

6th IEA International CCS Regulatory Network Meeting

*Taking stock of progress and identifying
next steps*

Tristan Stanley and Sean McCoy

INTERNATIONAL ENERGY AGENCY

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International Energy Agency
9 rue de la Fédération
75739 Paris Cedex 15, France

www.iea.org

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Executive summary

The IEA International CCS Regulatory Network held its 6th meeting in Paris, France on 27 and 28 May 2014. The first day of the meeting was a survey of progress in developing and implementing legal and regulatory frameworks in the jurisdictions represented. The second day was focused thematically, exploring a range of issues which have emerged in the development of legal and regulatory frameworks.

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A number of governments have now implemented CCS legal and regulatory frameworks, particularly to ensure the safe and effective storage of CO₂ underground. Many of these leading jurisdictions are now waiting for the regulations to be tested by early large scale CCS projects. Existing projects in these jurisdictions have often been developed under either existing energy or environmental frameworks or under special frameworks crafted for demonstration projects or R&D, and are now being integrated into new CCS specific regulation.

Other governments are in the earlier stages of developing CCS legal and regulatory frameworks. A common first step in these jurisdictions is to survey the application of existing legislation to CCS projects. This review and assessment highlights the gaps in existing legislation and helps to identify legislative vehicles for CCS specific regulation.

A number of common themes emerged experiences of governments in developing CCS legal and regulatory frameworks as relayed in the meeting. Legal frameworks are not developed in isolation but rather build on and adapt existing law. Furthermore, the nature of regulation will be greatly impacted by the regulatory context in a given jurisdictions. For both of these reasons, CCS legal and regulatory frameworks will differ greatly between jurisdictions and therefore, there is no “one size fits all” solution.

The meeting also discussed the important balance between flexibility and certainty in regulation. Best practice regulation and standard setting now encourages goal setting, rather than prescriptive requirements in order to remain flexible to technological developments and emergent risks. This is an area where standards can complement regulation, as they are regularly updated to reflect best practice. Counterbalancing this need for flexibility is the regulatory certainty required for projects to secure investment.

Introduction

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The IEA International CCS Regulatory Network held its 6th meeting in Paris, France on 27 and 28 May 2014. There were over 60 participants representing national and sub-national governments, industry and the research and academic community. The Regulatory Network was launched in Paris in May 2008 to provide a neutral forum for CCS regulators, policy makers and stakeholders to share updates and views on CCS regulatory developments. In addition to its annual face-to-face meeting, the Network engages through regular web-based seminars and ad hoc meetings on specific CCS regulatory issues. Over the past five years, hundreds of people from dozens of countries – developed and developing – have participated in network activities.

A flurry of activity took place between 2005 and 2011 during which time many OECD governments developed and implemented regulatory frameworks for geologic storage; since then, the pace of developments in the area of CCS law and regulation has slowed (IEA, 2014a)). In countries that have regulatory frameworks for CCS, the extent to which these frameworks have been tested varies: some governments have detailed frameworks that are being applied to demonstration projects (e.g., United States, Alberta) while others have detailed frameworks but few projects (e.g., Australian Federal Government, European Union member states). Of course, many other countries have yet to establish frameworks, but have processes underway that may lead to their development (e.g., New Zealand, South Africa) in the near future.

The objective of this meeting is to better understand progress to date around the world, develop a more complete understanding of the next steps for countries at all stages of regulatory development, and provide a forum for information sharing that can allow all countries to benefit from the lessons that are being learnt today.

The first day of the meeting was a survey of progress in developing and implementing legal and regulatory frameworks in the jurisdictions represented. The second day was focused thematically, exploring a range of issues which have emerged in the development of legal and regulatory frameworks. The meeting closed with a discussion on the future direction of the Regulatory Network and how it can best add value for participants. The presentations from the meeting provide further detail and are available on the IEA Website.¹

Day 1

Welcoming remarks

Juho Lipponen, Head of the CCS Unit, IEA formally opened the meeting with a general overview of the status and progress of CCS deployment generally, highlighting the role it needs to play in addressing climate change at the lowest cost. The emissions intensity of energy supply has been constant for several decades but will need to be substantially reduced in order to reach the targets put forward in the IEA 2°C Scenario (referred to as 2DS) (IEA, 2014b). CCS has a critical role to play in reducing the emissions intensity of energy supply, but can and will do so only if supported by comprehensive policy frameworks. As well as power generation, CCS will also need to be applied to industrial processes. The IEA estimates that around half of the CO₂ stored globally by 2050 will be captured from industrial processes (IEA, 2013).

Sean McCoy from the IEA CCS Unit introduced the themes and context of the meeting. Regulatory barriers to CCS were first identified as an issue in the early 2000s. For many years,

¹ <http://www.iea.org/workshop/ccs6thregulatorynetworkmeeting.html>

stakeholders and regulators considered various approaches to addressing the barriers and, beginning in the late-2000's, implemented solutions. Since 2005, over 50 legal instruments relating to CO₂ storage have been adopted. Several of the lessons learned in the development of these instruments were highlighted here and were developed further through the meeting, including:

- Developing legal frameworks is a long and complicated process and therefore needs to be started in advance of being necessitated by developing projects.
- CCS legislation and regulations are never developed from a blank slate, but rather build on and adapt existing legal frameworks.
- One size does not fit all. Regulations need to be flexible and adaptive to manage differences between projects and react to technological changes.

Session 1 – Developing regulatory frameworks

Session 1 was chaired by Nigel Bankes, University of Calgary, Canada. The purpose of Session 1 was to provide an update on the progress of developing CCS legal and regulatory frameworks in the jurisdictions represented, and discuss their experiences.

Barry Barton from the University of Waikato, New Zealand began the session with a presentation on the general context of CCS in New Zealand and presenting a new study into establishing a legal regime for CCS in New Zealand. The study, *Carbon Capture and Storage: Designing the Legal and Regulatory Framework for New Zealand* (Barton, Jordan and Severinsen, 2013) put forward recommendations on a legal framework which would make CCS possible in New Zealand.

The New Zealand Government is currently supporting research in to CCS to ensure its availability should it be necessary, but there are currently no current or anticipated CCS projects. In this regard, New Zealand is clearly a follower, not a leader, in CCS. Furthermore, the study in question does not represent the official views of the government.

One of the key issues which emerged from the study was the relationship of CCS regulations with existing laws. In New Zealand, CCS was found to interact primarily with environmental law, petroleum law, and the New Zealand emissions trading scheme (NZ ETS). Petroleum law, specifically The Resource Management Act, is considered to be a central piece of existing legislative which could form a basis for CCS law. New Zealand's environment law has not previously considered CO₂ as it dealt primarily with the discharge of contaminants. CO₂ was only regulated under the NZ ETS. The study recommended the environmental law should be amended to also cover CO₂ injection and fluid movement.

The interaction of CO₂ injection with petroleum law also presents challenges as it deals with the extraction of resources, whereas CCS regulation regards the injection of a substance which could potentially conflict with other uses of the subsurface. There is also a need to further define the sub-surface property rights in New Zealand's petroleum law.

The second presentation was from F.X. Sutijastoto from the Ministry of Energy Mineral Resources, Indonesia, who gave an update on the development of CCS in Indonesia. Indonesia is facing a significant increase in energy demand in the coming decades due to high population growth and high economic growth leading to growth in energy sector emissions. Furthermore, Indonesia possesses significant fossil fuel reserves which will be used domestically and exported. The Indonesian Government has partnered with a number of multinational companies, NGOs and other governments to explore the potential of CCS in Indonesia and develop a CCS Roadmap. While there is no specific CCS regulation, Indonesia has introduced a policy framework for achieving significant reductions in emissions by 2020 under which CCS will potentially play a

significant role. Existing oil and gas legislation can be a strong basis, but a dedicated CCS law could also be considered in the future.

I-Tsung Tsai of the Masdar Institute in the United Arab Emirates presented a summary of CCS activity in the Gulf Cooperation Council (GCC) region and discussed the legal and regulatory challenges to CCS projects in the area. CCS is likely to be a key mitigation technology in the GCC region. The GCC region has enormous hydrocarbon reserves with highly emissions intensive production given the use of desalination. Furthermore, primary energy consumption is projected to continue growing.

Industry and governments in the GCC region are looking to international climate change mitigation programs, such as the UN Clean Development Mechanism (CDM). In order for CCS projects in the region to qualify for credits under the CDM GCC Governments will need to implement laws and regulations relating to site selection; property rights regarding stored CO₂ and the subsurface pore space; and liability, remediation and compensation measures in the case of CO₂ leakage. At present there are no domestic CCS or CO₂ specification regulations in any GCC jurisdictions. CO₂-flood enhanced oil recovery (CO₂-EOR) is likely to be in the focus of attention in the short- to medium-term, as the countries in the region envisage using CO₂, instead of natural gas, to enhance oil recovery. Hence any legislation or regulation should consider CO₂-EOR.

The regulatory environment in the GCC region is somewhat unique. The majority of companies likely to undertake CCS are either public or semi-public entities that are self-regulating and self-permitting. These likely project proponents may only need to seek external permits and approvals for CO₂ storage to meet requirements tied to receiving funding from international climate regimes such as the CDM. This regulatory context will have a significant impact on the development of CCS legislation, emphasizing that there is no one CCS regulatory model which fits all jurisdictions.

The trans-boundary migration of CO₂ plumes may pose challenges for permanent storage regulations in the GCC, given that many of the geological formations in the region cross a number of jurisdictions. This is a different challenge to the trans-boundary issues faced in other regions, such as Europe, where the primary concern is the transport of CO₂ across borders prior to injection, potentially in contravention of international agreements.

Muzi Mkhize from the Department of Energy, South Africa, gave a presentation highlighting the importance of CCS in South Africa given the predominance of coal in its economy. South Africa's approach to developing regulations for CCS recognises that legal and regulatory frameworks need to adapt and build on existing laws. A 2013 World Bank – Department of Energy CCS Legal and Regulatory Study recommended four options for legislating/regulating CCS: (1) under the National Environmental Management (NEM) Waste Act; (2) under the NEM Act itself, recognising CCS as a specific activity; (3) under both the NEM Act and the Mineral Petroleum Resource Development Act; or (4) under stand-alone CCS legislation. The approach preferred by the government is under consideration, and could be a combination of some or all of the four options. One of the key priorities in the near term will be the permitting of the pilot scale test injection project which is currently in planning.

Ryozo Tanaka, Research Institute of Innovative Technology for the Earth (RITE), Japan, gave a presentation on CCS regulation and Demonstration in Japan from the perspective of the Tomakomai CCS demonstration project, the goal of which is to store over 100,000 tonnes of CO₂ per year for three years.

Of particular note are the extensive requirements for permitting and stringent environmental regulations applied to projects in Japan. Offshore storage in Japan is regulated through the amended Marine Pollution Prevention Act. In order to obtain the necessary permits, a CO₂

storage project must submit very detailed environmental impact assessments on any potential CO₂ leakage scenario, including separate simulations for CO₂ dispersion in the sea. Projects will also have to ensure that any CO₂ to be stored is of purity greater than 99%. Furthermore, any permit issued will only be valid for 5 years, with renewal required every 5 years. An interesting detail is that for the Tomakomai project, one ministry (METI) will apply for the necessary permits from another (MOE).

Orabile Seiphemo, Ministry of Minerals, Energy and Water Resources, Botswana, gave an outline of the current CCS scoping activities being undertaken in Botswana. Botswana is in the early stages of investigating the potential of CCS, including the availability of domestic storage resources. Botswana has considerable coal and coal bed methane deposits which it is looking to exploit in the near future. Botswana is also aiming to bring an additional 600MW of new coal fired capacity online to move from an electricity importer to an energy and electricity exporter to the broader southern African region. The CCS review will investigate the geological potential for CO₂ storage and the institutional and regulatory framework necessary for CCS.

The presentations and discussion in this session reiterated two messages which were raised in the introduction. Firstly, that CCS legislation is never developed from a blank slate and must build on existing law. As such, many jurisdictions begin the development of legal frameworks by reviewing the status of CCS activities within existing legislation and regulation. Secondly, that the context of CCS legislation and regulation is different in each jurisdiction. Differences can range from the identity of the regulator to existing sub-surface property rights and will have a defining impact on the development of legal and regulatory frameworks.

Session 2 – European developments

Session 2 was chaired by Navraj Singh Ghaleigh from the Edinburgh Law School, United Kingdom and explored developments in CCS laws and regulations in European jurisdictions. In 2009, the European Commission issued Directive 2009/31/EC regarding the geological storage of CO₂ (commonly referred to as the CCS Directive) which required EU Member States (MS) to implement legislation regulating the geological storage of CO₂². Session 2 focused on the progress and experiences of governments in transposing and applying the CCS Directive.

Mette Agerup, Ministry of Petroleum and Energy, Norway gave the first presentation of the session highlighting Norway's challenges in implementing the CCS Directive given that they have existing commercial CO₂ storage projects. While Norway is not a member of the European Union, it is required to implement most EU Directives by virtue of being a member of the European Economic Area (EEA). Norway has two operating CO₂ storage projects, Sleipner and Snohvit, the development of which preceded the issuance of the CCS Directive. The projects were established by Statoil to avoid paying a tax on CO₂ emissions under the CO₂-levies Act and regulated by the Ministry of Petroleum and Energy. Under the draft CCS regulations which transpose the CCS Directive, projects would also be regulated under a number of other Ministries determined by their location and nature, primarily the Ministry of Climate and Environment. Norway worked with the European Free Trade Surveillance Association (ESA) regarding application of the CCS Directive, particularly regarding financial security, to the two existing projects to ensure compliance with the CCS Directive. As regards long-term liability, transfer to the state could happen 20 years after closure but the operator would remain liable for the cost of monitoring for 30 years post-transfer.

² Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009: on the geological storage of carbon dioxide.

Unfortunately, Adam Wójcicki of the Polish Geological Survey was unable to attend, however Elzbieta Wroblewska from the Polish Ministry of Economy provided an update on CCS in Poland and on the process of transposing the CCS Directive. CCS is recognised as a vital technology in Poland, given its current and projected high dependence on coal for energy. The Polish Government has introduced a new act regulating CCS in order to comply with the CCS Directive, mostly by amending the current mining legislation. The transposing act is now in force, and the secondary legislation is being developed.

Almut Fischer, Federal Ministry of Economic Affairs and Energy, Germany presented Germany's approach to transposition of the CCS Directive. While Germany supports CCS development in Europe, it doesn't currently consider CCS to be a high priority in the decarbonisation of its domestic energy sector. There has previously been significant public opposition to CCS in Germany, particularly to onshore CO₂ storage. Consequently, Germany has limited the potential for CCS to demonstration only in its transposition of the CCS Directive. The CCS Law introduced in 2010 limited the amount of CO₂ which could be stored annually to 1.3 million tonnes per storage site and to 4 million tonnes nationwide. Furthermore, a clause in the CCS Law allows states to exempt either parts of its territory or the entire state from CO₂ storage – an option which a number of states have taken.

To end the session, Beatrice Coda, European Commission DG Clima, gave an update on the status of implementation and review of the EU CCS Directive. CCS is expected to be a key technology for the decarbonisation of the power sector in the EU, and the only option available for decarbonising some industrial processes. By late-2013, the European Commission had been notified by all MS of measures transposing the EU CCS Directive. Since then, seven MS have been issued notices of partial non-communication of transposing measures. Most MS have introduced new specific legislation and amendments, identified multiple competent authorities, and allowed the storage of CO₂.

The European Commission has recently announced a review of the CCS Directive to report in March 2015. The review will assess the effectiveness, relevance, efficiency, coherence and added value of the CCS Directive. One challenge the Commission will face in reviewing the Directive is the absence of any active projects which have been permitted under the framework put forward in the CCS Directive.

Session 2 highlighted that the varying approaches to transposing the CCS Directive reflected the different political, regulatory and legislative contexts of the EU MS and Norway and the prominence of CCS in their climate mitigation policies. While CO₂ storage legislation has now been developed and implemented in many parts of Europe, it has yet to be put into action as CCS projects have, so far, failed to materialise.

Session 3 – Developments in North America

Session 3 was chaired by Wendy B. Jacobs from Harvard Law School, and was a review of recent developments in CCS regulation in the United States and Canada. The session mainly focused on recent changes in US regulation of injection wells and CO₂ reporting, and the Alberta CCS Regional Framework Assessment (RFA).

Bob Van Voorhees opened the session with a review of the US federal environmental regulations for geologic storage of CO₂ from the perspective of the Carbon Sequestration Council, highlighting, in particular, the challenges these regulations could present to CCS projects. The US Environment Protection Agency (EPA) has created rules for the injection of substances underground that differentiate between injection wells on the basis of the substance being injected, the intent of injection and the geologic setting. So for example, a well to inject CO₂ for

the purposes of EOR can be permitted as a Class II well, whereas a CO₂ injection well for permanent sequestration of CO₂ is considered a class VI well and, as such, is more stringently regulated. Injection of CO₂ under a Class VI permit triggers reporting under Subpart RR of the greenhouse gas reporting rule, which is more stringent than the subpart applied to CO₂-EOR operations. Mr. Van Voorhees stated that the increased reporting burden for Class VI wells could provide a disincentive for EOR projects to transition to CO₂ storage projects.

The first Class VI permit applications were filed in 2011 (Archer Daniels Midland) and 2013 (FutureGen Alliance), and draft permits were issued this year: 15 April 2014 ((Archer Daniels Midland) and 31 March 2014 (FutureGen Alliance). The long time to obtain a Class VI permit was identified as an issue by project developers.

In January 2014, the EPA published a final rule that exempts "CO₂ streams" injected for geologic storage by Class VI permitted wells from the definition of hazardous waste under the Resource Conservation and Recovery Act (RCRA). However, somewhat counterintuitively, the preamble to the rule explicitly states that CO₂ destined for geological storage is a "solid waste" for the purpose of RCRA: i.e., the EPA had to demonstrate that RCRA could be applied to the supercritical CO₂ streams involved in CCS before exempting them. Because supercritical CO₂ had not previously been considered as a waste, either hazardous or non-hazardous (and was considered by some as "commodity") , the industry has some concerns about the impacts this exemption could have on EOR projects where CO₂ is injected through Class II wells, whether for storage or otherwise.

Jarad daniels from the US Department of Energy, summarised recent progress on CCS in the United States, highlighting eight existing projects, and discussing recent regulatory changes. The US has recently released a proposal for New Source Performance Standards (NSPS) limiting emissions from new generation burning at least 50% coal or natural gas. The NSPS would limit emissions from coal fired units at 1100 lbs CO₂/MWh, effectively mandating that carbon capture be incorporated in any new build coal generation. The captured CO₂ may be sent for storage, or potentially used for EOR with appropriate reporting (i.e., under Subpart RR). The EPA was also expected to propose regulations for existing power generation in the near future, and did so following meeting on 2 June 2014.

Kathryn Gagnon from Natural Resources Canada outlined the importance of CCS given Canada's abundant energy reserves and the steps Canada is taking to advance CCS. CCS regulation in Canada is divided between provincial and federal authorities. Of particular note is that the Province of British Columbia is currently developing a CCS regulatory framework which will identify and address any regulatory gaps, provide transparency and certainty in CCS development, and address regulatory barriers to projects. The framework will build on the existing oil and gas laws and regulations which include coverage of acid gas disposal and natural gas storage.

The session closed with a presentation from Rob Bioletti from the Alberta Government, outlining the progress of CCS in the Province. The Province of Alberta has invested significantly in CCS to demonstrate the integration of CCS technologies at a large scale and reduce Alberta's emissions. In 2013, The Alberta Government completed an 18 month review of its existing CCS regulatory framework. The Regulatory Framework Assessment (RFA) reviewed regulatory gaps and made 71 recommendations to the the Alberta Government across CCS permitting processes, risk assessment and monitoring, public engagement, and site closure and long term liability.³ The Alberta Government is now considering the recommendations and their implementation,

³ See the 4th edition of the IEA CCS Legal and Regulatory Review (2014a) for more detail, as well as the final report of the RFA (available at <http://solutionsstarthere.ca/29.asp>)

particularlry around the rate of project contribution to the Post Closure Stewardship Fund and regulatory amendments necessary to implement the recommendations.

Day 2

Session 4: Trends, challenges and next steps in CCS regulation

The second day of the workshp was arranged thematically, with each session focusing on key issues that have emerged in the development of CCS legal and regulatory frameworks. The goal of Session 4 which was chaired by Ian Havercroft from the Global CCS Institute, was to identify and discuss trends and recent developments in CCS law and regulation.

Nigel Bankes from the University of Calgary gave the first presentation of the session in which he raised four questions that must be considered by government when designing a transfer of liability from a project proponent to the government following the site closure. The questions are:

- What liabilities are transferred?
- What is the trigger to the transfer?
- How is the transfer of liability affected?
- What costs of assuming the transfer of liability are recovered from the operator in advance?

In Alberta, the Crown will accept statutory liabilities, third party tort liabilities, and liability for any continuing MMV responsibilities; but will not take liability for carbon accounting i.e. liability for repaying credits previously received for any CO₂ that leaks post closure. The liability transfer will be affected by the Crown becoming the relevant person under the various relevant statutes, providing an indemnity for tort liabilities to the project proponents, and assuming ownership of the injected CO₂. The costs of accepting these liabilities are to be partially covered by the Post Closure Stewardship Fund (PSCF), which projects pay into during their operations.

In order to determine the appropriate rate of contribution for projects to the PCSF in Alberta, legislators and regulators must regard the extent of the liability to be covered by the fund. The PSCF only covers a subset of the Crown's assumed liabilities, which include monitoring, measuring and verification, statutory liabilities, and liability of orphan wells; but does not cover any tort liability assumed by the Crown or carbon accounting liabilities. In determining the likely costs of the liabilities and therefore the appropriate rate of contributions from projects, governments must also consider that the transfer of liabilities will only occur once a site closure certificate has been issued and therefore the associated risk is very low. The RFA proposed that the financial contribution be risk-based and project-specific.

Barry Barton from the University of Waikato then spoke about challenges facing law-makers in developing CCS legal and regulatory frameworks, many of which reaffirmed the lessons arising from the experiences of jurisdictions presented on the first day. Firstly it takes time to develop and implement CCS legal and regulatory frameworks. Comprehensive legal and regulatory frameworks demonstrate a commitment by the Government to CCS in the long term and provide certainty and clarity to projects under consideration or in development. One off regulation is possible in the case of early mover projects, but this doesn't send a clear signal of the Government's intent to projects and the wider community.

Governments must also remember that CCS legislation is not developed in isolation from a blank slate, but rather must adapt or build on existing regulation. In considering the most appropriate approach to adapting existing legislation, governments may also consider broader issues such as

community acceptance. For example, if CCS law is fully developed under mining or petroleum law, CCS may be perceived to be captured by industry, and hence there may be value in also utilising environmental law.

The session continued with a presentation from Navraj Singh Ghaleigh, University of Edinburgh, which focused on the role of legal and regulatory frameworks in managing uncertainties and attracting finance for projects. The existence and nature of regulations can have a critical role in encouraging or stymying finance for CCS. Governments can reduce uncertainty for investors by putting in place comprehensive legal and regulatory frameworks as this signals an intent and long term commitment to CCS. However, overly stringent or prescriptive regulations or overly onerous reporting requirements can hamper investment and innovation.

The final presentation of the session was from Wendy B. Jacobs of the Harvard Law School and reviewed current trends and challenges in CCS regulation. The high levels of confidence in the potential of CCS in 2009 and 2010 globally have dissipated. In 2010, the US President directed a task force to make recommendations that, if carried out, would put the US on track to having five to ten commercial demonstration projects by 2016; however, in May 2014, only one commercial-scale coal-fired power plant is under construction in the US alongside two industrial projects. The absence of legislative and regulatory drivers for CCS is one of the key reasons that the US, and other countries, has not met targets for deployment. Emitters are not currently compelled to deploy CCS, and should a project come forward, there are often not the appropriate legal and regulatory frameworks in place to secure investment and public support.

In subsequent discussion a number of the presenters and participants raised the importance of regulation being flexible in order to adapt to changing circumstances and to avoid locking out technological advancements. One challenge is providing policy and regulatory certainty to investors and project proponents while retaining the necessary degree of flexibility in the regulatory regime. Governments must strike a balance between giving regulators the necessary flexibility, while ensuring projects have a clear view of the permitting pathway and reporting requirements.

Session 5 – Emerging findings from research that may impact regulation of geologic storage

The objective of Session 5, chaired by Tim Dixon, IEA GHG, was to highlight research and technological developments which may impact on the regulation of CO₂ storage.

The session opened with a presentation from Katherine Romanak, University of Texas Bureau of Economic Geology, discussing new methods in soil gas monitoring and its application in the case of the Weyburn-Midale CO₂-EOR project. In 2002, there was a report that CO₂ injected as part of the CO₂-EOR project was leaking at the surface. This report followed on a decade long series of allegations of environmental damages by landowners resulting from oil and gas operations and repeated testing of groundwater and soil.

The allegations were based on soil gas sampling. However, one of the challenges in soil gas monitoring for CO₂ storage is distinguishing natural variations in CO₂ levels from leakage. A new process based approach developed by Dr Romamak and colleagues that doesn't rely on background measurements was applied at the site, the results of which suggested that the CO₂ was biogenic in origin and not from the Weyburn-Midale project. This experience showed that it is important to adopt a protocol to address leakage claims in advance of injection and that relatively simple tools for responding to claims of leakage are now available.

Douglas Connelly from the National Oceanography Centre presented two recent research projects in offshore CO₂ monitoring. Offshore monitoring is challenging as offshore saline aquifers and depleted oil and gas reservoirs can extend under thousands of square kilometres of seabed and CO₂ leaked into the ocean will tend to form a plume which sits on the bottom of the ocean beneath the level which remotely operated vehicles can monitor. The QICS experiment explored the migration and impact of CO₂ in sediment from a controlled release to test different monitoring methods. The QICS study showed that significant changes could be expected in the sediment geochemistry that could be used to positively identify leakage. The results of the ECO2 and QICS project suggest that there are opportunities for monitoring for pre-cursory fluids that might be emitted at the seafloor before leaking CO₂ and also that the seafloor might provide the best site for measurement of CO₂ flux.⁴

Jens Wollenweber from TNO, presented on behalf of the CO₂ Site Closure Assessment Research (CO₂CARE) consortium. The CO₂CARE project seeks to develop procedures and technologies that allow compliance with the main requirements for transfer of responsibility in the EU CCS Directive to be demonstrated. The project developed 17 milestones and related judgement criteria for site closure derived from the high level principles for site closure and transfer of responsibility in the CCS Directive. The findings of the study include that demonstrating conformance between predictive models and measured performance will be difficult, and that the demonstration of conformance should be based on a systematic increase in predictive modelling capability with time and the collection of monitoring data. Nonetheless, uncertainty in the long-term stability of the site will remain, and it is thus advisable that regulators and operators focus on the "end-members" of the predicted range of outcomes when considering impacts. Based on this work, the members of the CO₂CARE project also developed recommendations for revisions to the EU CCS Directive.⁵

In the last presentation of the session, Grant Bromhal of the US National Energy Technology Laboratory presented an update on the work of the National Risk Assessment Partnership (NRAP). The NRAP is developing toolsets and methodologies for modelling CO₂ plume behaviour. The project is looking to reduce the costs of modelling plume behaviour by developing reduced order models which identify and focus on the specific site parameters which have the largest impact on the performance of a reservoir.

There were several conclusions which emerged from the presentations and discussion during this session. In particular, the levels of detectable CO₂ leakage will vary across projects and storage sites given the natural variability of CO₂ levels in soil, air and oceans, and technological limits. Therefore, terms such as no detectable leakage are problematic to define.

Session 5 also highlighted the importance of regulators developing and implementing detailed procedures for permitting, post-injection site closure and incident management. A number of the research projects presented in the session have developed model procedures and decision assisting tools for different processes in the permitting, monitoring and post closure of projects. The session clearly showed how important it is to develop flexible regulatory frameworks that can be adapted as science and experience allows a better understanding of important safety and integrity issues.

⁴ Further information on these research projects can be found at <http://www.bgs.ac.uk/qics/home.html> and <http://www.eco2-project.eu>

⁵ Public results of the CO₂Care project are available at <http://www.co2care.org/>

Session 6 – The relationship between standards and regulation

The final session of the meeting was chaired by Barry Barton, University of Waikato and explored the development of CO₂ storage standards, and the broader relationship between standards and regulation and the lessons for CCS regulation.

Céline Kauffmann, Organisation for Economic Cooperation and Development (OECD), opened the session with a presentation on the role of international standards and best practice governance in standards development, implementation and review. The quality of regulations and standards is not only in the design and rules, but also in the implementation and enforcement. Differences in enforcement of regulations are often a bigger hindrance to trade than different rules. Regulations and standards should be outcomes based wherever possible and avoid being prescriptive and potentially locking technologies in or out. There is an increasingly strong focus on private industry led up, bottom up standards development as the private sector are likely to have the most relevant expertise and experience.

Denis Deutsch, Total, presented an industry perspective on standards. The oil and gas industry is strongly involved in the standardisation process as robust standards save money, boost trade and reduce risk. The involvement of regulators is important as consensus standards can facilitate cross border trade and movement as well as simplify the drafting of legislation, regulation and guidance. Standards, like regulation, should be objectives based rather prescriptive so as not to hinder innovation or lock technologies in or out.

Hervé Quinquis, IFP Energies Nouvelles, then briefly introduced the work of the International Standards Organisation (ISO) technical committee which is developing standards for CCS. This was followed by a presentation from Sean McCoy, IEA, on CSA Z741-12 which was the first national standards developed for geologic storage of CO₂. The CSA Z741-12 served as a seed document for the ISO standard, and is being reviewed to ensure that it is representative of best practice internationally, appropriate for different regulatory environments, and is applicable to offshore storage as it originally only focused on onshore.

The session identified that it was being increasingly seen as best practice to develop standards which are objective based and not prescriptive. This message resonates with earlier discussions in the meetings around the importance of flexibility in regulations. In both cases, there is a danger that establishing prescriptive standards or regulations will hamper innovation. This flexibility is particularly crucial as CCS is a nascent technology which must embrace the significant technological advances and cost reductions likely to emerge in its early deployment.

There was also discussion around the treatment of standards within regulations, particularly as standards are periodically reviewed and updated. Regulations need to be clear on whether a reference to a standard is to that particular edition or to the most current update of the standard. Regulators need to ensure that regulations are up to date and reflect the best practice of the time, but also need to ensure they retain authority of regulation settings and don't provide other parties with *de facto* legislative authority.

Final remarks

As part of the final session, Juho Lipponen invited comments from those around the table on the meeting, ways it could be improved in future, and other activities of the regulatory network that could be helpful to attendees. One of the requests was for the IEA to investigate better dissemination of information from the meeting and Regulatory Network materials – something that is being actively considered. One of the interesting questions posed, but left unanswered, was how the lessons from development of regulatory frameworks and shared at the Regulatory

Network meetings could be brought together for countries that are working to develop regulatory frameworks.

Mr. Lipponen concluded that the meeting was a good platform for knowledge exchange, as well as to ensure improved understanding of current and future issues impacting regulation. It was particularly interesting to note the increased interest and activity by a number of emerging economies in analysing and developing CCS regulation

Annex 1: Meeting agenda

Table 1 • Agenda for the first day of the meeting, 27 May 2014

08:30	Registration	
09:00	Opening Session	
	Welcome and opening remarks	Philippe Benoit, Energy Efficiency & Environment Division, IEA
	Scene setting for meeting	Sean McCoy, CCS Unit, IEA
09:30	Session 1: Developing regulatory frameworks	Chair: Nigel Bankes, University of Calgary, Canada
	New Zealand	Barry Barton, The University of Waikato, New Zealand
	Indonesia	F.X. Sutijastoto, Ministry of Energy and Mineral Resources, Indonesia
	GCC Countries	I-Tsung Tsai, Masdar Institute, United Arab Emirates
10:30	Coffee	
	South Africa	Muzi Mkhize, Department of Energy, South Africa
	Japan	Ryozo Tanaka, RITE, Japan
	Botswana	Oarabile Seiphemo, Department of Geological Survey, Botswana
12:00	Lunch	
13:00	Session 2: European developments	Chair: Navraj Singh Ghaleigh, Edinburgh Law School, United Kingdom
	Norway	Mette Agerup, Ministry of Petroleum and Energy, Norway
	Poland	Adam Wójcicki, Polish Geological Survey, Poland
	Germany	Almut Fischer, Federal Ministry for Economic Affairs and Energy, Germany
	Upcoming Review of the EU Directive	Beatrice Coda, European Commission
14:30	Coffee	
15:00	Session 3: Developments in North America	Chair: Wendy B. Jacobs, Harvard Law School
	US Federal environmental regulations for geologic storage	Bob van Voorhees, Carbon Sequestration Council, United States
	Regulating the US DOE RCSP projects	Jarad Daniels, United States Department of Energy
	Canadian federal and select provincial developments	Kathryn Gagnon, Natural Resources Canada
	Alberta	Rob Bioletti, Alberta Energy
17:00	Closing remarks	
19:30	Dinner	

Table 2 • Agenda for the second day of the meeting, 28 May 2014

09:00	Session 4: Trends, challenges and next steps in	Chair: Ian Havercroft, GCCSI
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	CCS regulation	
	Panel discussion	Nigel Bankes, University of Calgary, Canada Barry Barton, The University of Waikato, New Zealand Navraj Singh Ghaleigh, Edinburgh Law School, United Kingdom Wendy B. Jacobs, Harvard Law School, United States
10:10	Coffee	
10:40	Session 5: Emerging findings from research that may impact regulation of geologic storage	Chair: Tim Dixon, IEAGHG
	Soil gas monitoring techniques and implications for MMV plans	Katherine Romanak, University of Texas at Austin, United States
	Offshore monitoring for geologic storage	Douglas Connelly, National Oceanography Centre, United Kingdom
	Risk management and best practice for CO ₂ storage site closure – key messages from the CO ₂ CARE project	Jens Wollenweber, TNO, Netherlands
	Reducing risk and uncertainty through modelling	Grant S. Bromhal, National Energy Technology Laboratory, United States
12:30	Lunch	
13:30	Session 6: The relationship between standards and regulation	Chair: Barry Barton, The University of Waikato, New Zealand
	The role of international standards in harmonizing environmental performance	Céline Kauffmann, Organization for Economic Cooperation and Development
	How does industry use standards?	Denis Deutsch, TOTAL, France
	ISO TC 265 Process and update	Hervé Quinquis, IFP Energies nouvelles, France
	What does CSA 741-12 say about geological storage?	Sean McCoy, IEA
15:30	Closing Session: Trends, challenges and next steps	
	IEA CCS Law and Regulation Database	Sean McCoy, IEA
	How can the network help you?	Juho Lipponen, IEA
16:00	Close	

References

Barton, B., K. Jordan and G. Severinsen (2013), *Carbon Capture and Storage: Designing the Legal and Regulatory Framework for New Zealand*, Centre for Environmental, Resources and Energy Law, Hamilton

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