



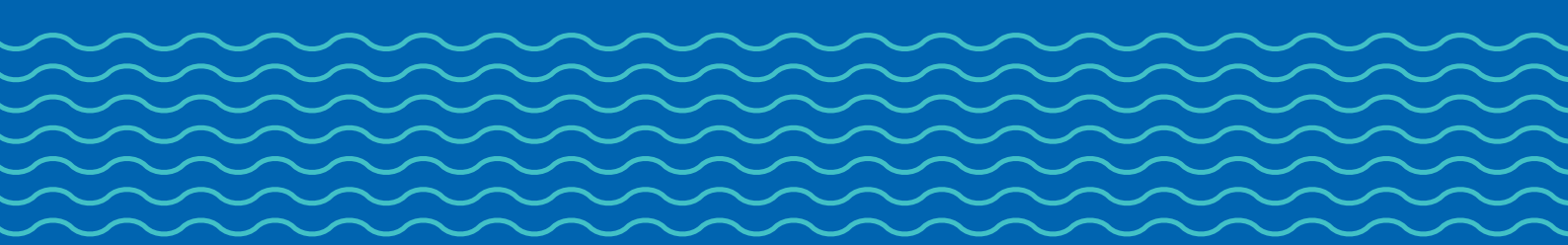
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2019 THOUGHT LEADERSHIP REPORT

LESSONS AND PERCEPTIONS: ADOPTING A COMMERCIAL APPROACH TO CCS LIABILITY

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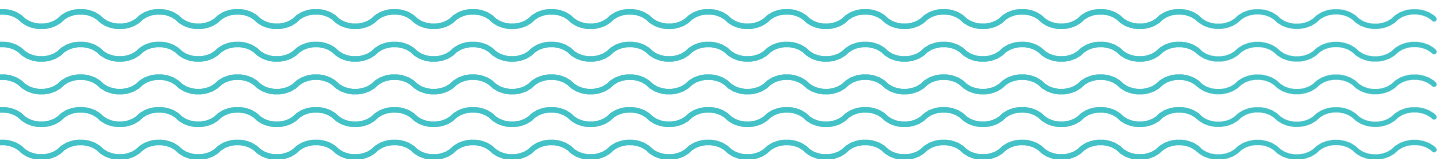
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KEY MESSAGES

1. Liability has long been raised as a significant barrier to the wide scale deployment of CCS.
2. Regulatory frameworks have been developed and adopted that address liability and other operator concerns, and to provide certainty for those seeking to invest in the technology's deployment. This has included the use of existing liability provisions, found in wider national and regional legislation, but also the development of innovative approaches to the management of operators' and regulators' risk exposure.
3. An assessment of the liability provisions within the early CCS-specific regulatory frameworks, reveals a wide range of CCS-specific models, which actively seek to address the various forms of liability throughout the project lifecycle. The development of these frameworks is largely complete, and, in some instances, their subsequent review has revealed them to be fit-for-purpose.
4. Project-level experience similarly confirms the suitability of these early liability models, citing overall, the positive impact that national frameworks have played in supporting project deployment. Interviews with project proponents and analysis of permitting experiences reveals many of the liabilities borne under CCS-specific models are both familiar and eminently manageable. The availability and benefits of transfer provisions in some jurisdictions, have proven particularly significant, with some proponents highlighting their beneficial impact upon project investment decisions.
5. In parallel with advances in the development of law and regulation and project-level experience, there have been significant improvements in the characterisation and quantification of the risks associated with the CCS process. Studies considering the magnitude of potential liabilities attaching to commercial operations, project and industry-level assessments of risk and insurability and greater confidence in the fate of stored CO₂, suggest the burden of liability is much less than predicted in early analysis.
6. Despite these regulatory developments, the topic of liability continues to be raised by some project developers, policy-makers and regulators as a critical issue in the deployment of carbon capture and storage.
7. The analysis undertaken in the compilation of this report, undertaken through policy and legislative review together with interviews conducted with policymakers, regulators, lawyers, project proponents and representatives from the insurance sector; reveals that greater effort be directed towards dispelling the widely-held view that liability is a potential 'showstopper' for the technology's deployment.

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8. To achieve this ambition, greater focus must be directed towards eliminating barriers and supporting deployment. Examples of the critical factors to be addressed include:
 - Closer examination and clarification of the types of liability borne by a CCS operation throughout the project lifecycle.
 - The unique challenges posed to both operators and regulators, of greenhouse emissions/ climate liabilities.
 - Consideration of the role of government and the private sector in allocating and managing risks across the CCS project lifecycle.
 - Further engagement of the insurance sector in the technical and regulatory debate, in order to allow them to develop effective and affordable products.
 9. The adoption of a more commercial approach to liability, the ultimate focus of this report, would see greater, collective review and engagement with the topic to address these outstanding issues. A renewed emphasis, which ultimately focuses upon their resolution will be crucial for those seeking to invest in or operate CCS projects. It is positive to note, as illustrated throughout this report, that there are many proposed solutions and examples upon which further action may be taken.

1.0 LIABILITY AND CARBON CAPTURE AND STORAGE

The capacity of pre-existing law and regulation to effectively address the perceived risks of carbon capture and storage (CCS), was addressed in several, early international studies and special reports that examined the role of the technology in future climate change mitigation strategies. Wide-ranging and highly-technical, these early analyses highlighted a host of factors that, absent their resolution in subsequent policy or legislation, would result in the creation of novel risks for those seeking to invest in or deploy the technology.

Several of these studies considered the impact of the liabilities, which would likely arise throughout the lifetime of CCS project. While many of these liabilities were likely to be broadly familiar to existing operators and regulators, several of the more novel elements of the CCS process were highlighted as posing particular risks and challenges. The conclusion in many instances, was that liability would remain a substantial barrier to investment and the widespread deployment of the technology.

Over the past ten years however, policymakers and regulators have sought to address these challenges, through the development of CCS-specific legal and regulatory regimes. While varied in scope and complexity, many of these new models establish regimes dedicated to regulating the more novel aspects of the CCS process and contain provisions aimed at limiting the impact of potential liabilities throughout the project lifecycle.

CCS-specific challenges

While many elements of the CCS process were considered well-understood and practised as part of existing oil and gas operations for many years, their application in the context of permanent geological storage was raised as a potential risk. Preliminary studies and academic analysis raised further areas of uncertainty surrounding CCS operations, principal among which were concerns regarding the security of the storage aspect of the CCS process. Limited information regarding global, regional and national storage capacity, the ability of formations to receive and retain CO₂ over the necessary timeframes and the impacts upon the environment and human health of sudden and large releases of CO₂ from a storage site, were all highlighted as potential risks (IPCC, 2005).

The timeframes associated with geologic storage were similarly highlighted by policymakers, regulators and project proponents as a challenge to the deployment of the technology. Notwithstanding the considerable experience garnered through analogous industries, including oil and gas operations or waste disposal activities, the temporal aspect of 'permanent' geological storage was viewed as a challenge which would likely outlast the traditional lifetime of a corporate entity. The need to safeguard the technology's position as a credible climate change mitigation response, as well as maintaining a high standard of protection for the environment and human health, required the consideration of novel policy and regulatory responses.

Experts determining the risk profile and examining the various liabilities attaching to CCS activities, as well as any accompanying financial responsibilities, similarly identified the challenges and limitations of both technical knowledge and for the extended timeframes associated with the CCS process (Trabucchi, 2008).

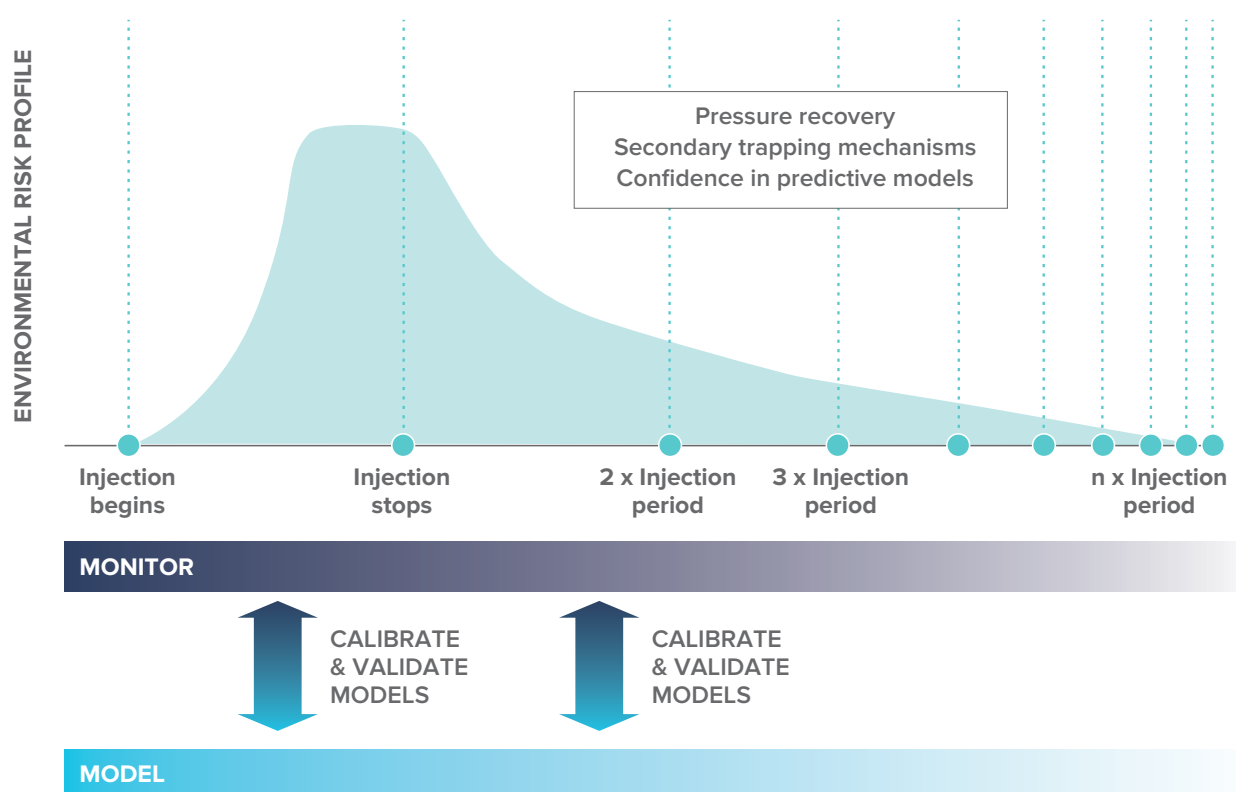
In many instances, analysis also confirmed that these novel challenges were to be considered additional to the more traditional risks typically borne by those undertaking oil and gas operations or major infrastructure projects. Wider risks to public and private interests, including the potential for damage to protected flora and fauna, water resources, other subsurface resources and human health, were all identified for CCS operations.

A further and perhaps more problematic issue concerned the ‘permanence’ of CO₂, when stored as a part of CCS operations, which was highlighted as a particular limitation under traditional risk and liability models. While several observers noted that an outright catastrophic failure of a storage site was highly unlikely, there was potential for financial exposure in instances where CO₂ leakage occurred under a carbon crediting scheme, as well as for wider impacts of this leakage upon the climate change mitigation objectives of the technology (Bode, 2004; Dooley, 2010). In many instances, it was observed that the options for mitigating these risks and consequential liabilities were limited and that solutions needed to be developed under new policy and regulatory models.

Early studies envisaged a CCS project lifecycle divided in to a series of distinct phases; site selection, injection, closure, post-closure and in some instances a transfer of responsibility phase. Scientific commentators have similarly proposed a discernible and widely-accepted risk profile, when considering these individual project phases. The model, a version of which is replicated in Figure 1 below, suggests the risk of leakage rises throughout a project’s injection phase, before reducing considerably as pressure in the storage site reaches its maximum when injection stops, and the site is closed. Some residual risks remain, however, following the cessation of injection and the closure of a storage site.

The lifecycle model presents distinct liability challenges, which are to be addressed when conceptualising and implementing a legal framework for the technology. It is significant to note therefore, that this lifecycle approach and risk allocation has been subsequently adopted and addressed in several of the early CCS-specific legal and regulatory models developed to-date.

Figure 1: Life-cycle risk profile for CO₂ Storage¹



¹ Model reproduced from Benson, S., Carbon Capture and Storage: Research Pathways, Progress and Potential, GCEP Annual Symposium, Stanford University, 2007.

Development of a legal and regulatory response to liability

In addition to assessing the legality of CCS operations and determining the ability of existing legal frameworks to regulate the CCS process, policymakers and regulators charged with developing policy and regulatory frameworks for the technology also focused upon the risks and liabilities attaching to CCS operations.

Central to the development of legal and regulatory frameworks was the CCS project lifecycle proposed in early studies and subsequently included in legal and regulatory analysis, discussion papers and regulatory guiding principles. A version of the CCS project lifecycle is included in Figure 2 below.

Of particular focus for policymakers and regulators globally, was the subsequent allocation of responsibilities for CCS operations and the stored CO₂ within this project lifecycle. The challenge of developing law and regulation was further complicated by the need to balance the societal interests of regulators, keen to ensure the process was comprehensively regulated, and those parties keen to invest in and deploy the technology. While the resulting CCS-specific legal and regulatory frameworks vary in their complexity and scope, several offer well-characterised and detailed liability provisions.

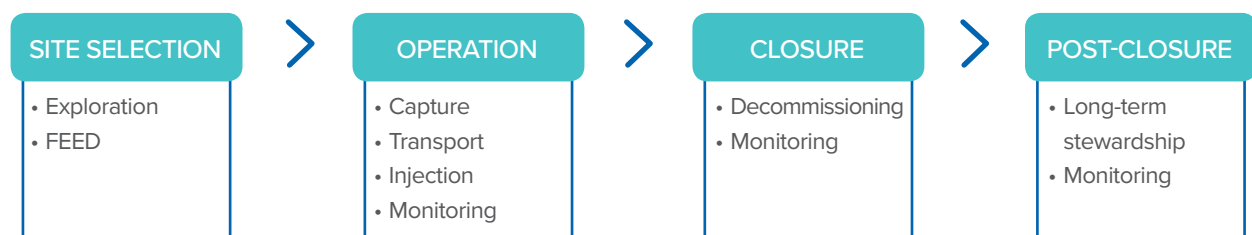
Amongst the first-mover jurisdictions that developed the earliest CCS-specific frameworks, many have adopted similar models and approaches to the management of liability throughout the project lifecycle. The storage aspect of the CCS process, however, with its notable complexities, resulted in the adoption of perhaps the most similar policies and regulatory frameworks in several jurisdictions globally.

Central to many of these CCS-specific regimes has been the development of a permitting or licensing model to regulate CCS activities, across part or the full project lifecycle. To date legislation has been developed at the national, regional and/or the State and Provincial level in the United States, Canada, Europe and Australia (Global CCS Institute, 2018). Within these jurisdictions specifically, several parallels may be drawn as to their treatment of liability, as regulators have sought to clearly allocate a wide range of potential liabilities between the operator and regulator throughout the project lifecycle. In some instances, this has been achieved through the design and implementation of new mechanisms, however in many occasions far broader obligations are likely to be borne by operators through the implicit application of a wider body of legislation and case law.

The International Energy Agency reviewed several of these early models and highlighted the following critical factors in the design of CCS-specific approaches to the management of liability (IEA, 2010):

- Establishing good site characterisation selection procedures, coupled with effective regulatory oversight.
- Establishing appropriate storage authorisation arrangements to ensure clear operational guidelines for operators.
- Imposing ongoing monitoring and reporting requirements.
- Imposing ongoing reporting and inspection of operations to ensure problems are identified and rectified early throughout the period of operator liability.
- Incorporating a structured and well-managed process for closure, post-closure and the transfer of responsibility, including regulatory oversight of closure methods.
- Incorporating a sensible system of cost recovery and use of financial security mechanisms for handling long-term cost implications, as considered appropriate within a jurisdiction.

Figure 2: CCS project lifecycle



The IEA's observations and recommendations largely reflect the approach adopted by many policymakers and regulators to-date.

RELIANCE UPON EXISTING MODELS

The use of existing liability provisions and models, to address individual aspects or the entirety of the CCS project lifecycle, is one approach that is common to these early regimes. In addition to the case law of national courts, regulators have also chosen to explicitly include CCS activities within the scope of existing legislation. The European Commission's CCS Directive (2009/31/EC), for example, amends both the existing EU Emissions Trading Directive (EU ETS) (2009/31/EC) and the Environmental Liability Directive (ELD) (2004/35/EC), to explicitly include CCS activities within their scope. The ELD requires environmental restoration and enables national regulators to impose obligations upon operators to undertake remedial or preventative measures, where damage has occurred or is threatened. The amendments effectively bring CCS activities within the scope of this Directive and applies its strict liability provisions to CCS operations, where damage to protected species and natural habitats, water, or land contamination creating a risk to human health risk has occurred or is threatened.

The CCS Directive's amendment of the EU ETS Directive removes CCS activities from the requirements of the latter Directive, where CO₂ is successfully captured, transported and permanently stored in geological formations. An operator will only therefore be required to account under the trading scheme, through the surrender of EU allowances (EUAs), where there are instances of CO₂ leakage.

ADDRESSING TITLE AND TENURE

Issues of tenure and title, notably the ownership of the pore space, have also proven critical considerations for regulators in some jurisdictions. Clarity as to property interests in a storage site, is essential for operators seeking to acquire the necessary surface and subsurface rights for injecting and storing CO₂ in a target geological formation. While in many jurisdictions the geology of the subsurface is owned by the State, in some jurisdictions ownership rights are far more complex. In the United States for example, subsurface ownership rights can vary from State to State, with different parties owning the pore space and mineral estates. Liability issues may therefore arise where the transboundary migration of injected CO₂ within the subsurface, impacts the interests of the owners of other estates (Jacobs, 2017).

In an attempt to resolve this issue, regulators in some jurisdictions have sought to explicitly address the ownership of the pore space and potential project interactions with mineral estates. In the Canadian Province of Alberta, for example, regulators have declared that ownership of the pore space is vested in the state.

FRONT-LOADING OF RISK

A common element of many CCS-specific legal and regulatory frameworks, is the inclusion of detailed requirements regarding site selection, monitoring and verification. These requirements comprise an important aspect of the initial project permitting process, but in many instances remain obligations throughout the lifetime of a storage operation. Taken together with the requirements for financial security, these obligations may be seen to effectively 'front-load' the risks associated with the technology to ensure that they are minimised in the latter stages of the project lifecycle.

From a regulatory and policy perspective the decision to 'front-load' legal and regulatory regimes, by placing considerable up-front requirements upon operators regarding site-selection and monitoring and verification, will also ensure government is adequately protected against any risks that may be transferred post-closure.

Monitoring and verification requirements are clearly therefore, a critical element of the liability regime in many jurisdictions. Effective monitoring and verification throughout the project lifecycle will be critical for ensuring that the behaviour of the CO₂ plume is in-line with predicted models and there is permanent containment of the injected CO₂. For those regimes which offer the opportunity to surrender and/or transfer an authority following the cessation of injection activities, monitoring and verification results will likely prove an important aspect in demonstrating compliance with the regulatory standards.

TRANSFER AND STEWARDSHIP

Concern surrounding the significant timeframes, intrinsic to the permanent geological storage of CO₂, was expressed by several parties during the design and development of many CCS-specific legal and regulatory regimes. Industry proponents were keen to ensure that project operators did not remain liable for storage operations in perpetuity, potentially beyond the lifetime of a traditional corporate entity. Regulators and the public, however, sought to ensure that the process was comprehensively regulated and that solutions afforded high-levels of protection to the environment and human health.

To address these challenges, several early legal and regulatory frameworks introduced provisions, which will enable the transfer of liability for a storage site or stored CO₂, from an operator to a state's competent authority. Examples of this approach have been implemented in frameworks in Canada, Australia and under the European Union's CCS Directive. The operation of these transfer provisions varies between jurisdictions, but all require the satisfaction of specific performance criteria before a transfer may be effected. In some instances, the completion of a post-closure time limit will also be necessary, prior to a proposed transfer.

FINANCIAL SECURITY

In addition to transfer provisions, several CCS-specific regimes include the requirement for operators to provide some form of financial security, aimed at addressing the various liabilities that an operator may incur over the long-term. While the approach adopted to financial security varies between jurisdictions, the underlining policy goal of reducing the exposure of the taxpayer and general government funds remains similar.

Table 1 provides an overview of the approach to liability, adopted in several CCS-specific legal and regulatory frameworks to-date.

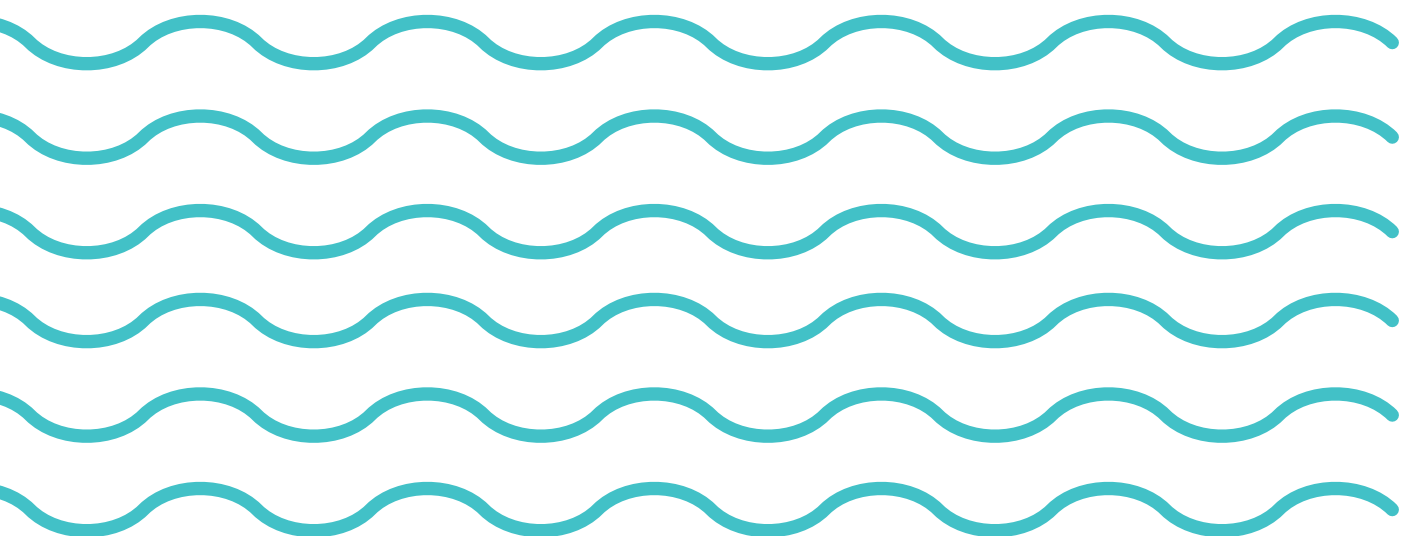


Table 1: Overview of liability provisions for CCS activities

	AUSTRALIA		CANADA		UNITED STATES		EUROPEAN UNION	
	Federal	States*	Federal	Provinces†	Federal	States**	Directive	Member States
Provision as to the ownership of the pore space, within CCS-specific legislation	✓ Commonwealth retains sovereignty over territorial sea, EEZ and continental shelf	✓ State owns onshore geological storage formations, reservoirs and resources	–	✓ Alberta only	✗	✓ Montana, North Dakota, Wyoming	✗	✓ Individual Member States to determine their approach to ownership
Liability to be borne by the operator during the operational phase	✓	✓	–	✓	✓	✓	✓	✓
MMV requirements	✓	✓	–	✓	✓	✓	✓	✓
Transfer of liability	✓	✓	–	✓ Alberta only	✗	✓ Montana, Texas, North Dakota	✓	✓
Conditions for Transfer	✓	✓	–	✓ Alberta only	✗	✓ Montana, Texas, North Dakota	✓	✓
Post-closure time limit for transfer	✓ 20 years	✓	–	✓ As per regulations in Alberta - no explicit statutory requirement regarding length of time yet	✗	✓ Between 10-15 years (North Dakota, Montana)	✓ Minimum of 20 years	✓
Scope of transfer	✓	✓✗ Common law liabilities arising from 3rd parties in Western Australia/ Only MMV costs in Victoria and Queensland	–	✓ In Alberta, climate change liabilities do not transfer to the state	✗	✓ All liabilities in North Dakota, Montana & Texas	✓ Only MMV costs	✓ In addition to MMV costs, individual states such as the UK have determined the scope of liabilities to be transferred
Financial security requirements	✓	✓	–	✓	✓	✓	✓	✓

* Commonwealth, Victoria, Queensland, Western Australia

† Alberta, British Columbia, Saskatchewan

** State examples provided are illustrative, not exhaustive.

What is meant by ‘liability’?

“Liability” is sometimes used without a clear definition of what is being meant by the term, and a review of the various CCS-specific legal regimes developed to-date, reveals three largely distinct forms of liability applicable to CCS operations (Havercroft, 2018). Liability may refer to civil liabilities where another party seeks compensation for damage caused by CCS operations, administrative liability where a CCS

operator may be subject to specific requirements imposed by a regulator, and Greenhouse emissions/ climate change liability where any subsequent leakage may require an operator to account for any credits previously gained for greenhouse gas storage.

Table 2 below provides a high-level overview of these different forms of liability.

Table 2: Forms of legal liability for CCS operations

CIVIL	<ul style="list-style-type: none"> • May be owed by an operator where CCS activities harm the interests of third parties, with whom no contractual arrangement exists. • Termed ‘tortious liability’ in some common law jurisdictions. • Depending upon the jurisdiction, these liabilities are determined in legislation, or through principles developed through the decisions of the courts. • A claimant will likely seek compensatory damage for losses suffered, and/or an injunction where the damaging activity is continuing.
ADMINISTRATIVE	<ul style="list-style-type: none"> • Borne by an operator under both CCS-specific legislation and the broader body of national energy-related and environmental protection legislation. • Liabilities stem from a competent authority’s statutory powers, which may compel an operator to undertake a specified action. • Designed to respond to a specific pollution problem and to secure practicable results, these powers are potentially broad in scope. • Wide-ranging obligations and potential for cost-recovery where an authority is compelled to act on an operator’s behalf.
GREENHOUSE EMISSIONS/ CLIMATE CHANGE	<ul style="list-style-type: none"> • In instances where some form of credit is secured for storing CO₂, a liability is borne by an operator in instances of subsequent leakage. • Although a form of administrative liability, it is specific to CCS and presents some distinct challenges.

2.0 PERCEPTION OF LIABILITY

The considerable legislative intervention, undertaken in recent years, has sought to address the challenges and risks raised in the early studies and policy documents. The resulting legal and regulatory regimes, developed in several jurisdictions worldwide, have done much to address parties' concerns and clarify their exposure. Notwithstanding these activities, the topic of liability remains divisive among project developers, policymakers and regulators globally and is viewed by some as a potential barrier to investment and indeed the wider deployment of the technology.

While more contemporary discussion of the topic has acknowledged the developments and clarity afforded by several of the new regulatory frameworks, specific liability issues continue to be raised in public fora, academic literature and policy reviews. The challenge presented by the timeframes associated with storage activities, as well as concerns surrounding the allocation of liabilities, are just two examples of the concerns highlighted.

The interviews conducted with policymakers, regulators, lawyers, project proponents and representatives from the insurance sector in the production of this report, together with wider literature reviews and the author's previous analysis, again reveal a far wider range of views as to the magnitude of the issue of liability. The results of the review have also offered a renewed perspective as to the adequacy of the approaches adopted to its management to-date.

Global regulatory experience

The development of national and sub-national CCS-specific legislation in recent years, as discussed in the previous sections, has resulted in detailed models that assign and, in some instances, limit liability for geologic storage operations.

The resulting frameworks are also demonstrative of careful negotiations and the satisfaction of a wide array of competing stakeholder interests, necessary for addressing liability issues. The emergence of legal and regulatory frameworks has also portended the parallel development and deployment of CCS projects in several jurisdictions worldwide. In many instances, these projects have been the first 'users' of these new regimes and have had to work closely with regulators to navigate the intricacies of the new provisions and obligations. The resulting interactions have provided some tangible, albeit preliminary, examples of liability regimes in operation.

EUROPEAN UNION

The European Commission's Storage Directive ("the Directive"), including its consequential amendments to wider European environmental legislation and the opportunity for operators to transfer their liabilities to the state following cessation of activities, remains the key piece of legislation for CCS liabilities in the EU. Member States have subsequently transposed its provisions into national frameworks, resulting in a largely harmonised European approach to liability.

In some Member States, notably those with strong commitments to deploying the technology, regulators have implemented models which go beyond the requirements of the Directive. The UK's transposition of the Directive is one example of this approach, with regulators adopting extensive transfer provisions that would encompass any sort of potential civil claim or administrative liability arising from a leakage, whether the leakage occurred before or after the transfer.

Notwithstanding the Directive's comprehensive approach to liability, several commentators have highlighted possible weaknesses in the European regulatory framework. The application of existing liability rules, uncertainty regarding causation and the potential for uncapped CO₂ leakage liabilities, have all been highlighted as potentially problematic (Pale Blue Dot, 2018; Faure, 2016).

A review of the UK government's second competition for government financial support for carbon capture and storage, identified similar challenges within the EU model (National Audit Office, 2017). The 2017 report raised the challenge posed by leakage under the EU ETS, which may necessitate the future surrender of allowances at an uncertain price. The report observed that it was likely that some form of risk-sharing agreement would be necessary to mitigate the impact of the liability burden, borne by an operator under the UK regime.

The European Commission's review of the Directive, completed in 2015, concluded that overall the Directive was "fit for purpose" in ensuring the safe capture, transport and storage of CO₂ and offered Member States sufficient flexibility in implementation (European Commission, 2015). The accompanying study and stakeholder responses, however, highlighted a number of concerns regarding the potential impact of the Directive's liability provisions (European Commission, Trinomics, 2015). While not universal, several stakeholder responses cited in the report highlighted:

- Potentially restrictive nature of liability provisions, in their aim to reduce all possible risks
- Uncapped liabilities remain unacceptable to companies
- Limited industry experience of the liability provisions within the Directive
- Nature of the provisions which address potential liabilities associated with shared storage resources
- Liability associated with an unpredictable carbon price.

AUSTRALIA

In recent years, the federal government and the state governments of Victoria, Queensland, Western Australia and South Australia, have all adopted CCS-specific legislation. The federal government has a complete regulatory framework for CCS activities, with the enactment of primary and secondary legislation to govern injection and storage activities in the offshore environment. At the state level, Victoria, Queensland and South Australia have all established regimes of varying complexity which regulate CCS activities in their territories, while the government of Western Australia has enacted project-specific legislation to regulate the Gorgon project.

The Commonwealth government's Regulatory Guiding Principles emphasised the potential environmental, health and safety risk and financial costs to operators and governments, in the absence of clear provisions governing liability (Australian Government, 2005). The Principles, which included several recommendations as to the design of regulatory frameworks, have largely been adopted by federal and state regulators in their legal and regulatory frameworks. The resulting Commonwealth and State-level legislation reveals similar approaches to the management of risks, although the provisions concerning long-term liability and post-closure are one area where there is little consistency between Commonwealth and State-level models. To-date, however, and with exception of the project-specific legislation in Western Australia, these frameworks remain largely untested.

The apparent disparity in the Australian approach to liability has been highlighted by several commentators, with some emphasising the fragmented and inconsistent relationship between the various State and Commonwealth regimes (Durrant, 2010). The disparity between these regimes, in terms of approach and process, will likely prove a challenge for project proponents when considering the impact of competing models upon the risk profile of projects (Gibbs, 2016).

A 2013 assessment by the Victorian State government, which examined the capacity of the Victorian regulatory models to effectively regulate a full-chain CCS project, included a number of observations regarding the State's liability regime (Victoria, 2013). Of particular note was the need to consider the degree of evidence required and conditions to be imposed before a liability transfer is effected, as well as wider need to align the approach to long term storage liability across Australian jurisdictions. The remediation of these issues was considered material to developing projects in the State.

CANADA

Regulatory developments, notably those concerned with the design and implementation of CCS-specific legislation, have principally occurred at the provincial level in Canada. Several of the provinces have undertaken reviews and scoping studies to examine the potential of existing regimes to manage CCS activities. In some instances, this has resulted in the promulgation of legislation, particularly as a response to supporting the development of early demonstration projects.

Predicated upon the province's current oil and gas regulatory model, Alberta's CCS-specific regime is perhaps the most advanced Canadian legal and regulatory regime and includes the most comprehensive model for addressing liability, during both the operational and post-closure phases. Under the province's model, operators will be able to transfer long-term liability for the storage site to the government, following the satisfactory closure of the site and demonstration of the site's stability. An operator will also be obliged to contribute to a Post-Closure Stewardship Fund, which will be used by the government to undertake ongoing monitoring of the site and any required maintenance or remediation activities.

The Regulatory Framework Assessment (RFA), which was concluded in December 2012, sought to identify and address regulatory gaps in Alberta's nascent regulatory regime. A critical element of this process was consideration of the liability provisions of the CCS regulatory framework and potential opportunities for their improvement. As part of the RFA's final report to government, several liability-specific recommendations were made, including:

- The inclusion of a post-closure time limit for transfer, notably a minimum time period be adopted prior to the issue of a site closure certificate .
- Establishment of performance criteria for the closure of a storage site.
- The transfer of liability for CO₂ credits to the Crown, following the transfer of liability.
- Requirement for operators to post financial security to address site closure and reclamation.

UNITED STATES

The development of CCS-specific law and regulation in the United States, has evolved through the interventions of both federal and state regulators. While the federal government has developed CCS-specific legislation, a legal competence in many areas of the regulatory environment has meant that in several instances, the states have led the way in the development of regulatory permitting frameworks for the technology.

The Environmental Protection Agency's (EPA) Final Rule under the UIC Program of the Safe Drinking Water Act (SDWA), together with requirements around the reporting of CO₂ emissions under the Clean Air Act, remain the focus of the federal framework for CCS activities. The key instrument in the federal government's approach, the final permitting rule, sets out detailed requirements for Class VI wells and the injection of carbon dioxide for the purposes of long-term storage. The final rule is supplemented by several guidance documents, which have been prepared to assist in the implementation of the Class VI program and to support well owners and operators in their compliance.

The management of liability, throughout the project lifecycle, is approached in several ways within state and federal legislation. Operators will likely bear several administrative liabilities under federal and state planning, environmental and pollution prevention legislation, as well as statutory liabilities under the Class VI permit. Under the federal UIC program, for example, operators will be required to monitor injection zones in order to mitigate the risk of leakage, as well as undertake surface air and soil gas monitoring at the discretion of the EPA as a means of identifying potential leaks.

It is notable however, that while the federal program includes detailed provisions relating to the cessation of storage activities, the closure of a storage site and the necessary 50-year period of post-injection site care (PISC); it does not include provision for the transfer of liability following the ultimate closure of a storage site. An operator will therefore remain potentially liable for damage to an Underground Source of Drinking Water (USDW), which may arise in the future. In addition, an operator will also remain liable for damages under wider federal and state statutes, as well as the common law (EPA, 2010).

Several of the state-level models developed in the US, include provisions for assessing and limiting liability, notably the provision of long-term monitoring and verification, or other stewardship over the site (Javedan, 2011; Anderson, 2017). In some instances, the state of North Dakota for example, this has included provisions to enable the state to assume the long-term liability for projects.

The topic of liability has received considerable attention in the US, with some commentators highlighting the topic as critical to the technology's deployment. While the issue of broad, open-ended long-term liabilities has been highlighted as problematic for industry, the legal literature has also focused upon the impact of likely civil liabilities attaching to CCS operations. The common law, notably issues relating to pore-space ownership and the courts' likely approach to subsurface trespass and CO₂ storage operations in the US, has been highlighted as a potentially critical issue when considering potential liabilities for project operators (Lo Baugh, 2011; IOGCC, 2014).

Project-level perspectives

CCS-specific legal and regulatory models have emerged alongside the development and operation of CCS projects in several jurisdictions worldwide. In many instances, project proponents have actively sought to engage regulators and policymakers in the design and development of these frameworks, offering both technical and practical perspectives. While these CCS-specific laws and regulations remain largely untested, several proponents have now utilised discrete aspects of national permitting frameworks and considered the practical realities of these regime's liability provisions.

Academic studies and project-authored analysis have revealed a breadth of regulatory experiences to-date, including some preliminary views of the impact and efficacy of the liability provisions. The interviews conducted with project proponents as part of this study, on an informal and unattributed basis, similarly reveal a variety of perspectives as to the effect of these CCS-specific models upon operations and decision-making.

In the United States, a detailed federal framework for the geologic storage of CO₂ has been developed, which builds upon a well-characterised permitting model. Historically, there has been significant experience with the Class II permitting pathway (for CO₂-EOR projects), however, several permits have now been issued under the UIC Program's new Class VI permitting model for long-term storage. To-date, two permits have been issued by the EPA for the Archer Daniels Midland (Illinois) Industrial CCS Project and four for the FutureGen 2.0 project.

Project proponents in the US, including those with operational projects, maintain largely positive views of the regulatory frameworks governing liability. Among the operational projects interviewed, there was little concern surrounding the topic, with interviewees highlighting the certainty afforded by the regulatory model and clarity around property rights as important factors. The recent Class VI permit approvals also demonstrate the potential flexibility of the regulator, notably in their approach to post-closure requirements. The ADM Illinois project permitting experience demonstrates that in the case of Post Injection Site Care (PISC), it is possible for an operator to successfully petition the EPA and reduce the default 50-year site-care period.

Despite this broadly positive outlook, some aspects surrounding the issue of liability remain a concern for project proponents in the US. Concerns were expressed about the likely scale of common law liabilities, particularly in instances where a project operator is not a landowner or does not own the pore space. The ability to insure against these risks and the cost of products, where there were products available, were also highlighted as important issues to be resolved.

European projects, notably the former ROAD project in the Netherlands and the two projects competing for funding under the UK government's former commercialisation competition, have published a wealth of information on their permitting experiences, including their perspectives of the liability provisions.

The Dutch ROAD project examined various forms of liability applicable to CCS operations in their 2013 special report and made an assessment as to their likely impact upon the project (ROAD, 2013). The project concluded that in many instances the liabilities, to be borne under the Dutch regulatory framework, were entirely manageable. The exception to this position was the potential climate liabilities, which exist where a project is required to surrender emissions allowances in the event of leakage. The project emphasised the need for a positive and collaborative relationship with the national regulator, to navigate the novel requirements of the regulatory framework and to address issues where there was remaining ambiguity or uncertainty.

Similar views were shared by the Peterhead and White Rose projects, which sought funding under the UK's second commercialisation competition. The Key Knowledge Deliverables (KKDs), subsequently published by both the White Rose and Peterhead projects, provide detailed insight into the projects' commercial and financing arrangements; risk management; consents and permitting; technical design, engineering and integration; and health and safety plans. The documents produced by the Shell Peterhead project reveal that many of the liabilities, likely to be faced by the project throughout its operational lifetime, were both manageable and insurable (Shell, 2014). For both projects, however, the issue of liability for CO₂ release and the cost of subsequently surrendering allowances under the EU ETS, was highlighted as a particular concern and uncertainty (CCSA, 2016).

Literature reviews and feedback from projects in other jurisdictions reveal similar opinions, with proponents highlighting positive examples of regulation to address the issue of liability. Those regimes which demonstrate clarity and potential consistency in approach, couple with regulators' willingness to engage with projects in addressing any perceived challenges or obstacles, were raised as positive examples of an attempt to reduce the burden of liability. There was however, recognition of the challenges to be faced by projects as they move through the operational lifecycle and begin to use the hitherto untested aspects of these early regulatory regimes.

Globally, many other governments and national regulators have yet to fully crystallise their approach to the issue. In many jurisdictions, the liability regime for CCS activities remains embryonic and ill-defined, an issue which will pose significant challenges for those seeking clarity as they seek to develop projects.

Assessments of the scale of risk and liability

The likely magnitude of the financial risk posed by liability, has also been consistently raised by operators, regulators and those seeking to finance or insure its deployment. A recent Institute study considered the various elements of risk associated with a CCS operation and in turn, how a financier's perception of these risks may have a material impact upon lending rates and the cost of debt (Global CCS Institute, 2019). While leakage risk and those risks associated with the project's legal system were determined to be 'General Project Risks', the risks associated with storage liability were perhaps 'Hard to reduce' and would therefore attract a higher risk premium.

Other studies have sought to consider the potential risks and financial consequences of CCS operations, using modelling and site-specific information. One example of this approach was the analysis and development of a model, undertaken in the United States in 2012 and which was aimed at helping developers value the economic damages arising from a well-sited and managed CCS project. The study focused upon the proposed FutureGen 1.0 project site in Jewett, Texas and used publicly-available risk assessment studies as the basis of the assessment (IEc, 2012).

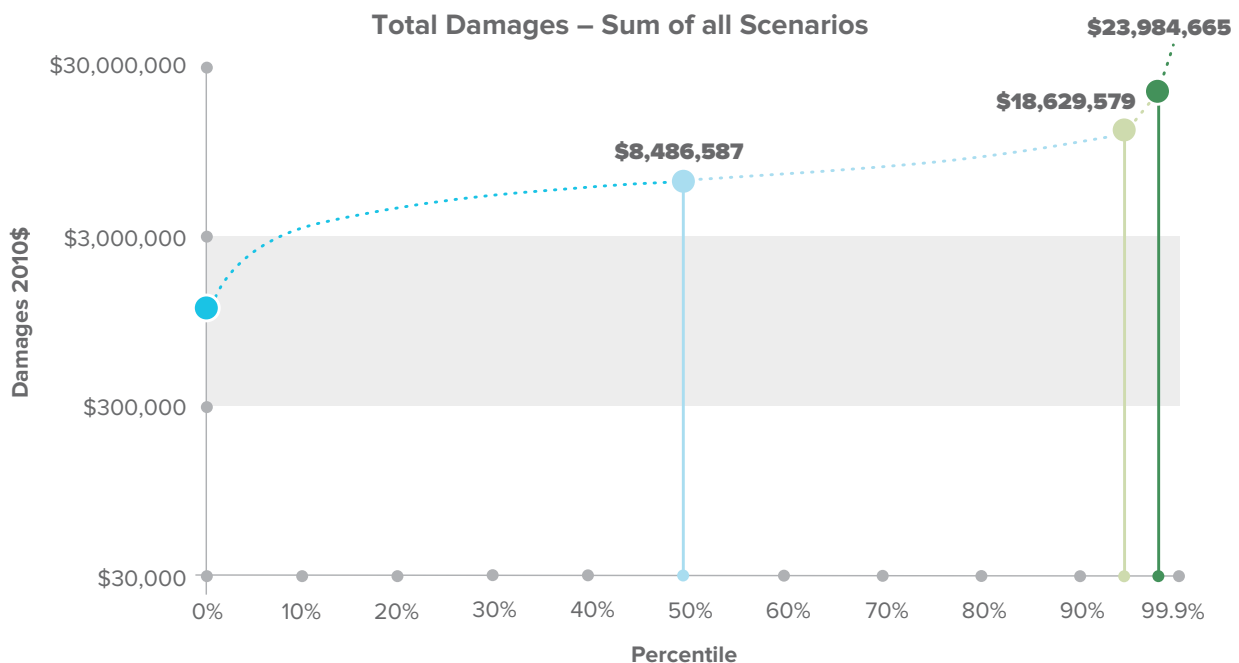
Using Monte Carlo modelling, the assessment considered the environmental and human health impacts arising from the storage portion of a CCS project, as well as costs arising from compensation, or remediation of these potential impacts. Notably this modelling included consideration of potential damages for what was termed ‘atmospheric release’, essentially the required purchase of carbon offsets to address accidental release of CO₂ to the atmosphere. The analysis considered a period of 100 years, reflecting 50 years of injection operations and 50 years post-injection monitoring.

The results of this analysis, shown in Figure 4 below, suggest that even in instances where there is a 99 per cent chance of damages being equal to or lower than \$24.0 million, this represents damages of only \$0.48 per ton of CO₂. Over the 100-year analysis period under consideration, there is a 99 per cent chance that damages would be less than or equal to \$0.50 per ton, and only a one percent chance that damages would exceed this estimate.

The analysis successfully demonstrated that estimates of expected financial liability with associated probabilities can be developed. Perhaps more significant, however, is the conclusion that in instances of appropriately sited and well-operated CCS projects, there is a relatively small potential for significant damages. One note of caution must be added to this analysis, however, and that is that the range and level of damage estimates are highly sensitive to site-specific data.

The availability of insurance, to manage the risks associated with CCS operations, is a further issue highlighted by both regulators and operators. Many CCS-specific regulatory frameworks require an operator to hold some form of insurance product throughout the lifetime of a project, make up-front payments into funds or schemes, or adopt specific forms of financial security product.

Figure 4: Results of the modelling for the Jewett, Texas site ²



² Figure reproduced from IEc, 2012, Trabucchi C., Donlan, M., Huguenin, M., Konopka, M. and Bolthrunis, S., Valuation of Potential Risks Arising from a Model, Commercial-Scale CCS Project Site, Global CCS Institute.



From a regulatory perspective, insurance policies are to be viewed as a key element in guarding against expenses and liabilities associated with injection and storage operations. The scope of this insurance will be necessarily broad and, in many instances, encompass the expense of complying with a regulator's directions with respect to clean-up, or to remedy the effects of a CO₂ escape.

Operators seeking to undertake storage operations will be required to self-insure or seek third-party products, to address liabilities throughout the project lifecycle. While the former may be an option for some larger organisations, it may prove to be a potential barrier for smaller, newer operators in the market.

The availability of insurance to cover discrete liabilities, has also been a topic of concern for many operators. Commentators have even suggested that, in some instances, off-the-shelf insurance solutions may simply not exist (ClimateWise, 2012). The Shell Peterhead project, in its insurance strategy document, considered the various forms of risks and liability to be faced throughout the project's lifetime (Shell, 2014).

Figure 5 below includes a risk matrix developed by the project team, which identifies individual risks and their insurability. The assessment reveals that while many project liabilities are eminently insurable, there are some for which insurance may not currently be procured.

Absent a viable insurance product, a project would therefore be required to retain these risks until such point that a viable alternative or solution be found.

Figure 5: Peterhead CCS project risk matrix³

RISK	DESIGN AND CONSTRUCTION	OPERATIONS	CLOSURE AND DECOMMISSIONING	POST-CLOSURE
LIABILITY				
Third Party Liability	●	●	●	●
Seepage & Pollution (Reservoir)	●	●	●	●
Automobile Liability	●	●	●	●
Professional Liability	●	●	●	●
Employers Liability	●	●	●	●
Sub-surface Liability	●	●	●	●
PHYSICAL DAMAGE (PD)				
Damage to the Works	●	●	●	●
Damage to Existing Assets	●	●	●	●
Loss of Well Controlled	●	●	●	●
Automobile Physical Damage	●	●	●	●
Transit/Cargo	●	●	●	●
OTHER				
Loss of Carbon Credits	●	●	●	●
Business Interruption (caused by a PD event)	●	●	●	●

- Not applicable
- Insurable / to be insured
- Not to be insured / not insurable

³ Figure reproduced from Shell, 2014, Peterhead CCS Project – insurance plan, Shell UK Limited, 11.148, 12-09-14, p 9.

Technical outlook for permanent storage

Confidence in the technical feasibility and security of storage operations remains a critical aspect of ensuring that CCS is viewed as a credible mitigation strategy. Early studies suggested that meeting the climate change ambitions for the technology and ensuring environmental effectiveness, would require leakage rates of less than 0.01 per cent per year – equivalent to a CO₂ retention rate of 99 per cent over 100 years (IPCC, 2005; Hepple, 2005).

The reconciliation of these policy and technical ambitions into a practical definition of what constitutes successful ‘permanent’ storage, has proven a critical element of several regulatory frameworks. The EU CCS Directive’s requirement for CO₂ to be “completely and permanently contained”, coupled with its precautionary requirements for financial security, have been described by some commentators as too conservative in their actuarial approach (Haszeldine, 2018).

For operators the burden of these provisions, which may be described as less technically pragmatic, is likely to be high when assessing and making provision for potential liabilities.

A long history of successful storage as a part of CO₂-EOR operations, together with advances in the understanding of potential leakage rates, storage site performance and in monitoring technologies, further emphasise the low risks of leakage from CO₂ storage sites. Significant developments in research and modelling, of the kind detailed below, demonstrate there is now very high confidence in long-term storage security at a global scale.

Whether or not this improved scientific and technical understanding will afford decision-makers greater confidence in the security of storage and consequently result in a reduced regulatory burden, remains to be seen. It is positive to note, however, that there has been an apparent willingness in recent years for regulators and policymakers to engage project proponents throughout the lifetime of a project, particularly when navigating the challenges of the regulatory framework.

LOW RISK OF LEAKAGE

“... a secure, resilient and feasible option for climate mitigation ...”⁴

A recent article, published in Nature Communications by Alcade et al., discussed the findings of the Storage Security Calculator (SSC) that aims to determine the global security and longevity of geological CO₂ storage, for mitigating climate change.

The SSC, which is designed to “quantify the immobilisation of CO₂ injected into the subsurface for geological storage and the total CO₂ leakage to the atmosphere”, was applied to a number of scenarios and concluded that:

“For regional implementation of CO₂ storage in a realistically well-regulated industry, with a moderate density of legacy wells, our program calculates a 50% probability that more than 98% of the injected CO₂ will remain trapped in the subsurface over 10,000 years. Applying the SSC to a worst-case, unrealistic scenario of CO₂ storage being inadequately regulated and implemented in a region with a high risk of leakage along abandoned wells, calculates that at least 78% of the CO₂ will be trapped in the subsurface over 10,000 years.”

⁴ Alcade, J., Flude, S., Wilkinson, M., Johnson, G., Edlmann, K., Bond, C. E., Scott, V., Gilfillan, S. M. V., Ogaya, X., Haszeldine, R. S., 2018, Estimating geological CO₂ storage security to deliver on climate mitigation, Nature Communications, Volume 9, Article number: 2201

3.0 ADOPTION OF A COMMERCIAL APPROACH TO LIABILITY

Experience garnered in regulating CCS liabilities to-date, together with the practical knowledge of regulators and operators, has done much to address parties' concerns and clarify their exposure. While particular liability issues have been ostensibly overlooked and will likely require further policy and legislative intervention, the feedback from project proponents, regulators and wider industry sectors in the compilation of this report, reveals that many issues are eminently manageable.

The adoption of a more commercial approach to liability, the ultimate focus of this report, would see greater, collective review and engagement with the topic to resolve the outstanding issues. Closer examination of the types of liability borne by a CCS operation, current perceptions of the regulatory model and the practical challenges encountered by projects, would place a greater focus upon eliminating barriers and supporting deployment.

Defining liability

The need to clarify exactly what is meant by the term liability, an issue presently mired in wider debate surrounding the topic, will be an important starting point for further action. A collectivist approach, where the singular term is used to encompass a host of potential liabilities, appears to have been adopted in discussions in recent years. A closer assessment, however, reveals that in many instances there exist several far more nuanced issues, all with very different impacts upon an individual project.

Project proponents, interviewed in the course of this study, highlighted the risks of failing to clarify exactly what is meant when referring to liability in the broadest manner. The challenges of this ambiguity were considered particularly acute when communicating the topic to a broader, or potentially lay audience. Several interviewees agreed that liability was frequently referred to in a broad and ill-defined manner, with one commenting that the use of the term – effectively as a collective noun – had done much to establish the issue as a potential obstacle.

Identifying and subsequently assessing the impacts of the various forms of liability, likely applicable throughout the CCS project lifecycle, may be the focus of a more commercially-minded approach to the topic. As seen in Section 1.0 above, a variety of civil and administrative liabilities, together with those potentially borne under national or regional emissions trading schemes, will pose risks and challenges to both operators and regulators alike throughout the project lifecycle. A renewed focus upon those issues determined to be critical for investment and deployment, may ultimately result in their timely resolution.

CIVIL LIABILITY

Civil liabilities are potentially borne by an operator, where the interests of third parties are harmed during operations. Termed 'tortious liability' in many common law jurisdictions, damage caused by CCS activities may result in actions brought for compensatory damage for losses suffered, and/or an injunction where the damaging activity is continuing. Civil liabilities constitute a broad category of potential liabilities, with the principles governing their scope and extent, largely determined through the courts' application of case law.

Operators familiar with the magnitude of risk and likely damages associated with liabilities attaching to major infrastructure projects, or oil and gas operations, will also be aware of practices aimed at minimising their exposure to these liabilities. The interviews conducted with regulators, project proponents and the insurance sector, confirmed these liabilities are indeed widely understood and that there is confidence they could be adequately managed through traditional means such as insurance. Broader legal academic analysis of the topic would similarly support these views, suggesting that a greater reliance upon these forms of liability may even afford further clarity for investors and operators (Adelman, 2011).

The absence of CCS-specific experience and case law may offer some uncertainty, as to the approach to be adopted when interpreting the extent and application of third-party liabilities. There are, however, likely analogues to be found in prior case law and legislation that may enable an insight as to how these liabilities may apply under particular scenarios.

Notwithstanding this positive outlook, the liability implications attaching to property ownership remain a critical consideration in some jurisdictions. While the issue is less of a concern for those jurisdictions where underground storage resources – notably the pore space – are publicly-owned; the topic raises some significant civil liability challenges where ownership rights are less clear.

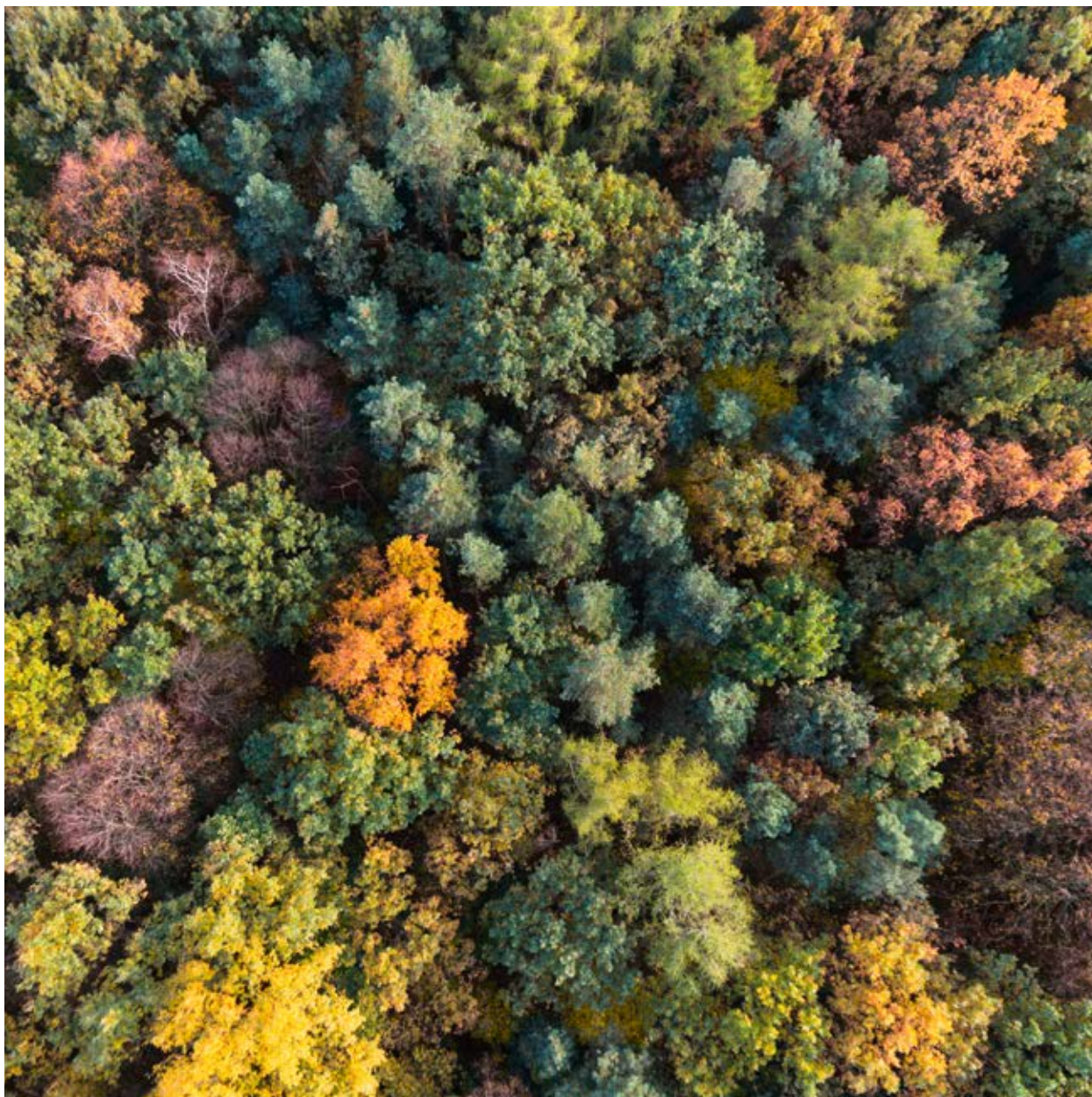
In Australia, the public proprietorship of underground resources is a public interest and the government, through legislation, has established statutory titles which authorise their holders to undertake specific activities. In the case of CCS, the Australian Commonwealth Act:

“... does not assert property in the seabed of Australia’s territorial sea and continental shelf, as previously noted, or in petroleum, greenhouse gas storage formations or greenhouse gas substances therein. Instead, it prohibits specified activities unless they are authorised by the Act pursuant to a statutory title or otherwise. These activities are exploration for petroleum, recovery of petroleum, construction or operation of an infrastructure facility or pipeline, exploration for a potential greenhouse gas storage formation or a potential greenhouse gas injection site, and injection and storage of greenhouse gas substances.” (Crommelin, 2018)

The status of the pore space was similarly clarified in the Canadian province of Alberta, under the Carbon Capture and Storage Statutes Amendment Act 2010. Under the Act, the Government of Alberta is designated as the owner of all pore space, save for pore space under federally owned land. While the ownership of mine and mineral resources remains unchanged in the province, the Minister of Energy is empowered to enter into agreements to grant pore space rights.

A cursory review of policy, legal and academic literature reveals that pore space ownership and its implications for liability, remain an important consideration in the United States. Interviews conducted with project proponents, lawyers and regulators, revealed that the topic raises significant concern and will undoubtedly require closer scrutiny in many jurisdictions, if more widespread project deployment is to occur. The potential for conflict between the owners of the surface and mineral estates, the likelihood of transboundary trespass and the perceived inadequacies of remedies under the common law, remain live issues in many States and regimes.

While it is not possible to provide an exhaustive analysis of this issue here, a host of options have been proposed to address the issue. For some project operators in the US, their status as landowners with full ownership of the pore space, has proven an important factor in enabling their project to proceed. Among the US projects interviewed, there was broad consensus that this would continue to prove decisive, absent a definitive legal position. Legal commentators have proposed several further options to address the issue, including: the designation of locations on federal land for carbon sequestration; the unitization of multiple parcels of land into an injection unit; or the application of correlative rights to ownership in the pore space (Marston, 2008, Jacobs, 2017, Righetti, 2017).



ADMINISTRATIVE LIABILITY

Earlier analysis revealed a host of potential liabilities likely applicable to CCS, under both CCS-specific and wider energy-related and environmental protection legislation, which would likely prove challenging for both operators and regulators (Havercroft, 2018). Many of these liabilities, contained within a competent authority's statutory powers and which may only come into effect in the event of actual or potential environmental damage, may oblige operators to undertake a wide-range of activities.

Absent the necessary practical experience to-date, where this type of liability has been brought into play, it remains difficult to fully-quantify the impact of these liabilities upon an operator. The practicality and scale of broad remediation requirements contained in some national regimes, or the likely magnitude of the cost of complying with these obligations, remains indeterminate. As such, any judgment as to the impact of administrative liabilities remains bound in the hypothetical and in the application of analogous situations observed in other industrial activities.

Despite a level of ambiguity and the related category of greenhouse emissions liabilities (discussed in the following section), operators appear to have largely accepted the potential impact of these liabilities. The assessments undertaken of national permitting regimes to-date, reveal that many of these liabilities are readily identifiable within broader law and regulation (Barton, 2013; Victoria, 2013). Improved confidence in the technical feasibility and security of storage operations, together with existing risk transfer options and the availability of insurance and/or self-insurance, may go some way to alleviating both the perception and impact of administrative liabilities.

GREENHOUSE EMISSIONS/CLIMATE LIABILITIES

The incorporation and recognition of CCS activities within a national or regional greenhouse gas trading scheme and the liabilities created, continue to be highlighted as problematic for operators and investors. The topic was highlighted by nearly all those parties interviewed in the preparation of this report – including those interviewees based in jurisdictions where a carbon pricing scheme does not currently operate.

Greenhouse emissions/climate liabilities are borne where the mitigation objectives of the technology are ultimately frustrated under a greenhouse gas trading scheme. In situations where an operator has secured financial reward for permanent geological storage and leakage is subsequently discovered, regulators require an operator to account for this leakage through the surrender of an equivalent number of emissions allowances.

For operators and regulators these liabilities present some unique challenges, not least the technical and temporal challenges of determining the volume and timeframe of a potential CO₂ leak. Perhaps the greatest issue, however, remains the practicality of coupling climate change liabilities to the provision of financial security (discussed below) effectively linking liability to the uncertainty of pricing under an emissions trading scheme. From an operator's perspective, these liabilities represent a considerable financial risk and remain hard to forecast.

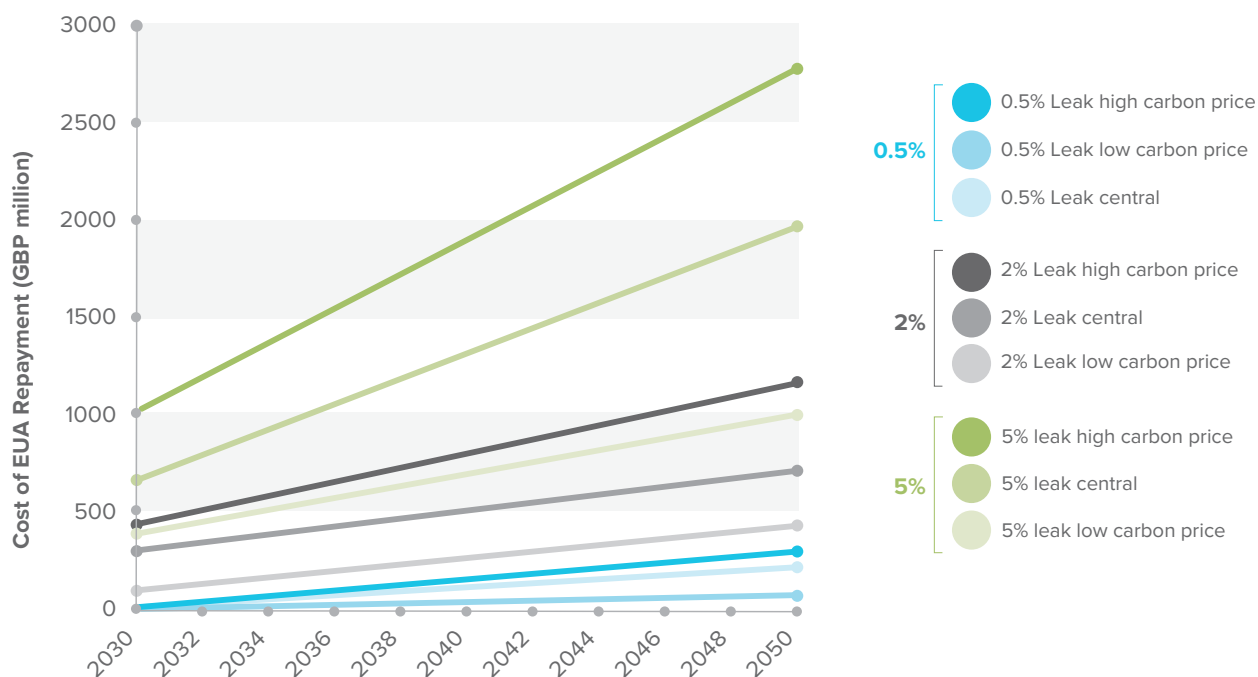
A review of the likely estimated costs of surrendering emissions allowances (EUAs) under the EU Emissions Trading Scheme, following leakage from a storage site is provided in Figure 7 on the next page. The results of the analysis, which is based upon the UK government's modelling of forward carbon price estimates, revealed potentially significant cost implications for projects under the EU ETS. The report's authors suggest that under their analysis, a 2 per cent leakage from a store of 200 million tonnes in 2035 would necessitate around £412 million for the required EUAs (ClimateWise, 2012).

A note of caution, however, should qualify this analysis. While illustrative of a particular scenario, this modelling does not account for the more recent improvements in the technical outlook for CO₂ storage performance and likely leakage rates, which may practically impact the magnitude of this risk.

The issue is further complicated by the absence of insurance products to address these risks, as highlighted in the commentary surrounding the UK's second commercialisation competition (National Audit Office, 2017). Project proponents and insurers have similarly confirmed that there are still, currently no available 'off-the-shelf' insurance products to address these liabilities.

Despite these concerns, there have been several proposals for addressing these liabilities, not least through their eventual transfer to the State in the post-closure period. One potential option would be to cap an operator's liability, in line with the total financial gain received from the ETS scheme throughout storage period of the project lifecycle. It is clear, however, that the issue remains a live one and that further work will be necessary to provide project proponents and investors with confidence that this form of liability may be managed throughout the project lifecycle.

Figure 7: Estimated costs of surrendering EUAs under the EU Emissions Trading Scheme⁵



Management of risk – the role of government and the private sector

Analysis of policy reviews, wider academic commentary and interviewee responses has reinforced the view that the allocation of risk, throughout the CCS project lifecycle, has been a critical consideration in the development of policy, law and regulation for the technology. Close consideration of who is best-placed to bear or manage risk, at a specific point during the project process, has resulted in the adoption of a largely similar approach to envisaging and allocating liabilities.

Clear from this analysis are the important roles both government and the private sectors may play in managing risk and concomitant liabilities. While certain strategies adopted to-date have gone some way towards addressing the various forms of liability, there may be further options for both the public and private sectors to further address their impact. One significant conclusion however, notable from interviews with project proponents and particularly relevant to the management of these risks, is that operators prioritise and prize ‘certainty’ in their policy and regulatory environment. As one operator suggested, projects operate on strict timelines and, while perhaps not insurmountable, where risks become too difficult to manage they have the potential to stall a project.

⁵ Figure reproduced from ClimateWise, 2012, Managing Liabilities of European Carbon Capture and Storage, ClimateWise, University of Cambridge Programme for Sustainability Leadership, p.30. The analysis is based upon estimated costs of surrendering EUAs following 0.5%, 2% and 5% CO₂ leakage scenarios from a 200 million tonne CO₂ storage site (for illustration only). The EUA Price estimates are based on a 2009 UK government (Department for ECC study on traded carbon value at 2009 constant price. The risk-free rate assumption by DECC (2009) is 3.5%.

ROLE OF GOVERNMENT

Perhaps the greatest concern for regulators and potential operators, has been the management of the longer-term aspects of the storage process – notably the closure and post-closure phases of the project lifecycle. Initially, the absence of a clear regulatory position, coupled with the novelty of the timeframes associated with the CCS process, afforded high levels of uncertainty for those seeking to invest in the technology. While government and industry sought to deploy and commercialise the technology, many proponents feared potentially open-ended liabilities that would prove an insurmountable financial burden. Government policymakers and regulators, conscious of the wider public interest and the need to protect the public purse, sought to ensure the environmental integrity of the storage process was upheld.

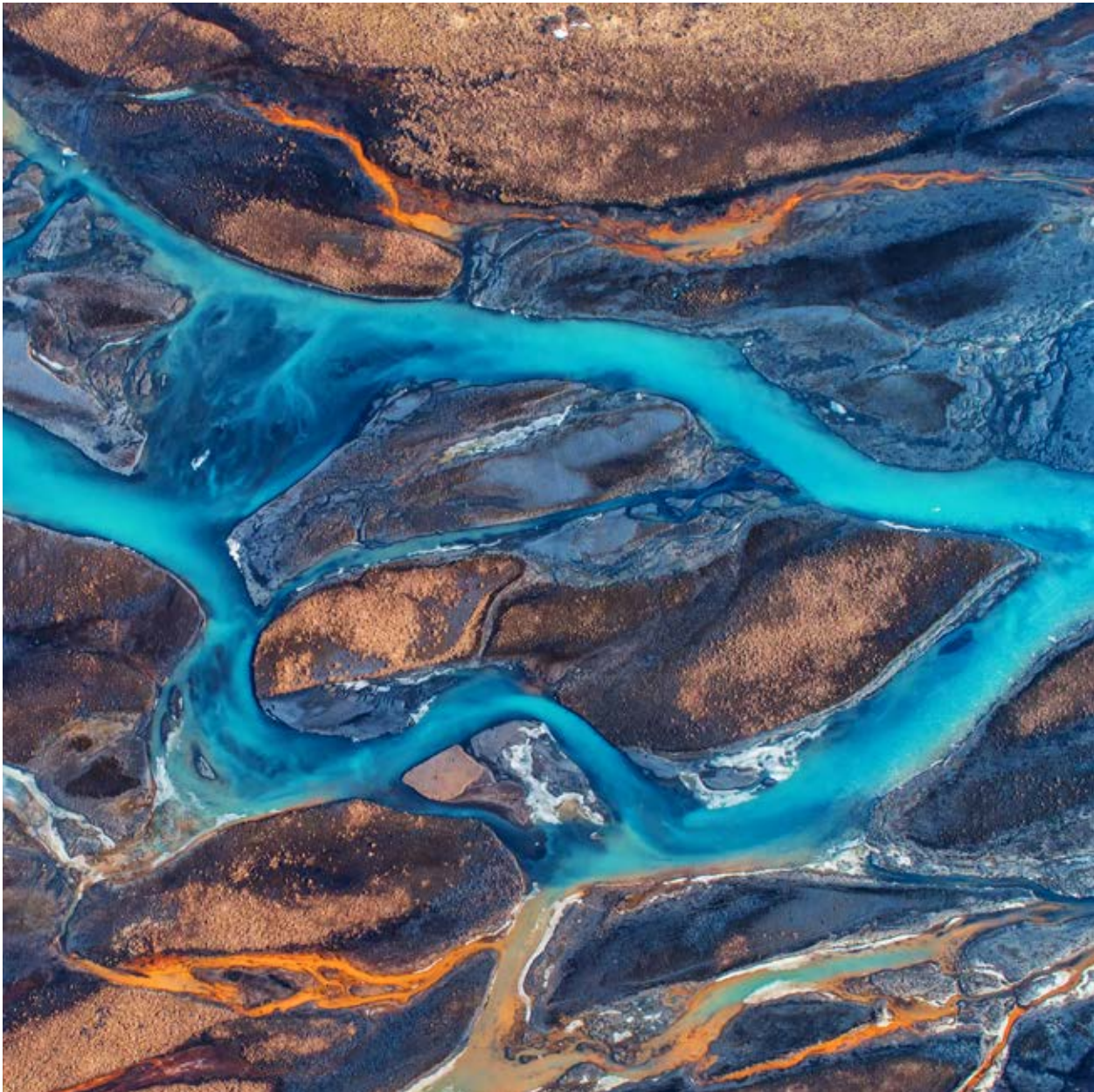
In several instances⁷ regulators have sought to address these concerns through the development of provisions, within CCS-specific legal and regulatory models, which transfer liability from the operator to the State within a clearly-defined period. Many projects have voiced strong support for this type of government regulation; with some highlighting the mechanism as critical for taking a project's final investment decision and others promoting the public perception benefits of long-term government-led management of storage sites. It may be suggested that the availability of a transfer, or indeed an unambiguous decision not to provide one, affords proponents and investors greater certainty as to their future liabilities.

While the benefits of the transfer model have been widely acknowledged, several limitations to this approach may be identified. Some commentators have even suggested that to adopt such an approach may compromise the incentive offered to operators by the common law, to safely operate their storage sites (Adelman, 2011). It is clear there are some limiting aspects to the transfer model and that within the CCS-specific frameworks developed to-date, the scope and efficacy of these transfer mechanisms varies considerably.

Ambiguity surrounding how transfers are to be effected and which liabilities are transferred, may be observed in even some of the most advanced examples of regulatory framework (Havercroft, 2018). There is a clear role for government here, to provide further clarification and address the perceived ambiguities found within these frameworks.

Government may also play a greater role in addressing some of the harder to manage liabilities, created under the new regulatory regimes. One example may be where CCS is included within greenhouse gas trading schemes, as discussed in the previous section, resulting in climate change liabilities which may prove more difficult to quantify and insure. Where specific insurance products do not currently exist, and smaller operators may find it hard to self-insure these risks, greater burden-sharing through the setting of a liability cap may be accepted by government. An example of this approach was proposed by the UK government, under its second commercialisation competition (National Audit Office, 2017).

Other proposals for government intervention, have included the establishment of a new, stand-alone body or agency that would manage the full-chain risk associated with the technology's deployment (Oxburgh, 2016). The recommendations of the 2016 Parliamentary Advisory Group in the UK included the establishment of the 'CCS Delivery Company' (CCSDC) that would assume those long-term liabilities, which the private sector was incapable of accepting under present circumstances. It was suggested that this model would ultimately *"promote the right standards for the rest of the industry, and enhance the prospects of this risk being privatised in time"*.



PRIVATE SECTOR

The previous section emphasised the role of government in accepting particular liabilities and project risks, however the private sector also has an important role in managing risk and the accompanying liabilities. Research and interviews with project operators reveal that in many instances, commercial arrangements will ultimately play a significant role in apportioning these risks and liabilities throughout the project lifecycle.

Many operational risks within the CCS process may be managed through existing practises, including a history of undertaking these types of agreements as part of current petroleum, industrial and power plant operations worldwide. Liability apportionment mechanisms found in existing commercial contracts, for example those that apportion responsibility where oil and gas are carried in common pipes, are going to provide useful analogues for aspects of CCS operations. Commentators have also highlighted the significance of indemnities and project contracts as a means of clearly clarifying risk and apportioning liabilities between the relevant project parties (Lawrence, 2018).

Role of financial security

The goal of financial security is to achieve an important balance between two potentially competing goals—protecting the public purse from the financial and operational risks of the storage operator, but also ensuring that high up-front costs against unrealistic risks do not deter investment. The financial security models adopted to-date largely seek to address the public obligations of an operator, rather than claims that may be brought under civil law for liabilities arising out of their operations. The approach adopted by each country in their choice and design of mechanism, has been influenced in many instances by similar systems within each national jurisdiction, including those used in the regulation of landfill and oil and gas operations.

Many aspects of this concept are well-understood by operators and regulators and are largely viewed as a practical approach to managing the risks associated with the process. Despite these developments, however, concerns have been raised as to the provision of financial security to cover novel events.

One example may be found in Article 19 of the EU CCS Directive, which requires an applicant for a storage permit to provide proof by way of ‘financial security or any other equivalent on the basis of arrangements to be decided by Member States’, in order to ensure that any obligations under the permit including closure and post-closure obligations can be met.

The financial security is to be provided in advance of the grant of a permit and is to remain in place up until the point that responsibility for the storage site is transferred to the State in accordance with the Directive.

Table 3 below, taken from the European Commission’s accompanying Guidance, sets out the obligations that must be covered by the Article 19 financial security requirements. Clear from the Guidance is that the scope of financial security includes the costs of CO₂ leakage under the EU ETS, which would require an operator to provide an up-front payment for an ostensibly uncapped liability. While the Guidance proposed that Member States should use current prices or estimates for near-term allowance prices over a 3-5 year period, making amendments to financial security periodically, these provisions remain viewed by many as potentially problematic.

Project-level experience to-date, however, would suggest that national regulators are willing to adopt a more constructive approach to these requirements. Discussions between the Peterhead and ROAD projects, with their respective national regulators, demonstrated a greater willingness to adopt a more flexible approach to both the scope of security and the types of instruments to be used (ROAD, 2013; CCSA, 2016).

Table 3: Obligations under the permit that must be covered by Financial Security under the CCS Directive⁶

OPERATIONS PERIOD		CLOSURE & POST-CLOSURE PERIOD	
1A	monitoring, updates of monitoring plan, and required reports of monitoring results	1B	monitoring, updates of monitoring plan, and required reports of monitoring results
2A	updates of corrective measures plan, and implementing corrective measures, including measures related to the protection of human health	2B	updates of corrective measures plan, implementing corrective measures including measures related to the protection of human health
3A	surrender of allowances for any emissions from the site, including leakages, pursuant to the ETS directive	3B	surrender of allowances for any emissions from the site, including leakages, pursuant to the ETS directive
4A	update of a provisional post closure plan	4B	sealing the storage site and removing injection facilities
5A	maintaining injection operations by the CA until new storage permit is issued, if storage permit is withdrawn, including CO ₂ composition analysis, risk assessment and registration, and required reports of CO ₂ streams delivered and injected	5B	making required financial contribution (FC) available to the CA

⁶ Guidance Document 4, Financial Security (Art. 19) and Financial Mechanism (Art. 20), European Commission, p 9.

A further and perhaps more commercial approach to financial security and a crediting system, may be found under the recent amendments to the Low Carbon Fuel Standard (LCFS) in the US State of California. The 2018 amendments enable CCS projects that reduce emissions associated with the production of transport fuels sold in California, and projects that directly capture CO₂ from the air, to generate credits under the LCFS scheme. To qualify for crediting under the scheme, operators will be required to meet the requirements of the accompanying CCS Protocol.

The Protocol requires operators to monitor a storage site for at least 100 years post-injection. Under the accounting requirements of the CCS Protocol, operators will be required to contribute between 8% and 16.4% of the credits they generate, to a reserve or 'Buffer Account'. To maintain the environmental integrity of the LCFS, this reserve may then be subsequently drawn upon in the event that credits issued are no longer valid due to the leakage of CO₂.

For up to 50 years post-injection, credits are to be first taken from the contribution to the Buffer Account made by the CCS project when the credits were issued. Over and above the contributed amount, an operator must retire or purchase further credits.

Following this 50-year period and up to the 100-year requirement, the contributions made by all parties to the Buffer Account would be used to cover any credits found to be invalid due to leakage and the project operator would not be required to retire any additional credits.

The approach adopted to CO₂ leakage under the Buffer Account feature of the LCFS, is in addition to more traditional financial instruments which will be required to provide cover against the potential endangerment to public health and the environment from CO₂ leakage. It is suggested that a host of more conventional and readily-available products will meet this requirement. As such, the LCFS model provides an example of a practical approach to the management of the range of potential liabilities, allocating responsibility clearly between the operator and regulator. The model also affords a high level of practicality, enabling an operator to make contributions to the Buffer Account while they are operating and benefitting from the scheme.

Engaging the insurance sector

The insurance sector will undoubtedly play a significant role in assisting operators with the management of CCS-specific liabilities. Several of the regulatory frameworks developed to-date, require an operator to hold some form of insurance product to address the expenses and liabilities associated with their operations – notably the costs of complying with directions under the regulatory framework and/or to cover the costs of remedying any damage to the environment, human health or property.

Both project and wider industry assessments, highlighted earlier in this report, reveal that in many instances current products will adequately address these extant liabilities. The reviews have also highlighted, however, several areas where projects will be unlikely to secure insurance for certain risks – noting in particular, the future cost of allowances under an emissions trading scheme.

Interviews with representatives from the insurance sector, undertaken in the preparation of this report, provide some important perspective to these discussions. Perhaps the most significant conclusion was that there was a far greater need to engage the insurance sector, by both industry and regulators, in discussions surrounding the technology. While it was recognised that the availability of insurance was an important factor in supporting project deployment, respondents also felt that in many instances the issues were regulatory in nature and that law and regulation were currently determining the availability of coverage. While all the insurers consulted had a good understanding of the processes involved, not all were fully appraised of recent research, the status of the technology or the development of law and regulation.

The interviews revealed that the absence of active CCS facilities meant it remains difficult for insurers to discuss specific, tailored policies or to identify suitable products. Some interviewees were aware of products that had been developed in the past, notably the Zurich Carbon Capture and Sequestration Insurance Policy from 2009 but were unaware of any subsequent products on the market.

Some conceptual products, which seek to address the more problematic risks and liabilities, have been proposed in recent years. The Carbon Allowance Reimbursement Insurance (CARI) policy, developed by the ClimateWise insurance industry leadership group, has been highlighted by some as a potential model for insuring against the cost of surrendering EU emissions allowances, in instances of leakage to the atmosphere (ClimateWise, 2012).

Among those interviewed, there was wide agreement that analogues may be drawn from existing Enhanced Oil Recovery (EOR) operations and broader industrial, oil and gas operations. Respondents suggested breaking the CCS process into its component parts and considering the likely liability and insurance implications for the capture, transport and storage aspects separately. When examining the CCS process in this manner, it was thought that the capture and transport elements would be considered relatively low-risk and underwriters would be confident in developing products to address them. Ultimately, the storage aspect of the process was considered perhaps the more problematic element to insure, particularly when considering the novel requirements of CCS-specific regulatory frameworks.

Notwithstanding these reservations, representatives from the insurance sector offered a more prosaic outlook on the future development of CCS-specific products. It was thought that current uncertainties could be readily overcome and that the risks posed by CCS activities were far less significant than those of other industry sectors – many of which, have been successfully insured for years. The expansion of the CCS industry would, ultimately provide greater impetus to develop CCS-specific products. Further dialogue between insurers, project proponents and regulators, would be a critical factor in ensuring that fit-for-purpose products were made available.

Regulatory relationship

The development of CCS-specific laws and regulations has provided much-needed clarification and guidance, however, reconciling the novel aspects of both the technology and these provisions will likely continue to prove a challenge to all parties. While many operators readily understand and accept the extension of some traditional forms of liability to CCS operations, the imposition of potentially new liabilities and the absence of practical experience in their application, have proven significant hurdles for investment. Regulators will be similarly challenged by the lack of practical experience in applying new regulatory frameworks, as well as potentially challenging administrative arrangements.

Analogies may clearly be drawn from the regulation of other industrial processes, from which several aspects of the CCS-specific frameworks are derived; however, the application of these new regimes across the entirety of the CCS lifecycle has yet to occur.

Project proponents that have successfully utilised the early permitting regimes, have highlighted the importance of robust dialogue with regulators when navigating the permitting process and ultimately meeting the requirements of CCS-specific legislation. Where there has been the potential for ambiguity, or an operator has specific requirements regarding financial instruments or timing, a heuristic approach to engagement has enabled operators and regulators to meet these challenges.

The timeliness of this dialogue has also proven significant, with projects citing particular success where there has been engagement early in the regulatory development process.

The absence of law and regulation, or clarity as to liability, remains problematic in many jurisdictions and it is unlikely that the technology will be deployed, absent a clear position on the allocation of liabilities or where operators are unsure that they can successfully meet their obligations. For those seeking to develop legislation, there is now a substantial body of experience upon which to draw. Greater understanding of the critical issues and risks of the technology, coupled with early project-level experience, should offer those seeking to develop legislation useful analogues upon which to develop regimes.

4.0 CONCLUSIONS

1. The challenges of liability attaching to CCS operations have long been raised by policymakers, regulators and project proponents, as a potential barrier to the widespread deployment of the technology. Early on the issue was highlighted as a major uncertainty by several reviews of the technology, and one that would likely require extensive legal and regulatory intervention.
 2. A range of detailed, CCS-specific legal frameworks have been adopted in a number of jurisdictions around the world in recent years and these have sought to address operators' concerns and provide greater regulatory certainty. The models have concentrated upon addressing the novel challenges of the CCS-project lifecycle and the distinct liabilities they create. The regulatory regimes rely in many instances upon the existing liability provisions, found in wider national and regional legislation, but have also developed innovative approaches to the management of operators and regulators' risk exposure. Notwithstanding these regulatory developments, the topic of liability continues to be raised by some project developers, policy-makers and regulators as a critical issue in the deployment of carbon capture and storage.
 3. The review of liability-specific provisions conducted in this report, undertaken through policy and legislative analysis together with interviews conducted with policymakers, regulators, lawyers, project proponents and representatives from the insurance sector; sought to challenge these views and make the case for adopting a more commercially-minded view of liability. Effort must be directed towards dispelling the widely-held view that liability is a potential 'showstopper' for the technology's deployment and afford both the public and private sectors greater confidence that these issues can be managed.
- The success of this approach depends upon a shift in focus from high-level concerns, towards identifying successful practices and eliminating the remaining obstacles to more widespread CCS deployment.
4. An assessment of the liability provisions within the early CCS-specific regulatory frameworks, reveals a wide range of CCS-specific models which actively seek to address the various forms of liability throughout the project lifecycle. The development of these frameworks is largely complete, and, in some instances, their subsequent review has revealed them to be fit-for-purpose.
 5. Project-level experience similarly confirms the suitability of these early liability models, citing overall, the positive impact that national frameworks have played in supporting project deployment. Interviews with project proponents and analysis of permitting experiences reveals many of the liabilities borne under CCS-specific models are both familiar and eminently manageable. The availability and benefits of transfer provisions in some jurisdictions, have proven particularly significant, with some proponents highlighting their impact upon project investment decisions.
 6. In parallel with advances in the development of law and regulation and project-level experience, there have been significant improvements in the characterisation and quantification of the risks associated with the CCS process. Studies considering the magnitude of potential liabilities attaching to commercial operations, project and industry-level assessments of risk and insurability and greater confidence in the fate of stored CO₂, suggest the burden of liability is much less than predicted in early analysis.

7. Notwithstanding the broadly positive assessment of legal and regulatory development to-date, there remain several discrete issues which have yet to be adequately addressed within existing frameworks. The magnitude of these issues is perhaps exacerbated by a lack of practical experience in applying the frameworks across the entirety of the CCS lifecycle. A renewed emphasis, which ultimately focuses upon resolving these remaining barriers will be crucial for those seeking to invest in or operate CCS projects. It is positive to note, as illustrated throughout this report, that there are many proposed solutions and examples upon which further action may be taken.
8. Clearly determining what is meant by the term liability, beyond the broad colloquial language found in many assessments and commentary, will be central to a more targeted and practical approach to delivering solutions. A potentially broad range of liabilities will be applicable throughout the CCS project lifecycle; however, their impact varies considerably when considered individually. Critical examples may be found in the case of both common law and greenhouse emissions/climate liabilities. The former are readily accepted by many operators as business as usual risks, which are well-understood and managed through existing practices. In the United States, however, several commentators and proponents have highlighted that conflicting property rights in the subsurface, may have potential implications in instances of transboundary trespass.
9. Greenhouse emissions/climate liabilities present unique challenges to both operators and regulators. The approach adopted to their management under some legal and regulatory regimes to-date, has resulted in some operators claiming they are unmanageable and uninsurable – a position confirmed by some insurance-sector professionals. Despite these concerns, proposals for addressing this form of liability have been developed, ranging from the conceptual to the practical financial security provisions found in the recent amendments to the Low Carbon Fuel Standard scheme (LCFS) in the US State of California.
10. The role of government and the private sector in allocating and managing risks across the CCS project lifecycle, will also impact the management of liabilities. Projects have reacted positively towards government's willingness to share the risk burden and associated liabilities under the liability transfer provisions found in many regulatory regimes. While there are some limitations to this approach, which may be addressed through further regulation or guidance, this approach has proven a popular model among regulators and operators alike. The adoption of a liability cap, in instances where commercial insurance is currently unavailable, or the establishment of a stand-alone agency to manage full-chain risks, are two examples where government may be able to further reduce the impact upon operators.
11. Further engagement of the insurance sector will be essential in developing products to assist operators manage their potential liabilities. Insurance professionals suggest that existing products may adequately address many aspects of the CCS process and that even for those liabilities currently beyond the scope of traditional products, there was clear potential for insurance to be developed. It will be critical, however, for insurers to be more closely engaged in the technical and regulatory debate, in order to allow them to develop effective and affordable products.
12. A close and robust dialogue, between project proponents and regulators will prove essential as projects seek to navigate the regulatory process and management of CCS-specific liabilities. Experience to-date has demonstrated that timely engagement has assisted both parties in determining the practical requirements of novel or ambiguous legislation. The importance of the regulatory relationship will be particularly significant in jurisdictions where legislation has yet to fully determine the allocation of liabilities.

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