CO_2 Capture Project®

REGULATORY CHALLENGES AND KEY LESSONS LEARNED FROM REAL WORLD DEVELOPMENT OF CCS PROJECTS

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About the CO_2 Capture Project (CCP)

The CCP was formed in 2000 to advance technologies and improve operational approaches to help make CCS a viable option for CO_2 mitigation. Today, this partnership of major energy companies is focused on delivering results from its demonstrations, field trials and studies. The group is made up of four teams; Capture, Storage, Policy & Incentives and Communications.

About the CCP Policy & Incentives Team
The P&I Team is committed to providing technical, economic and social insights to inform the development of legal and policy frameworks and to helping public understanding.

Previous P&I reports, including *CCS Stakeholder Issues Review and Analysis Report (2011)* are available online to download.

In 2013 the P&I Team will be undertaking a study on local community benefit-sharing options. Please register on www.co2captureproject.org to receive updates on new reports.

CO_2 Capture Project Phase Three participating organizations.

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Carbon capture and storage (CCS) will need to play an important role in climate change mitigation strategies. As stated by the IPCC Fourth Assessment Report (AR4), no single technology can provide all of the mitigation potential required for the stabilisation of atmospheric greenhouse gas concentrations, but CCS (along with other mitigation technologies and policies) will be key in mitigating greenhouse gas emissions over the coming decades[1]. Robust regulatory frameworks for CCS are important in helping with the successful planning, development and implementation of CCS projects.

In 2010, the CO_2 Capture Project undertook an update on selected regulatory issues for CO_2 capture and geological storage. This study provides an update to the 2010 report by undertaking a practical and focused review of regulatory developments and issues, looking in particular at CCS projects that have undergone or progressed significantly through the regulatory process. Eight CCS case studies across Australia, Canada, Europe and the US were investigated at as part of the study. Because a number of the projects are still progressing through the regulatory approval process, individual case study responses have been kept confidential and broader findings and conclusions from the case studies have been integrated into the report.

The study found that pathways for the regulatory approval of a CCS project do exist and that, although various gaps and barriers in the regulatory frameworks in place were identified, these were not insurmountable in the cases studied and projects have been able to progress with the relevant permits in place or expected to be granted.

Findings from the case study interviews provided the basis for:

- An update on key regulatory issues in the different jurisdictions studied;
- The analysis of broader cross-cutting findings; and
- A summary of case study lessons learnt that could be generally applicable to the development of regulatory frameworks for CCS in other regions, and the regulatory approval process for other CCS projects.

The table and text below provide an overview of key regulatory developments and issues in the jurisdictions studied. This is followed by a summary of broader cross-cutting findings and case study lessons learnt.

[1] IPCC 2007: IPCC Fourth Assessment Report (AR4) - Synthesis Report, pages 58 and 60; and IPCC, 2005: IPCC Special Report on Carbon Dioxide Capture and Storage, page 3.

Overview of regulatory frameworks and issues

	Australia (Victoria)	Canada (Alberta)	Europe	US
Context	Regulatory framework for CCS in onshore and offshore Victoria	CCS plays a key role in Alberta's climate strategy and significant progress has been made in building a robust regulatory framework	Transposition of the EU CCS Directive on geological storage of CO_2 (completed by 10 of 27 EU Member States)	Regulation of various issues at the federal level under Clean Air Act (reporting) and Safe Drinking Water Act (injection & storage of CO_2) Other issues (long-term liability; pore space) regulated at State level
Key regulatory developments	Australian carbon tax ($23 per tonne) introduced July 2012	On-going Regulatory Framework Assessment (RFA) evaluating current regulation of CCS and identifying / resolving gaps	Evolving regulatory frameworks for CO_2 storage following the transposition of the CCS Directive by Member States	Finalisation of the Underground Injection Control (UIC) Class VI Rule for Geological Sequestration projects
Key regulatory issues	• Long-term liability for CO_2 cannot be transferred to the state (Victoria) • This differs to Commonwealth Offshore regulations – potential issues with cross-boundary storage sites	• Gaps around transfer of liability to the Crown and structure of the Post-closure Stewardship Fund, but these are being addressed through the RFA • Questions about the regulation of CO_2-EOR and transitioning from CO_2-EOR to CCS	• Insufficient detail in some areas of the regulations in some states (e.g. MMV; health & safety criteria for CO_2 transport) • Common concerns about liability for stored CO_2 – particularly climate liability and uncertain future of EUA prices	• Onerous requirements made of CCS projects under the UIC Class VI Rule • Preference to develop CO_2-EOR projects under UIC Class II Rule and questions about regulation of CO_2-EOR • Lack of carbon pricing mechanism causing funding difficulties / uncertainty amongst investors

Australia

A significant policy development in Australia was the introduction of a carbon tax in July 2012. In the near-term, however, it is unlikely that the carbon tax (at AU $23 per tonne CO_2e) will significantly change the economics of CCS.

The federal Offshore Petroleum and Greenhouse Gas Storage (OPGGS) Act was finalised in 2011 with the development of two final sets of regulations under the Act. State onshore regulations exist in Victoria, Queensland and South Australia and are under development in New South Wales and Western Australia. In addition, Victoria's state offshore regulations came into play at the start of 2012, making it the first Australian state to finalise its CCS regulatory framework for both onshore and state offshore CO_2 storage.

The Victoria onshore and offshore regulations do not provide for the transfer of tort liability for stored CO_2 to the state, and this poses a regulatory risk to project

developers in the region. The case study highlighted the important role that demonstration projects can play in helping to inform the development of a CCS regulatory framework, and the importance of being able to tailor regulations to projects of different sizes: some onerous aspects of CCS regulations geared towards large-scale CCS projects could pose difficulties to smaller-scale demonstration projects.

Canada

In Canada, CCS regulatory frameworks are being developed in a number of provinces including Alberta, Saskatchewan, British Columbia and Nova Scotia. In Alberta, CCS plays a key role in Alberta's climate change strategy; CAD $1.5bn has been allocated for the funding of three CCS projects in the province. A robust regulatory framework for CCS is evolving through the development of the Carbon Capture and Storage Statutes Amendment Act (2010), the Carbon Sequestration Tenure Regulation (2011) and the CCS Regulatory Framework Assessment (2011). Alberta's currently on-going CCS Regulatory Framework Assessment (RFA) is helping to address any remaining gaps or issues in the regulations, for example in relation to details of the criteria that must be met before responsibility and liability for stored CO_2 can be transferred to the Crown, and the structure of the Post-closure Stewardship Fund that can be used by the Crown in the post-closure phase for monitoring and potential remediation actions. The RFA draws together scientific, academic, regulatory, administration and industry experts, including CCS projects currently under development in the region.

Enhanced oil recovery using anthropogenic CO_2 (CO_2-EOR) is regulated according to long-standing petroleum laws and is not explicitly addressed in the existing regulatory framework for CCS in Alberta, but CO_2-EOR projects are able to gain credit for sequestered CO_2. Questions remain about the regulation of EOR-CCS projects (including provisions for a transfer from CO_2-EOR to CCS) and these are not being addressed in the RFA but will be looked into following completion of the CCS RFA process, in as early as 2013.

Europe

In Europe, the transposition of the 2010 CCS Directive on the geological storage of CO_2 has triggered a number of regulatory developments at the EU Member State level. To date, ten Member States have completed the transposition of the Directive. Whilst the CCS Directive helps to set a robust regulatory framework for the storage of CO_2, some of the more practical and technical details must be developed at the Member State level. In some cases this detail is currently lacking, posing some difficulties for projects first to progress through the permit application and regulatory approval process in these countries as these issues are resolved.

Other regulatory concerns relate to uncertainty about potential liability for global environmental impacts resulting in the event of a leak of CO_2. In the event of a CO_2 leak, operators would be required to surrender an amount of EU Allowances (EUAs) equal to the volume of CO_2 leaked, but there is uncertainty in the future value of EUAs, and uncertainty therefore in potential liabilities. Some concerns also exist in relation to the practicalities of being able to hand over liability for local

environmental damages under the EU Environmental Liability Directive to the state, since strict liability is placed on operators and a strong 'polluter pays' principle applies.

Finally, some concerns were raised by project developers around the third-party access provisions of the Directive, with fears that the provisions for transparent and non-discriminatory third-party access to CO_2 transportation and storage infrastructure could place significant risks on CO_2 storage site operators in the event where they are required to accommodate new and additional sources of CO_2. It is likely that as the first CCS projects progress through the regulatory approval process and as more guidance is issued across Member States, a number of these issues will be resolved and a more robust regulatory approval process will evolve for future projects.

US

In the US, the finalisation of the EPA's Underground Injection Control (UIC) Class VI rule (under the authority of the Safe Drinking Water Act) in December 2010 has important implications for the regulation of CCS. Projects injecting and storing CO_2 not for the purposes of EOR are required to gain a Class VI permit and will need to meet stringent regulatory requirements designed to minimise risk to underground sources of drinking water (USDWs). To date, no Class VI permits have been issued, though four permit applications have been submitted to the EPA. Project developers perceive the regulatory requirements made of Class VI wells (particularly in relation to meeting requirements during the default 50-year post-injection site care period) to be particularly demanding, and some indicated a preference to develop CO_2-EOR projects using anthropogenic CO_2 that can be permitted under UIC Class II requirements. The US EPA also finalised a rule under authority of the Clean Air Act that requires facilities that conduct geologic sequestration (GS) of CO_2 and all other facilities that inject CO_2 underground to report greenhouse gas data to the EPA annually. This rule amends the regulatory framework for the US Greenhouse Gas Reporting Program.

CO_2-EOR (using anthropogenic CO_2) is likely to play an increasingly important role in providing the necessary incentives for the deployment of CCS in the US. CO_2-EOR projects are regulated under the UIC Class II regulations. Issues relating to when a project might transition from a Class II EOR well to a Class VI CCS well have been addressed to some extent; criteria determining when such a transition might be made have been developed and further guidance on this transition is due to be published in the near future. With the lack of a federal carbon pricing mechanism, specific CCS funding initiatives such as the American Recovery and Reinvestment Act (allocating US $3.4bn to CCS development) play a key role in helping the development of CCS in the US, and the 45Q Tax Credit that would provide a $10-20 / tonne CO_2 storage tax exemption has the potential to support early projects, providing uncertainties in the credit system are addressed.

Cross-cutting findings

Long-term liability for stored CO_2

Long-term liability for stored CO_2 is an important regulatory consideration for CCS projects, and a common concern across jurisdictions.

In Victoria, Australia, common law liability cannot be transferred to the state following the closure period, posing a risk to project developers in the region. This differs to provisions of the Australian Commonwealth offshore CCS regulations, where common law liability can be transferred after a minimum 15 year 'closure assurance period' has passed following the cessation of injection operations, raising questions about how liability would be handled with potential future cross-boundary storage projects.

In Alberta, tort liability can be assumed by the Crown following the issuance of a closure certificate, but climate change liabilities cannot currently be transferred.

In Europe, there is uncertainty about the potential extent of liability held under the EU Emissions Trading Scheme Directive with uncertain future prices of EU Allowances in the system.

In the US, long-term liability for stored CO_2 was one of the regulatory barriers to CCS deployment analysed by the Interagency Task Force on Carbon Capture and Storage in 2010. A number of options for the regulation of long-term liability were presented by the task force, including regulation at the Federal level, but to date legislation addressing long-term liability has been developed only at the state level. States have addressed the topic in different ways and in some states such as Texas there is a lack of clarity about the extent to which a CCS trust fund enables the transfer of liability to the state.

Climate change policy context

The study illustrated the important role that a jurisdiction's broader policy context plays in shaping the regulatory landscape for CCS and in influencing other factors important in determining a project's success. CCS development can be incentivised by carbon pricing mechanisms placing a value on carbon and enhancing the business case for CCS (as seen for example with the EU Emissions Trading Scheme, the Alberta Specified Gas Emitters Regulation, and the Australia 2012 Carbon Tax), though market uncertainties (in terms of fluctuating carbon prices) present a risk to project developers and investors, particularly in Europe. Funding initiatives are therefore also important in incentivising CCS deployment: the American Recovery and Reinvestment Act (allocating US $3.4bn to the development of CCS), and the Alberta CCS Funding Act (allocating CAD $1.5bn to the development of three CCS projects) have provided vital sources of funding to projects. Policies and regulations for industry and power generation that set energy efficiency and/or emissions targets such as Canada's recently introduced greenhouse gas performance standards for coal-fired electricity generation can also play an important role in driving the development of CCS.

As well as providing economic incentives for CCS project development, robust and ambitious climate change strategies can help to foster strong relationships between CCS project developers and regulators, as regulators have an inherent interest in the successful implementation of CCS projects and work closely with project developers to help them through the regulatory approval process. For example, in Alberta, widespread deployment of CCS (and the robust regulatory framework this requires) will be critical if targets set by the province to reduce emissions by 200 Mt by 2050 (representing a 50% reduction in business as usual emissions) are to be achieved.

Regulatory frameworks for CO_2-EOR

In North America, the issue of the regulation of enhanced oil recovery projects using anthropogenic CO_2 is gaining increasing attention. There is a history of CO_2-EOR operations in Alberta and in the US, and robust and long-standing regulatory frameworks for these activities are in place. However, case study interviews with both CO_2-EOR and (non-EOR) CCS projects highlighted significant differences that exist in the regulatory frameworks that apply to the different types of projects, for example in terms of requirements for monitoring, reporting and verification (MRV), financial responsibility, and closure period monitoring. Requirements made of CCS projects in these areas are perceived to be more stringent than those made of business as usual CO_2-EOR projects. Differences in regulatory treatment may mean that there are both financial and regulatory incentives to develop a CO_2-EOR project over a CCS project.

Following the cessation of CO_2-EOR, a project may have the opportunity to transition to a full CCS project. In the US, the EPA UIC Program has outlined risk-based criteria that will determine when a transition from Class II to Class VI should be made, and is developing guidance on the practicalities of doing so. Class II EOR projects can opt in to the EPA's Greenhouse Gas Reporting Program's Subpart RR and report the quantity of CO_2 sequestered at any time during the project. In Alberta, questions about the procedures that may exist for a CO_2-EOR to CCS transition have been raised but have yet to be addressed. The Alberta regulators are likely to look into this following the completion of the CCS RFA in 2013. In the meantime, questions about the regulation of CO_2-EOR in the context of a CCS project remain.

Case study lessons learnt

Interviews with project developers highlighted a number of lessons that were learnt from going through the regulatory approval process. Broadly, these can be framed in the context of lessons learnt that may be applicable to the development of regulatory frameworks in jurisdictions, and lessons learnt that may be applicable to CCS project developers going through the regulatory approval process across jurisdictions.

Development of regulatory frameworks for CCS

- Projects already in existence (including small-scale demonstration projects) can help with the development of regulations by providing insights based on technical knowledge and experience.

- Projects first to test a newly developed regulatory framework can play an important role in working closely with regulators to help shape the development of regulations.
- Issues may arise when considering how and to what extent newly implemented regulations will be retroactively applied to projects already existing and permitted by other means.
- It is important to be able to tailor regulatory requirements to projects of different sizes and contexts; a small-scale demonstration project may not be able to meet requirements geared towards a large-scale CCS project.

Progression through the regulatory approval process

- Projects first to progress through a newly developed regulatory framework may face a lengthy and rigorous permitting procedure if there is a lack of technical and practical detail in the regulations, and where there is a desire for a robust precedent to be set for future projects.
- Where regulatory requirements are not sufficiently detailed (for example following the introduction of a new regulatory framework), projects can take a conservative approach and go beyond perceived minimum requirements to help gain regulatory and stakeholder approval.
- In North America, CCS project developers may choose to follow a more well-defined regulatory pathway by developing CO_2–EOR projects (using anthropogenic CO_2).
- Regulatory barriers do not exist in isolation. Even when regulatory approval has been or is likely to be given, other issues are critical in influencing the successful implementation of a CCS project, including gaining stakeholder approval, being able to secure financing, and achieving commercial reality where the consumers are willing to pay for the price of the products (i.e. energy, gas, oil, electricity).
- Close relationships between CCS project developers and regulators have been crucial in helping with the development of regulations and helping with the progression of projects. Even where gaps and questions remain in CCS regulatory frameworks, project developers have been able to work closely with regulators to gain regulatory approval and progress with project development and implementation.

LIST OF ACRONYMS

ARRA	American Recovery and Reinvestment Act
CCP	CO_2 Capture Project
CCPI	Clean Coal Power Initiative
CCS	Carbon Capture and storage
CERs	Certified Emission Reduction credits under the CDM
CDM	Clean Development Mechanism under the Kyoto Protocol
CFR	Code of Federal Regulations (US)
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COAG	Council of Australian Government
DPI	Victorian Department of Primary Industries
EHR	Enhanced Hydrocarbon Recovery
ELD	Environmental Liability Directive (EU)
EOR	Enhanced oil recovery
EU ETS	European Union Emissions Trading Scheme
EUAs	European Union Allowances under the EU ETS
GGGS	Greenhouse Gas Geological Sequestration Act (Victoria)
GHG	Greenhouse Gas
GS	Geologic Sequestration
MIT	Mechanical Integrity Tests
MMV	Measurement, Monitoring and Verification
MRV	Monitoring, Reporting and Verification
MS	Member State (of the EU)
Mt	Mega tonne
NER	New Entrants Reserve (under the EU ETS)
NETL	National Energy Technology Laboratory (US)
OPGGS	Offshore Petroleum and Greenhouse Gas Storage Act (Australia)
PCSF	Post-closure Stewardship Fund
RCSPs	Regional Carbon Sequestration Partnerships (US)
RFA	CCS Regulatory Framework Assessment (Alberta)
SDWA	Safe Drinking Water Act (US)
SGER	Alberta Specified Gas Emitters Regulation
UIC	Underground Injection Control (US)
UNFCCC	United Nations Framework Convention on Climate Change
US DOE	US Department of Energy
US EPA	United States Environmental Protection Agency
USDW	Underground Sources of Drinking Water (US)
VEPA	Victoria Environmental Protection Agency

1 INTRODUCTION

This report has been prepared for Phase 3 of the CO_2 Capture Project (CCP) by Environmental Resources Management Limited (ERM) over the period June – October 2012.

1.1 PROJECT BACKGROUND

Founded in 2000, the CO_2 Capture Project (CCP) is an award-winning partnership of leading energy companies working to advance the technologies that will underpin the deployment of industrial-scale CO_2 capture and storage (CCS), currently in its third phase (CCP3), which runs from 2009 through 2013.

The CCP is dedicated to advancing and sharing the industry's knowledge to ensure that CCS can make a significant impact on CO_2 emissions. CCS has an important role to play in reducing emissions from power plants and heavy industrial processes such as oil and gas refining and gas processing.

1.2 AIMS & OBJECTIVES

CCS project developers can face a number of potential regulatory issues that can affect the implementation, and potentially the viability, of a CCS project. Regulatory concerns can disrupt the planning, development, facilitation or timing of the various elements of the CCS value chain. Project developers need a reasonable degree of regulatory certainty for the cost and lead-time estimates that determine projects' economic viability.

This study aims to provide a practical and focused review of developments relating to a number of key regulatory issues pertaining to CCS. The report provides an update to the 2010 report on key regulatory issues and barriers by looking in particular at CCS projects that have undergone or progressed significantly through the regulatory process. More specifically, the main objectives of this work are to:

- Look at how selected CCS projects obtained the necessary regulatory approvals in order to identify lessons learnt potentially relevant for other projects;
- Characterise regulatory challenges and key issues arising from such projects and in different jurisdictions, and understand how they were resolved and how this could apply elsewhere;
- Provide perspectives from CCS project developers and regulators based on actual project experience, and consider how such regulatory experience might inform the regulatory process for other projects; and
- Develop case studies that summarise key regulatory issues and outcomes for each project selected for review, identifying key lessons learnt, barriers

or gaps overcome, and analysing how these results might inform other projects.

For this study, CCS case study interviews were conducted with eight projects in Australia, Canada, Europe and the US that have undergone or are a significant way through the regulatory approval process. The case studies comprised three power generation projects, three industrial CCS projects, and two CO_2 storage demonstration projects. Interviews were held with between one and three individuals from each case study project, and interviewees comprised project instigators and lead developers, policy and regulatory advisors, and stakeholder managers- all with experience and knowledge on the regulatory approval process. Because a number of the projects interviewed are still progressing through the regulatory approval process, individual case study responses have been kept confidential and instead broader findings from the case studies have been integrated into the report.

Having conducted the case study interviews, regulators in the region in question were interviewed such that the key findings from the case studies (in relation to regulatory frameworks, gaps and barriers) could be explored in more detail. In total, eight such interviews were carried out with regulators, policy advisors and CCS legal experts across Australia, Canada, Europe and the US.

1.3 OVERVIEW OF REGULATORY ISSUES FOR CCS

The case study interviews suggest that a regulatory pathway for CCS projects does exist in these jurisdictions and that, under the right circumstances, projects have been successful in gaining regulatory approval or are expected to do so. However, as projects progress through the regulatory pathways for CCS in these jurisdictions, a number of gaps and barriers have been or may be encountered. Some of the regulatory issues in various stages of the CCS chain that emerged from this study are discussed below.

CO_2 capture and transport

A number of issues need to be considered when developing regulations for the capture of CO_2, including planning legislation and authorisation processes for the fitting of CO_2 capture equipment, requirements for environmental impact assessments and public consultations, and regulations governing pollution control and monitoring. In addition, health and safety legislation in industrial plants may be required in light of hazards associated with CO_2 and chemicals used in the capture process.

Transport of CO_2 by pipeline is a mature technology in many regions including onshore in North America and offshore in Norway. However, there is often a lack of experience and inadequate regulations and guidelines dealing with CCS-specific transport issues including health and safety (notably a lack of CO_2-specific safety regulations and standards), pipeline ownership, and third-party access rights. The latter issues could arise where

spare capacity exists in a CO_2 pipeline or storage site and where the market for CCS could be influenced by limiting access to this spare capacity. Regulations are required to ensure that third parties are able to access CO_2 transportation and storage sites in a transparent and non-discriminatory manner.

The potentially differing legal classifications of CO_2 as a waste or pollutant, or a resource (for example for use in Enhanced Oil Recovery, EOR), can complicate regulations around the capture and transportation of CO_2. Different operational procedures, health and safety measures and contingency plans may be required according to how CO_2 is classified, and this issue may be compounded in cases where transboundary transport of CO_2 is required.

CO_2 storage

Whilst it is often possible to develop regulatory frameworks for the capture and transport or CO_2 based partly on existing regulations (for example for oil and gas, mining, waste, and health and safety), CO_2 storage presents an often novel set of regulatory issues to be addressed. As such, the regulation of CO_2 storage can present the most significant challenges to jurisdictions.

Some of the most prominent regulatory concerns emerging from this study in relation to CO_2 storage activities are discussed below.

- **Sub-surface property rights:** Pore space ownership has yet to be clearly defined in some jurisdictions, resulting in uncertainties for permitting CO_2 storage operations. Issues may also arise where other sub-surface users and authorisations may exist, for example in relation to oil and gas or geothermal energy production.

- **Monitoring, reporting and verification (MRV) requirements:** Standards for the monitoring, reporting and verification of injected CO_2 are critical in order to ensure robust data can be collected on the containment and behaviour of stored CO_2. The results of MRV activities also impact liability for stored CO_2; in various jurisdictions liabilities can be handed over to the state following the cessation of injection operations and a subsequent 'closure period' in which continued monitoring is undertaken by the operator.

- **Liability for stored CO_2:** liability for damages caused by a storage site during the exploration, operation and closure phases of a CCS project typically lie with the storage site operator. Operators are usually liable for the remediation of any local environmental and health and safety impacts associated with leakage from a storage site, as well as global (climate change) environmental impacts during this time. However, when monitoring results from the closure period (after the cessation of injection) suggest that the stored CO_2 is permanently and safely stored, provisions are frequently in place allowing for the transfer of liability to the relevant state authority. A number of issues can arise when providing for this in a regulatory framework, including:

- The definition of criteria to be met to allow for the transfer of responsibilities to the state (including MRV results);
- Minimum timeframes required for the monitoring of a storage site during the closure period;
- The extent of the transfer of liability; and
- Arrangements for payments into a fund to be used by the authority following the transfer of responsibility for further monitoring and to cover assumed liabilities.

1.3.1 Recent Regulatory Developments

There has been significant progress in developing CCS regulations since the last report on regulatory issues for CCS was published by CCP in 2010.

At the international level, a significant advancement at the 17th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) (COP 17) in late 2011 was the formal inclusion of CCS in the Clean Development Mechanism (CDM), highlighting CCS as an important climate change mitigation option and potentially putting in place a funding mechanism for CCS in developing countries. This is an important development and could set a precedent for future regulations, but given the current low values of Certified Emission Reduction credits (CERs) under the CDM, it is unlikely to significantly change the economics of CCS in developing countries in the near future.

Progress has also been made internationally with the full ratification of the 2007 amendments to the Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention) that will allow countries to store CO_2 under the seabed (previously prevented through the Convention). However, less progress has been made with the 2009 amendment to the London Protocol that aims to allow for the cross-border transportation of CO_2 as a waste for the purposes of storage. The amendment needs to be ratified by two-thirds of the total 42 contracting parties before being adopted, but thus far only two countries (Norway and the UK) have done so meaning that there is still some way to go before the London Protocol ceases to be a barrier to transboundary CCS projects.

In Europe, Member States have transposed, or are in the process of transposing, the CCS Directive, thereby addressing key legal requirements relating to permitting, MRV and long-term liability for stored CO_2. In Canada, the US and Australia, various provinces and states are advanced in the development of a regulatory framework for CCS activities, having developed legislation designed to address a number of specific regulatory issues including long-term liability for stored CO_2 and pore space ownership.

Progress has also been made by governments in countries in the earlier stages of regulatory framework development, such as South Africa, where an Interdepartmental Task Team on CCS has been established to drive framework development.

1.4 REPORT STRUCTURE

The remainder of this report provides an update on recent regulatory developments in Australia, Canada, Europe and the US, highlighting findings from interviews with project developers and regulators (Sections 2-5). The last section (Section 6) provides an overview of overall findings and conclusions, and highlights key case study lessons learnt that might be generally applicable to other CCS projects in development.

2 AUSTRALIA

2.1 POLICY AND REGULATORY DEVELOPMENTS

This section provides an overview of key CCS policy and regulatory developments in Australia before taking a more focused look at the regulation of CCS in the state of Victoria, following interviews with project developers and climate policy experts in the region.

2.1.1 Commonwealth

Carbon pricing mechanism

A significant policy development in Australia was the introduction of a carbon pricing mechanism by the Labor Government that commenced on July 1st 2012. The mechanism is a hybrid between a carbon tax and an emissions trading scheme, and places a cost on carbon (initially AU $23 per tonne CO_2e) for facilities emitting above 25,000 tonnes of CO_2e each year. Initially, this is not likely to have a significant impact on the financial viability of CCS, since prices are too low to significantly change the economics of CCS deployment, and because revenues from the tax will not be filtered towards CCS technology development. The carbon price will rise in real terms each year until 2015, when the mechanism will transition to an emissions trading scheme (ETS) from July 2015 (the intention being to link it to the EU ETS). The implications of the carbon tax on the development and economic feasibility of CCS in Australia will depend on the evolution of the carbon price.

It should be noted that with the development of a carbon pricing mechanism that aims to help to steer investment decisions for greenhouse gas mitigation, the government has decided not to proceed with requirements for all new coal-fired power stations to be built CCS ready (as previously under consideration).

Regulation of CCS

In Australia, states and territories have jurisdiction over CCS activities onshore and up to three nautical miles offshore, beyond which jurisdiction is with the federal government. At the federal level, offshore storage of CO_2 is regulated through the 2006 Offshore Petroleum and Greenhouse Gas Storage Act (OPGGS Act), as amended by the Offshore Petroleum and Greenhouse Gas Storage Legislation Amendment (Miscellaneous Measures) Act 2010. The most significant development following the adoption of the Amendment to the OPGGS Act in November 2010 was the establishment of a new national body to regulate offshore CCS activities. The National Offshore Petroleum Titles Administrator will fulfil this role and help to coordinate the system of joint commonwealth/state jurisdiction for offshore CCS activities.

In 2011, the development of a set of Regulations under the OPGGS Act was finalised with the publication of the Resource Management and

Administration Regulations 2011[1], and the Gas Injection and Storage Regulations 2011[2]. These regulations consolidate and streamline the various resource, administration, injection and storage-related requirements set out under the OPGGS Act. Regulations specific to safety and the environment were published previously in 2009.

In addition to the development of specific CCS regulations at the Commonwealth level, action has been taken in order to promote consistency in CCS regulations across Australian jurisdictions. The Council of Australian Governments (COAG)'s Carbon Capture and Storage Working Group has been set up in order to ensure a robust and nationally consistent policy and legislative regime exists across Australia, addressing a number of issues including (amongst others) the current lack of consistency on long-term liability across regulatory frameworks, cross-boundary storage issues (not addressed by various regulatory frameworks), and also helping to identify potential CO_2 pipeline and infrastructure corridors.

These latest legislative, regulatory and administrative actions aim to deliver a positive regulatory framework for CCS in Australia.

2.1.2 Australian States

Dedicated CCS legislation exists onshore in the States of Victoria, Queensland, and South Australia. New South Wales and Western Australia are in the process of developing CCS legislation that is likely to be based on existing oil and gas regulations, as well as federal offshore CCS legislation[3].

Section 2.2 investigates the development of the Victoria CCS regulations in more detail and outlines key findings from discussions with project developers.

2.2 VICTORIA

Victoria's regulatory framework for CCS centres on the 2008 Victoria Greenhouse Gas Geological Sequestration Act (GGGS)[4], which regulates the injection and storage of captured CO_2 onshore, and the 2010 Offshore Petroleum and Greenhouse Gas Storage Act (Victoria Offshore Act)[5], which regulates the injection and storage of CO_2 up to three nautical miles offshore (up to the point where the federal regulations apply).

[1] Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011. Available online at: http://www.comlaw.gov.au/Details/F2011L00647/Explanatory%20Statement/Text

[2] Offshore Petroleum and Greenhouse Gas Storage (Greenhouse Gas Injection and Storage) Regulations 2011. Available online at: http://www.comlaw.gov.au/Details/F2011L01106/Explanatory%20Statement/Text

[3] New South Wales Greenhouse Gas Storage Bill 2010; Petroleum and Geothermal Energy Legislation Amendment Bill 2011 (Western Australia)

[4] Greenhouse Gas Geological Sequestration Act 2008. Available online at: http://www.legislation.vic.gov.au/

[5] Offshore Petroleum and Greenhouse Gas Storage Act 2010. Available online at: http://www.legislation.vic.gov.au/

Regulations for the GGGS Act came into place in December 2009, and regulations for the Victoria Offshore Act came into force on January 1st 2012. This makes Victoria the first Australian state to have finalised its CCS regulatory framework for both onshore and offshore CO_2 storage.

2.2.1 Key findings

Development of the Victoria regulations

There was one project already in existence when the Victoria onshore regulatory framework for CCS was developed in 2008. The Otway Project (a CO_2 storage demonstration project located in south-western Victoria) commenced planning in 2004 and was regulated according to existing R&D, petroleum, environmental, water and planning regulations. During the development of the 2008 GGGS Act, the Victoria Department of Primary Industries (DPI) and Victoria Environmental Protection Agency (VEPA) worked closely with the Otway Project, drawing on its experience to help inform the development of the regulations.

Tailoring regulations to suit project of different sizes

It is important to be able to tailor regulatory frameworks to projects of different sizes and contexts. Following the development of the Victoria GGGS regulations, the Otway Project identified a number of requirements that were particularly onerous for a small-scale demonstration project such as Otway. These included reporting requirements, the scope of project proposals, and financial security requirements. The Otway Project was in close dialogue with the Victoria EPA during the development of the regulations and the State recognised the particular circumstances of the project, granting the site exemption from various state requirements.

The development of a new regulatory framework for CCS can have implications for existing projects permitted by alternative and previously existing regulations. Experience from existing projects can be used to help to shape the development of a CCS regulatory framework.

It is important to consider how the regulations will apply to projects of different sizes and contexts.

Regulatory issues – long-term liability

Australia's 2006 Offshore Petroleum and Greenhouse Gas Storage Act allows for the transfer of liability for damages associated with stored CO_2 to the Commonwealth, following the passing of a 'closure assurance period' (with a minimum 15 year timespan) after the cessation of CO_2 injection, and providing that damages are attributable to an act associated with authorised (rather than unauthorised) operations. However, whilst the Victoria onshore and offshore CO_2 storage regulations allow for the transfer of *ownership* of

injected CO_2 to the Commonwealth following the cancellation or surrender of a GHG injection license (with the State then assuming ownership and monitoring responsibilities following license surrender), they do not provide for a transfer of common law liability to the Victoria Government as with the Australian OPPGS Act; instead, all common law liabilities (including adverse impacts arising from negligence, nuisance, trespass and breach of statutory duty) remain with the operator indefinitely. This could pose a regulatory risk to project developers.

The differing treatment of long-term liability in Commonwealth offshore as opposed to State onshore and offshore areas may lead to difficulties for projects seeking to inject CO_2 into a storage reservoir that spans the different jurisdictions. In the event of a leak, questions arise in relation to how common law liability would be treated (according to which liability framework). This issue is currently being addressed by regulators in the COAG's CCS Working Group.

Unlike under the Commonwealth Offshore CCS regulations, the Victoria Offshore and Onshore CCS regulations do not provide for the transfer of common law liability to the State following the authorised closure of the site. This presents a regulatory risk to project developers in Victoria.

A lack of alignment in the treatment of long-term liability in the Commonwealth offshore and the Victoria offshore and onshore domains could pose administrative difficulties to governments seeking to regulate cross-boundary CO_2 storage projects.

3 CANADA

3.1 POLICY AND REGULATORY DEVELOPMENTS

There have been a number of policy, legal and regulatory developments in Canada since the last regulatory update was done in 2010. Legal and regulatory developments have been centred at the provincial level, with the development of provincial regulatory frameworks for CCS that build on existing oil and gas regulations. This section provides an overview of key policy and regulatory developments in Canada and goes on to give a more detailed overview and analysis of regulatory developments in Alberta, following interviews with two project developers and follow up discussions with regulators in the province.

3.1.1 *Federal level*

No significant developments in relation to CCS-specific regulations have taken place at the federal level in Canada since the last regulatory update in November 2010. Regulatory frameworks for CCS in Canada are mainly being developed at the provincial level for now.

There have however been some policy developments at the federal level, with important implications for the development and incentivisation of CCS in Canada. In September 2012, regulations for GHG performance standards to be applied to coal-fired electricity generation facilities in mid-2015 were published[1]. Under the regulations, units commissioned after July 1st 2015, and units reaching end-of-life after this date, must meet an emissions intensity limit set by the regulations. Emissions that are captured, transported and stored can be excluded from facilities' emissions limit, and temporary exemptions to the regulations (up to 2024 for new units) are available if plants are CCS ready and plan to implement CCS. Following the implementation of these regulations, power plants wishing to continue using coal are likely to need to implement CCS in order to meet the standards set. However, there are concerns that the regulations do not incentivise quick action with respect to CCS, since the standard is only applicable from mid-2015 onwards (and not sooner), and because the 10 year deferral provision for CCS ready plants means that such plants will not need to meet standards until 2025.

There have been some significant legal and regulatory developments across the provinces in Canada, notably in Alberta, Saskatchewan, British Columbia and Nova Scotia. In Saskatchewan, amendments to The Oil and Gas Conservation Act and The Pipelines Act were made in 2011 and 2012 such that CO_2 injection and storage could be regulated. British Columbia is currently drafting a regulatory framework for CCS, building on the existing oil and gas regulations. Nova Scotia is in the final stages of evaluating the technical and

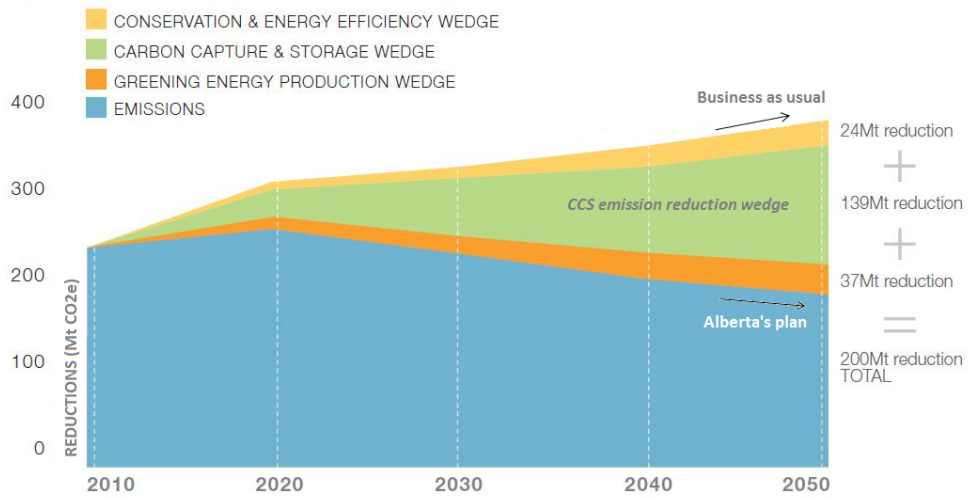
[1] Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations, available online at: http://gazette.gc.ca/rp-pr/p2/2012/2012-09-12/html/sor-dors167-eng.html

economic feasibility of the application of CCS to coal-fired power stations in the province. A number of developments have taken place in Alberta, and following interviews with two CCS project developers and follow up discussions with regulators in the province, these are explored in more detail below.

3.1.2 Alberta

Alberta, with 10% of Canada's population, is responsible for a significant proportion of Canada's greenhouse gas emissions (34% of the national total of 692 Mt in 2010). As a large exporter of energy (primarily in the form of crude oil and natural gas), power plants and oil sands are responsible for some 70% of the province's emissions. An ambitious emissions reduction strategy is needed in Alberta in order to enable both the province and the country to meet emissions reductions targets in the coming years, and as a major oil and gas producer with great CO_2 storage potential, CCS is a key element of Alberta's climate change strategy (Figure 3.1).

Figure 3.1 Alberta's climate change strategy and the role of CCS



Source: Government of Alberta: Alberta's 2008 Climate Change Strategy

A strong focus on CCS as part of its climate change strategy, as well as a robust set of regulations already in existence for oil and gas activities, means that Alberta is well advanced in the development of a robust regulatory framework for CCS. In 2009, the Carbon Capture and Storage Funding Act[1] allocated CAD $1.5bn of funding for CCS demonstration projects which has supported the development of three CCS projects in the province to date. Important regulatory developments more recently include:

[1] Carbon Capture and Storage Funding Act, SA 2009, c C-2.5. http://www.canlii.org/en/ab/laws/stat/sa-2009-c-c-2.5/latest/sa-2009-c-c-2.5.html

- **The Carbon Capture and Storage Statutes Amendment Act (2010)**[1], which amended a number of pieces of existing oil and gas legislation to address previously identified regulatory barriers for CCS development, helping to set out a regulatory framework for long-term liability for CO_2 stored underground (allowing acceptance of liability by the province) and clarifying pore space ownership (vesting ownership in the crown);

- **The Carbon Sequestration Tenure Regulation (2011)**[2]**,** which established a process for companies to obtain tenure for pore space for CO_2 storage (allowing Alberta to grant evaluation permits and sequestration leases to project developers); and

- **CCS Regulatory Framework Assessment (RFA) (2011 – on-going)**, undertaken by a steering committee comprising a number of organisations and authorities and led by Alberta Energy. The RFA is reviewing the existing regulatory framework for CCS project development and implementation, and identifying remaining gaps and opportunities for improvement in the framework. It will help to define the procedures to be followed and processes to be undertaken in order to implement the various measures set out in the Carbon Capture and Storage Statutes Amendment Act.

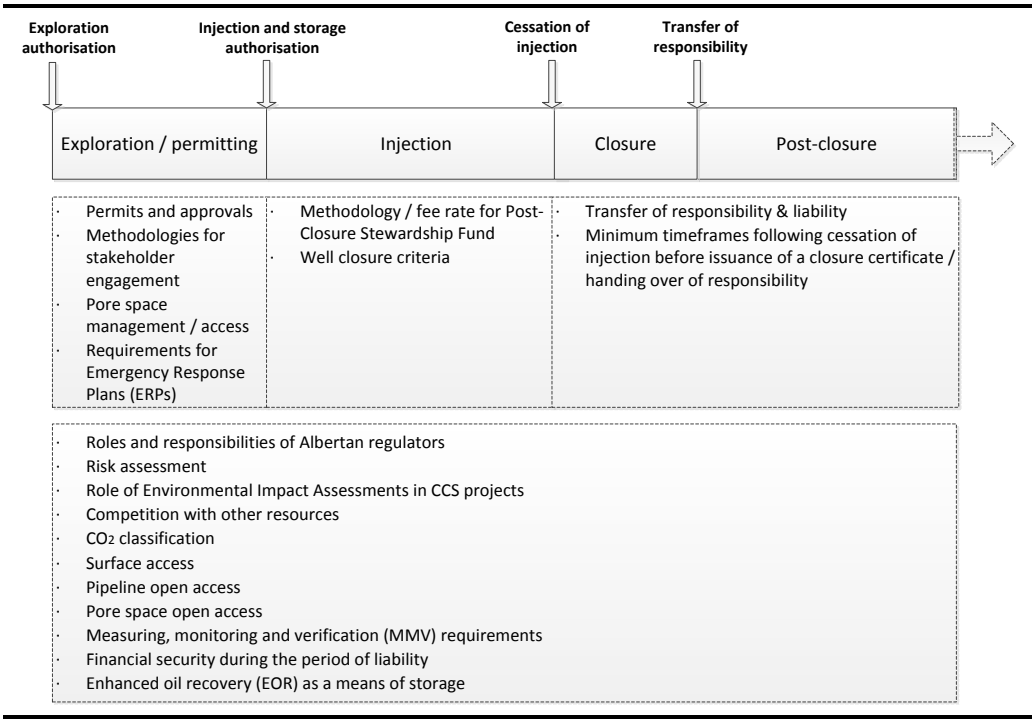
The Alberta Carbon Capture and Storage Statutes Amendment Act helped to address two key barriers facing project developers: arrangements for the long-term liability for stored CO_2, and ownership and access to pore space. The Carbon Sequestration Tenure Regulation established a process for companies to obtain pore space ownership, allowing project developers to enter into agreements with the Alberta Government for storage site evaluation and pore space lease.

Discussions with project developers in the region suggest that some of the details of the regulations have yet to be clarified and confirmed. The currently on-going Regulatory Framework Assessment (RFA) process for CCS in Alberta aims to help resolve these issues, as illustrated in Figure 3.2.

[1] Bill 24 – the Carbon Capture and Storage Statutes Amendment Act (2010): www.energy.alberta.ca/Initiatives/1902.asp

[2] Appendix to the Mines and Minerals Act: Carbon Sequestration Tenure Regulation (2011). http://www.qp.alberta.ca/documents/orders/orders_in_council/2011/411/2011_179.html

Figure 3.2 ***Issues being addressed in Alberta's CCS Regulatory Framework Assessment (RFA)***



3.1.3 Outstanding regulatory issues - Alberta

The RFA serves to address a number of uncertainties that currently exist for CCS project developers in the province under the regulations set out in the 2010 Carbon Capture and Storage Statutes Amendment Act. Conversations with project developers in Alberta highlighted the following priority concerns:

- **Transfer of long-term liability for stored CO_2 to the Crown**

  With the 2010 Act, responsibility for stored CO_2 can be transferred to the Crown following the issuance of a closure certificate. However, some details remain to be confirmed, including:

  - Criteria that must be met in order to demonstrate that stored CO_2 is contained and behaving in such a way that it presents a sufficiently low risk to the government (i.e. in a 'stable and predictable manner') such that a closure certificate can be granted; and
  - The minimum timeframe required following the cessation of injection before liability can be transferred to the state (i.e. length of the closure period).

  Closure criteria are being detailed through the RFA process, and it is likely that a 10 year minimum closure period will be imposed by the regulations. Currently, there is no provision for the transfer of climate liability (i.e. effects on climate change in the event of a CO_2 leak) to the Crown, causing some concern for CCS project developers who, under the Alberta Specified Gas Emitters Regulation (SGER), are liable for

recovering carbon credits equal to volumes released. The RFA is likely to recommend that the Crown accepts all liabilities for stored CO_2, including this climate liability.

- **Structure of the Post-closure Stewardship Fund (PCSF)**

  The PCSF serves to ensure funds are available for the province following the transfer of responsibility after the closure period in order to finance on-going monitoring, liability assumed by the Crown, and potential remediation actions in the event of a CO_2 leak.

  A number of details remain to be confirmed in relation to the PCSF, causing some uncertainty and concern for project developers. These include details on the methodology that will be used to set the fee charged per tonne of CO_2 injected, and confirmation of what liabilities the PCSF will need to cover and what the fund can be used for. It is thought that these details will be confirmed following the conclusion of the RFA process.

Both project developers and regulators recognise the important role played by projects first to progress through the recently developed Alberta CCS regulations. The RFA provides a forum where input and feedback from project developers can be used in a constructive way in order to help with the development of a robust framework for the regulation of CCS projects going forward. It should be noted that whilst a number of questions currently remain with respect to the regulatory framework for CCS projects, project developers indicated they were confident that issues would be resolved and that remaining gaps would not prevent them from gaining regulatory approval.

CCS plays a key role in Alberta's climate strategy, and the province has made significant progress in building a robust regulatory framework for CO_2 storage projects. The current regulations leave some questions unanswered, and these are being addressed through the on-going Regulatory Framework Assessment.

Treatment of CO_2-EOR projects

Alberta has a long history of EOR operations, and CO_2 has been used in EOR in Alberta for a number of years. During the process of injecting CO_2 into an oil reservoir to help with the recovery of hydrocarbons, a proportion of injected CO_2 is sequestered. Recognising this, and the fact that over time significant amounts of CO_2 can be geologically stored in this way, a number of CO_2-EOR CCS projects using anthropogenic CO_2 for EOR have been developed with the purpose of both enhancing hydrocarbon recovery and sequestering anthropogenic CO_2.

In Alberta, CO_2-EOR is currently regulated through long-standing petroleum laws. EOR operators must gain a Petroleum and Natural Gas lease in order to

produce oil, and must also gain approval for CO_2 injection. Recent developments in CCS regulations in Alberta do not affect the regulatory framework for CO_2-EOR: the 2010 Carbon Capture and Storage Statutes Amendment Act, the 2011 Carbon Sequestration Tenure Regulation and the on-going RFA process all apply specifically to the regulatory framework for (non-EOR) CCS projects.

Although recent developments have focused on the regulatory framework as it applies to CCS projects, there is widespread recognition of opportunities stemming from the use of industrial CO_2 in EOR in Alberta, and the importance of encouraging their development. Opportunities stem from the dual benefits of CO_2-EOR[1] projects: increased oil production, and the geological sequestration of anthropogenic CO_2. In Alberta, CO_2-EOR projects can gain recognition for CO_2 sequestration activities in the form of CO_2 offset credits under the Alberta Specified Gas Emitters Regulation (SGER)[2]. Projects wishing to gain credit for sequestered CO_2 must meet specific Measurement, Monitoring and Verification (MMV) requirements set out in the CO_2-EOR protocol for eligibility for CO_2 credits to ensure the viability of the long-term storage of CO_2[3].

A number of questions have been raised in relation to the difference between the regulatory frameworks for CO_2-EOR projects, and CCS projects. Some issues that arise when comparing the different regulatory frameworks for CO_2-EOR and CCS projects include:

- **MMV requirements:** There are differences in the MMV requirements made of CO_2-EOR projects receiving credits (according to the offset quantification protocol) as opposed to non-EOR CCS projects (according to Alberta CCS legislation). For example, CCS project operators are required to monitor the underground CO_2 plume, but this requirement is not made of CO_2-EOR projects, including those gaining credits under the Alberta SGER.

- **Long-term liability for stored CO_2:** EOR operators (including CO_2-EOR projects gaining storage credit) retain liability for stored CO_2 sites indefinitely; there is no provision for the transfer of this liability to the Crown (unlike with CCS projects). CO_2-EOR projects may be able to transition to CCS projects, therefore being subject to the same requirements as a CCS project under the 2010 Carbon Capture and Storage Statutes Amendment Act and able to transfer liability to the

[1] CO_2-EOR in this context refers to CO_2-EOR projects using CO_2 generated from industrial sources.

[2] Alberta Regulation 139/2007 Climate Change and Emissions Management Act – Specified Gas Emitters Regulation. http://www.canlii.org/en/ab/laws/regu/alta-reg-139-2007/latest/alta-reg-139-2007.html. Under the SGER, large industrial emitters in Alberta are required to meet emissions intensity reduction targets of 12% per year from an approved baseline emission intensity. Facilities in Alberta that are able to reduce their GHG emissions according to a government approved protocol are eligible to generate CO_2 offset credits that can be bought and sold in the Alberta offset market. This offers a compliance option to facilities subject to SGER emissions intensity reduction targets.

[3] Alberta Environment - Specified Gas Emitters Regulation: Quantification Protocol for Enhanced Oil Recovery, 2007. http://environment.alberta.ca/02291.html

Crown. However, there is currently no defined process for a CO_2-EOR to CCS transition making it difficult for projects to do this in practice. The RFA has identified the transition of CO_2-EOR projects to CCS projects as something that should be investigated and addressed in the future.

- **Financial responsibility:** According to the 2010 Carbon Capture and Storage Statutes Amendment Act, CCS projects must ensure funds are available to cover on-going monitoring costs as well as liabilities assumed by the Crown following the transfer of responsibility at the end of the closure period, and must pay a levy per tonne of CO_2 injected into a Post-closure Stewardship Fund. However, these financial responsibility requirements are not made of CO_2-EOR operators (including those gaining storage credits); financial responsibility in this case does not extend beyond the payments made to an established orphan well account by all oil and gas production operations in Alberta.

- **Monitoring during the closure period:** Monitoring during the closure period is required of CO_2 storage projects under the 2010 Carbon Capture and Storage Statutes Amendment Act. This requirement is not however made of CO_2-EOR projects (including those gaining storage credits), where closure periods do not exist.

The Regulatory Framework Assessment has identified the need to review the differences between the regulation of CO_2 injection and storage activities under the CCS and CO_2-EOR regulatory frameworks, and it is likely that this will be addressed following the conclusion of the RFA in late 2012. Some issues that may be looked at include the differences in monitoring requirements, permanence of CO_2 storage, collection of baseline data, and regulatory issues such as public notification, tenure and risk assessment.

A number of issues arise when comparing regulatory frameworks that exist for CO_2-EOR projects eligible for CO_2 storage credits and CCS projects in Alberta. These will be addressed following the conclusion of the Regulatory Framework Assessment, in as early as 2013.

4 EUROPE

4.1 POLICY AND REGULATORY DEVELOPMENTS

There have been a number of regulatory developments in Europe since late 2010, primarily centred on the transposition of the CCS Directive by EU Member States and the subsequent development of regulatory frameworks for the storage of CO_2 at a national level. Following discussions with three project developers in Europe, and follow up conversations with a number of regulators and policy experts, this section focuses on selected key developments and regulatory issues in the region.

4.1.1 EU Emissions Trading Directive

With the start of Phase II of the EU Emissions Trading Scheme (ETS) in 2008, Member States have been able to include CCS projects under the EU ETS. The revised EU ETS Directive (2009) gives fuller recognition to CCS in Phase III of the EU ETS which commences in 2013.

In Phase III, CO_2 emissions that have been successfully captured and stored by installations will be considered as having not been emitted, meaning that European Union Allowances (EUAs) will not be needed to cover these emissions.

Phase III of the EU ETS will also support the financing of CCS demonstration projects through the 'NER300' fund[1]. This mechanism sets aside 300 million EUAs from the EU ETS new entrants reserve (NER) for sale on the carbon market in order to generate finance for CCS and renewable energy projects across the EU. Although the NER300 fund will help to incentivise the development of CCS in the EU, there are concerns about the future of carbon prices in the EU and accordingly the level of funding that will ultimately be available to these demonstration projects because the value of the EU Allowances being sold under NER300 is less than anticipated.

4.1.2 EU CCS Directive

In Europe, transposition by Member States of the 2009 EU Directive on the geological storage of carbon dioxide ('CCS Directive')[2] is underway. Few states met the 25 June 2011 deadline for the transposition of the Directive into national law, for a number of reasons including public opposition to the technology (Germany and the Netherlands), a complex division of power between regions and central governments (UK and Germany), and the unfeasibility of CO_2 storage in certain locations (Finland).

[1] European Commission NER 300 http://ec.europa.eu/clima/policies/lowcarbon/ner300/index_en.htm

[2] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0031:EN:NOT

The European Commission increased the pressure for states to transpose the Directive with the launching of a number of infringement procedures against Member States who had failed to implement the law, starting in July 2011. As of October 2012, ten Member States had completed the transposition of the Directive: Spain, Lithuania, Slovakia, Malta, the Netherlands, Denmark, Italy, France, Portugal, and Romania. The UK is close to completion of its implementation. Germany has faced significant delays in the transposition process owing to strong public opposition to the technology.

In 2011, the European Commission published four Guidance Documents to support the interpretation and transposition of the CCS Directive[1]:

- **Guidance Document 1:** CO_2 Storage Life Cycle Risk Management Framework
- **Guidance Document 2:** Characterisation of the Storage Complex, CO_2 Stream Composition, Monitoring and Corrective Measures
- **Guidance Document 3:** Criteria for Transfer of Responsibility to the Competent Authority
- **Guidance Document 4:** Financial Security (Art. 19) and Financial Mechanism (Art. 20)

4.2 KEY REGULATORY ISSUES

4.2.1 Transposition of the CCS Directive

As the CCS Directive is transposed into national law by EU Member States, a number of concerns arise. Project developers in three different EU Member States highlighted a number of issues associated with the transposition of the Directive, summarised below.

Technical details in MS CCS regulations

The CCS Directive outlines a number of requirements that must be set out in the national laws of Member States. Whilst the Directive lays down an 'end result', Member States are responsible for developing more detailed regulations and guidance to help projects achieve this.

Project developers in Europe highlighted a number of cases where insufficient technical detail currently exists in national regulations developed in accordance with the provisions of the Directive. In Italy, the CCS Directive was transposed into national law by Legislative Decree no. 162 in October 2011[2]. Whilst the legislative decree sets a regulatory framework for CO_2 storage in Italy, some specific technical and practical details are lacking, for example in relation to storage site monitoring requirements (including

[1] European Commission: Implementation of the CCS Directive – Documentation. http://ec.europa.eu/clima/policies/lowcarbon/ccs/implementation/documentation_en.htm

[2] Legislative Decree no. 162 (in Italian). http://www.ucl.ac.uk/cclp/pdf/ipzs_gurifree.pdf

definition of the baseline, determining the area of interest, use of best available technologies, and requirements on the frequency and intensity of monitoring), resulting in some uncertainty for project developers. A number of implementation decrees will be published in the coming months that should help to provide more detail on the provisions set out in Legislative Decree 162 and help to resolve a number of current uncertainties. In the Netherlands, issues exist in relation to the CO_2 pipeline safety regulations and standards. Although CO_2 pipelines exist in the country (used to transport CO_2 to greenhouses for food production), there are no validated safety standards for CO_2 transport and projects developing a transport permit have needed to work closely with regulators to define appropriate standards.

In addition to instances where a lack of technical detail exists, project developers in Europe also reported concerns about the arrangements for long-term liability and requirements for financial security in Member State regulations. This is discussed in more detail in Section 4.2.2 below.

Testing the regulatory framework

Case study interviews suggested that the first few projects to test the emerging regulatory frameworks for CO_2 storage in European Member States are likely to play an important role in informing the development of the regulations in place, and guidance around these. The CCS permitting process is likely to be lengthy for these projects whilst a robust set of standards and regulations are developed. Future projects submitting permit applications are likely to face fewer issues as the regulations develop.

Some technical details have yet to be given in Member State regulations developed during the transposition of the CCS Directive. The permitting process for projects first to go through new regulatory frameworks can be thorough and lengthy as details are resolved.

Impact of the CCS Directive on existing projects

In some European countries, projects undertaking the capture, transport and storage of CO_2 already exist and were permitted through existing regulatory frameworks (normally pertaining to oil and gas production activities), with additional CCS-specific requirements set out in project permits. In Norway, CCS has been practiced for a number of years in the context of separating CO_2 from natural gas streams for transport to and storage in underground reservoirs. The extent to which these projects may be affected by the transposition of the CCS Directive remains to be seen, particularly considering that these operations have not been included in the scope of the EU ETS in Phases I and II (where combustion installations were included, but not CO_2 captured from natural gas)[1].

[1] From Phase III of the EU ETS, commencing in 2013, CO_2 captured from natural gas will be included in the EU ETS.

The extent to which existing CCS projects are affected by new regulations developed following the transposition of the CCS Directive remains to be seen.

4.2.2 *Long-term liability for stored CO_2 and financial responsibility requirements*

A primary concern raised by project developers in Europe is in relation to the treatment of long-term liability for stored CO_2 under the Directive and the resultant CCS-specific national laws. Project developers in various Member States have reported difficulties in understanding the period and extent of liability for stored CO_2 that operations must consider, making an investment analysis difficult. The main issues are discussed below.

Liability for global environmental damage (climate liability)

A key issue presents itself in relation to climate liability. In the event of a leak of CO_2 before the transfer of responsibility to the state at the end of the closure period, projects will need to purchase CO_2 credits equivalent to the volumes released as these emissions would have been counted as having been 'not emitted' under the ETS Directive. This liability is potentially significant. Furthermore, there is uncertainty on the possible extent of this liability. Logically, credits would be priced according to the value of European Union Allowances (EUAs – tradable CO_2 units under the EU ETS) at the time of release, but there is considerable uncertainty about the future prices of EUAs.

There are concerns about the extent of the liability for stored CO_2 under the ETS Directive. Uncertainty about the future price of EUAs makes it difficult for project developers to estimate potential liability for damages relating to global environmental change.

Local environmental liability under the Environmental Liability Directive

Another issue raised by one CCS developer in Europe was the treatment of local environmental liability. The CCS Directive makes CCS operators liable for local environmental damages under the provisions of the 2004 Environmental Liability Directive (ELD). The ELD establishes rules for allocating liability in cases of harm to the environment (covering harm to protected species and habitats, harm to water, and harm to land), based on the 'polluter pays' principle. A list of industrial sectors and activities subject to strict liability for environmental harm is provided in Annex III of the ELD, and under the CCS Directive, the operation of CO_2 storage sites has been added to this list.

The CCS Directive places environmental liability (under the ELD) with CO_2 storage site operators during operations and also during the closure period. However, at the end of the closure phase and following the transfer of

responsibility to the Member State competent authority, liability under the ELD transfers to the Member State.

Although the CCS Directive lays out provisions for the transfer of liability under the ELD to the state, some CCS project developers and operators have concerns about the practicalities of this considering the ELD apportions strict liability with a storage site operator. Although liability under the ELD can be transferred to the state following the issuance of a closure certificate, some operators are concerned the 'polluter pays' principle could prevail.

Concerns exist in relation to the extent to which strict liability for damages to the environment under the Environmental Liability Directive can be transferred to the State at the end of the closure period, as provided for by the CCS Directive.

4.2.3 Third-party access

The CCS Directive requires CO_2 transport and storage providers to ensure third parties are able to access CO_2 transportation and storage sites in a transparent and non-discriminatory manner. However, one CCS project developer reported concerns that these provisions could impose significant risks to storage site providers in the event where they are required to accommodate new CO_2 transport and storage requirements, and where CO_2 injection rates and CO_2 storage capacity need to be increased, and the timeframes for CO_2 injection need to be extended. Furthermore, the authorities are able to force 'fair' terms (including remuneration) upon the storage provider and this creates concern in relation to ensuring that financial burdens, in terms of long-term liability and financial securities, are valued correctly.

Provisions in the CCS Directive on third-party access to CO_2 transport infrastructure and storage sites have raised concerns with some project developers. Requirements to accommodate new and additional sources of CO_2 in transport networks and storage sites could pose risks to operators.

5 UNITED STATES

5.1 POLICY AND REGULATORY DEVELOPMENTS

There have been a number of developments in the regulation of CCS in the United States in the past few years. This section highlights key developments and explores in more detail particular aspects of these, based on discussions with two CCS project developers in the US and follow up conversations with regulators.

5.1.1 Federal level

Since mid-2010, the US has witnessed two key developments in relation to the regulatory framework for CCS at the federal level.

Finalisation of the UIC Class VI Rule

In December 2010, the US Environment Protection Agency (EPA) published its finalised Underground Injection Control (UIC) rule for a new category of injection wells (Class VI) that undertake the underground injection of CO_2 for the purpose of geological sequestration[1].

The Rule regulates the underground injection of CO_2 for the purpose of geologic sequestration under the Safe Drinking Water Act, and is based on existing UIC requirements for other injection well classes, with amendments making it specific to CCS activities and associated risks posed to underground sources of drinking water. To date, four Class VI permit applications have been submitted to the US EPA, though no permits have yet been issued. The Class VI requirements are more stringent than those of other well classes, and project developers have reported a number of challenges in relation to meeting the permitting requirements. Table 5.1 summarises the key carbon sequestration regulatory issues addressed by the Rule, and highlights some important differences between the requirements made of Class VI wells as opposed to the requirements for other well Classes.

[1] Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, Final Rule, 75 Fed. Reg. 77230 (Dec. 10, 2010).

Table 5.1. Summary of key Class VI Rule requirements and comparison with other well Classes

Rule requirement	Summary	Comparison with requirements of other well classes
Site characterisation	Well owners or operators must perform a detailed assessment of the following aspects at the proposed GS site: - Geology (ensuring adequate CO_2 storage capacity and a dependable confining zone) - Hydrogeology - Geochemical properties - Geomechanical properties Information and data from the above allows unacceptable sites to be eliminated and identifies potential risks for sites. Information collected will be used to inform the development of well construction and operating plans as well as the monitoring plan.	Site characterisation requirements for Class VI wells are more stringent than requirements for other well classes. A larger area must be studied, and a more detailed investigation into the site and surrounds is required.
Testing and Monitoring Plan	The following testing and monitoring activities are required to ensure USDWs are not endangered and to demonstrate whether a project is performing as expected: - CO_2 stream analysis - Mechanical integrity tests (MITs) - Injection well testing (including corrosion monitoring) - Ground water monitoring in several zones - Tracking of CO_2 plume and pressure front (using 'direct' methods to track the pressure front within the injection zone, and indirect geophysical techniques to track the extent of the CO_2 plume) - Soil and surface air monitoring (at UIC Program Director's discretion)	A more detailed and comprehensive Testing and Monitoring Plan is required of Class VI well owners, in comparison to other (Class I to V) well owners. Semi-annual testing and monitoring results must be submitted to the UIC Program Director.
Well construction materials and monitoring of well integrity	Wells must be constructed such that well integrity is ensured and leaks into a USDW are prevented, addressing in particular: - Buoyancy of CO_2 - Corrosivity of CO_2	Well construction requirements reflect key differences in CO_2 injection in Class VI GS wells vs. Class II EOR wells, including: - Corrosivity of CO_2 in presence of water - Longer timeframe of injection - Larger volumes of CO_2 injected / higher pressures - Lesser known geology at GS sites compared to oil extraction sites

Rule requirement	Summary	Comparison with requirements of other well classes
Post –injection monitoring and site care	The purpose of post-injection site care (PISC) and Site Closure is: - To ensure continued monitoring of the CO_2 plume and pressure front once CO_2 injection has finished - To ensure no risk is posed to USDWs The post-injection period (during which monitoring must continue) will last for a minimum of 50 years, unless an alternative timeframe is approved. Site closure and cessation of PISC activities will take place at the UIC Program Director's approval.	PISC and site closure requirements are not typical of most other well classes (though a period of closure monitoring can be required for Class I hazardous waste wells).
Financial responsibility	Financial responsibility instrument(s) in place sufficient to cover the cost of: - Corrective action - Injection well plugging - Post-injection site care and site closure - Emergency and remedial response, including potential remediation activities in the case of contamination of USDWs Financial coverage from a list of qualified independent third-party instruments, or self-insurance to cover estimated costs.	Financial responsibility is required for more phases and activities than for other UIC well classes (e.g. during post-injection site care), due to the long-term nature of CCS projects and the uncertainty of risk associated with GS projects.

Whilst the UIC Class VI regulations cover a number of regulatory aspects specific to CCS projects (in terms of carbon sequestration), these requirements were developed in the context of protecting groundwater resources in the US and certain issues such as pore space ownership, long-term liability, greenhouse gas accounting, and the treatment of non-GS CO_2-EOR projects, are not addressed by the Class VI UIC Rule. These other aspects would require the development of further CCS-specific regulations which to date have been seen at state level in some US states (see Section 5.1.2).

GHG reporting requirements for CCS facilities

In December 2010, the EPA also finalised a rule under the authority of the Clean Air Act requiring all facilities that conduct geologic sequestration of CO_2 ('GS') and all other facilities that inject CO_2 underground to report greenhouse gas data to the EPA on an annual basis. This rule amends the regulatory framework for the Greenhouse Gas Reporting Program that requires reporting of greenhouse gases and other relevant information from certain source categories in the United States, including suppliers of captured CO_2 (Subpart PP). The data obtained through this rule will inform Agency policies and decisions under the Clean Air Act related to the use of CCS for mitigating GHG emissions.

Reporting must be undertaken in accordance with the Greenhouse Gas Reporting Program Subpart RR (for facilities injecting CO_2 underground for geologic sequestration) or Subpart UU (all other facilities that inject CO_2 underground for any reason, including enhanced oil and gas recovery)[1]. The Greenhouse Gas Reporting Program Rule is complementary to and builds on the EPA's federal requirements under the UIC Program. CCS facilities are required to report under both the UIC and the Greenhouse Gas Reporting Program Rules, but the reporting requirements under the GHG Reporting Rule are designed in such a way that overlap between the two programs is minimised[2].

Facilities undertaking CO_2-EOR may report under subpart RR if the owner or operator chooses to opt-in to subpart RR. The subpart RR reporting requirements serve to ensure that CO_2 sequestered during the course of EOR is properly accounted for. CO_2-EOR facilities may be required to report under subpart RR if they are seeking to gain federal tax credits for the use of anthropogenic CO_2 for EOR under IRS 45Q (see below). Table 5.2 compares the reporting requirements under Subparts RR and UU.

[1] Environmental Protection Agency 40 CFR Parts 72, 78 and 98. Mandatory Reporting of Greenhouse Gases: Injection and Geologic Sequestration of Carbon Dioxide; Final Rule. Available at: http://www.gpo.gov/fdsys/pkg/FR-2010-12-01/pdf/2010-29934.pdf

[2] Overlap was minimized during the rulemakings in that neither program requests information that was duplicative and unnecessary to achieving the goals of the program (drinking water protection for the Safe Drinking Water Act, and GHG reporting for the Clean Air Act).

Table 5.2 Reporting requirements under Subpart RR and Subpart UU

	Subpart RR	Subpart UU
Facilities and well types captured	Facilities that conduct geologic sequestration in subsurface geologic formations, including UIC Class VI wells; and Facilities injecting CO_2 for EOR opting in to Subpart RR	Facilities that inject CO_2 underground such as for enhanced oil or gas recovery or any other purpose, including UIC Class II wells
Monitoring and reporting requirements	Site-specific MRV plan to be developed and approved by EPA. Monitoring and reporting required includes: • Basic information on CO_2 received for injection (CO_2 source; CO_2 transferred on site; CO_2 injected) • CO_2 vented and leaked • CO_2 stored in subsurface (annual and cumulative mass)	Annual reporting to EPA on: Basic information on CO_2 received for injection (CO_2 source; CO_2 transferred on site; CO_2 injected) No MRV plan requirement.
Estimated annual monitoring and reporting costs	US $320,000 (deep saline storage projects)	US $4,000

Section 45Q tax credits for CO_2 sequestration

A final development at the US federal level is the introduction of legislation in September 2012 that would serve to modify the existing carbon capture and storage tax incentive in tax code Section 45Q[1]. Section 45Q tax credits were introduced in 2008 and provide companies with US $10 credit per metric ton of CO_2 stored through enhanced oil recovery and $20 credit per metric ton of CO_2 stored through deep saline formations for a total maximum of 75 million tonnes of CO_2. However, owing to unforeseen issues in the initial statute, the 45Q program lacked sufficient transparency and certainty for companies to be able to use the tax credit system, and few (if any) projects have been able to use the system. Following recommendations from the National Enhanced Oil Recovery Initiative (NEORI), an organisation founded to help make changes to 45Q such that it was more useful to the energy industry, legislation has now been introduced that would modify the existing tax incentive and make it accessible to companies in the US, by establishing a credit allocation and certification process that would enable operators to see how many credits had been claimed, as well as a list of projects in line to receive credits. This could have positive implications for the financing of CO_2-EOR and CCS projects going forwards.

[1] 26 USC Section 45Q – Credit for carbon dioxide sequestration. http://uscode.house.gov/uscode-cgi/fastweb.exe?getdoc+uscview+t26t28+83+2++%2845q%29%20%20%20%20%20%20%20%20%20%20

5.1.2 *US State level*

CCS injection activities are regulated through the existing UIC permitting programme under the Safe Drinking Water Act (SDWA). The UIC Rules set criteria that must be met by different types of underground injection wells in relation to well construction, use and closure; monitoring and corrective actions; and post-injection site care (PISC); thereby forming a regulatory framework within which CCS projects can operate. The SDWA provides US states with an option to assume primary enforcement responsibility ('primacy') for the UIC Program when certain requirements for state primacy (e.g. ensuring state regulations are equally stringent and effective) are met. Though a number of states have primacy for UIC Class I to V wells, none have obtained primacy for the relatively recently published Class VI Rule, and US EPA therefore directly implements the Class VI Program across states. The EPA has to date received four Class VI permit applications, though no permits have yet been issued. Meanwhile several US states are in dialogue with the US EPA and likely to submit applications for Class VI primacy in the near future; these include Kansas, Wyoming, North Dakota, Montana, Louisiana and possibly Texas.

A number of US states have developed CCS regulations outside of the scope of the UIC Class VI Rule. Issues addressed in state regulations include (amongst others) pore space ownership, eminent domain for CO_2 pipelines, and long-term liability for stored CO_2. Possibly the most significant development at the state level since 2010 was the passing of the *Clean Coal FutureGen for Illinois Act* in 2011, which sets a liability regime for the FutureGen CCS project.

5.2 *KEY REGULATORY ISSUES*

5.2.1 *Regulation of CO_2-EOR*

CO_2 has been used for enhanced oil recovery in the US since the early 1970s, and, as in Canada, a robust regulatory framework for EOR activities is in place. Historically, naturally-sourced CO_2 has been used by EOR operators but increasingly, attention is being paid to opportunities offered by the use of anthropogenic CO_2 in EOR operations in bringing about both increased oil and gas recovery, and the sequestration of anthropogenic CO_2 over time.

In the US, CO_2-EOR projects (using both natural and anthropogenic CO_2) are regulated under the UIC Class II requirements. Reporting requirements of CO_2-EOR projects are made under the GHG Reporting Program, Subpart UU. However, CO_2-EOR operators have the option of reporting the quantity of CO_2 sequestered to EPA if they meet the monitoring, reporting and verification requirements set out in 40 CFR Part 98 subpart RR (Geologic Sequestration of Carbon Dioxide), and may need to do so if they are claiming credit under IRS Section 45Q (see above).

5.2.2 *Transitioning from a Class I, II and V well to a Class VI well*

Historically, and during the period of development of the Class VI Rule specific to geologic sequestration projects, geologic sequestration (GS) projects were placed in other well classes, including:

Class I: injection of hazardous wastes, industrial non-hazardous liquids, or municipal wastewater beneath the lowermost USDW;

Class II: injection of brines and other fluids associated with oil and gas production, and hydrocarbons for storage (CO_2 injection for the purposes of EOR); and

Class V: injection wells not included in Classes I – IV; in general, shallow, on-site disposal systems but also used for geologic sequestration field studies that are experimental in nature (experimental GS projects).

Class I and V permits for CO_2 injection wells

Following publication of the Class V GS experimental technology well permitting guidance document in March 2007, GS projects were typically permitted as Class V experimental technology wells[1] unless they were injecting CO_2 for EOR and were permitted as Class II wells. The guidance served as an interim measure while EPA developed an appropriate regulatory framework (i.e. the Class VI Rule) for GS. Following finalisation of the Class VI Rule, where CO_2 injection for the purposes of geologic sequestration is still being undertaken at wells previously permitted as Class I or Class V wells (and in the case of a Class V well if this is no longer for experimental technology purposes), these projects will need to apply for a Class VI permit as clarified at US Code of Federal Regulations (CFR), in 40 CFR 146.81(c).

Class II permits for CO_2 injection with EOR

A number of GS projects in the US operate in conjunction with existing EOR operations. These include several demonstration projects implemented by Regional Carbon Sequestration Partnerships (RCSPs), which are public/private partnerships funded through the US DOE's National Energy Technology Laboratory (NETL). Phase II of the RSCP initiative focused on increasing knowledge and understanding of the injectivity, capacity and storability of various geologies in the US, and a number of projects went about this by partnering with EOR operators to test CO_2 injection and monitoring techniques. For projects such as these, Class II (EOR) permits were issued.

The criteria that will inform a transition from a Class II to a Class VI well are given at 40 CFR 144.19 'Transitioning from a Class II to Class VI'[2]. The requirement for transition will be based on any change in activities that alters

[1] One exception is the Class I well in Illinois.

[2] Code of Federal Regulations, Title 40 – Protection of Environment. Section 144.19 'Transitioning from a Class II to Class VI'. Available online at: http://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol23/xml/CFR-2011-title40-vol23-sec144-19.xml

the risk posed to USDWs. A transition from a Class II to Class VI well may be required at the point where the primary purpose of the well becomes geologic sequestration, rather than the enhanced recovery of oil and gas, and when there is an increased risk posed to USDWs (see Box 5.1). At this point, operators will need to apply for a Class VI permit, and going forward will be subject to the more extensive requirements that GS wells are subject to (see Box 5.1).

Box 5.1 Transition from a Class II to Class VI well

40 CFR 144.19 – Transitioning from a Class II to Class VI.

(a) Owners or operators that are injecting carbon dioxide for the primary purpose of long-term storage into an oil and gas reservoir must apply for and obtain a Class VI geologic sequestration permit when there is an increased risk to USDWs compared to Class II operations. In determining if there is an increased risk to USDWs, the owner or operator must consider the factors specified in § 144.19(b).

(b) The Director shall determine when there is an increased risk to USDWs compared to Class II operations and a Class VI permit is required. In order to make this determination the Director must consider the following:

- **(1)** Increase in reservoir pressure within the injection zone(s);
- **(2)** Increase in carbon dioxide injection rates;
- **(3)** Decrease in reservoir production rates;
- **(4)** Distance between the injection zone(s) and USDWs;
- **(5)** Suitability of the Class II area of review delineation;
- **(6)** Quality of abandoned well plugs within the area of review;
- **(7)** The owner's or operator's plan for recovery of carbon dioxide at the cessation of injection;
- **(8)** The source and properties of injected carbon dioxide; and
- **(9)** Any additional site-specific factors as determined by the Director.

Of particular concern for projects that may in the future transition from a Class II to a Class VI well is the extensive (default 50 years) post-injection site care (PISC) period required of Class VI wells. Experimental projects may face a major barrier if transitioning to Class VI wells when it comes to securing funding for PISC requirements (including monitoring) for this length of time following well closure. The EPA is developing a number of guidance documents in relation to the Class VI rule which help to clarify requirements and will be working closely with project developers to help them progress through the permitting process.

In addition to reduced financial incentives, stringent requirements made of geological sequestration projects under the Underground Injection Control Class VI rule may act to discourage the development of saline aquifer CCS projects over CO_2-EOR projects.

5.2.3 Climate change policy at the Federal level

It is widely recognised that a robust carbon pricing signal is vital in incentivising CCS activities. Without a strong carbon price CCS is unlikely to be commercially viable for non-EOR projects.

The lack of a national climate policy and carbon-pricing mechanism at the federal level in the US has had a negative impact on CCS projects, including those linked with EOR activities. Project developers have faced delays in securing finance for CCS projects owing to uncertainty amongst potential investors on the commercial viability of CCS. A clear signal from the federal government in the form of a robust carbon-pricing mechanism would help to increase the financial incentives for potential investors and would help to make it clear that 'business as usual' cannot continue indefinitely.

However, in the absence of a robust national climate policy, various funding initiatives in the US are currently playing an important role in both providing funding to CCS projects and in encouraging the provision of finance from potential CCS investors. Such funding initiatives include the 2002 Clean Coal Power Initiative (CCPI) and 2009 American Recovery and Reinvestment Act (ARRA), both providing finance to CCS projects in order to help advance the development of clean coal technologies in the US, and Regional Carbon Sequestration Partnerships (RCSPs) established by the DOE's National Energy Technology Laboratory (NETL) in 2003, which aim to facilitate the identification, evaluation and development of carbon sequestration opportunities and technologies in various regions of the US. As well as these funding initiatives, the successful implementation of the 45Q tax credit system (offering a $10 tax credit per tonne of anthropogenic CO_2 stored in EOR, and a $20 tax credit per tonne of CO_2 stored in deep saline formations) could help to provide a business case for CO_2-EOR and CCS.

Whilst the absence of a robust climate change policy and carbon pricing signal in the US has discouraged private investment in CCS projects, funding initiatives such as the Clean Coal Power Initiative have helped to provide finance to CCS projects and encouragement for investors on a case by case basis.

6 OVERALL FINDINGS, CONCLUSIONS AND LESSONS LEARNT

This section presents the overall findings of the study, and highlights some key lessons learnt from the case studies developed during the course of the study.

6.1 OVERALL FINDINGS

6.1.1 Recent regulatory developments at the International level

There have been some significant developments in CCS regulatory frameworks at the international level in recent years. In 2011, CCS was formally included in the Clean Development Mechanism (CDM). This potentially puts into place a funding mechanism for CCS developments in developing countries, though given the current low values of Certified Emission Reduction credits (CERs) under the CDM, the economics of CCS in these countries is unlikely to change dramatically in the near future.

Other developments include the full ratification of the 2007 amendments to the Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention), allowing countries to store CO_2 under the seabed (previously prevented through the Convention). Less progress has been made with the 2009 amendment to the London Protocol that aims to allow for the cross-border transportation of CO_2 as a waste product for the purposes of storage; only two contracting parties have ratified this amendment to date.

6.1.2 Key findings by Jurisdiction

The case studies undertaken as part of this project helped to highlight the latest regulatory developments in CCS in the jurisdictions studied, and helped to identify gaps that remain within regulatory approaches to CCS. The key findings for each jurisdiction are summarised in this section.

Australia

In Australia, a key policy development was the introduction of a carbon tax in July 2012; however, at AU$23 per tonne CO_2 this is unlikely to significantly affect the economics of CCS. Victoria has a relatively robust regulatory framework in place for both onshore and state offshore CO_2 storage. The regulations do not provide for the transfer of tort liability for stored CO_2 to the state, and this poses a regulatory risk to project developers in the region. The case study highlighted the important role that demonstration projects can play in helping to inform the development of a CCS regulatory framework. The case study also highlighted the importance of being able to tailor regulations to projects of different sizes; demonstration projects may need to gain exemptions from some onerous CCS regulations that could prevent demonstration-scale operations from continuing.

Canada

In Canada, CCS regulatory frameworks are being developed in a number of provinces including Alberta, Saskatchewan, British Columbia and Nova Scotia. In Alberta, CCS plays a key role in Alberta's climate change strategy; CAD $1.5bn has been allocated for the funding of three CCS projects in the province. A robust regulatory framework for CCS is evolving through the development of the Carbon Capture and Storage Statutes Amendment Act (2010), the Carbon Sequestration Tenure Regulation (2011) and the CCS Regulatory Framework Assessment (2011). Alberta's currently on-going CCS Regulatory Framework Assessment (RFA) is helping to address any remaining gaps or issues in the regulations, for example in relation to details of the criteria that must be met before responsibility and liability for stored CO_2 can be transferred to the Crown, and the structure of the Post-closure Stewardship Fund that can be used by the Crown in the post-closure phase for monitoring and potential remediation actions. The RFA draws together scientific, academic, regulatory, administration and industry experts, including CCS projects currently under development in the region.

Enhanced oil recovery using anthropogenic CO_2 (CO_2-EOR) is not explicitly addressed in the existing regulatory framework for CCS in Alberta, but CO_2-EOR projects are able to gain credit for sequestered CO_2. Questions remain about the regulation of CO_2-EOR (including provisions for a transfer from CO_2-EOR to CCS) and these are not being addressed in the RFA but will be looked into following completion of the CCS RFA process, in as early as 2013.

Europe

In Europe, the transposition of the 2010 CCS Directive on the geological storage of CO_2 has triggered a number of regulatory developments at the EU Member State level. To date, ten Member States have completed the transposition of the Directive. Whilst the CCS Directive helps to set a robust regulatory framework for the storage of CO_2, some of the more practical and technical details must be developed at the Member State level. In some cases this detail is currently lacking, posing some difficulties for projects first to progress through the permit application and regulatory approval process in these countries as these issues are resolved.

Other regulatory concerns relate to uncertainty about potential liability for global environmental impacts resulting in the event of a leak of CO_2. In the event of a CO_2 leak, operators would be required to surrender an amount of EUAs equal to the volume of CO_2 leaked, but there is uncertainty in the future value of EU Allowances (EUAs) that would need to be purchased, and uncertainty therefore in potential liabilities. Some concerns also exist in relation to the practicalities of being able to hand over liability for local environmental damages under the EU Environmental Liability Directive to the state, since strict liability is placed on operators and a strong 'polluter pays' principle applies.

Finally, some concerns were raised by project developers around the third-party access provisions of the Directive, with fears that the provisions for transparent and non-discriminatory third-party access to CO_2 transportation and storage infrastructure could place significant risks on CO_2 storage site operators in the event where they are required to accommodate new and additional sources of CO_2. It is likely that as the first CCS projects progress through the regulatory approval process and as more guidance is issued across Member States, a number of these issues will be resolved and a more robust regulatory approval process will evolve for future projects.

US

In the US, the finalisation of the EPA's Underground Injection Control (UIC) Class VI rule (under the authority of the Safe Drinking Water Act) in December 2010 has important implications for the regulation of CCS. Projects injecting and storing CO_2 not associated with EOR are required to gain a Class VI permit and will need to meet stringent regulatory requirements designed to minimise risk to underground sources of drinking water (USDWs). To date, no Class VI permits have been issued, though four permit applications have been submitted to the EPA. Project developers perceive the regulatory requirements made of Class VI wells (particularly in relation to the post-injection site care requirements) to be particularly demanding and some indicated a preference to develop CO_2-EOR projects that can be permitted under the UIC Class II requirements. The US EPA also finalized a rule under authority of the Clean Air Act that requires facilities that conduct geologic sequestration (GS) of CO_2 and all other facilities that inject CO_2 underground to report greenhouse gas data to EPA annually. This rule amends the regulatory framework for the Greenhouse Gas Reporting Program.

CO_2-EOR (using anthropogenic CO_2) is likely to play an increasingly important role in providing the necessary incentives for the deployment of CCS in the US. CO_2-EOR projects are regulated under the UIC Class II regulations. Issues relating to when a project might transition from a Class II EOR well to a Class VI CCS well have been addressed to some extent; criteria determining when such a transition might be made have been developed and further guidance on this transition is due to be published in the near future. With the lack of a federal carbon pricing mechanism, specific CCS funding initiatives such as the American Recovery and Reinvestment Act (allocating US $3.4 billion to CCS programs) play a key role in helping the development of CCS in the US, and the 45Q Tax Credit, providing a $10-20 / tonne CO_2 storage tax exemption, has the potential to support early projects, providing uncertainties in the credit system are addressed.

6.1.3 Cross-cutting findings

The study highlighted a number of broader findings in relation to the development of CCS regulatory frameworks across jurisdictions. These cross-cutting regulatory issues are summarised below.

Long-term liability for stored CO_2

Long-term liability for stored CO_2 is an important regulatory consideration for CCS projects, and a common concern across jurisdictions. Frequently, CCS regulatory frameworks provide for a transfer of liability for stored CO_2 to the state following a closure period after the cessation of injection, but often uncertainty remains:

- In Australia, Victoria's onshore and offshore CCS regulations do not provide for the transfer of common law liabilities to the state and these remain with the operator indefinitely. This differs to the Commonwealth offshore CCS regulations, where common law liability can be transferred, and raises questions about how liability would be handled if cross-boundary storage sites are used.

- In Alberta, Canada, tort liability can be assumed by the Crown following the issuance of a closure certificate, but climate change liabilities cannot be transferred to the Crown (though this recommendation is being made through Alberta's RFA process).

- In Europe, the CCS Directive provides for the transfer of liability under the EU Emissions Trading System and the EU Environmental Liability Directive at the end of the closure period. Concerns are primarily focused on the uncertainty of the extent of liability under the ETS before the transfer of responsibility to the state, owing to the uncertain future of EUA prices. Some concerns also exist about the extent to which ELD liability can be transferred to the state, considering the strict liability placed on operators in the ELD.

- In the US, liability for stored CO_2 has to date been addressed at the state level[1]. In some states including Louisiana, Montana, and North Dakota, liability for stored CO_2 can be transferred to the state once various criteria around the stability of stored CO_2 have been met. Other states such as Texas and Mississippi have addressed long-term liability for stored CO_2 to some extent, for example by setting up trust funds that can be used for monitoring and potential remediation activities by the state after responsibility for stored CO_2 has been handed over to the state. In Texas, questions remain on the extent to which the fund provides for a transfer of liability to the state and further clarification is required in relation to what the fund covers and what liabilities may be retained by storage site operators.

Climate change policy context

A jurisdiction's broader policy context plays an important role in shaping the regulatory landscape for CCS and in influencing other factors important in

[1] Note that in 2010, the Interagency Task Force on Carbon Capture and Storage that was set up to investigate barriers to CCS deployment in the US addressed long-term liability for stored CO_2. Various approaches for the regulation of long-term liability were put forward, including liability frameworks developed at the federal level, but to date this topic has been addressed only in US state CCS regulations.

determining a project's success. A country, state or province's climate change policy framework can affect the successful development and implementation of a CCS important in a number of ways:

- A robust climate change strategy that sets ambitious GHG reduction targets and emphasises the role of CCS in helping to achieve these can help to drive the development of a robust regulatory framework for CCS (required such that projects are implemented and emissions reductions are made accordingly). In Alberta, widespread deployment of CCS will be vital in helping to achieve GHG emission reduction goals set by the province; similarly, in the Netherlands, CCS will be important in achieving the ambitious carbon reduction targets set by the Rotterdam Climate Initiative (50% emissions reduction in Rotterdam by 2025 from a 1990 baseline).

- Carbon pricing mechanisms (e.g. a carbon tax or a greenhouse gas trading scheme) can help to put a price on carbon and increase the economic incentives of CCS (a potential barrier to project development). Carbon pricing mechanisms exist in the EU (EU ETS), Alberta (Alberta SGER) and Australia (2012 Australian carbon tax).

- Funding initiatives for CCS (including CCS demonstration programs) are important in encouraging the development of CCS demonstration projects as well as large-scale industrial and power projects. A number of CCS funding and support initiatives exist in different forms such as emission trading systems, grants, tax incentives, and carbon taxes. Such initiatives exist across Europe, the US, Canada, and Australia, and some (including the American Recovery and Reinvestment Act, and the Alberta Specified Gas Emitters Regulation and CCS Funding Act) have played an important role in the driving the deployment of CCS.

  There is less confidence in some funding initiatives where funds are linked to the price of carbon. This is primarily due to the market uncertainty involved in these initiatives; for example there is concern that funding made available through the Australia carbon tax and the European NER300 fund (established under the EU ETS) could be less significant than hoped owing to low carbon prices in these jurisdictions. In addition to overall adequacy of support, CCS project developers and investors require certainty considering the long-term investments they are making in order to reduce project risks. In cases where financing and incentive mechanisms are linked to carbon market prices, more certainty is needed both on the timing of the funding distribution as well as on overall level of funding. To that end, carbon price guarantees are one way to tackle carbon price volatility and reduce revenue risk. CCP's 2009 study on financial support mechanisms for CCS provides more information and insight into the effectiveness of different types of financing and incentive mechanisms[1].

[1] CO_2 Capture Project (2009). Financial Support Mechanisms for CO_2 Capture and Storage – Final Report. Available online at http://www.co2captureproject.org/financial_support_mechanisms.html

- Policies and regulations developed for industry and power generation that set energy efficiency and/or emissions targets can play an important role in incentivising CCS. For example, Canada's recently introduced greenhouse gas performance standards for coal-fired electricity generation could help to drive the deployment of power sector CCS projects.

In addition to directly incentivising CCS, a robust and ambitious climate change strategy can help to foster strong relationships between CCS project developers and regulators. Where significant funding has been given to CCS projects, or where CCS plays an important role in helping countries to meet GHG reduction commitments, regulators will work closely with project developers to help projects overcome potential regulatory issues that arise in order to help projects through the regulatory approval process.

Regulatory frameworks for CO_2-EOR

In North America (both the US and Canada), EOR using anthropogenic CO_2 is playing an important role in advancing CCS deployment. Many CCS projects in North America receiving funding from governments involve the use of CO_2 in EOR. Revenue gained from the sale of CO_2 to EOR operations can be important in making a CCS project more financially viable.

A robust regulatory framework for CO_2-EOR exists in the US and Canada. Regulatory frameworks for CO_2-EOR differ to those developed for CCS in a number of ways. Some important differences include the strict MRV requirements made of CCS projects to ensure CO_2 is permanently stored (including into the closure period), and consideration of long-term liability for stored CO_2, and the development of a fund to cover this. When considering the different regulatory frameworks that exist for CO_2-EOR and CCS, two main issues emerge:

- **Regulation of CO_2-EOR projects gaining storage credits**: In Alberta, projects using anthropogenic CO_2 for EOR can be considered CCS projects and gain credit for stored CO_2 provided they meet specific MRV requirements under Alberta's CO_2-EOR offset protocol. However, these projects are not currently required to meet the same requirements around MRV, financial responsibility and closure period monitoring that would be made of a CCS project under the regulatory framework that exists for CCS.

- **Enabling a transition from CO_2-EOR to CCS**: Following the cessation of CO_2-EOR operations (when it is no longer economic to produce oil), a project may have the opportunity to transition to a full CCS project, and may wish to do so if there is a value for stored CO_2. In the scenario where a transition is to be made, a number of regulatory issues arise in relation to when and how this transition is made.

In the US, CO_2-EOR to CCS transition has been addressed by the US EPA's Underground Injection Control Rules under the Safe Drinking Water Act. CO_2-EOR is regulated according to the UIC Class II Rule, and in 2010 a new well class, Class VI, was introduced for the regulation of Geological Sequestration wells. The EPA has indicated that a transition from a Class II to a Class VI well will be required when the risks posed to USDWs change in relation to changes in the injection operation from principally EOR to sequestration of CO_2. Following the transition, well operators will need to meet specific MRV and post-injection site care requirements (amongst others). EOR projects do have the option of reporting the quantity of CO_2 sequestered under the Greenhouse Gas Reporting Program.

In Alberta, questions about the procedures that may exist for a CO_2-EOR to CCS transition have been raised but have yet to be addressed. The Alberta regulators are likely to look at this in 2013.

Unlike North America, Europe does not have a history of CO_2-EOR operations and the topic was not raised in the case study interviews (with no projects interviewed intending to combine CCS and EOR). However, opportunities for CO_2-EOR in Europe are being identified and the topic is receiving increasing attention in Europe. The CCS Directive addresses enhanced hydrocarbon recovery (EHR) in the preamble, stating that '*EHR is not in itself included in the scope of this Directive. However, where EHR is combined with the geological storage of CO_2, the provisions of this Directive for the environmentally safe storage of CO_2 should apply*'. The preamble serves as a context setting and interpretation tool for Member States to use when developing national regulations. The text suggests that CO_2-EOR projects seeking to gain CO_2 storage credits will need to meet a number of requirements (including in relation to MRV and liability for stored CO_2), similar to or the same as what would be required of CCS projects. Details of how individual Member States will regulate CO_2-EOR projects remain to be seen.

6.2 *CASE STUDY LESSONS LEARNT*

In the course of this study, eight CCS case studies were developed in order to gain practical insights into the development and implementation of regulatory frameworks in the jurisdictions studied. The case study interviews highlighted a number of lessons that were learnt by going through the regulatory approval process in the various jurisdictions, and these could help future projects to progress through the regulatory process.

6.2.1 *Development of regulatory frameworks for CCS*

The following lessons learnt may be generally applicable to the development of regulatory frameworks in jurisdictions:

- **Projects already in existence (including small-scale demonstration projects) can be important in helping with the development of CCS regulations in a jurisdiction.** These projects can play an important role in working with regulators and providing insights based on technical

knowledge and experience that are useful in informing regulatory requirements under development.

- **Projects first to test a newly developed regulatory framework can play an important role in working closely with regulators to help shape the future development of those regulations.** These projects can help to test the regulatory framework and can provide practical insights into the regulations, including helping to highlight potential gaps and barriers for CCS project development.

- **The effect of newly developed CCS regulations on already existing CCS projects should be considered.** Existing projects need to work closely with regulators in order to understand how newly implemented regulations could affect the project's operations and may need to resolve potential issues that may arise, particularly in relation to new or more onerous requirements that the regulations may impose.

- **It is important to be able to tailor regulatory requirements to projects of different sizes and contexts and not to adopt a 'one size fits all' approach.** Small-scale demonstration projects that were interviewed during the course of the study highlighted the challenges associated with meeting onerous regulatory requirements geared towards large-scale CCS projects (for example, extensive requirements in relation to financial securities and responsibilities). Regulators should consider how requirements should apply to different types of CCS projects.

6.2.2 Progression through the regulatory approval process

The following lessons learnt may be generally applicable for CCS projects progressing through the regulatory approval process across jurisdictions:

- **Projects that are first to progress through a newly developed regulatory framework can face delays in the permitting process.** Case studies developed in the course of this study suggest that a lengthy permitting procedure may be attributed to:

    - The requirement to work closely with regulators in order to define various detailed technical requirements not yet specified in the regulations or associated guidance documents (for example in relation to MRV requirements, and CO_2 pipeline health and safety requirements); and

    - The intention of the regulators to set a robust precedent for the permitting of CCS activities that will apply for future projects seeking regulatory approval.

- **Where regulatory requirements are broad in scope and where detailed guidance notes have yet to be developed, projects can take a conservative approach and go beyond perceived minimum requirements to help to gain regulatory and stakeholder approval.**

Projects can increase the likelihood of regulatory and stakeholder approval by submitting permit applications that go beyond what is interpreted from the regulations as minimum requirements for areas such as stakeholder consultation, CO_2 safety plans and procedures, and MRV.

- **In North America, CCS project developers may choose to follow a more well-defined regulatory pathway by developing CO_2-EOR projects.** A well-defined regulatory framework for CO_2-EOR has existed for a number of years in the US and Canada, and Alberta EOR operations using anthropogenic CO_2 are eligible to gain CO_2 offset credits under the Alberta SGER. Regulatory frameworks for CO_2-EOR are considered to be less onerous than the regulatory frameworks for CCS projects.

- **Even when regulatory approval has been or is very likely to be received, other issues can arise that might affect the successful implementation of a CCS project.** Case studies highlighted the importance of other aspects that affect the successful implementation of a CCS project; these include both ensuring stakeholder approval of the project, and being able to secure financing for the project. Even with the relevant permits in place, projects encountering issues in these areas could experience significant delays.

- **Even where gaps and questions remain in CCS regulatory frameworks, project developers have been able to gain regulatory approval and progress with project development and implementation.** Regulatory gaps or barriers were encountered by the majority of projects interviewed. However, many of these projects have been able to progress through the regulatory approval process, working closely with the relevant regulators to be secure in the knowledge that these gaps will be resolved in the future.

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