

**Carbon Capture, Use and Storage (CCUS)
Action Group**

**Recommendations to the
Clean Energy Ministerial, April 2011**

Introduction

There is clear scientific evidence that there is a high risk of damaging climate change if the world does not move quickly to significantly reduce greenhouse gas (GHG) emissions. The large scale deployment of carbon capture and storage (CCS) is essential for the world to meet agreed climate change mitigation targets. Such deployment is assessed as being a key element of any least cost approach to reducing GHG emissions, providing base-load electricity generation at a cost generally estimated to be competitive with other low-emission alternatives.

Many countries have policies and mechanisms in place to support the deployment of CCS, and these actions are vitally important. However, more needs to be done to deliver CCS at the scale and on the timeline required. The CCUS Action Group has identified key actions aimed at closing this gap.

The challenge for Energy Ministers

Energy Ministers around the world are facing a unique set of challenges in meeting growing domestic energy demands and addressing energy security and affordability challenges while also significantly reducing greenhouse gas (GHG) emissions from energy production. Primary energy use is projected to increase by 84% by 2050.¹ Despite a significant expansion of renewable technologies, fossil fuels will continue to underpin this demand due to their abundance and affordability, leading to a doubling of energy-related CO₂ emissions by 2050. Against this baseline, International Panel on Climate Change analysis suggests that 2050 emissions must be reduced to half 2000 levels in order to stabilise CO₂ atmospheric concentration below 450 parts per million (ppm). This is vital to meet global climate change targets.

Global CO₂ emissions and the path to 450 ppm continue to diverge. To meet this challenge, an energy revolution is required, involving the immediate and aggressive deployment of a portfolio of low-carbon technologies. Within this portfolio, CCS will be critical, along with energy efficiency and renewables. International analysis suggests that CCS will contribute significantly to the required emissions reductions by 2050.² Without CCS, the overall cost of addressing CO₂ emissions rises significantly.

While transitioning to a low carbon economy will be expensive, recent modelling by the IEA concluded that, in their lowest cost scenario for reducing global emissions by 50% by 2050, CCS will be required to contribute around one fifth of the reductions.³ The modelling found that the cost of meeting this emissions reduction target would be significantly higher without CCS.

Required CCS scale-up

For CCS to meet its emissions reductions potential, the 2009 International Energy Agency *Technology Roadmap: Carbon Capture and Storage (CCS Roadmap)* indicates that around 100 CCS projects will be required by 2020, and 3400 by 2050. Importantly, CCS deployment must occur equally in the power sector (coal and gas fired) and industry/upstream sectors by 2050.⁴ In addition, while CCS deployment is currently focussed in OECD regions, CCS technology must spread rapidly to

¹ Relative to 2007 levels. International Energy Agency *World Energy Outlook 2010*

² International Energy Agency *Energy Technology Perspectives 2010*

³ IEA *Energy Technology Perspectives 2010*

⁴ In addition to being the largest contributor to CO₂ emissions reductions in the power sector, CCS is likely to be the most important technology for direct emissions reductions from industry and fuel transformation.

the developing world. Around 65% of projects needed by 2050 will need to occur in non-OECD regions by 2050.

For CCS to be effectively deployed both globally and across sectors, significant domestic and international collaboration will be required to ensure adequate CCS capacity across all relevant regions and sectors.

Current status

According to the *Global Status of CCS 2010* report, there are currently eight large-scale integrated CCS projects in operation. In addition, there are over 65 large-scale, fully integrated projects at various stages of development globally. More than a third of these projects are in advanced stages of development planning prior to making a final investment decision and four are currently under construction.⁵ The experience gained from early demonstration projects will be critical to the successful future deployment of CCS.

Progress is being made in developing the policy, legal and regulatory frameworks necessary for deploying CCS, and public funding commitments to the deployment of large-scale CCS demonstration projects are in the range of USD 26.6 billion to USD 36.1 billion globally⁶. However, these developments are insufficient if CCS is to be available at the scale and within the timeframes required. Urgent additional effort and commitment is required from governments and industry to support and progress projects already underway and to ensure that sufficient new projects are entering the pipeline.

While policy and financial drivers are insufficient to promote CCS deployment, opportunities for economic, beneficial re-use of CO₂ such as in fertilizer production may provide valuable experience in developing and operating CCS technologies.⁷

Purpose of these recommendations

The Carbon Capture, Use and Storage (CCUS) Action Group was established to provide recommendations to the Clean Energy Ministerial (CEM) on concrete, near-term actions to accelerate global CCS deployment. These recommendations support the longer-term actions outlined by the Major Economies Forum Technology Action Plan, the IEA CCS Roadmap and the IEA/CSLF G8 Report 2010.

The recommendations set out in this document address CCS financing, regulation, knowledge sharing and storage, and can be undertaken by Energy Ministers leading up to the 2012 CEM in London. The recommendations are key actions aimed at closing the gap between the current status of CCS today and where it needs to be to effectively contribute to climate change mitigation.

It is acknowledged that CEM governments will have differing energy supply and security priorities and that not all recommendations will apply to all countries.

5 Global CCS Institute – Global Status of CCS - 2010

6 2010 IEA/CSLF Report to the Muskoka 2010 G8 Summit

7 For further discussion of CO₂ use, see the Global CCS Institute study.

CCUS Action Group members⁸

Governments:

Australia, Canada, China, France, Germany, Japan, Republic of Korea, Mexico, Norway, South Africa, the United Arab Emirates, the United Kingdom, and the United States.

Businesses and institutions:

Aker Clean Carbon, Alstom, Bellona, Carbon Capture and Storage Association, Clinton Foundation, Center for American Progress, Global CCS Institute, Integrated CO₂ Network, International Energy Agency, IEAGHG, Sasol, Scottish Power, Shell, World Coal Association, and World Resources Institute.

⁸ Brazil, the European Commission, the World Bank, Asian Development Bank, Duke Energy, Calera, IC02Net, Edinburgh University and USA Green Energy Group have also participated in the work of the CCUS Action Group.

Recommendations

The CCUS Action Group urges Energy Ministers to work within their respective governments to progress the recommendations below, with a progress report to be provided to the London 2012 CEM. The rationale for each recommendation and supporting near-term actions are provided in the second part of this document.

Recommendation 1: Reduce the financial gap

By CEM3; Advance policies that address the financial gap and risk associated with early mover CCS demonstration and deployment.

Recommendation 2: Funding support in developing economies

By CEM3; Identify and advance appropriate funding mechanisms to support the demonstration of large-scale CCS projects in developing economies.

Recommendation 3: Develop legal and regulatory frameworks

By CEM3; Advance the development of legal and regulatory frameworks for CCS demonstration and deployment.

Recommendation 4: Acknowledge importance of marine treaty amendments

By CEM3; Promote the importance to global CCS deployment of ratifying key international marine treaty amendments.

Recommendation 5: Share knowledge

By CEM3; Support and encourage the development of best practice knowledge sharing from early mover projects, in particular those with public funding.

Recommendation 6: Investigate CO₂ storage

By CEM3; Review key gaps in storage data coverage and knowledge, and progress storage exploration and capacity assessment.

Recommendation 7: Support CCS in industry

By CEM3; Recognise the potential of CCS for industrial emission sources and review demonstration opportunities.

Recommendation 8: Report on progress

By CEM3; Request the CCUS Action Group to support the delivery of these recommendations and report on progress.

Recommendation 1: Reduce the financial gap

By CEM 3: Advance policies that address the financial gap and risk associated with early mover CCS demonstration and deployment.

Rationale:

Integrated CCS projects at commercial scale, in both the electricity production and industrial sectors, require multi-billion dollar investments where the risks may be such that the private sector could find it difficult to mobilise financing at costs that would be acceptable. While a number of countries already have policies and mechanisms to support CCS, in general, these risks have not been comprehensively addressed. The specific risks are:

- Early mover technology risks
- Market risks

A framework of financial policies that would facilitate the application of public and private sector financing at the required level would address these risks. Appendix A provides a tabulation of policies around the world that have been applied to stimulate investment in CCS and other low-emission technologies. These policies generally address one of the following:

- Direct application of public funding to support the early stage deployment of technologies, either directly for CCS or more broadly for low-emissions technologies.
- Underwriting of risk against a future carbon price or other direct, output-based support. This approach is essential to attracting private sector financing to the sector.

These policies should be targeted at facilitating the application of public and private sector finance to commercial-scale, integrated CCS projects at a level consistent with the G8 objectives of broad CCS deployment by 2020.

Suggested near-term actions:

- Undertake a gap analysis to identify shortfalls in existing CCS or climate change policies against this recommendation by September 2011
- Establish or identify a structure and resources to support jurisdictions with assessment of the appropriate policy set to meet this recommendation
- Develop policy frameworks to encourage and facilitate the deployment of the second wave of CCS projects

Recommendation 2: Funding support in developing economies

By CEM 3: Identify and advance appropriate funding mechanisms to support the demonstration of large-scale CCS projects in developing economies.

Rationale:

Global emissions reduction scenarios, such as those of the IEA⁹, show that a significant proportion of emissions reductions must come from developing economies. The IEA *CCS Roadmap* suggests that in 2020, 50% of all CCS projects will need to occur in non-OECD regions, increasing to 65% in 2050. Currently there are no CCS projects in non-OECD regions, although China has taken a leadership role in CO₂ re-use projects and the GreenGen project in China anticipates moving to storage. For this level of deployment to occur, there will need to be significant funding transfers from developed to developing countries.

Today, the Clean Development Mechanism (CDM) is the only large scale CO₂ market operating in developing economies; however CCS is yet to be fully included in the mechanism.

There has been a high level commitment in global negotiations for a Global Climate Fund to be established to finance adaptation and mitigation in developing economies. CCS projects in developing economies could be funded through such a fund. However, it is unclear how such a fund will be financed to the level required and how developing economies will attract the additional public and private sector investment required.

Analyses such as those commissioned by the Carbon Sequestration Leadership Forum (CSLF) Financing CCS Task Force and undertaken by the Asian Development Bank (ADB) provide some insight into the mechanisms that could address the costs associated with CCS.¹⁰

Suggested near-term actions:

- Request an international CCS body such as the CSLF or Global CCS Institute to recommend a preferred funding mechanism for projects in developing countries.
- Work to establish a preferred funding mechanism and a process for project solicitation and support in developing countries.
- Support and encourage the UNFCCC work program in 2011 on CCS in the CDM to seek agreement on its inclusion at CMP7.¹¹
- Support and encourage CCS in other UNFCCC processes, including but not limited to the Global Climate Fund.
- Collaborate to enable the production of roadmaps for CCS in developing countries.
- Collaborate and support funding mechanisms that enable joint research and development towards commercial scale CCS.
- Urge multilateral development banks to support CCS as an effective low emission technology in developing countries and to introduce mechanisms to address institutional and financial barriers.

⁹ IEA *ETP 2010*.

¹⁰ ADB 2010. *Carbon Dioxide Capture and Storage Demonstration in Developing Countries – Analysis of Key Policy Issues and Barriers*

¹¹ United Nations Climate Change Conference – Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol – 7th meeting to be held in Durban, South Africa.

Recommendation 3: Develop legal and regulatory frameworks

By *CEM 3*: Advance the development of legal and regulatory frameworks for CCS demonstration and deployment.

Rationale:

Appropriate regulatory frameworks provide assurance regarding the protection of public health, safety and the environment and the effective stewardship of storage sites over the long term. Regulation also provides certainty regarding rights and responsibilities of relevant stakeholders, underpins commercial transactions related to CCS operations and performance and associated incentive schemes, and builds public confidence.

To support the required level and urgency of CCS deployment to meet broader climate change mitigation goals, the IEA CCS Roadmap recommended that countries put in place regulatory frameworks for CCS demonstration by:

- 2011 in OECD countries;
- 2013 in early mover non-OECD countries; and
- 2015 in other non-OECD countries with CCS potential.

The Roadmap also recommended that by 2020, all countries have in place legal and regulatory frameworks for the large scale deployment of CCS.

The regulation of CCS ready may also be important for plant constructed prior to regulatory or economic drivers for CCS being in place, to ensure CO₂ emissions from such plant are not 'locked-in'.

Suggested near-term actions:

- Perform a gap and barrier analysis of existing regulatory frameworks and relevant institutions for their ability to regulate CCS and:
 - amend existing frameworks or develop dedicated frameworks for CCS demonstration and/or deployment; and
 - work towards ensuring institutional capacity is sufficient for regulating CCS operations.

Countries' individual focus will depend on the status of CCS legal and regulatory development to date.

- Engage in greater collaboration and capacity building on the development of CCS legal and regulatory frameworks, in particular with developing countries, including by working with international organisations such as the IEA, IEAGHG, Global CCS Institute and the CSLF.
- Consider the development of a national definition for 'CCS-ready', building on the CCS-ready definition presented to the *IEA/CSLF G8 Report 2010*, and taking into account any regionally specific issues.

Recommendation 4: Acknowledge importance of marine treaty amendments

By CEM 3: Promote the importance to global CCS deployment of ratifying key international marine treaty amendments.

Rationale:

In certain regions, deploying integrated CCS projects may require the transportation of CO₂ across national maritime boundaries and the offshore storage of CO₂. The London Protocol¹² and OSPAR Convention¹³ currently restrict some configurations of offshore CCS operations in party regions. Offshore storage of CO₂ is likely to be important for the deployment of CCS at the scale required, with a significant number of projects looking to utilise such storage options for domestic and internationally sourced CO₂.

While amendments have been made to the London Protocol to allow for cross-border transportation of CO₂ for the purposes of offshore CO₂ storage¹⁴, and to the OSPAR Convention to allow key configurations of CO₂ storage offshore in relevant regions¹⁵, both amendments require ratification by a sufficient number of parties to enter into force.

Not all parties to these protocols are currently interested in offshore CO₂ storage, making ratification of these amendments a low priority. This is understandable, however may ultimately prevent countries with only offshore CO₂ storage available from deploying CCS in their jurisdiction.

It is acknowledged that ratification of the London Protocol and OSPAR Convention amendments may fall outside the remit of Energy Ministers. However, ratification of the amendments will ensure all configurations of CCS are available to address energy related CO₂ emissions, an outcome which is likely to be relevant to Energy Ministers' portfolios. To facilitate global CCS deployment, all countries are encouraged to consider ratifying these amendments, even if the specific issue is not a priority for a country.

Suggested near-term actions:

- Raise awareness, amongst relevant government ministries, of the importance to global CCS deployment of ratifying the 2009 London Protocol amendment to allow transboundary movement of CO₂ for the purposes of storage.
- Raise awareness, amongst relevant government ministries, of the importance to global CCS deployment of ratifying the 2007 OSPAR Convention amendment to allow the sub-seabed injection of CO₂ for the purposes of storage.

¹² 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

¹³ Convention for the Protection of the Marine Environment of the North-East Atlantic.

¹⁴ Resolution LP.3 (4) of October 2009, to amend Article 6.

¹⁵ 2007 proposed amendments to Annex II and Annex III.

Recommendation 5: Share knowledge

By CEM 3: Support and encourage the development of best practice knowledge sharing from early mover projects, in particular those with public funding.

Rationale:

By sharing knowledge from project development, other projects and countries can learn from previous success and failure, ensuring ongoing CCS deployment happens in the most efficient way possible. The challenge of urgently deploying CCS at the scale required becomes significantly harder if knowledge from projects that are operating or under development is not shared. Public and private funders of large-scale CCS demonstrations are increasingly looking to knowledge sharing as a tool to maximise the benefits of their investment. Sharing and compiling knowledge can also underpin the development of best practice techniques around different aspects of CCS development and operation.

Knowledge sharing will be particularly important in transferring learnings from countries that are more advanced in the development of CCS to those that are less advanced, in particular developing countries.

In addition to sharing knowledge and developing best practice on a project and national level, further value can be achieved by aligning regional knowledge sharing efforts at an international level. This will ensure the knowledge generated from projects can be leveraged as widely as possible.

Valuable work to assist project proponents to share experiences is currently underway through the European CCS Demonstration Project Network, the North American Knowledge Sharing Arrangement, the Global CCS Institute and others.

To further encourage a culture of sharing without hampering commercial interests, a framework for CCS Knowledge Sharing was recently developed by the Global CCS Institute, the European Commission and six governments which presently deliver large-scale CCS demonstration programs – namely Alberta, Australia, Canada, Norway, the United Kingdom, and the United States of America.

Suggested near-term actions:

- Encourage the development of a national knowledge sharing framework and principles for publicly funded CCS demonstration projects, building on the Global CCS Institute's Knowledge Sharing Framework.¹⁶
- Encourage CCS project proponents, government bodies, and publicly-funded regional initiatives to work with international organisations, such as the Global CCS Institute, to coordinate global collaboration around CCS knowledge.
- Request international CCS organisations, such as the Global CCS Institute, CSLF and IEAGHG, to undertake an annual review of existing best practice guidelines and facilitate capacity building in key regions to ensure the sharing of experience.

¹⁶<http://www.globalccsinstitute.com/resources/publications/global-knowledge-sharing-framework>

Recommendation 6: Investigate CO₂ storage

By CEM 3: Review key gaps in storage data coverage and knowledge, and progress storage exploration and capacity assessment.

Rationale:

For CCS to meet its emissions reductions potential, over 1.2 GtCO₂ of storage capacity will be required by 2020 and 145 GtCO₂ by 2050.

Theoretical global storage capacity is more than sufficient to meet these requirements, but more work needs to be done to establish what percentage of this capacity can be utilised in practice, given the significant uncertainty regarding estimates of viable capacity. There is also similar uncertainty regarding the distribution of this storage capacity.

Further storage assessments are needed urgently so that countries can understand their national CCS potential and the global level of CCS deployment envisaged can be realised. Further storage assessment is particularly critical at the project level, where this data is required for projects to be able to proceed.

Suggested near-term actions:

- Request international CCS organisations, such as the Global CCS Institute, CSLF and IEAGHG, to facilitate CO₂ storage capacity building in key regions including developing countries.

For governments that have not completed a national storage atlas:

- Produce a national CO₂ storage atlas, identifying focus areas for potential CO₂ storage and mapping potential storage against CO₂ sources.
- Identify key gaps in storage data coverage, and actions and resources to fill those gaps. This should include establishing regional priorities and programs for storage data acquisition, and commencing exploration to obtain that data where required.

For governments that have already completed a national storage atlas:

- Continue investigation and characterisation of high potential CO₂ storage areas, including by exploration, in order to facilitate private investment and detailed site-specific characterisation required by projects.
- Strive to establish bilateral and multilateral partnerships with countries that are not as advanced in this area in order to expedite progress in storage mapping, analysis and exploration as appropriate.

Recommendation 7: Support CCS in industry

By CEM 3: Recognise the potential of CCS for industrial emission sources and review demonstration opportunities.

Rationale:

Industry accounts for one third of total global energy use and for 40% of direct and indirect energy and industrial process CO₂ emissions (IEA *ETP 2010*). Industrial energy use and CO₂ emissions are projected to increase in the coming decades: the IEA *CCS Roadmap* estimates that CCS from industry and upstream sources will account for 45% of all CCS deployment, and 1.7 to 2.5 Gt of CO₂ captured annually, in 2050. In certain industry sectors, such as iron and steel and cement making, CCS may offer the largest mitigation potential.

Industrial sources may also present low cost early opportunities for CCS application where the processes involved produce high concentrations of CO₂ or where a number of CO₂ sources are clustered in close proximity. Clustered CO₂ sources, such as industrial complexes, may allow for economies of scale in capture and transport.

Demonstration plants are needed to prove the feasibility of industrial CCS, ascertain smooth operation and create more clarity concerning CCS costs. CCS technologies required in industry are more diverse than in power generation and therefore need a more diverse demonstration program.

It is acknowledged that, while certain industrial emission sources such as oil refineries or natural gas production are likely to fall within Energy Ministers' portfolios, others may not. However, industry as a whole may present early opportunities for CCS, which may have future benefit for CCS applications relevant to Energy Ministers' portfolios, and learning from early industry CCS application is likely to be relevant across industries.

Suggested near-term actions:

- Review opportunities for industrial CCS in sectors such as gas processing, refineries, iron and steel, cement, ethanol production and emerging coal to liquids industries.
- Explore the development of 'clusters' for CO₂ capture from industry to reduce costs and promote synergy between emission sources.
- Identify and encourage possible demonstration opportunities for low cost CCS in relevant industry sectors.

Recommendation 8: Report on progress

By CEM 3: Request the CCUS Action Group to support the delivery of these recommendations and report on progress.

Rationale:

Reporting on progress enables the CEM to better understand progress towards key CCS goals and more specific CCS recommendations. This will allow Energy Ministers to identify where good progress is being made and where more effort is needed and put a response into place in a short term timeframe.

Suggested near-term action:

- Request the CCUS Action Group, with the assistance of the IEA, Global CCS Institute and other interested stakeholders, to report on progress towards 2011 CEM CCS recommendations at the London 2012 CEM.
- Encourage collaborative work between CCUS Action Group and other stakeholders in order to achieve the delivery of the 2011 CEM CCUS recommendations.
- Request the IEA, CSLF and the Global CCS Institute to report on progress towards global CCS deployment.

Financial Incentives & Mechanisms to Support CCS Projects

Application of Funds

(Note: Effective support will need to address initial capital increment, ongoing cost penalty and carbon risk)

Mechanism	Examples	Application	Strengths	Weaknesses
Capital Grant for capture project	<ul style="list-style-type: none"> • UK Competition; EEPR • DOE • Australian Flagship Program • UK and US programs may include Opex subsidy • Canada federal and provincial governments • Japan 	<ul style="list-style-type: none"> • Directly, and usually partially, funds the incremental initial capital and/or operating costs for early mover projects • Could be CCS specific or available to low emission technologies in general 	<ul style="list-style-type: none"> • Addresses the initial capital hurdle to the extent of the funding, averaging 50% • Justified public funding for early stage technology risks 	<ul style="list-style-type: none"> • Criteria can be complex • Often incomplete. • Needs to be complemented by some form of carbon pricing and risk management. • Competitive bidding and conditions can be onerous
Direct funding of storage characterisation and assessment	<ul style="list-style-type: none"> • Australian Government; • Canada federal and provincial governments • Japan 	<ul style="list-style-type: none"> • Subsidies for geological studies 	<ul style="list-style-type: none"> • Logical point for Government involvement. • Addresses the time-critical element in large-scale CCS projects 	<ul style="list-style-type: none"> • Should be part of a • comprehensive package

Direct funding for research and development (R&D)	<ul style="list-style-type: none"> • Canada – Clean Energy Fund, ecoETI, Program of Energy Research and Development 	<ul style="list-style-type: none"> • Funding to address technical and knowledge gaps that may lead to deployment cost reductions 	<ul style="list-style-type: none"> • Addresses funding gaps where returns for private sector investment may be lacking • Cost reductions make private investment more attractive 	<ul style="list-style-type: none"> •
Loan Guarantees	<ul style="list-style-type: none"> • DOE 	<ul style="list-style-type: none"> • Can reduce up-front capital costs 	<ul style="list-style-type: none"> • Can be cost effective, depending on accounting treatment 	<ul style="list-style-type: none"> • Often too small to make a real difference • Can be unacceptable in some jurisdictions from an accounting treatment perspective
Tax credits/Tax deductibility	<ul style="list-style-type: none"> • US Treasury/DOE 	<ul style="list-style-type: none"> • Can reduce some combination of capital or operating costs 	<ul style="list-style-type: none"> • Fills the gap created by policy uncertainty 	<ul style="list-style-type: none"> • Does not address the initial capital hurdle
Quantifiable Emissions constraint	<ul style="list-style-type: none"> • Cap and trade • Carbon Tax 	<ul style="list-style-type: none"> • Effectively addresses initial capital on ongoing operating cost penalty 	<ul style="list-style-type: none"> • If set properly should drive lowest cost mitigation outcome • Acts as both a 	<ul style="list-style-type: none"> • Target uncertainty makes it difficult for the market to price effectively • Political risks mean that targets

			source and application of funding by pricing emissions	or tax levels are set too low, leading to worst outcome <ul style="list-style-type: none"> • Does not address early mover cost penalty
Direct government equity	<ul style="list-style-type: none"> • Norway/Gassnova 		<ul style="list-style-type: none"> • Lowers cost of finance 	<ul style="list-style-type: none"> • Requires government balance sheet involvement • May not address operating cost penalty
Off-take Agreement/Power Purchase Agreement	<ul style="list-style-type: none"> • State of Indiana Gas Authority, USA 	<ul style="list-style-type: none"> • Applied to output • Addresses the ongoing cost penalty • Purchase gas at a fixed price from a coal-to-methane plant 	<ul style="list-style-type: none"> • Similar in effect to feed-in tariff but for larger scale projects • Provides a guaranteed price for the output 	<ul style="list-style-type: none"> • Who pays? • Requires direct government intervention on projects • Does not address the initial capital cost premium
Feed-in Tariff	<ul style="list-style-type: none"> • Has been commonly used to support embedded solar, at both the domestic and utility scale; Spain, 	<ul style="list-style-type: none"> • Applied to output 	<ul style="list-style-type: none"> • Attractive to investors, provided counter-party is secure • Enables costs to be averaged across a 	<ul style="list-style-type: none"> • Very difficult to scale and target • Can be expensive to government or to consumers over time

	<p>Germany, Australia.</p> <ul style="list-style-type: none"> • Several Asian countries 		<p>large market leading to relatively low cost impact, at least initially</p>	
Contract for Difference	<ul style="list-style-type: none"> • UK 	<ul style="list-style-type: none"> • Long term contract with Government which guarantees income regardless of the wholesale market price 	<ul style="list-style-type: none"> • Most effective in addressing the carbon price issue • Provides greater long term carbon price certainty than other options 	
Low-emission Obligation	<ul style="list-style-type: none"> • Common in renewable space: RO (UK); RPS (USA); RET (Australia) 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • If set properly, has the potential to drive investment in CCS quite effectively 	<ul style="list-style-type: none"> • Is less likely to address the initial capital hurdle
Government CCS Authority with capacity to contract	<ul style="list-style-type: none"> • Proposed CarbonNet structure 	<ul style="list-style-type: none"> • Across the chain 	<ul style="list-style-type: none"> • Could facilitate coordination of the full chain, particularly for networks 	<ul style="list-style-type: none"> • Governments reluctant to expose balance sheets • Future exit may be challenging
Capacity-based payment	<ul style="list-style-type: none"> • Variant of some of the above, but paid on plant or pipeline availability rather than output 	<ul style="list-style-type: none"> • Can address both the capital and operating cost penalties • Most obviously 	<ul style="list-style-type: none"> • Lowers risk (transfers to government or community) 	<ul style="list-style-type: none"> • Has the potential to be relatively expensive

		applicable for transport and storage elements of CCS chain		
Transfer of financial obligations for long term liability, monitoring and (if needed) remediation	<ul style="list-style-type: none"> Proposed Alberta <i>Carbon Capture and Storage Statutes Amendment Act (Bill 24)</i> 	<ul style="list-style-type: none"> Long term liability for storage site and monitoring/remediation costs post-closure 	<ul style="list-style-type: none"> Addresses financial risks after operations cease 	<ul style="list-style-type: none"> Financial obligation for CCS operators for a fund to address ongoing, post-closure monitoring costs and any required remediation

Sources of Funds

Mechanism	Strengths	Weaknesses
On-budget government allocation	<ul style="list-style-type: none"> • Simplicity 	<ul style="list-style-type: none"> • Always limited by government's budgetary cycles
Allocation from cap and trade permit auctions	<ul style="list-style-type: none"> • Potentially of the scale necessary for CCS deployment 	<ul style="list-style-type: none"> • Competes with multiple other contenders • Gets caught up in the complexity of cap and trade
Global Climate Fund	<ul style="list-style-type: none"> • Could be effective for early projects in developing countries • Could be best structured as a CCS-specific Fund 	<ul style="list-style-type: none"> • Competes with adaptation in developing countries • International political processes can take time.
Multi-lateral development banks	<ul style="list-style-type: none"> • Can both lower project cost of capital and also reduce risks for commercial banks • Generally applies to developing economies 	<ul style="list-style-type: none"> • Usually supports a relatively small tranche of debt
Public/private partnerships	<ul style="list-style-type: none"> • Can lower project cost of capital through blend of differential rates 	<ul style="list-style-type: none"> • Can be politically challenging and generally jurisdictionally specific
Levy on power prices	<ul style="list-style-type: none"> • Visible and direct • Could be used to address both initial capital and ongoing operating cost barriers 	<ul style="list-style-type: none"> • Politically difficult when prices may be rising for other reasons
Institutional investors (pension funds, insurance funds, sovereign wealth funds)	<ul style="list-style-type: none"> • Relatively low return expectations, provided risks can be reduced accordingly; 	<ul style="list-style-type: none"> • Requires policies or related mechanisms that serve to lower the risk profile (Refer 'Application of Funds',

	<ul style="list-style-type: none">• Potentially very large sources of funds• Could then be leveraged strongly	above)
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