed. Effectively, this accelerates that rate through the transfer of knowledge and skills.

THE ESSENTIAL REQUIREMENTS FOR CCSR

The recently established CCSR definition provides a list of essential requirements that represent the minimum criteria that should be met before a facility

[3] United Kingdom Department for Business, Enterprise & Regulatory Reform (2009), Impact Assessment of the Carbon Capture Readiness requirements described in the Government response to the 'Towards Carbon Capture and Storage' consultation, www.berr.gov.uk.

[4] ICF International (2010) Defining CCS Ready: An Approach to an International Definition, www.globalccsinstitute.com.

can be considered CCSR. These criteria are included as part of the definition to provide information and guidance to both regulators and project proponents to assist in future planning.

The criteria place the onus of meeting CCSR requirements on project developers and provide the regulator with a series of conditions that project proposals can be measured against.

Under the definition, in order for a facility to be considered CCSR, the project developer should:

- carry out a site specific study in sufficient engineering detail to ensure the facility is technically capable of being fully retrofitted for CO_2 capture, using one or more choices of technology which are proven or whose performance can be reliably estimated as being suitable;
- demonstrate that retrofitted capture equipment can be connected to the existing equipment effectively and without an excessive outage period and that there will be sufficient space available to construct and safely operate additional capture and compression facilities;
- identify realistic pipeline or other route(s) to storage of CO_2;
- identify one or more potential storage areas which have been appropriately assessed and found likely to be suitable for safe geological storage of projected full lifetime volumes and rates of captured CO_2;
- identify other known factors, including any additional water requirements that could prevent installation and operation of CO_2 capture, transport and storage, and identify credible ways in which they could be overcome;
- estimate the likely costs of retrofitting capture, transport and storage;
- engage in appropriate public engagement and consideration of health, safety and environmental issues; and
- review CCSR status and report on it periodically.

While the criteria provides a guide to what will be required to be considered CCSR, governments seeking to establish CCSR policies will need to provide proponents with further guidance and information on how CCSR criteria will be assessed during the approval process. This will provide industry with certainty and assist in the development of feasibility studies.

ESSENTIAL REQUIREMENTS – CAPTURE

For a plant to be capture ready, consideration must be given at the design stage as to whether there is adequate installation space to retro-fit a plant. The intricacy of a CCSR policy is that it needs to be rigorous enough to ensure that retrofit takes place while also being sufficiently flexible to avoid technology lock in.

The essential criterion relating to capture addresses technology lock in by requiring plant developers to 'demonstrate that retrofitted capture equipment can be connected to the existing equipment...'.

The impact of pre-investment choices on capture technology needs to be closely considered by regulators and governments when developing the capture component of CCSR policy.

ESSENTIAL REQUIREMENTS – TRANSPORT

The essential criteria place minimal requirements on CO_2 transportation by requiring proponents to 'identify realistic pipeline or other route(s) to storage of CO_2'. This is in recognition that CO_2 pipeline transportation requirements are well established with many jurisdictions having developed regulations to support CO_2 transportation for enhanced oil recovery. These requirements can be utilised to inform the development of CCSR provisions.

By comparison, transportation of CO_2 by non pipeline methods is less established and may warrant further investigation. Regulators should consult with industry in the formation of CCSR requirements to identify whether proponents will utilise this option and to assess whether additional legislation will be required, especially in relation to transborder transportation.

ESSENTIAL REQUIREMENTS – STORAGE

Storage is the most critical and potentially the most costly element of CCSR requirements and underpins what it means to be CCSR.

The need to identify and assess storage sites in a timely manner is critical to the process of meeting CCSR requirements, and can be influenced by the current state of general storage assessment activities. Where a jurisdiction is still in the early in its storage assessment, proponents may be dissuaded from undertaking CCSR activities if they bear the full costs of exploration.

Additionally, there is a risk that not all storage sites identified by CCSR project proponents will be viable when fully characterised at the time of retrofit. This risk is compounded when the associated risks of capture and transport readiness are undertaken in advance of exploration and characterisation of the storage site.

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Recognising these sensitivities, the essential requirements take a broad approach to storage readiness which is described as 'storage areas which have been appropriately assessed and found likely to be suitable for safe geological storage of projected full lifetime volumes and rates of captured CO_2'.

This approach allows individual jurisdictions to establish what is required to be 'appropriately assessed' and 'likely to be suitable' depending on their own country-specific circumstances.

HOW STRINGENTLY CAN GOVERNMENTS APPLY CCSR?

The risks and costs associated with plant siting and storage highlight the complex sensitivities for implementing CCSR requirements and that individual jurisdictions will have differing appetites for these and other risks. Individual jurisdictions may want to adopt differing levels of stringency depending on their climate change objectives. This was recognised and specifically highlighted in the CCSR definition.

The least stringent CCSR requirements regarding plant siting have low cost and time imposts on project developers and allow for a high degree of flexibility in the choice of capture technology. The benefits of less stringent options for CCSR are already mentioned, for example avoiding technology lock-in for capture retrofit.

Where higher levels of stringency are adopted, uncertainty is reduced but this could also lead to significantly higher costs and the potential for CCSR regulations becoming outdated as technology advances and the performance of the different technologies is discovered.

In contrast, low levels of stringency with regard to CO_2 storage may lead to an outcome where storage is proven to not be viable when fully characterised at a later date. The lack of suitable storage potentially undermines the intent of a CCSR policy.

However, there is a trade-off between reducing uncertainty around future storage potential and the costs incurred at the time of project design. A high level of stringency could require project proponents to provide sufficient information on the capacity, integrity and injectivity of the storage site. Higher levels of assurance regarding storage potential incur increasingly higher, and sometimes rapidly rising, costs. The challenge for policy makers is to strike the right balance between ensuring total costs are minimised as well as meeting industry and community expectations in establishing credible CCS policy.

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The approach taken in the CCSR policy of the United Kingdom requires proponents to demonstrate that a suitable storage area exists and that there are no known barriers to future CO_2 storage. In order to further mitigate the risk that not all storage sites will be viable, the policy also requires proponents to identify two sites along with a study on the storage capacity of each site.

SUPPORTING MECHANISMS

Because of the exploration risks associated with storage assessments, there is a strong need for governments seeking to implement CCSR policies to examine whether supporting mechanisms that support storage exploration and initial characterisation will lower the overall cost impost of implementing CCSR and provide certainty to project developers.

Many of the legal and regulatory issues associated with CCS such as property rights and liability will need to be addressed under CCSR regulation as they will apply at the retrofit stage. While many of these issues will not require immediate resolution, a comprehensive legal and regulatory framework will reduce uncertainty for project developers.

GLOBAL STATUS OF CCSR

The constituent elements of CCSR policy have been debated internationally since 2007 following the release of the IEAGHG report *CO_2 Capture Ready Plants* and discussion during the 2007 G8-IEA Calgary workshop on near-term opportunities for CCS. Because consensus could not immediately be reached, the G8 accepted the 2008 Hokkaido recommendation that 'further work is required to understand and define the concept of 'capture and storage ready' plants and its value as a viable mitigation strategy'.

However, a number of jurisdictions have implemented, or are in the process of developing CCSR requirements for new build power plants, including the European Union, the United Kingdom (excluding Scotland) and South Africa.

EUROPEAN UNION

Article 33 of the European Union Directive on the Geological Storage of Carbon Dioxide requires that, prior to a new combustion plant with a capacity at or over 300MW being constructed, a number of assessments must be carried out relating to the technical and economic feasibility of capturing, transporting and storing its CO_2 emissions.

The assessments are designed to determine whether it is reasonable to expect that the proposed power station will be fitted with CCS in the future. Depending on the outcome of those assessments, the Directive then requires space to be set aside to accommodate future carbon capture equipment, making the proposed plant in effect 'carbon capture ready' (CCR).

UNITED KINGDOM

The Government of the United Kingdom requires similar assessments to be undertaken as part of the process of granting development consent under its Electricity Act 1989. The government is clear on its intention that no new combustion plant covered by the threshold for CCR will be approved unless the assessment concludes that it will be CCR when built.

SOUTH AFRICA, AUSTRALIA AND CANADA

In 2008, the Government of South Africa announced its intention to introduce CCSR regulations for the 5400MW Kusile power generation plant.

The newly elected Australian Government has announced that all new coal-fired power stations will be required to meet best practice emissions standards and be CCSR.

State and provincial governments in Australia and Canada, respectively, have also announced CCSR requirements. The Queensland Government in Australia recently announced that all new build coal fired power stations will need to be constructed CCSR. The Alberta Government has also announced that any new oil sands projects must be constructed CCSR.

The Global CCS Institute provided significant input into the establishment of the CCSR definition. This included hosting a series of regional workshops in Amsterdam, Washington DC, Beijing and Tokyo in 2009. These workshops informed two CCSR reports commissioned by the Institute: Defining CCS Ready: An Approach to an International Definition; and CCS Ready Policy: Considerations and Recommended Practices for Policymakers.

The Institute organised and jointly hosted a CCSR workshop in Ottawa, Canada, with the International Energy Agency and the Carbon Sequestration Leadership Forum. After achieving broad consensus at this meeting, the three organisations established a working group to finalise the definition.

The Institute will continue to provide assistance on CCSR by undertaking capacity development activities for policymakers and regulators to provide them with information to consider in the development of their CCSR policies.

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