Challenges to Commercial Scale Carbon Capture and Storage: Regulatory Framework

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Abstract

Carbon Capture and Storage (CCS) can play a unique and critical role in climate change mitigation strategies over the coming decades. In order to put CCS on the path to deliver on its promises to reach large-scale CO_2 emissions reductions, a workable legal and regulatory framework is essential. The regulations must be stringent enough to ensure that geological storage of CO_2 is both safe and effective, and at the same time do not restrain the demonstration and deployment of CCS.

A variety of approaches are being considered in countries that have CCS activities. Yet the current legal frameworks are often unclear, primarily because most were not originally drafted for CCS, and there are numerous gaps and overlapping legal issues that that could prevent CCS projects taking place.

This paper provides an up-to-date examination of a number of key existing legal and regulatory aspects with regard to CCS. Rather than focusing on general climate change regulations, the paper targets project-specific regulation and legislation in Europe, Australia and North America that covers property rights, the permitting process, financial assurances, and long-term liability related to CO_2 storage. We conclude that actions towards the construction of a workable set of regulations should be prioritized now in order to pave the way for the efficient global implementation of CCS once climate policy moves forward.

1. Introduction

Given the magnitude of the energy-related CO_2 emissions as the world's energy systems keep up with ever-growing energy demand, the role of Carbon Capture and Storage (CCS) technologies will become critically important. In order to have a significant impact on climate change mitigation and to dramatically reduce CO_2 emissions, CCS would need to operate at the billion ton (Gt) per year level. This implies that CCS will need to be demonstrated and broadly implemented in the next decades at fossil fuel power plants and industrial facilities (Herzog, 2011; CSLF, 2011; IEA, 2013; Nykvist, 2013; GCCSI, 2014). Today it is fair to say that CCS is still in an early phase of development, with a number of pilot and demonstration plants up and running, but it is not sufficiently mature to be considered a competitive abatement technology at the present time. Many reasons have been put forward to explain the present state of CCS (Krahe, 2013; Lupion, 2013; Davies, 2013). The inadequacy of policies supporting CCS and the lack of a business model that promotes private investment are key reasons. While other low-carbon technologies such as renewable energy have received sufficient attention to allow their development and deployment, CCS promotion has depended upon policy programs that failed to effectively provide financial mechanisms to ensure delivery.

Progress has been made over the last decade in terms of the construction of the legal and regulatory framework necessary to make CCS a reality. Nevertheless, it has been a slow process and not always satisfactory to industry. It is particularly important to define the regulations stringently enough to adequately address health, safety, and environmental concerns, but not so stringently that they stifle the growth of CCS.

There are two categories of legal and regulatory issues associated with CCS. First, there is general climate change regulations that include emissions reduction goals and incentives to award credit for avoided emissions. Having sound climate change regulations in place is essential to create the necessary market for CCS to be implemented. Examples of this type of legislation are found in Europe, where CCS was included in the scope of the revised *Emissions Trading System (ETS) Directive* in order to provide complementary financing. The financial support for CCS demonstration via EEPR[1] and NER300[2] programmes, and the existence of the EU carbon market gave expectations of the construction and operation of CCS at up to 12 power and industrial plants in Europe by 2015. Despite its efforts, the EU will not achieve this goal. A major reason is the collapse of the carbon price under the EU Emission Trading System Directive, resulting in prices for CO_2 allowances an order of magnitude below the assessment for the Climate and Energy Package in 2008, which projected prices in the order of 30€/tCO_2 by 2020.

In the US, major climate bills were introduced, including The *2003 Climate Stewardship Act*, The *Global Warming Pollution Reduction Act of 2007* and The *American Clean Energy and Security Act of 2009*. While the US Congress has failed to pass any of these bills and chances for climate legislation before the next Presidential elections in 2016 are essentially zero, there has been administrative action. In 2010, the US Environmental Protection Agency (EPA) released a mandatory requirement for the reporting of greenhouse gases, including CO_2 injections and emissions. In September 2013, the EPA released a draft rule to restrict CO_2 emissions from new power plants. Draft regulations for CO_2 reductions from existing power plants were released in June 2014. However, none of these actions will create any significant markets for CCS (Clark, 2014).

The second category of regulations, and focus of this paper, is the set of regulations applied to CCS facilities to ensure that operations are safe and effective in transporting, injecting and retaining the captured CO_2. If these legal and regulatory issues are not addressed well, they could present a significant hurdle for CCS projects. In addition, the regulatory framework influences stakeholder engagement towards CCS, recognized as a significant component of the CCS system.

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[1] European Energy Programme for Recovery

[2] New Entrants Reserve of the EU Emissions Trading Scheme Programme

This paper investigates the critical legal and regulatory issues of CO_2 storage. While the status of the regulatory development varies among jurisdictions, the discussion revolves around the same common issues of permitting, the long-term liability and property rights. The paper analyzes, in the context of regulatory gaps and barriers encountered, the actions taken to date and the insights gathered from a review of CCS projects that have undergone or are going through a regulatory approval process.

2. CCS legal and regulatory framework

Most OECD[3] countries are taking steps to review and adjust their legal frameworks to incorporate CCS (IEA, 2012). The starting point is often defined by the history of the country and business needs. Countries that have a history of oil and gas exploration have regulations on underground utilization that can be adapted to meet the need of geological storage of CO_2. Yet there are aspects which remain uncertain, primarily because most they were not originally drafted for CCS, and there are numerous gaps and overlapping legal issues that could prevent the expansion of CCS projects.

For this study, a review of project-specific regulation and legislation in Europe, Australia and North America has been undertaken. The main focus is demonstration and commercial scale projects, which are facing a more complex regulatory process than small scale projects.

2.1 European CCS legislation

The European Commission launched in 2009 the *Directive on the geological storage of carbon dioxide*, which aimed to establish the legal framework for the environmentally safe geological storage of CO_2 (EC, 2009). To be applicable, the CCS Directive needs to be transposed into national law in the different Member States (MS). The speed with which the CCS Directive was transposed into national laws depended on different national conditions, but did not correlate with national CCS policies, financial situations or storage capacities. By 2012, most of European MS with CCS projects underway had implemented the Directive (EC, 2012a).

However, a clear candidate to host CCS demonstration projects like Germany failed to fully transpose the European Directive before the EC deadline. In July 2011, Germany's lower house approved a bill allowing the underground storage of CO_2 but it was rejected by the upper house on September 2011. This caused Vattenfall to abandon its CCS demonstration project in Jaenschwalde, Brandenburg, and stop the planned €1.5 billion investment (Vattenfall, 2011). The project had been awarded with €180 million from the EEPR and submitted an application for the European NER300 funding programme.

[3] Organisation for Economic Co-operation and Development

Although the delays with the transposition of the CCS Directive caused problems for some European CCS demonstration projects, it is the content of the Directive itself that creates uncertainties primarily regarding liabilities and risks for early project operators. The Directive gives a general regulatory framework and introduces several key elements such as a monitoring plan, financial security provisions, long-term liability and financial mechanisms. Yet it only gives a high-level description of these elements; the interpretation of these is up to the Member States. Insufficient detailed information in some technical areas of the regulations such as criteria for the composition of the CO_2 stream and storage site monitoring requirements are also issues of concern.

Another important issue is the role to play by National policies in Member States. The situation in the UK is one of the most promising in Europe considering national policy programs and other ongoing actions towards CCS. However, only offshore storage is likely to be permitted; the same situation applies in the Netherlands. Three countries have prohibited or are planning to prohibit CO_2 storage permanently in their territory except for research purposes (Estonia, Ireland and Finland), while others took measures to prohibit CO_2 storage temporarily (Austria, Czech Republic, Latvia, Poland and Sweden). Belgium, Greece and Italy do not permit storage in selected areas, and Bulgaria limits the amount of permitted CO_2 storage. Denmark banned onshore storage until 2020, which led to the abandonment of its onshore demonstration projects.

Table 1 summarizes the overall state of the CO_2 storage activities in European countries. Categories are defined taking into consideration the status of the transposition of the EU Directive, national CCS act in place permitting or prohibiting CO_2 storage, ongoing pilot and demo projects (CGS Europe, 2013).

Table 1. Classification of European countries according to their overall achievements regarding CO_2 storage (from CGS Europe, 2013)

Category	Countries
Advanced	Norway, Italy, United Kingdom, France, The Netherlands
Progressing	Germany, Spain, Poland, Romania
Emerging	Hungary, Portugal, Slovakia, Lithuania, Greece, Bulgaria, Croatia, Belgium, Turkey
Rejecting	Finland, Serbia, Denmark, Slovenia, Sweden, Czech Republic, Ireland, Austria, Latvia, Estonia

2.2 North American CCS legislation

At present, the US Federal Government has addressed the permitting of underground injection of CO_2 through the Environmental Protection Agency (EPA). The EPA's Underground Injection Control (UIC) is primarily concerned with the protection of Underground Sources of Drinking Water (USDW) and has designated all subsurface injection to be permitted through one of the six categories or "classes".

In September 2011, the EPA established the most recent well class, the UIC Class VI well, which is specifically for the underground injection of CO_2 (EPA, 2011a). CO_2-EOR (Enhance Oil Recovery) projects will still be permitted through a UIC Class II well that is designed for oil and gas injection activities. However, if they want to claim CO_2 storage, they will need to convert to a Class VI permit. Class VI well permits have a much more stringent requirements than Class II wells, including a contentious 50-year long-term post closure liability period. Since the establishment of Class VI well permits, the EPA is firm that all large-scale non-EOR CCS injection projects need to obtain a Class VI well permit.

Complimentary to the UIC are Subpart RR and Subpart UU of the EPA's Greenhouse Gas Reporting Program. These subparts require the annual reporting of all CO_2 volumes from sequestration sites, including received, injected and emitted CO_2. Subpart RR is only for reporting CO_2 volumes from geologic sequestration sites and Class VI wells. Subpart UU is for all other facilities that inject CO_2 underground including EOR projects (EPA, 2010). These Subparts came into law in September 2012 and they provide the EPA with necessary data on current CO_2 volumes that are sequestered in the US.

On March 4 2014, an amendment came into law to the *Resource Conservation and Recovery Act (RCRA)* to conditionally exclude CO_2 streams as a hazardous waste if they are captured and injected into the ground under the UIC Class VI well for geologic storage (EPA, 2014a). Although this development decreases some regulatory uncertainty, it is a small step in a regulatory environment where there are still a lot of unknowns. Gaps in areas such as pore space ownership and long-term liability are still unsettled.

A number of these issues have been tackled by individual states. Nine states have addressed some of the specific legal requirements needed to implement a CCS project (Table 2). North Dakota, Wyoming and Montana have passed several bills and have given potential CCS project operators good guidance as to how to operate CCS projects in their State. Other States have passed rudimentary rules on only a few of the important topics needed (Javedan, 2013). Another important factor regarding CCS project legislation at state level is the existence of a CO_2 storage fund. Six states had passed legislation for the establishment of funds for the long-term management and monitoring of the CCS sites. The money may come from a variety of fees: project application fees, well permitting fees, annual well operating fees, well closure fee and if assigned, the amount per metric ton of CO_2 injected (Aldrich, 2011).

Table 2. Summary of US State legislation and topics covered

Category	Liability	Storage fund	Pore space owner	CO_2 owner	Uniti-zation	Mineral Rights vs. CCS	Inter-state
Montana	X	X	X	X	X	X	
Wyoming		X	X	X	X	X	
North Dakota	X	X	X	X	X		
Oklahoma				X		X	
Kansas	X	X					
Illinois	X						
Louisiana	X	X		X			
Texas (onshore)		X		X		X	
Texas (offshore)	X	X					
West Virginia						X	X

Similar to the US, Canada has decades of experience from its operations in the oil and gas sector which form a solid foundation for regulation of CCS projects. Canada also announced a CO_2 emission performance standard at the federal level. This stringent performance standard is to come into effect on 1 July 2015 to new coal-fired units as well as units reaching the end of their economic life (GC, 2012). Units must not emit more than 420t/GWh on average during a calendar year, which is comparable to high-efficiency natural gas combined cycle unit. Units that incorporate CCS could receive a temporary exemption from the standard until 2025 (IEA, 2012).

The provinces of Alberta, Saskatchewan and British Columbia are at the forefront of CCS developments in terms of demonstration projects and regulatory framework. Relevant legal issues such as resource ownership, management and royalties, land use and regulation on exploration, development, conservation and use of natural resources fall under provincial jurisdiction while responsibilities for environmental protection are shared between the federal and provincial governments.

Several CO_2-EOR operations are active in Alberta and Saskatchewan. Saskatchewan started CCS activities in the early 1980's with a Shell proposal to undertake a small CO2-EOR pilot project. Existing regulatory tools for oil and gas operations were applied. This starting point has influenced Saskatchewan's approach to regulation of subsurface injection of CO2 ever since. In addition, there are regulations in place for gas disposal in deep saline aquifers and depleted hydrocarbon reservoir in Alberta and British Columbia. There is extensive operational experience with the separation, capture, transportation and injection of these gases and, more importantly, a regulatory framework dealing with the permitting, operation and abandonment of these operations already exists (Odeh, 2009; Gagnon, 2014).

The *Alberta Climate Change and Emissions Management Amendment Act* came into force in 2007 and provides for a cap-and-trade scheme applicable to all emitters of more than 100,000 tCO_2 annually. Alberta also introduced *The Carbon Capture and Storage Statutes Amendment Act (Bill 24)* to address some significant barriers to deploying CCS, which passed into law in December 2010. In March 2011, it launched the CCS Regulatory Framework Assessment (RFA) to identify and develop recommendations for regulatory enhancements in response to Alberta’s $1.3 billion investment in two commercial-scale CCS projects in the province. The RFA presented its recommendations by the end of 2012, and identified gaps and issues related to the regulatory frameworks (GA, 2012). Other Canadian provinces which have introduced regulations on CCS are British Columbia and Saskatchewan. These are also based on the existing regulations in the oil and gas sector (IEA, 2014).

2.3 Australian CCS legislation

Over the last decade, Australian Commonwealth and State governments have made significant progress in the development of CCS regulatory framework. The *Regulatory Guiding Principles for Carbon Dioxide Capture and Geological Storage*, endorsed in 2005, served to highlight key considerations of CCS regulatory regime such as access and property rights, post-closure responsibilities and financial issues (MCMPR, 2005).

The legislative model is based on the *Offshore Petroleum Act 2006* under which the federal government has responsibility for jurisdiction of the Commonwealth waters (i.e. .beyond the 12 mile limit). The *Offshore Petroleum Amendments Greenhouse Gas Storage Act 2008 (OPGGS)* introduces modifications to accommodate GHG storage offshore. Greenhouse Gas specific regulations are included in the *Offshore Petroleum and Greenhouse Gas Storage (Greenhouse Gas Injection and Storage) Regulations 2011*, which came into force in June 2011. The Federal Government has CCS legislation but only for offshore. Onshore areas and coastal waters legislative and regulatory systems is a matter for each state and territory (ComLaw, 2006; ComLaw, 2011; IEA, 2012).

Victoria, Queensland and Western Australia states, hosting CarbonNet and Otway, Callide, and Gorgon projects respectively, are developing their own legislative and regulatory framework in both onshore and offshore areas - up to the jurisdictional boundary with the Commonwealth of Australia. Offshore regulations mirror the Commonwealth’s offshore CCS regulations but differ in some aspects such as the transfer of liability.

In terms of projects, Otway was initiated under Victorian EPA R&D legislation and was excluded from the broader CCS legislation because it was small scale. It was regulated under the research, development and demonstration approval provisions of the *Environment Protection Act 1970* (Ranasinghe, 2014). In Western Australia the Gorgon project was covered by the *Barrow Island Act 2003*, enacted specifically for the project for permitting procedures for CO_2 storage.

3. Key CCS regulatory challenges

There are several critical regulatory challenges facing CCS projects that are common to all regions. These are discussed below.

3.1 CO_2 Storage permitting process

The European CCS Directive states that storage sites should not be operated without a storage permit that ensures that the requirements of the Directive are met and that the storage takes place in an environmentally safe way. The ROAD project in the Netherlands filed the storage permit application in 2010. The EU Directive was implemented in the Dutch legislation in its original format without any amendment adding national provisions. After two years of a difficult process, especially because of the permitting obligations and lack of sufficient clarity in the Guidance Documents for the implementation of the Directive, the EC concluded that the application confirms the suitability of the CO_2 storage location chosen (EC, 2012b; ROAD, 2013).

However, the project still does not have the final storage permit. The ROAD project could not submit all the required plans fully developed at the moment of the permit application. The Directive requires all the final plans to be submitted with the application, but the normal practice is that this type of information would only be completed after a final investment decision on the project is taken, which requires a granted storage permit. The Dutch Government committed then to ensure that the remarks made by the European Commission are further elaborated in due course. It was agreed that the final plans will be submitted one year before the injection of CO_2 starts by 2015 (EC, 2012a) (ROAD, 2013). No other storage permit has been submitted for review to the European Commission, showing the difficulties that project developers are facing.

Norway, with experience since 1996 in storing CO_2 in geological formations, has taken action independently to address the regulatory challenges of CCS. Norway did not have dedicated CCS legislation on permitting Sleipner and Snøhvit projects. Regulations were based on the *Petroleum Act of 29 November 1996 nr.72*, which is very different from the regulations defined by the EU Directive. Norway successful experiences in CO_2 storage demonstrate that the permitting process substantially depends on the close cooperation between project developers and national competent authorities. In the US, any CCS project requires a Class VI well permit to inject CO_2 into the subsurface. EPA is the Implementing Authority for Class VI as of September 2011. At time of publication there are only two projects which have applications pending for a Class VI well permit from 2011 and 2013. These are the Archer Daniels Midland's Industrial Sources (Decatur project) and FutureGen 2.0 projects respectively. Tenaska Taylorville had previously applied for a well permit; however, during the lengthy permitting process, Tenaska announced that it was cancelling this project as it was no longer economically viable (Van Voorhees, 2013; MIT, 2013). In April 2014, the EPA awarded five draft Class VI well permits to FutureGen 2.0 (4 wells) and the Decatur project (1 well). EPA accepted comments from the public on the draft permits thorough May 15 (EPA, 2014b). On September 2 2014, EPA approved permits allowing the FutureGen Industrial Alliance Inc. to inject carbon dioxide deep underground near Jacksonville, Illinois.

3.2 CO_2-EOR and CCS

CO_2-EOR activity has continually expanded in North America since first being undertaken in the 1970's. As operations at natural CO_2 sources have reached full capacity, interest in using anthropogenic CO_2 has increased. Currently CO_2 is valued at around USD 20-30/t.

In the absence of strong national policy tools such as cap-and-trade system applied to GHG emissions, or other incentive mechanisms to encourage CCS investment, potential revenue derived from CO_2-EOR is being viewed as a possible pathway to maintain North America's progress and build a business case for demonstration projects. The three power demonstration projects which have taken final investment decision and commenced construction have contracts to sell the captured CO_2 for EOR purposes. These are the Kemper County IGCC project in Mississippi (US), NRG's Parish Plant in Texas (US), and Boundary Dam in Saskatchewan (Canada).

The legal framework for CO_2-EOR has a long trajectory and is now well established. However, while CO_2-EOR and CCS might share common aspects, the legal and regulatory frameworks are in essence quite different. The CO_2-EOR operation aims to maximize the production of oil in a commercially - based premise and it is primarily regulated by oil and gas laws. CO_2 is a commodity that may be injected, extracted and re-used multiple times. In contrast, the CCS operation presupposes the permanent storage of CO_2, with the aim at reducing the impact of CO_2 emissions on the environment.

In the US, there are currently multiple states with oil and gas operations that have EPA Class II well primacy to operate CO_2-EOR. Only North Dakota state has applied for Class VI injection primacy, which would allow geological storage of CO_2. A Class II well permit can be re-permitted into a Class VI well permit when the primary purpose of CO_2 injection changes from EOR to long term storage. According to EPA, the Class II aquifer exemptions may be expanded into the Class VI well but only if the operators can prove that the aquifer does not serve as a source of drinking water or may in the future and/or that there is a high concentration of dissolved solids (EPA, 2014c). However, given the lack of a policy driver, EOR operators currently have no interest in getting Class VI permits. Furthermore, EOR-operators have become very wary of Class VI permits because of their more stringent requirements compared to Class II and the long processing time of Class VI permits to date (CO2conference, 2011).

In Europe, the potential for CO_2-EOR is markedly different from that in North America. Europe's oil fields are mainly located offshore adding technical complexity and expenses to a project. However, examples like the North Sea indicate that CO_2-EOR might prove commercially viable. The Don Valley project (UK) combines geological storage of CO_2 and CO_2-EOR for additional revenues in the North Sea. The project represents a rather different approach to EOR than has been seen in places such as the US thus far. Rather than maximizing the oil production efficiency of each tonne of CO_2, which leads to storage of the lowest possible amount of CO_2, the primary objective of the project is to store a given volume of CO_2. Nevertheless, the Don Valley project failed to secure both UK Government funding and European NER300 funds. The reliance on revenues from CO_2-EOR was viewed as increasing the project risk (Scott, 2013).

3.3 Liability and financial securities

Uncertainties with regard to the long-term liability and financial securities required in most of the existing CCS legislation might become a critical obstacle for the development of CCS projects. In Europe, project developers in various MS have reported difficulties in understanding the extent and provisions of transfer of responsibility of CO_2 storage sites as defined in the EU Directive.

This is a key challenge identified by the ROAD project (Jonker, 2013; Lako, 2011). There is no certainty on the period after abandonment before the responsibility for the storage site can be shifted from the operator to the competent authority. According to the EU Directive, the post-closure pre-transfer phase should be at least 20 years, but national competent authorities are allowed to reduce the period if assured that the stored CO_2 will be *completely and permanently contained* before. On the other hand, if national liability regulations are very strict, longer periods before the transfer of responsibility can be shifted, dramatically increasing cost uncertainty and making the decision-making analysis more difficult. In addition, it is not clear when and how to prove that the stored CO_2 will be completely and permanently contained and who would assess it. In theory, the transfer could be postponed indefinitely. With the transfer of responsibility over the storage site, the liabilities are also transferred to the competent authority. The national liability system in the Netherlands distinguishes different grounds for liability, each of which has specific liability horizon, different compensation in case of damage and possible defenses for the liable party. It is not indicated which specific liability would apply to CCS. This undermines the certainty of the project and therefore functions as an obstacle to the viability of the project (ROAD, 2013).

Another important aspect identified is the financial security required by the EC Directive before commencement of injection. The operator needs to prove that it is able to finance the storage operation, the closure and the post-closure corrective measures. The CCS Directive and Guidance Documents describe financial instruments that can be used to provide the security requested. However, it is not clearly defined which activities must be included in the financial security, which instruments would be acceptable for the competent authority at the time of the injection and how to estimate the cost of an adequate level of financial security. Provisions related to liabilities linked to the EU Emission Trading System Directive (ETS) can impose large financial burdens on projects. Questions arose by ROAD included the calculation method for the estimation of EU Allowances (EUAs) in case of leakage. Since the allowances must be handed over in the year that the leakage occurs, the price will likely be higher than today but there is unavoidable uncertainty about the future price. The extended period of liability therefore increases the risk of high costs.

In the US, prior to the release of the EPA Class VI well permits, six States had addressed the issue of long-term liability and transfer of site ownership to the state post-injection. There was a range of years for long term post closure liability: Kansas would never assume liability of the CCS site, Illinois (for FutureGen 2.0 project only) and Texas offshore would assume liability on site closure and Montana would accept liability after a 30 year post injection site monitoring period.

The EPA passed guidance in the Class VI well Guidance Documents to ensure financial responsibility of the operator to the project. Although these documents do not outline specifics like the cost per ton of CO_2 injected and the permit price per well, it does cover detailed financial requirements which the operators need to undertake prior, during and post operation of the CCS injection project (EPA, 2011b). But there are still many issues regarding the Class VI well that affect the progress of CCS demonstration projects such as the requirement for 50 year post injection site monitoring, the need for the robust and detailed site modeling, and the demonstration of financial responsibility every 6 years. As EPA only recently awarded draft Class VI well permits, it is difficult to comment on the effect that these detailed financial and other requirements would have on projects. However, industry groups and other stakeholders have warned the EPA that these complicated requirements could undermine their efforts to adopt CCS technologies.

In Australia, the original bill for the Commonwealth offshore regulatory framework was amended to incorporate provisions on a transfer of long-term liability. Compared to the European CCS Directive, the OPGGS Act is less troubling in terms of requirements before there can be a transfer of liability. Critical aspects related to the European Directive such as the long and uncertain closure period prior to a transfer of liability or the financial contribution required are more favorable for CCS operators. Under the OPGGS Act, the Commonwealth takes over monitoring operations from site closure onwards, and is entitled to the costs of long-term monitoring of the storage formation. At the state level, Victoria and Queensland's Offshore Acts largely adopt the main requirements of the OPGGS Act. Following decommissioning, the well is transferred to the state and the injected greenhouse gas substance becomes the property of the Crown. However, it is not specified yet what responsibilities or liabilities are transferred. No civil liabilities are transferred, and therefore the operator will still remain liable for potential claims arising from the GHG operations. As in Canadian legislation, any liability of the Crown in respect of a leakage occurring and causing damage after surrender has taken place would depend on some degree of negligence being proved. Future responsibilities under environmental laws are presumed to be transferred, although are not specified (Havercroft, 2014).

In the case of Western Australia, as previously mentioned, there is a project-specific piece of legislation introduced to regulate the Gorgon CO_2 injection Project (Barrow Island, 2003). The Barrow Island Act also restricted the project proponent (Chevron Australia) to a 300 hectare project site. However, it does not expressly provide for the transfer of liability from the operators, and therefore it had to be negotiated with both the Federal and the Western Australian governments. Agreement was subsequently reached for transferring the liability at the end of the project life after a certain period of time showing that the CO_2 is behaving as predicted. Western Australia and Canberra shared the liability.

3.4 Property rights

Property rights at a storage site are an essential legal aspect of any CCS operations. The definition of who owns the necessary surface and subsurface rights and how they can be transferred over the lifetime of a CCS project has direct implications to the liability of CCS projects. In most regulatory frameworks, liability for CO_2 during the injection phase of a project generally lies with the operator, and it is transferred to a public body after closure. Mineral rights and water rights are of particular interest given the analogy between oil and gas operations and CO_2 storage activities, and the potential for CO_2 underground storage in saline formations.

In this context, pore space ownership related to CCS is not clearly articulated in some jurisdictions, resulting in uncertainty for permitting CO_2 storage operations. In some cases such as the European Union or the Canadian Province of Alberta or in Australia, the ownership of pore space is vested in the State/provincial Crown. This provides the most certainty for CCS operators since they would deal with a single owner. However, there are still questions such as priority of use that require regulatory approvals from the provincial government (GCCSI, 2013).

In British Columbia, the legislative framework for CO_2 storage rights are based on the framework for natural gas storage rights, under which it is unclear whether such rights may be owned by the surface owner or the mineral rights owner. In order to solve this uncertainty, British Columbia has created a procedure for vesting storage rights in the Crown, subject to the payment of compensation. The provincial government is allowed to designate land as storage area, and may grant these storage rights to an operator. A private owner whose land has been designated as storage area may then apply to the province for compensation. The Saskatchewan situation presents the most risk to operators. While pore space associated with Crown minerals is vested in the Crown, pore space ownership where the mineral interest is privately held is less clear. Mineral owners have the right to inject CO_2 for EOR purposes, which implies the right to use pore space for any incidental CO_2 storage that occurs in the course of EOR operations. However, legislation is silent on whether this right would extend to CO_2 permanent storage projects or if the pore space ownership would be vested in the Crown or a private owner depending on the background mineral ownership (Bankes, 2009; GCCSI, 2013).

Nevertheless, even though the State or the Crown own pore space, it cannot force public acceptance of CCS activities. The perceived absence of a clear regulatory framework might raise public concerns over the safety of a CO_2 storage project. The cancellation of the Barendrecht project in The Netherlands is an example of how lack of a good regulatory framework impacted communication and outreach. The CO_2 storage project in Barendrecht was included in the Dutch National Coordination Regulation (NCR). This meant that it was considered as a project with national impact and so the national government could grant all permissions, including the ones related to the zoning plan that are normally awarded by the municipal government. With the municipal government seen as disempowered under the NRC, the municipality felt that the decision had been taken out of its hands, and that they did not have any legal possibilities or power left to oppose the project. Their opposition to the project increased, which caused delay in the project implementation and ultimately its cancellation (Feenstra, 2010).

In the US, private ownership of pore space is the norm. The landowners usually receive some kind of compensation for the pore space use. This seems to play a positive role in the context of public acceptance of CCS projects (Klaas, 2010). Yet all existing legislation in the US defines that mineral rights have primacy over CCS. Wyoming's legislation states that the existence of minerals in the subsurface takes precedence over the occurrence of pore space. Texas legislation defines that a CCS permit may only be issued if it is shown that CCS will not endanger or injure any oil, gas or other mineral formations. In Oklahoma, the Corporation Commission will determine if the chosen CCS site is suitable and if it will impact any existing mineral resources.

In relation to pore space ownership, only three States have passed legislation specifically addressing pore space ownership with respect to CCS (Table 2): Montana, Wyoming and North Dakota. All three states have defined that that the subsurface pore space is the property of the surface owner. Montana and Wyoming allow the transfer of pore space ownership as a separate property from the surface. North Dakota defines that the pore space belongs to the owner and that the title to the pore space may not be severed from the owners of the overlying property, although leasing is allowed. Six states have specifically addressed the ownership of CO_2 post injection: Montana, Wyoming, Texas onshore, Oklahoma, Louisiana and North Dakota. They all defined that the project operator is responsible and owns the CO_2 up to and until the liability is transferred to the state and at no time is the pore space owner responsible for the injected CO_2. Louisiana further defines that although the project operator has CO_2 ownership, it is possible to transfer the CO_2 ownership when the CO_2 is in the storage facility (Javedan, 2013).

3.5 Other legal factors

There are other regulatory challenges that remain open and directly affect the feasibility of specific CCS projects. These include, amongst others, CO_2 transportation, interboundary issues or access to the storage site by more than one operator, whether for injection activities or for monitoring.

Spain was the first MS that transposed the European CCS Directive in 2010. However, the later release of the four guidance documents of the Directive by March 2011 caused a delay in the process of implementing the CO_2 storage regulation. While the Compostilla project obtained exploration permits for two potential storage sites under the mining law prior to the transposition, a re-application for a storage license was necessary. The process has not finished yet. In addition, CO_2 transportation is not covered by the European Directive, and there is not a specific legislation in place in the Spanish jurisdiction, making the permitting process of CO_2 transport impossible at present.

Interboundary issues may play an increasingly complex issue when large volumes of CO_2 are injected into the subsurface and that plume begins migration into neighboring states or countries. Currently only West Virginia in the US has passed legislation that addresses the possibility of interstate interaction with regards to CO_2 storage. However West Virginia’s bill only allows cooperation with interstate agencies for the purpose of formulation and creation of interstate agreements. It does not begin to delineate all the issues associated with interstate CO_2 storage.

4. Conclusions

Deployment of CCS projects worldwide are facing many challenges, including financial issues, public acceptance and the establishment of regulatory frameworks. Different legal approaches are under development in most countries that have significant potential CO_2 storage resources and CCS activities. Despite the approach taken, it should be ensured that their regulatory framework is kept up to date with the accumulation of new knowledge regarding CCS. While progress is being made, examples of projects analyzed in Europe, North America and Australia show that the legal framework is still immature and often insufficient to assure a successful and effective permitting process. Even in the event of having some CCS regulatory framework in place, the storage permit process is long, more than 2 years in the cases examined in Europe and North America.

Critical common challenges that are facing CCS projects include long-term liability and financial responsibility, resulting in delays and difficulties moving forward. In this regard, early project developers can play a relevant role in helping with the construction of suitable frameworks. Lessons learnt may be applicable to the development of regulations for CCS in the corresponding jurisdictions and, more broadly, across jurisdictions.

The lack of a robust and comprehensive regulatory framework creates an environment of uncertainty that slows down the progress of CCS demonstration projects. Even though the current economic and policy situation is not favorable to launching large numbers of CCS projects, postponing the construction of the proper legal environment for CCS is not an effective strategy. Actions towards the construction of a workable set of regulations should be prioritized now, in order to pave the way for the efficient global implementation of CCS once climate policy moves forward.

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