I. Introduction

Climate change is a major challenge. Secure, reliable and affordable energy supplies are needed for economic growth, but increases in the associated carbon dioxide (CO₂) emissions are the cause of major concern. About 60% of all CO₂ emissions, and 60% of all greenhouse gas emissions, are energy-related.¹ Recent IEA analysis projects that the CO₂ emissions attributable to the energy sector will increase by 130% by 2050 in the absence of new policies or supply constraints, largely as a result of increased fossil fuel usage.² The 2007 Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report indicates that such a rise in emissions could lead to a temperature increase in the range of 4.7°C, with major impacts on the environment and human activity.³ It is widely agreed that a 50% reduction in energy-related CO₂ emissions is needed by 2050 to limit the expected temperature increase to less than 3 degrees Celsius. To achieve this will take an energy technology revolution involving increased energy efficiency, increased renewable energies and nuclear power, and the decarbonisation of power generation from fossil fuels.

Oil, coal and natural gas will remain the world’s dominant sources of energy over the next decades, resulting in unsustainable levels of carbon dioxide emissions. This trend can be reversed only via a near revolution in the way we produce, transform and consume energy. Concerted global action is urgently needed to increase investment in energy technology solutions. Carbon dioxide capture and storage (CCS) is a particularly promising solution, and many nations have ambitious plans for CCS development. However, the next decade is a critical “make or break” period for CCS: if CCS is to deliver the necessary greenhouse gas (GHG) reductions in time to stabilize the climate, governments need to rapidly finance large-scale demonstration projects, develop regulations to ensure public health and safety, and integrate CCS incentives into GHG emissions mechanisms. This article will provide an overview of the urgency for action on CCS. It will then document emerging financing and legal developments and provide recommendations for next steps.

² IEA, Energy Technology Perspectives, IEA/OECD, Paris 2008.
⁴ CCS is a process whereby CO₂ is captured from gas produced by fossil fuel combustion, compressed then transported and injected into deep geologic formations for long-term storage. The subterranean layers are located several hundreds of meters below ground. See IEA, CO₂ Capture and Storage: a Key Carbon Abatement Option, IEA/OECD, Paris 2008.
⁵ IEA, Energy Technology Perspectives, Paris 2008.
announced that 20 large-scale CCS demonstration projects need to be committed by 2010, with a view to beginning broad commercial deployment by 2020.

CCS investment and policy development are not proceeding rapidly enough to achieve these high-level goals. There are currently only 4 full-scale geologic CO₂ storage projects in the world, and none of these projects involves emissions from a coal-fired power plant. CCS technology demonstration has been held back for a number of reasons, including lack of financing, need for regulatory frameworks, and lack of public awareness of the need for CCS. The first two of these topics will be discussed in turn; the topic of public awareness will need to be addressed in a separate article.

II. CCS Financing

As a pollution control measure which adds additional costs (as opposed to energy efficiency or energy supply measures), it is clear that CCS will not be invested in without sufficient financial and regulatory requirements. It is helpful to think in terms of two specific needs for CCS financing: near-term government spending for large-scale demonstration projects, and creation of incentives for CCS via formal inclusion in GHG regulatory mechanisms. The most urgent financing need is government financial support for large-scale demonstration projects—thus the focus of the 2008 G8 announcement. These early projects will provide the necessary verification of the performance of CCS technologies. They will also provide policy makers with monitoring data that they will need to develop regulations for CO₂ transport and storage. The incremental costs for the 20 G8 large-scale demonstration projects will be on the order of US$20 billion. Due to the critical learning that will result, there are some governments who are investing in CCS demonstration projects with the philosophy that CCS is a “public good.” For example, in summer 2008, the Alberta Provincial Government announced the creation of a CAN$2 billion fund for CCS demonstration. The Australian and Norwegian governments are also investing heavily in CCS. More governments will need to follow these examples, and commit real funds toward full-scale CCS demonstration, if CCS is to contribute the emissions reductions that it must deliver in the coming decades to achieve climate stabilisation. In parallel with paying for CCS demonstration, governments also need to spell out methodologies by which CCS can be included in GHG regulatory mechanisms at the international, supranational and national levels. While it is clear that a limit on GHG emissions will automatically create a value for the CO₂ avoided through CCS, a number of studies confirm that CO₂ prices alone are insufficient to stimulate CCS investment in the short term.³

At the international level, the United Nations Framework Convention on Climate Change contains no explicit reference to the use of CCS, although the Kyoto Protocol does refer to CCS research and use by Annex 1 Parties. The Proposed IPCC 2006 inventory methodologies provide a good basis for inclusion of CCS in climate change mitigation mechanisms. One of these mechanisms, the Clean Development Mechanism (CDM), allows developing nations to host emission reduction projects which generate credits that can be used towards an Annex I country’s emissions targets. However, there has been a controversy over the inclusion of CCS projects in the CDM. The CDM Executive Board, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Conference and Meeting of the Parties (COP/MOP) to the Protocol, have all considered whether CCS is to be included in the CDM. Concerns have been raised by some Parties, including the impact of large CCS projects on the global CDM market, accounting for leakage, and the additional energy penalty associated with capturing CO₂. It is hoped that a final decision as to its inclusion will be made at the fourth COP/MOP in December 2008.

At the supranational (primarily the European Union) and national levels, there is currently an active discussion about the incorporation of CCS into GHG trading schemes. The European Commission’s current stance is that the Emissions

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7 Interestingly, the US Troubled Asset Relief Program (TARP) legislation passed in September 2008 includes a US$20/tonne CO₂ storage (US$10/tonne for enhanced oil recovery) tax credit. It remains to be seen how and when this proposal will be implemented by the U.S. Department of the Treasury.
Trading Scheme (ETS) provides a sufficient market-based incentive for CCS deployment. However, some in the Parliament disagree, and are actively considering various proposals to accelerate CCS, including setting aside ETS auction allowances specifically for demonstration project financing and the creation of an Emissions Performance Standard (a CO₂ emissions/kilowatt-hour performance metric) that new power plants must meet. In the United States, the climate change legislation that was debated in summer 2008 included a special ‘bonus’ allowance for CCS projects that met certain criteria. Other countries (Australia, Japan, and others) are also evaluating this issue.

III. Selected CCS Legal and Regulatory Issues

At the same time that governments work to identify suitable mechanisms for CCS financing, they are developing the necessary regulatory frameworks to support CCS projects. CO₂ capture standards will likely be considered as part of GHG regulatory schemes. However, CO₂ transport and storage present unique issues that must be addressed in separate regulations. Despite important progress in identifying guiding principles, no country has developed a comprehensive, detailed legal and regulatory framework to govern the transport and storage of CO₂. There are a number of important issues that must be addressed in a comprehensive CCS regulatory framework, this article focuses on some of the most critical issues.

1. CO₂ Pipeline Transport

CO₂ pipeline transport is not a new activity; the United States and Canada have decades of regulatory experience with siting, permitting and monitoring CO₂ transport pipelines. However, as densely populated areas like the EU and Japan explore CCS implementation, they must address CO₂ pipeline transport health and safety and siting issues. In the United Kingdom, for example, the Health and Safety Executive recently published an initial view on the safety of transporting CO₂ by pipeline for CCS activities. The interim guidance concludes that the hazards from transporting natural gas are different and highlights the need to develop best practice guidelines for the transmission of CO₂ in pipelines. The siting of pipelines and the granting of third-party access is also an area of regulatory concern. There is a need for current regulatory frameworks to be adapted to accommodate the anticipated increase in the volumes of CO₂ to be transported for the purpose of CO₂ storage. Legislation governing planning permissions, environmental impact assessment, rights of way and the compulsory acquisition of land may all need to be evaluated in the light of this increased expansion of pipeline networks.

2. CO₂ Storage Site Selection

While studies of existing CO₂ storage sites suggest leakage rates of less than 1% over thousands of years, regulators must develop safeguards to ensure that CO₂ storage is conducted properly. This includes a thorough planning and geologic analysis of the storage site, using established site selection methods and under regulatory approval. While site selection methodologies are currently under development by national and international authorities, more needs to be done to identify (and harmonize) site selection practices.

11 Speech by Chris Davies, Rapporteur for the European Parliament for the EU ETS, Japan-EU Centre meeting on International Collaboration on CCS, Brussels (12 November 2008).
14 See, e.g., IEA 2007, Legal Aspects of CO₂ Storage: Updates and Recommendations.
3. CO₂ Storage Monitoring and Verification

Monitoring and verification (M&V) is another important regulatory issue. Expected CCS M&V practices include seismic monitoring, groundwater analysis, and the use of chemical tracers. The EU, the United States, Japan, Australia and Canada are working independently to develop M&V standards; more should be done to share emerging practices. Governments should also develop appropriate mitigation steps (e.g., aeration) that must be performed to minimize impacts on plants, humans or animals.

4. Long-Term Stewardship

Finally, responsibility for long-term storage site integrity and safety is also an important issue for policy makers. Under the EU CCS Directive, operators are required to make financial provisions to ensure that all the terms of the Directive and the issued permit are met. For long-term post-closure care, the EU envisions transfer of liability from the operator to the competent authority. The timescales for this are left flexible, but the basic condition is that the evidence indicates that the CO₂ will be completely contained for the indefinite future.¹⁸ In contrast, the US, Japan and other countries current CCS regulations are silent on this transfer of authority.¹⁹ Some have looked to similar long-term storage/disposal frameworks in the energy, waste or nuclear arenas for models that might be transferred.²⁰ Others observe that contrary to public perception, no country has established a framework that addresses true “long-term liability” (e.g., multiple hundreds of years of responsibility). They suggest instead that governments should explore the creation of new entities that can act as long-term stewards over CO₂ storage sites.²¹ The insurance industry has also begun to develop CCS insurance products to manage this liability.

IV. Recommended Next Steps

It is clear there is a critical need for CCS to be rapidly expanded if it is to achieve our global climate change goals. In addition to an urgent need for large-scale demonstration projects, governments need to integrate CCS into GHG regulatory mechanisms such as CDM and emissions trading schemes. There is also a rapid expansion of CCS regulation around the world, with the emergence of dedicated legal frameworks that create permitting mechanisms and leave much to the competent authorities to implement. The next step will be to provide performance-based standards for key issues like site selection, CO₂ transport planning and regulation, and M&V and stewardship at CO₂ storage sites. As they are developing these standards, governments should strive toward greater international collaboration, with an aim toward harmonizing site selection and M&V standards in particular. This will facilitate global public acceptance, as well as the generation of internationally tradable carbon credits from CCS projects.

To foster international collaboration on legal and regulatory frameworks for CCS, in 2008, the International Energy Agency launched the International CCS Regulators’ Network.²² The Network aims to provide a forum for potential CCS regulators and, via web conferences and other exchange mechanisms, affords them the opportunity to discuss possible solutions to challenges they face developing adequate CCS legal and regulatory frameworks. For more information on the Network, visit http://www.iea.org/Textbase/subjectqueries/ccs_network.asp.

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¹⁸ See supra, note 13.
¹⁹ Under the proposed U.S. Environmental Protection Agency Safe Drinking Water Act regulations for CO₂ injection, the site operator has a default responsibility of 50 years for post-injection site care (including monitoring). The long-term responsibility remains indefinitely with the owner or operator. For more information, see http://www.epa.gov/ogwdw/uic/wells_sequestration.html.