The EU Legal Liability Framework for Carbon Capture and Storage: Managing the Risk of Leakage While Encouraging Investment

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Abstract

Ensuring the security of energy supply, while reaching climate change mitigation targets, is a most difficult objective. Yet the European Union (EU) can no longer afford to delay its achievement. In this context, the relatively novel technology of carbon capture and storage (CCS) has gained increasing support at EU level, as it promises to deliver a much needed solution. An enabling legal framework for the geological storage of CO_2, in the form of a 2009 CCS Directive, was rapidly adopted in order to stimulate the environmentally safe deployment of CCS. Nevertheless, deployment remains slow. This article aims to emphasise that in its present form, the Directive fails to encourage investment in CCS. By maintaining a focus on the EU provisions governing liability for leakage of CO_2 from CCS projects, it is argued that the Directive fosters legal uncertainty. Furthermore, it creates an imbalance between the responsibilities of private and public actors for the inevitable risks inherent in a socially useful and arguably necessary technology. A proposal for reform is outlined, which corrects this imbalance and provides more legal certainty.

Keywords: Carbon capture and storage/CCS, Leakage, Climate change, Geologic sequestration, EU Directive, Liability

1. Introduction

With humanity only 35 years away from what is predicted to be dangerous levels of anthropogenic climate change,[1] efforts to deploy a series of greenhouse gas mitigation and clean energy technologies have never been more relevant. The European Union (EU) has long acknowledged this urgency and has taken its place as an international leader in the adoption of policy and legal instruments enabling and encouraging the development of such technologies.[2] Over the past decade, one

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[1] IPCC, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2015) <www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf> accessed 3 March 2015.

[2] James Meadowcroft and Oluf Langhelle, *Caching The Carbon: The Politics and Policy of Carbon Capture and Storage* (Edward Elgar 2009) 217.

option which has been gaining increasing support from an EU policy perspective is Carbon Capture and Storage (CCS).

CCS represents a set of technologies which aim to prevent emissions and achieve the capture, transport and storage of CO_2 resulting from energy generation and other industrial processes, within underground geological formations.[3] Such storage is intended for tens of thousands of years.[4] The technology is promising and well understood from a theoretical perspective, yet still lacks widespread application and extensive practical experience.[5] While it promises to provide a significant contribution to climate change mitigation efforts, it simultaneously facilitates the continued use of fossil fuels.[6] This is one of the main reasons why it remains controversial among stakeholders. As Bradshaw notes, CCS has been 'described variously as a "magic bullet", "an uncomfortable but necessary option", "an expensive distraction" and a "false hope"'.[7]

The EU has taken a strong supportive stance on the deployment of CCS. This is particularly evident from its adoption of an enabling legal framework for the geological storage of CO_2, in the form of the 2009 CCS Directive.[8] However, the EU approach to regulating CCS is not without its shortcomings. One area which is arguably in need of improvement is the legal liability regime. This refers to the set of EU provisions which allocate legal responsibility for harm resulting from CCS projects.[9]

This article aims to evaluate some of the provisions of the CCS Directive in terms of their effectiveness in achieving a balance between ensuring environmentally safe deployment and the encouragement of investment in the technology. The focus of the Directive on the storage component of the CCS chain is maintained in this respect. A particular focus is also maintained on the most serious among several environmental risks associated with CO_2 storage, the risk of leakage, which refers to the possibility of CO_2 escaping from the storage site into the atmosphere or water column, thus undermining the objective of climate change mitigation.[10]

This article aims to build upon the public policy reasoning which should inform the development of a rational and coherent EU legal liability regime for CCS. Chapter one emphasises the reasons why the EU seeks to pursue the deployment of

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[3] Stuart Haszeldine, 'Geological Factors in Framing Legislation to Enable and Regulate Storage of Carbon Dioxide Deep in the Ground' in Ian Havercroft, Richard Macrory and Richard B Stewart (eds), *Carbon Capture And Storage: Emerging Legal and Regulatory Issues* (Hart Pub 2009) 8.

[4] ibid.

[5] KA Daniels, HE Huppert, JA Neufeld and D Reiner, 'The Current State of CCS: Ongoing Research at the University of Cambridge With Application to the UK Policy Framework' (2012) EPRG Working Paper 1228 <www.repository.cam.ac.uk/handle/1810/244744 > accessed 3 March 2015.

[6] Meadowcroft and Langhelle (n 2) 217.

[7] Carrie Bradshaw, 'The New Directive on the Geological Storage of Carbon Dioxide' (2009) 11 Env L Rev 196, 196.

[8] European Parliament and Council Directive 2009/31/EC of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 ('CCS Directive') [2009] OJ L140/114.

[9] Avelien Haan-Kamminga, 'Long-term Liability for Geological Carbon Storage in the European Union' (2011) 29 JENRL 309, 314.

[10] Meadowcroft and Langhelle (n 2) 282.

CCS and why said reasons are of equal relevance to the risks involved with CCS, as well as their implications for the regulatory framework and the goals, which liability should seek to achieve in this context. It highlights two essential parameters of an effective liability regime: a balance between the responsibilities of stakeholders and legal certainty with respect to the obligations of each of the relevant actors. Chapter two provides a short analysis of the types of liability associated with leakage which are governed at EU level and their effectiveness in achieving balance and legal certainty. It emphasises that in its present form, the CCS Directive places unnecessary barriers on investment in CCS due to an, arguably, inappropriate allocation of the burden of uncertainty. Chapter three draws upon existing options for a more balanced management of this uncertainty and proposes a set of amendments to the CCS Directive.

2. Making use of CCS: Importance, Risks and the Need for Balanced Regulation

Throughout their evolution, the coherence of EU energy and climate change mitigation strategies has been threatened by a conflict between two fundamental but seemingly irreconcilable objectives. On the one hand, the EU has long recognised and acted upon the need for urgent action in the fight against climate change and has established itself as a global leader in this context.[11] The collective commitments of its Member States, in line with international efforts and consensus,[12] are illustrative of the level of ambition pursued: the current target of a 20% reduction of greenhouse gas emissions as part of its 2020 climate and energy package,[13] will be supplemented by a 40% reduction target by 2030.[14] Looking ahead to the pivotal year of 2050, the EU aims to reduce its emissions by 'at least 80%'.[15] On the other hand, the only realistic prospect of EU energy security for the next half-century would perpetuate the current 'carbon lock-in', a scenario intimately linked to the use of fossil fuels, the main cause of dangerous levels of CO_2 emissions.[16] It is not an exaggeration to state that 'Europe's energy situation is precarious'.[17]

In theory, CCS presents itself as a promising, albeit controversial solution to this inherent clash between crucial EU policy goals. The geologic sequestration of CO_2 on a sufficiently large scale could not only bring a vital contribution to its

[11] James Meadowcroft and Oluf Langhelle, *Caching the Carbon: the Politics and Policy of Carbon Capture and Storage* (Edward Elgar 2009) 217.
[12] Notably the United Nations Framework Convention on Climate Change (UNFCCC 1992) and the Kyoto Protocol to the Convention.
[13] Compared to 1990 levels. Commission, '20 20 by 2020: Europe's Climate Change Opportunity' (Communication) COM (2008) 30 final, 2.
[14] Compared to 1990 levels. Commission, 'A Policy Framework for Climate and Energy in the Period From 2020 to 2030' (Communication) COM (2014) 15 final, 5.
[15] Compared to 1990 levels. Commission, 'Communication on the Future of Carbon Capture and Storage in Europe' (Communication) COM (2013) 180 final, 11.
[16] Gregory C Unruh, 'Understanding Carbon Lock-in' (2000) 28 Energy Policy 817.
[17] Meadowcroft and Langhelle (n 11) 211.

emission reduction efforts,[18] but it could also act as a 'bridge' that can buy time for Europe's currently slow transition to sustainable energy sources.[19] Its own vast coal reserves could then be utilised in a way that is compatible with environmental objectives which, in turn, would allow the EU to reduce its increasing dependence on energy imports and the associated vulnerability with international political instability.[20] There are also important economic considerations involved. Deploying CCS is said to be a significantly cheaper means of meeting climate change mitigation objectives. In this respect, Professors Adelman and Duncan note that the economics are 'sobering' and refer to the International Energy Agency ('IEA') estimate of a 71% increase in the costs for meeting 2050 targets without CCS.[21] Moreover, it can offer Europe the possibility to develop, improve and export the technology, thus enhancing its economic competitiveness at every stage and contributing to the emergence of a global CCS industry.[22] This uniquely combined potential for climate change mitigation coupled with energy security and economic development opportunities explains the significant interest in CCS shown by nations around the world and the EU's remarkably swift efforts in devising a regulatory framework supporting such projects, namely in the form of the 2009 CCS Directive.[23]

The realisation of this potential engages a number of underlying assumptions and complexities which are beyond the scope of this article.[24] Nevertheless, it involves one occasionally neglected aspect which is worth emphasising, as it arguably has a significant bearing on the design of an appropriate liability regime for CCS. This refers to an assessment of the potential harm resulting from CCS operations when viewed in light of the risks inherent in failing to incentivise deployment of the technology at the necessary scale.

A. Technical Aspects of CCS and the Risk of Leakage

Among the various types of CCS, the application to large point sources of emissions is considered to be the most promising for the purposes climate change mitigation.[25]

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[18] International Energy Agency (IEA), 'Technology Roadmap: Carbon Capture and Storage' (OECD/IEA 2013) 5 <www.iea.org/publications/freepublications/publication/technology-roadmap-carbon-capture-and-storage-2013.html> accessed 3 March 2015.

[19] European Parliament and Council Directive 2009/31/EC of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 ('CCS Directive') [2009] OJ L140/114, Preamble para (4).

[20] John Bowman and Juliette Addison, 'Carbon Capture and Storage -"The Only Hope for Mankind?" An Update' (2008) 2 LFMR 516, 516.

[21] David E Adelman and Ian J Duncan, 'The Limits of Liability in Promoting Safe Geologic Sequestration of CO_2' (2011) 22 DELPF 1, 1.

[22] Bowman and Addison (n 20) 517; Meadowcroft and Langhelle (n 11) 222.

[23] As Bowman and Addison note, 'Politically, the EU Commission, Council and Parliament, together with the USA, Australia, the UK, Norway and Canada have been competing with each other to demonstrate their leadership in the field of CCS for some time.' Bowman and Addison (n 20) 517.

[24] The large scale deployment of CCS will ultimately depend on a number of factors, in addition to the liability regime, such as the creation of sufficient financial incentives for investment, political backing and public opinion. Meadowcroft and Langhelle (n 11) 232.

[25] ibid 10.

In essence, the technological processes involved aim to prevent the CO_2 resulting from energy generation and other industrial activities from being vented into the atmosphere. Instead it ensures that it is stored underground, within suitable geological formations, for many thousands of years.[26] The CCS chain can be broadly divided into three operations: the capture of the CO_2, its transportation to the storage site and its sequestration within the underground formation.[27] Additionally, the storage phase is comprised of three stages itself, namely CO_2 injection, closure and post-closure of the site.[28] At the capture stage, the gaseous mixture emitted by point sources (either centralised power generation or other large industrial facilities such as those producing steel, cement, paper, etc.) is separated in order to obtain an almost pure stream of CO_2.[29] This is then transported to the storage site, which may be located either onshore or offshore, by pipeline or ship.[30] Among the types of subsurface formations which may be deemed suitable for the ultimate sequestration of the CO_2 are depleted oil and gas reservoirs, saline aquifers, un-mineable coal seams, and shale and basalt formations.[31]

Many of the technologies forming part of the CCS chain are well-established and their practical application is well understood. CCS operators benefit from a wealth of knowledge and practical experience gained in the context of various industries that similarly deal with subsurface geology.[32] These include hydrocarbon exploration and production, mining, underground disposal of industrial and nuclear waste, as well as underground storage of natural gas.[33] Nevertheless, there is still limited commercial-scale operational experience of the CCS chain in its entirety, which inevitably leads to a degree of uncertainty surrounding its environmental integrity.[34] Several risks associated with CCS have been identified, at a local level (potentially affecting the natural environment, human health and property) and in relation to the global climate.[35] Understandably, the concern that features most prominently in the minds of policy makers and the general public relates to the risk of CO_2 escaping from the storage formation into the surrounding environment

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[26] Stuart Haszeldine, 'Geological Factors in Framing Legislation to Enable and Regulate Storage of Carbon Dioxide Deep in the Ground' in Ian Havercroft, Richard Macrory and Richard B Stewart (eds), *Carbon Capture and Storage: Emerging Legal and Regulatory Issues* (Hart Pub 2009) 8.

[27] Elizabeth Lokey Aldrich and Cassandra Koerner, 'Assessment of Carbon Capture and Sequestration Liability Regimes' (2011) 24 Electricity Journal 35, 36.

[28] ibid.

[29] Intergovernmental Panel on Climate Change (IPCC), *Special Report on Carbon Dioxide Capture and Storage* (Cambridge University Press 2005) 25.

[30] Sven Bode and Martina Jung, 'Carbon Dioxide Capture and Storage—Liability for Non-Permanence Under the UNFCCC' (2006) 6 IEA 173, 175.

[31] Sasha Russell, *Carbon Capture and Storage Projects within Emissions Trading Systems: The Treatment of Carbon Credits Arising from Carbon Capture and Storage Projects* (Lambert Academic Pub 2011) 6.

[32] Haszeldine in Havercroft, Macrory and Stewart (n 26) 8.

[33] Kay Damen, André Faaij and Wim Turkenburg, 'Health, Safety and Environmental Risks of Underground CO_2 Storage – Overview of Mechanisms and Current Knowledge' (2006) 74 Climatic Change 289.

[34] KA Daniels, HE Huppert, JA Neufeld and D Reiner, 'The Current State of CCS: Ongoing Research at the University of Cambridge with Application to the UK Policy Framework' (2012) EPRG Working Paper 1228, 3 <www.repository.cam.ac.uk/handle/1810/244744> accessed 23 March 2015.

[35] Meadowcroft and Langhelle (n 11) 4. These risks include leakage of CO_2, leakage of CH_4 (methane), induced seismicity, ground movement and displacement of brine: Damen and others (n 33) 292.

(either the atmosphere or the water column) with the associated potential to undermine the very purpose of climate change mitigation.[36] It is therefore important briefly to explore the probability, magnitude and effects of such leakage.

i. Likelihood and Severity of Leakage

Numerous commentators emphasise that both the likelihood and magnitude of potential leakage can be considered minor and should not be overstated.[37] A frequently quoted Intergovernmental Panel on Climate Change ('IPCC') estimate states that the quantity of CO_2 escaping from rigorously selected storage sites will remain below 1%. This is 'very likely' for the first hundred years and 'likely' over the first thousand years.[38] A properly selected and competently managed storage site could experience a level of leakage that is 'much less than 0.1 per cent in even 1 million years'.[39] This is because, in spite of its novelty, CCS technology mimics analogous geological processes using 'the same natural trapping mechanisms which have already kept huge volumes of oil, gas and CO_2 underground for millions of years'.[40] Only stable geological formations are chosen, so as to provide a primary, secondary or even tertiary seal as well as side and under seals, which serve to contain the CO_2 within the porous subsurface.[41] Once injected, the natural processes referred to as 'trapping' begin to occur, further contributing to the permanent sequestration of the CO_2.[42] As a consequence of these phenomena, even an intentional effort to re-extract the entire quantity of injected CO_2 would be largely fruitless.[43] While this means that the likelihood of catastrophic accidents leading to extensive and uncontrollable leakage is extremely low, a degree of uncertainty remains as to the possibility of CO_2 escaping from transport pipelines, through operational or abandoned wells on the site, as well as through fault lines, depending on the characteristics of the geological formation in question.[44] Importantly, this risk is dictated to a significant extent by the level of maintenance of both active and abandoned infrastructure and the standard of quality applied in well design and construction.[45] Additional factors contributing to this uncertainty relate to the

[36] Meadowcroft and Langhelle (n 11) 282.
[37] Haszeldine in Havercroft, Macrory and Stewart (n 26) 14; Meadowcroft and Langhelle (n 11) 282; Adelman and Duncan (n 21) 5.
[38] IPCC 2005 (n 29) 34.
[39] Haszeldine in Havercroft, Macrory and Stewart (n 26) 14.
[40] Meadowcroft and Langhelle (n 11) 228.
[41] Haszeldine in Havercroft, Macrory and Stewart (n 26) 10.
[42] Mark Anthony de Figueiredo, 'The Liability of Carbon Dioxide Storage' (DPhil thesis, Massachusetts Institute of Technology 2007) 34-35.
[43] Haszeldine in Havercroft, Macrory and Stewart (n 26) 19.
[44] Damen and others (n 33) 296; CATO 2, 'Support to the Implementation of the CCS Directive'- Overview and Analysis of Issues Concerning the Implementation of the CCS Directive in the Netherlands' (2010) CATO2-WP4.1-D01, 68 <www.co2-cato.org/publications/library1/-support-to-the-implementation-of-the-ccs-directive-overview-and-analysis-of-issues-concerning-the-implementation-of-the-ccs-directive-in-the-netherlands> accessed 23 March 2015; de Figueiredo (n 42) section 2.2.3.
[45] Damen and others (n 33) 295.

unprecedented time scales for which CO_2 storage is sought, incomplete knowledge of the dynamics of leakage and the possibility of a scientific knowledge failure.[46]

ii. Effects of Leakage

Should the risk materialize, the consequences of leakage similarly depend on the location of the storage site and the way in which incidents are managed. For instance, leakage from onshore storage sites is likely to affect a much more significant number of people than in the case of offshore sites, particularly if they are situated in valleys.[47] The effects of heightened levels of CO_2 on human health and local fauna are well understood. Depending on the concentration, effects range from the more benign 'rapid breathing, headaches and tiredness' to the most serious dangers of 'brain malfunction, loss of consciousness' and death by asphyxiation.[48] In this context, lethal incidents involving natural releases of CO_2 are often invoked in order to illustrate the dangers of potential leakage from storage sites, notably the 1986 Lake Nyos incident in Cameroon, with 1700 human fatalities.[49] Many commentators, however, warn against such analogies for three main reasons. Firstly, if a release of CO_2 does occur from a CCS site, it is more likely to take the form of gradual seepage rather than sudden and rapid leakage, which means that the quantity of escaped CO_2 would be, at least initially, much lower than in the case of natural events.[50] Secondly, in contrast to the unpredictable nature of such events, CO_2 storage sites are subjected to close monitoring by parties who are under a legal duty to remediate the leakage immediately.[51] Unlike in the case of a natural CO_2 release, there would therefore be an opportunity to restrict public access to the location in question until it dissipates.[52]

The effects of CO_2 leakage on the local natural environment, however, are less certain.[53] The main concern relates to the contamination of drinking water and surface water, leading to adverse effects on the health of marine ecosystems.[54] With respect to the impact on the global climate, the danger is that extensive leakage would render the whole CCS exercise futile as a climate change mitigation option. Consequently, one aspect to be established from the start is the level at which CO_2 releases would start to undermine, rather than help achieve emission reduction targets. All these considerations, however, need to be balanced against the scenario in which CCS is not deployed at the necessary scale.

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[46] Meadowcroft and Langhelle (n 11) 284.

[47] Damen and others (n 33) 298.

[48] Jennifer J Roberts, Rachel A Wood and R Stuart Haszeldine, 'Assessing the Health Risks of Natural CO_2 Seeps in Italy' (2011) 108 PNAS 16545, 16545.

[49] Damen and others (n 33) 297.

[50] Roberts and others (n 48) 16547.

[51] CCS Directive (n 19) art 16.

[52] Roberts and others (n 48) 16547.

[53] Damen and others (n 33) 298. There may be 'damage to the global climate system, (…) direct damage to the flora and fauna due to the exposure to CO_2, and (…) damage due to changes in the quality of groundwater and surface water': CATO 2 (n 44) 64.

[54] Ian Havercroft and Richard Macrory, *Legal Liability and Carbon Capture and Storage: A Comparative Perspective* (Global CCS Institute 2014) <www.globalccsinstitute.com/publications/legal-liability-and-carbon-capture-and-storage-comparative-perspective> accessed 23 March 2015; Damen and others (n 33) 298.

B. Consequences of Failing to Deploy CCS

While CCS is only one example within a diverse portfolio of greenhouse gas abatement strategies, numerous commentators emphasise that it is the only option that can help achieve the necessary scale of emission reductions within the relevant time frame.[55] Other measures, particularly increased energy efficiency and renewable energy generation are preferable from a sustainability perspective, yet still face significant obstacles and cannot deliver the required results within the few short decades left to avoid dangerous anthropogenic climate change. Moreover, while these alternative strategies can only address emissions from power plants, CCS can be applied to many other large industrial processes that emit CO_2 and thus contribute significantly to climate change.[56] CCS' contribution can be important precisely in relation to the sources that are most problematic and most likely to see an increase in emissions.[57] In addition, CCS is among the very few technologies that can achieve negative CO_2 emissions when coupled with biomass energy.[58] It is therefore often argued that reaching current emission reduction targets is simply not possible unless CCS technology is installed for almost all large CO_2 emitters.[59]

In this context, the potential severity of the effects of CO_2 leakage from CCS activities should arguably be put into a broader perspective, as many of them are already occurring without CCS, precisely due to the regular accumulation of yearly emissions. For instance, the main feared consequence of CO_2 leakage from offshore storage sites relates to ocean acidification and its adverse effects on marine ecosystems and the livelihood of populations depending on them.[60] However, the IPCC estimates that 'the ocean has [already] absorbed about 30% of the emitted anthropogenic CO_2' and will continue to do so in the context of ever increasing emissions, leading to the very same types of adverse effects.[61] A similar reasoning can be applied to the fear of CO_2 leakage into the atmosphere. As Roberts et al note, 'Anthropogenic CO_2 release is contributing to a process which will have catastrophic effects on human lives across the globe'.[62] Therefore, it can be argued that insofar as the risk of leakage from CCS activities is affected, it is relatively small and manageable and it is preferable to the much greater and unmanageable risks associated with climate change, the effects of which can already be observed in the natural world.

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[55] Daniels and others (n 34); Adelman and Duncan (n 21) 1; Commission, 'Proposal for a Directive of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006' COM (2008) 18 final, 2.

[56] Bowman and Addison (n 20) 516.

[57] Meadowcroft and Langhelle (n 11) 253.

[58] See Christian Azar, Kristian Lindgren, Eric Larson and Kenneth Möllersten, 'Carbon Capture and Storage from Fossil Fuels and Biomass – Costs and Potential Role in Stabilising the Atmosphere' (2006) 74 Climatic Change 47.

[59] Meadowcroft and Langhelle (n 11) 8.

[60] IPCC 2005 (n 29) 38.

[61] IPCC, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2015) 4 <www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf> accessed 23 March 2015.

[62] Roberts and others (n 48) 16547.

Finally, a related aspect which should arguably carry some weight in the risk assessment refers to the idea that the likely consequences of failing to develop CCS at a large enough scale would not be confined to the European context, as climate change affects the whole of humanity. It can be said that the EU, as a union of developed United Nations Member States, should act as a leader in the urgent improvement and deployment of climate change mitigation technologies, accepting the associated costs and local risks in accordance with the principle of 'common but differentiated responsibility'.[63] Indeed, this is a role that the EU is aiming to fulfil, as it has repeatedly stated, but which requires a more holistic approach than that which is currently being adopted through legislation.[64]

C. Implications for the Regulatory Framework and the Role of Liability

Two central facets of the discussion on appropriate regulation therefore emerge. Firstly, the risk of leakage as outlined above shows that the likelihood of its occurrence depends to a significant extent on human action and is associated primarily with elements which are under the operator's full control. Crucially, careful site selection both in terms of the location of the storage site relative to densely populated areas, and in terms of the geological formation itself, will minimise the likelihood and effects of leakage to a level at which it can be considered as nearly insignificant. The potential magnitude of the leak, if it does occur, can be further reduced through appropriate monitoring and remediation measures. The residual risk that inevitably remains, due to the incompleteness of scientific knowledge and the lack of extensive practical experience with CCS, is potentially less acute than many of the risks that are routinely accepted in relation to other industries.[65] Secondly, many of the fears relating to the effects of CO_2 leakage on the global environment as a consequence of CCS activities are arguably unwarranted as they are already in the process of materialising precisely due to the absence of CCS. Adding this aspect into the equation could lead to the conclusion that a relatively permissive approach should be taken to the regulation of CCS projects, in light of the urgency of climate change mitigation efforts.

Such an approach, however, would be dangerous. As Anderson et al note, 'because geological sites *can* be found and managed safely in such a way as to all but rule out leakage, does not mean they *will* be found and managed in that way if the proper guidelines, incentives and oversight are not in place'.[66] Similarly, Meadowcroft and Langhelle point out that 'the fact that risks can be managed successfully (and have been […] in similar types of industrial setting in the past)

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[63] United Nations Framework Convention on Climate Change (UNFCCC, 1992) art 4.

[64] As argued in Chapter Three.

[65] Chris Clarke, 'Long-term Liability for CCS: Some Thoughts about Specific Risks, Multiple Regimes and the EU Directive' in Ian Havercroft, Richard Macrory and Richard B Stewart (eds), *Carbon Capture and Storage: Emerging Legal and Regulatory Issues* (Hart Pub 2009) 179; 'With appropriate site selection the local health, safety and environment risks of geological storage would be comparable to the risks of current activities such as natural gas storage, enhanced oil recovery and deep underground disposal of acid gas': Russell (n 31) 40.

[66] Jason Anderson and others, 'Results from the Project "Acceptance of CO_2 Capture and Storage: Economics, Policy and Technology (ACCSEPT)"' (2009) 1 Energy Procedia 4649, 4650.

does not automatically guarantee that they will be managed successfully in the case of CCS projects'.[67] Once the decision has been made to proceed with the deployment of CCS projects, the supporting regulatory framework should be devised in such a way as to ensure that leakage risks are indeed minimised to the greatest extent possible by the parties who are in the best position to do so at any given stage. Yet, it should also allocate the burden of uncertainty in a manner that reflects the social utility of the technology. This is where a balanced legal liability regime can bring a vital contribution. However, it can only do so if it is carefully tailored to the characteristics of CCS projects and if it takes a broad (perhaps global) perspective in creating a balance between various stakeholders' interests. It can therefore be said that the liability regime in the context of CCS projects should seek to achieve two aims:

- It should represent a clear legal expression of what is considered to be an appropriate division of responsibilities between CCS operators (along with their insurers) and Member States. This needs to be constructed on the basis of a realistic assessment of the risk of leakage[68] and the allocation of a party (or parties) which is in the best position to accept this risk at various stages of the CCS operation. An excessive level of liability on either private or public entities would effectively inhibit the deployment of CCS projects at the necessary scale. This is due to two possible reasons: either investment cannot be secured (if operators cannot shoulder the financial burden or cannot find appropriate insurance) or it would be politically and publically unacceptable (if the Member States were to be solely liable for leakage, there would be little incentive for operators to exercise the necessary degree of care throughout CCS operations – the issue of 'moral hazard').[69] A balance must be struck between the interests of operators, the concerns of individual Member States and the collective interest in addressing climate change. Particularly in the EU context, creative solutions may need to be devised in order to ensure their political acceptability.

- It should be formulated based on an awareness of the extent to which these rules play a role in encouraging or discouraging investment in CCS projects. In this context, what must be achieved is much-needed legal certainty with respect to the nature, extent and duration of liabilities, as this element carries considerable weight in investment decisions.

The third chapter will proceed to analyse the current EU approach to liability for leakage within the framework of the 2009 CCS Directive, in terms of the achievement of two aims: balance and legal certainty.

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[67] Meadowcroft and Langhelle (n 11) 281.

[68] As Roberts and others note, 'uncertainty does not mean inevitable leakage' (Roberts and others (n 48) 16545).

[69] Avelien Haan-Kamminga, 'Long-term Liability for Geological Carbon Storage in the European Union' (2011) 29 JENRL 309, 326; Meadowcroft and Langhelle (n 11) 12.

3. Legal Liability for Leakage: The EU Regulatory Framework

The 2009 CCS Directive is the final result of an accelerated effort on the part of EU institutions to translate a strongly supported policy into a regulatory framework.[70] The proposal for a Directive that would govern the environmentally safe deployment of CCS projects formed part of the 2008 Climate and Energy Package. It represents an ambitious set of legislative measures that would not only ensure the attainment of the EU's own greenhouse gas reduction targets but also strengthen its position of international leadership in the matter of climate change mitigation at a strategically important moment.[71] The speed with which the Directive was adopted, coupled with the political context which required an especially strong emphasis on ensuring the environmental integrity of CCS projects, may, however, also explain some of its shortcomings.[72]

In respecting the fundamental principles of subsidiarity and proportionality,[73] the CCS Directive represents an instrument of minimum harmonization which leaves a significant amount of discretion to Member States, an aspect which in itself may generate a degree of regulatory uncertainty.[74] The CCS Directive only provides for what is necessary to create a general legal framework for site selection,[75] permitting of exploration and storage,[76] monitoring[77] reporting[78] and management[79]

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[70] The idea of CCS as a climate change mitigation strategy had only recently been gaining increasing support, since a 2005 Commission Communication, 'Winning the Battle against Global Climate Change' COM (2005) 35 final; James Meadowcroft and Oluf Langhelle, *Caching the Carbon: The Politics and Policy of Carbon Capture and Storage* (Edward Elgar 2009) 217.

[71] It was important that the EU implement a set of concrete climate measures ahead of the 2009 Copenhagen summit in order to convince key States to reach an agreement on greenhouse gas reduction targets. Meadowcroft and Langhelle (n 70) 221.

[72] The Commission services worked at 'incredible speed' (Meadowcroft and Langhelle (n 70) 225) voting on the Directive on 'Super Tuesday' (John Bowman and Juliette Addison, 'Carbon Capture and Storage -"The Only Hope for Mankind?" An Update' (2008) 2 LFMR 516, 518). Furthermore, 'the Directive (…) was agreed at a time when many Member States were (and remain) sceptical of the possibility of permanent CO_2 storage' (Ian Havercroft and Richard Macrory, *Legal Liability and Carbon Capture and Storage: A Comparative Perspective* (Global CCS Institute 2014) 38 <www.globalccsinstitute.com/publications/legal-liability-and-carbon-capture-and-storage-comparative-perspective> accessed 23 March 2015.

[73] Consolidated Version of the Treaty on European Union [2012] OJ C326/13 art 5.

[74] Avelien Haan-Kamminga, Martha M Roggenkamp and Edwin Woerdman, 'Legal Uncertainties of Carbon Capture and Storage in the EU: The Netherlands as an Example' (2010) 3 CCLR 240, 241-242.

[75] Under art 4 of the CCS Directive (n 19). Member States decide which parts of their territory may be used for the selection of storage sites. The suitability of geological formations for this purpose must be determined on the basis of the Annex 1 criteria (these refer to data collection, geological modelling, characterisation of the storage dynamic behaviour, sensitivity and risk assessment). Such formations may only be selected for storage if no significant risk of leakage or environmental or health risks are identified.

[76] Under art 5 (exploration permits) and arts 6-11 (storage permits) of the CCS Directive (n 19).

[77] Art 13 of the CCS Directive (n 19).

[78] Art 14 of the CCS Directive (n 19).

[79] Most importantly, measures for addressing leakages (art 16) and closure and post-closure obligations (art 17). In order to ensure that the operator is able to meet its obligations under the Directive, financial security is required under art 19 and a financial contribution must be made under art 20 towards post-transfer costs borne by the competent authority for ensuring the permanent storage of the CO_2 (CCS Directive) (n 19).

of CO_2 storage sites, as well as a division of responsibilities between the operator and the competent national authority.[80] Leakage of CO_2 from the storage site may generate four types of legal consequences.

- Firstly, administrative liability arising under the provisions of the CCS Directive itself (as transposed within national law);
- Secondly, liability in relation to environmental harm;[81]
- Thirdly, an obligation to purchase emission allowances;[82] and
- Fourthly, liability under delict/tort and other laws at national level.

The first three categories are addressed through EU instruments and constitute the focus of this analysis, which is built upon the two essential criteria proposed above in Chapter One.

A. Liability under the CCS Directive

i. Balance

It can be said that the provisions of the CCS Directive reflect an awareness of the extremely long timescales which are envisaged for the management of CO_2 storage sites and of the idea that storage is intended to be permanent. The timescales involved far exceed the usual lifespan of the private entities managing CCS storage sites.[83] The necessity for a degree of 'intergenerational transfer of risk'[84] is reflected in the Article 18(1) requirement that most liabilities[85] arising in connection with the storage site are to be transferred to the competent authority after a sufficient period of time has passed, indicating post-closure stability.[86] Nevertheless, until the point of such transfer,[87] there is a significant imbalance in the distribution of risks between the operator and the Member State, which does not adequately reflect the nature and purpose of CCS as a climate change mitigation technology. In essence, the competent authority does not contribute at all to shouldering the burden of pre-transfer risks of leakage, while the operator is exposed to potentially unquantifiable and uncapped liability. The two most important obligations in this respect relate to the requirement

[80] Through the transfer of post-closure responsibilities to the competent authority at national level: CCS Directive (n 19) art 18.
[81] Governed by the ELD: Consolidated Version of the European Parliament and Council Directive 2004/35/CE of 21 April 2004 on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage ('ELD') [2013] OJ L143/56, Annex III.
[82] Under European Parliament and Council Directive 2003/87/EC of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC ('ETS Directive') [2003] OJ L275/32.
[83] Avelien Haan-Kamminga, 'Long-term Liability for Geological Carbon Storage in the European Union' (2011) 29 JENRL 309, 310.
[84] Meadowcroft and Langhelle (n 70) 285.
[85] Only those relating to monitoring and corrective measures under the CCS Directive, purchase of allowances under the ETS Directive and preventive and remedial action under the ELD, the transfer of other liabilities being left to the discretion of the Member States.
[86] The minimum is 20 years, unless the competent authority is satisfied that the CO_2 will be 'completely' and 'permanently' stored at an earlier date. CCS Directive (n 19) art 18(1)(b).
[87] Which may be uncertain or may not occur at all, as argued below.

for financial security [88] and contribution under the financial mechanism, [89] as cumulatively they encompass financial cover for all of the operator's leakage liabilities under the CCS and ETS Directives. Particularly in respect of the amount of financial security, there are concerns that these obligations may prove to be prohibitively expensive for operators.[90]

As a matter of principle, it is unclear why the Member State should not bear part of this liability, at least until sufficient practical experience with CCS is gained in order better to estimate the financial amounts involved in the risk of leakage and, importantly, to encourage the development of appropriate insurance products.[91] The difficulty with this imbalance can also be framed in terms of a lack of legal certainty.

ii. Legal certainty

Both the criteria for determining the amount of the financial security and the contribution under the financial mechanism are surrounded by uncertainty. This is, on the one hand, due to the difficulty in calculating the amounts of the separate components within the financial security and, on the other hand, due to the uncertainty surrounding the precise components of the financial contribution.

Firstly, among the pre-transfer obligations covered by the financial security, there is at least one which is arguably unquantifiable: the obligation to surrender allowances under the ETS Directive.[92] The main difficulty is that neither the CCS Directive nor the published Guidance allows the simple estimation of this obligation based on the likelihood of leakage[93]. Theoretically this leaves open the possibility for the operator to be required to insure against the loss of the whole quantity of stored CO_2, which is both 'physically impossible' and 'an unacceptable position for

[88] CCS Directive (n 19) art 19, covering all of the operator's pre-transfer obligations under the CCS and ETS Directives.

[89] ibid art 20, covering at a minimum the costs of monitoring for a period of 30 years post-transfer but potentially including 'costs borne by the competent authority after the transfer of responsibility to ensure that the CO_2 is completely and permanently contained'.

[90] Chiara Armeni, 'Case Studies on the Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide: United Kingdom' (University College London, Centre for Law and the Environment, Carbon Capture Legal Programme 2011) 32 <http://decarboni.se/sites/default/files/publications/49456/cclpeucasestudiesprojectunitedkingdom.pdf> accessed 23 March 2015.

[91] ClimateWise, 'Managing Liabilities of European Carbon Capture and Storage' (2012) 5 <www.climatewise.org.uk/storage/_website-2012/collaborations/ccs/ClimateWise%20CCS%20Report%20Nov%202012%20-%20Full%20Report.pdf> accessed 23 March 2015.

[92] Havercroft and Macrory (n 72) at 46 summarise the obligations which fall under the financial security.

[93] ibid 47; Commission, 'Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide Guidance Document 4: Article 19 Financial Security and Article 20 Financial Mechanism' (European Communities 2011) (Commission Guidance Document 4) 12 <http://ec.europa.eu/clima/policies/lowcarbon/ccs/implementation/docs/gd4_en.pdf.> accessed 23 March 2015.

commercial businesses'.[94] Conversely, it is unrealistic to expect that no leakage will occur at all.[95]

Secondly, the criteria for assessing the post-transfer financial contribution under Article 20 of the CCS Directive, which opens the possibility to include any costs 'borne by the competent authority […] to ensure that the CO_2 is completely and permanently contained'[96] may be so broad as to 'not represent an actual transfer of responsibility' at all.[97] In the absence of a cap or of an understanding with the competent authority, practical experience with demonstration projects shows that this may significantly hinder investment decisions.[98]

Another important source of legal uncertainty relates to the precise conditions under which transfer of responsibilities to the competent authority is to take place and the period of time post-closure that must elapse for this purpose. It is noteworthy that the Directive leaves both aspects at the discretion of the Member States.[99] This means that such transfer may never take place at all, as the competent authority is not satisfied that 'all available evidence indicates that the stored CO_2 will be completely and permanently contained' [100], even if the set minimum period has elapsed. Furthermore, the requirement of Article 18(1)(b) does not make the decision as to the appropriate minimum period exclusively dependent on the characteristics and behaviour of the particular storage site. As the Commission itself notes, 'the [competent authority] is always at liberty to determine a longer period than 20 years if it considers this appropriate'.[101] Even if a storage site shows strong signs of stability throughout its active existence, as well as for 20 years post-closure with only a very minor risk of leakage, the competent authority may never declare itself

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[94] Stuart Haszeldine, 'Geological Factors in Framing Legislation to Enable and Regulate Storage of Carbon Dioxide Deep in the Ground' in Ian Havercroft, Richard Macrory and Richard B Stewart (eds), *Carbon Capture and Storage: Emerging Legal and Regulatory Issues* (Hart Pub 2009) 19.

[95] CATO 2, '"Support to the Implementation of the CCS Directive"- Overview and Analysis of Issues Concerning the Implementation of the CCS Directive in the Netherlands' (2010) CATO2-WP4.1-D01, 6 <www.co2-cato.org/publications/library1/-support-to-the-implementation-of-the-ccs-directive-overview-and-analysis-of-issues-concerning-the-implementation-of-the-ccs-directive-in-the-netherlands> accessed 23 March 2015.

[96] Which, according to Guidance Document 4 (n 93) at 42 may include any obligations under the CCS Directive, namely monitoring, corrective measures, surrender of allowances and preventive and remedial actions under the ELD.

[97] Dentons, 'The Experience of CCS Demonstration Projects in the European Union with the Transposition of the CCS Directive' (Global CCS Institute 2013) 4 <www.globalccsinstitute.com/publications/experience-ccs-demonstration-projects-eu-transposition-ccs-directive> accessed 23 March 2015.

[98] ibid 29.

[99] CCS Directive (n 19) art 18(1) where four conditions are imposed (complete and permanent containment, a minimum period of time, a financial contribution and the sealing of the storage site with removal of the injection facilities), yet the first two are arguably surrounded by uncertainty.

[100] ibid art 18(1)(a). It has been argued that this test may be 'extremely difficult or impossible to fulfil in practice', and suggested that 'a single dissenting view of an expert would mean the test is not fulfilled' (Havercroft and Macrory (n 72) 38).

[101] Commission, *Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide: Guidance Document 3 - Criteria for Transfer of Responsibility to the Competent Authority* (European Communities 2011) (Commission Guidance Document 3) 14 <http://ec.europa.eu/clima/policies/lowcarbon/ccs/implementation/docs/gd3_en.pdf> accessed 23 March 2015.

satisfied that the CO_2 is 'completely' and 'permanently' contained. It is true that guidance as to what constitutes 'complete' and 'permanent' storage has been given, but this is contained in a non-binding (though persuasive) document.[102] The competent authority does have an incentive not to accept the transfer, as it would thus avoid the associated liabilities.[103] Still, it will be aware that uncertain or unreasonable conditions for transfer would undermine investment in CCS.[104] The decision on transfer will then, perhaps, depend on the level of political support for CCS within that Member State at any given time, which may vary and thus create unnecessary uncertainty for operators and investors.[105] Crucially, even if transfer of responsibilities has taken place, the operator may still find himself exposed to unexpected liability through the Article 18(7) 'claw back' provision, which allows for post-transfer recovery of costs 'including [in] cases of deficient data, concealment of relevant information, negligence, wilful deceit or a failure to exercise due diligence'. It is, without a doubt, necessary and reasonable for such a provision to exist. However, this formulation is particularly open-ended in the complete absence of definitions for each of the terms and situations that are being referred to.[106] As Durrant argues when comparing the Australian regime to the EU CCS Directive, the result is that '[…] under both [schemes], proposed operators must make provision for the possibility, in the absence of any other temporal or quantum limits, of almost indeterminate liability arising from these CCS projects'.[107]

It can therefore be argued that binding criteria as to what constitutes complete and permanent containment of the CO_2, as well as criteria for the manner in which the pre-transfer period is to be determined, should be adopted within the CCS Directive.[108] In relation to post-transfer recovery of costs, it is vital that precise definitions be given. Legal certainty is needed in relation to these aspects, as they carry considerable weight in investment decisions.[109] In this context, experience from several CCS demonstration projects across four Member States has shown that uncertainty surrounding the transfer of responsibilities constitutes an important challenge.[110] One proposed solution is the removal of the 20 year rule altogether[111] and its replacement with clear and certain criteria. Alternatively, it has been suggested that risk levels are not expected to vary significantly between storage

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[102] ibid 4-11, with a particular emphasis on the content of the operator's transfer report. As Havercroft and Macrory (n 72) note at 38, the competent authority is ultimately allowed to exercise its 'own independent judgment'.

[103] Haan-Kamminga, Roggenkamp and Woerdman (n 74) 247.

[104] ibid.

[105] In this respect it has been pointed out that the objectivity of the competent authority in relation to the transfer decision is doubtful and that it may find itself under political pressure (Dentons (n 97) 29).

[106] Havercroft and Macrory (n 72) 44.

[107] Nicola A Durrant, 'Carbon Capture and Storage Laws in Australia: Project Facilitation or a Precautionary Approach?' (2010) 18 Environmental Liability Journal 148, 168.

[108] Tom Kerr, Ian Havercroft and Tim Dixon, 'Legal and Regulatory Developments Associated with Carbon Dioxide Capture and Storage: A Global Update' (2009) 1 Energy Procedia 4395, 4400.

[109] Haan-Kamminga, Roggenkamp and Woerdman (n 74) 247.

[110] Dentons (n 97) 28.

[111] ibid.

sites, in light of the site selection criteria under Article 4 of the CCS Directive.[112] A standard pre-transfer period at EU level would therefore be desirable in order to prevent both a 'race to the bottom' and a 'race to the top' between Member States in relation to safety standards.[113]

B. Environmental Liability under the ELD

i. Balance

The set of rules contained in the Environmental Liability Directive ('ELD') can perhaps be characterised as the only type of leakage liability imposed on CCS operators that is insufficiently rigorous from the point of view of environmental protection.[114] Even for the types of environmental damage or potential damage for which the operator may be held strictly liable,[115] there are two particularly important defences which may be available if the Member State in question opted to implement them: the 'permit' defence and the 'state of the art' defence.[116] In theory, operators may use these defences in cases of leakage where there was no fault or negligence on their part and where they were either fully complying with the terms of their storage permit or the activity causing the leakage was not considered likely to be harmful at the time. These two defences may prove to be particularly useful given the characteristics of CCS and may cover a large number of cases involving prudent operators who were neither at fault nor negligent. Nevertheless, they may not have access to these defences, as some Member States may have opted not to implement them. In this context, it could be suggested that the availability of these two defences should be made compulsory in the case of CCS, in light of the need to acknowledge that there is little benefit in holding scientific knowledge failures against operators, when this may hinder the deployment of a socially useful project.

Still, there are disadvantages in relying on the ELD to regulate operators' environmental liability. In this respect, Bradshaw notes the importance of the distinction between framing certain obligations as matters of compliance with the storage permit, as opposed to matters of liability.[117] There is a symbolic discrepancy between the obligation of the competent authority to carry out corrective measures in respect of leakage if the operator fails to do so under the permit,[118] and the lack of

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[112] CATO 2 (n 95) 10.

[113] ibid.

[114] This is because Article 2 of the ELD (n 81) gives a restrictive definition to 'environmental damage', covering only damage to protected species and natural habitats under EU law, damage to water covered by the EU Water Directive and land damage affecting human health. As Havercroft and Macrory (n 72) note at 27, this may only cover an extremely low number of cases.

[115] ELD (n 81) art 3(1)(a) imposes strict liability for damage or imminent threats of damage caused by Annex III activities, which include CCS.

[116] Under art 8(3) of the ELD (n 81) compulsory defences include the 'third party defence' (despite appropriate safety measures being in place) and compliance with a compulsory order or instruction. Optional defences under art 8(4) include compliance with an authorisation (the 'permit defence') and the 'state of the art defence' (the activity was not considered likely to cause damage according to the state of scientific and technical knowledge at the time).

[117] Carrie Bradshaw, 'The New Directive on the Geological Storage of Carbon Dioxide' (2009) 11 EL Rev 196, 201-202.

[118] CCS Directive (n 19) art 16(4); Bradshaw (n 117) 202.

an equivalent obligation on the authority in the context of preventing environmental damage under the ELD.[119] Indeed, under Articles 5(4) and 6(4) of the ELD, respectively, the relevant authority *may* take preventive or remedial actions and then recover the costs, should the operator fail to act. It could be said that the issue is of little practical relevance in light of the first obligation under the CCS Directive, yet the corrective measures necessary to remedy the leakage itself may not always be synonymous with the measures necessary to prevent or remediate *environmental* damage. In addition to the fact that operators' environmental liability is not capped, the Member State is also not bound to intervene, not even as a last resort for the prevention or remediation of environmental harms resulting from CCS. This discrepancy can therefore also be said to reflect an imbalance between the responsibilities of private and public stakeholders for the risks associated with CCS.

C. Risks of Payment for Leakage under the ETS Directive

i. Balance

Through the inclusion of CCS projects under the EU Emission Trading System ('ETS'), CO_2 that is captured and stored in accordance with the CCS Directive will be treated as an avoided emission and will therefore not give rise to the obligation for surrender of allowances.[120] In order to maintain the environmental integrity of the EU ETS, operators will be required to surrender allowances only for the quantity of leaked CO_2, on a yearly basis.[121] However, it is unclear from the perspective of balance why it is only the operator that is required to bear the (potentially) prohibitively expensive burden of purchasing allowances, particularly in light of the extremely high and strict financial penalties that are imposed for the failure to comply with this obligation.[122] The competent authority only bears this liability post-transfer, a point which is, again, uncertain.[123] This question emerges more clearly from the perspective of legal certainty.

ii. Legal certainty

While the obligation imposed on operators to buy credits under the ETS in the event of leakage makes intuitive sense, both as a 'penalty' (providing an incentive for operators to observe a high standard of care) and as 'compensation' (for breaching the environmental integrity of the EU ETS), there is a difficulty caused by the potentially significant variation in the price of carbon at two relevant times: the point of storage of the CO_2 (the moment at which it becomes an avoided emission) and the (unpredictable) point of occurrence of leakage. This relates to uncertainty surrounding the level of the carbon price years into the future, which can lead to two situations:

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[119] Bradshaw (n 117) 202.
[120] ETS Directive (n 82) art 12(3a).
[121] ETS Directive (n 82) art 6(2)(e).
[122] Currently a penalty of 100 EUR per tonne of excess CO_2 emitted, under art 16 of the ETS Directive (n 82). This penalty will be imposed even when the breach was unintentional, for instance in the context of an unpredictable leak (n 72) 35.
[123] CCS Directive (n 19) art 18.

(i) The price of carbon at the point of leakage may be lower than the operators' financial gain from having stored that quantity of CO_2. While a relatively low future carbon price is unlikely in light of the expected tightening of environmental protection measures, the situation may nevertheless arise, for instance, due to an economic crisis.[124] In this context, it has been argued that such a price 'may fail to address any financial gain which could be garnered from a failure to remedy leakages' and that climate liability should be addressed through a penalty that is more 'dissuasive' than the ETS system.[125] Such an argument, however, overlooks the reality that the maximum an operator can be required to do, is to apply industry best practice and the highest standard of care during CCS operations. The familiar reasoning applied to penalties under criminal law (the harsher the punishment, the greater the deterrent effect) cannot apply to CCS as there is only so much risk mitigation that human knowledge and skill can achieve. There is a point beyond which a high financial penalty will lose its deterrent effect and start to lower the chances of investment in CCS being secured at all. Liability should therefore not exceed this level. Furthermore, it is arguably unreasonable to penalise operators for fluctuations in the strength of the European economy or for the failure of the EU ETS system to reflect the true price of emissions at any given time.

(ii) The price of carbon at the point of leakage may be significantly higher than the operator's financial gain from having stored the CO_2. This is arguably a more likely and a more concerning scenario, as it exposes the operator to unquantifiable liability. This risk may also be heightened by uncertainty surrounding the actual quantity of CO_2 that has leaked, the measurement of which may give rise to debates particularly in relation to the precise point in time at which leakage started to occur.[126]

Rather than imposing the burden of this uncertainty exclusively upon operators, there is a more suitable approach to addressing climate liability. Firstly, to include CCS under the ETS in the sense that stored CO_2 is treated as not emitted (maintain the current approach[127], but to deal with the responsibility of surrendering allowances for leaked CO_2 in a different manner and under a different legal instrument, such as the CCS Directive.[128] An option would be to spread the possible financial burden of this obligation between three 'layers' of relevant parties (as proposed in chapter three). The operator would be liable to buy credits up to a predetermined cap. If the leakage exceeds that cap, the mutual operators' fund would intervene up to a second cap; if that second cap is exceeded as well, the State would contribute the rest of the amount. This proposal would bring a vital dose of legal certainty. If the carbon price at the point of leakage is higher than at the point of storage and, if the level of the operator's cap is exceeded, the financial burden will

[124] The Commission notes that carbon prices dropped from €30 in 2008 to €5 in 2013 as a result of the global recession (n 15) 4.
[125] Bradshaw (n 117) 202.
[126] As leakage measurement techniques will likely be provided in the monitoring plan, disagreements may only arise in relation to the start of leakage (Haan-Kamminga (n 83) 317).
[127] As Russell (n 31) notes at 11, the 'avoided emission' method of accounting for CCS adopted by the ETS Directive is more effective than treating the technology as an offset.
[128] This is because the ETS Directive does not currently allow Member States to cap liability in respect of allowances, though such an exception could be introduced in respect of CCS (n 72) 36.

be shared between the three stakeholders in light of the broader social utility of CCS and of the need to incentivise investment in the first place. A similar balance could be achieved through the setting of a simple cap and floor price for emission allowances,[129] with the Member State contributing the amount that is needed above the cap, though this would require an amendment of the ETS Directive. Importantly, capping operators' climate liability would ensure that appropriate insurance products could be much more easily obtained than at present, when no such products exist for the cover of ultimately unquantifiable liability.[130]

4. Proposals for Reform

It is important not to lose sight of the fact that the choices made in the drafting of the CCS Directive, particularly its shortcomings with respect to balance and legal certainty are the result of a minimum harmonization strategy and not of an unsupportive policy. The EU did not seek to intrude into the choices of national legal systems more than was necessary to provide a general framework for regulating the most challenging component (that of CO_2 storage) of a still controversial technology.[131] Such an approach is profoundly incompatible with the rhetoric of a necessity and urgency for commercial-scale deployment of a key climate change mitigation strategy[132], which requires a strongly supportive regulatory framework. Yet given the nature of the EU, it may prove difficult to secure the agreement of all Member States on such a framework. Particularly in respect of the liability regime, the challenge is to devise a set of reforms which carefully balance the achievement of three aims: ensuring political acceptability, ensuring the long-term environmental integrity of CCS projects (avoiding moral hazard), and incentivising rapid and widespread commercial deployment. This chapter proposes an approach for the combined achievement of these aims.

A. Ensuring Political Acceptability

The idea of amending the CCS Directive so as better to balance the operator's obligations and shift a proportion of its pre-transfer liabilities onto the Member State, may be countered by pointing to the nature of the legal instrument used (a Directive, rather than a Regulation) and to the decision on a minimum harmonization strategy. However, it is important to note that the approach taken does not reflect a long-term strategy for the regulation of CCS at EU level; it merely reflects the most convenient option available at the time for securing the rapid adoption of a key legal instrument regulating a relatively novel and controversial technology. The Commission's report

[129] Dentons (n 97) 28.
[130] ClimateWise (n 91) 5.
[131] The choice of using a Directive was made in order to secure the agreement of the majority of Member States, as it inherently leads to a significant degree of discretion as to the manner of its transposition into national law. CATO (n 95) 3.
[132] 'CCS is (…) vital for meeting the Union's greenhouse gas reduction targets'. COM (n 15) 3.

on the CCS Directive[133] may very well conclude, in light of the currently slow take up of CCS, that the uncertainty surrounding operators' liabilities is an obstacle to investment which must be reduced through amendments, either providing more clarity to the existing rules or introducing a re-distribution of risks between operators and competent authorities.

If such reforms are proposed, there is one aspect which should arguably be emphasised in order to secure their political acceptance. This relates to the idea that under Article 4(1) of the CCS Directive, Member States retain discretion as to which parts of their territory, if any, are allowed for CO_2 storage and the extent to which storage is allowed. They exercise full control over these decisions. Therefore, insofar as Member States decide to allow the deployment of CCS on the whole or parts of their territory[134], an argument should be put forward that the broader interests of achieving Europe's (and ultimately, the world's) energy security and climate change mitigation goals justify a restriction of their discretion as to how the burden of uncertainty is to be distributed, in order to ensure the commercial viability of CCS.

The main advantage of this approach is symbolic, yet sends a powerful message that is more compatible with EU policy statements. It is symbolic in the sense that if a Member State is not particularly supportive of CCS or remains sceptical as to its viability, it retains the right to prohibit CCS on the whole or parts of its territory under both approaches. However, in relation to those Member States which allow CO2 storage, a more 'intrusive' and balanced liability regime at EU level would send the message that if CCS is to be deployed this is to be done at the necessary scale.

B. Ensuring Long-term Environmental Integrity

As Tysoe argues, 'prevention is better than cure'.[135] Given that the overarching purpose of the CCS Directive is to ensure the 'environmentally safe storage of CO_2'[136] and that what is needed first and foremost for the achievement of this goal is rigorous site selection,[137] a much stronger emphasis on this aspect arguably needs to be reflected in the Directive. This is because, currently, the criteria for site selection under Article 4 are not sufficiently defined. There are 'difficult concepts' which are in need of clarification and may not have been defined through national legislation.[138] One example is UK legislation, which merely refers back to definitions under the Directive.[139] Article 3 of the CCS Directive only gives general definitions to elements such as 'storage complex' and 'significant risk'. Notably, the meaning of the term 'leakage' is made dependent on the ambiguous definition of 'storage

[133] Due on 31 March 2015, under Article 38(2) of the CCS Directive (n 19).
[134] Particularly as such parts may be chosen strategically in order to reduce risks associated with storage; for instance, the UK has chosen, as a matter of policy, to allow CCS deployment only offshore, where risks to human health are lower. Armeni (n 90) 21.
[135] S Tysoe, 'Carbon Capture and Storage: Pulling Down the Barriers in the European Union' (2009) 223 IMechE 281, 285.
[136] CCS Directive (n 19) Preamble para (49).
[137] As argued in ch 1.
[138] Armeni (n 90) 22.
[139] ibid.

complex'.[140] Insofar as the Member State has not clarified these concepts through legislation, the ambiguity at the level of EU law is simply transferred to the national level, possibly creating the potential for disputes on whether leakage has occurred or may occur within the meaning of the relevant legislation.[141] Such ambiguity is undesirable in light of the importance of site selection for the minimisation of leakage risks.

The soft approach taken at EU level has been to provide detailed guidance on site selection and monitoring in a non-binding document.[142] A better approach would arguably be to translate such guidance into detailed, clear and binding norms on site selection and management. It has been proposed that a storage site be deemed safe where the characterisation and assessment process either predicts no leakage or predicts minor leakage only, for reasons which are clear and understood.[143] It has also been suggested that a clear and realistic definition be given to the notion of 'permanence' under the CCS Directive by setting a time horizon for acceptable risks of leakage.[144]

There are two strong arguments in favour of uniformity at EU level on these issues. Firstly, there is a collective interest in avoiding climate damage due to leakage from improperly selected sites. Secondly, if the aim is to deploy CCS at commercial scale, there is a collective interest in ensuring that public perception throughout the EU of the nascent CCS industry is positive. For this to be achieved, perceptions must be built on practical experience gained in relation to carefully selected and safely managed storage sites, which are unlikely to experience leakage and cause environmental damage. As Reiner and Herzog note, '[…] significant problems in the early years of a technology's development affected public perceptions and produced regulatory regimes and political battles that took decades to reform or resolve'.[145]

C. Incentivising Commercial Deployment

i. A 'layered' approach to liability

The third component of the proposed approach would address the shortcomings of the current CCS liability regime in terms of balance and legal certainty. The proposal

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[140] CCS Directive (n 19) art 3.

[141] As Hamann (ed) notes, 'Bearing in mind that the storage complex comprises the storage site and the surrounding geological formations, the determination of a case where leakage has occurred is difficult to establish'. Kristin Hamann (ed), 'ECO_2 Briefing Paper No 3: Assessing the Risks, Costs, Legal Framework and Public Perception of Offshore CCS' (ECO_2 Project 2013) 12 <http://oceanrep.geomar.de/22701/> accessed 23 March 2015.

[142] Commission, *Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide Guidance Document 2: Characterisation of the Storage Complex, CO_2 Stream Composition, Monitoring and Corrective Measures* (European Communities 2011) (Commission Guidance Document 2) <http://ec.europa.eu/clima/policies/lowcarbon/ccs/implementation/docs/gd2_en.pdf> accessed 23 March 2015.

[143] CATO 2 (n 95) 6.

[144] ibid 50.

[145] DM Reiner and HJ Herzog, 'A Search for Regulatory Analogs to Carbon Sequestration' (2003) I and II Greenhouse Gas Control Technologies 235, 241 <http://sequestration.mit.edu/pdf/ghgt6_paper_135.pdf> accessed 23 March 2015.

is to structure the liability regime through a simple three-tier or 'layered' approach, introduced at EU level through an amendment to the CCS Directive.[146] The idea is well-known, having been explored and applied in the context of various industries, such as oil and gas and nuclear energy.[147] As Adelman and Duncan note, CCS requires a 'hybrid' liability regime, which maps onto the characteristics of such projects and their risk profiles, particularly the combination between short-term and long-term risks.[148] Crucially, a layered approach ensures that the broader social utility of CCS and the need to encourage investment is adequately factored into the liability regime, by spreading the burden of uncertainty between stakeholders at all stages of the project.

The first layer would involve a limitation or capping of the liability of the operator for all pre-transfer risks associated with leakage under the CCS Directive. The operator would therefore bear the burden of uncertainty and would be required to show that financial security will cover its liabilities under the CCS and ETS Directives, in a manner that is similar to the current approach. However, a vital dose of legal certainty would be injected through the setting of a cap, which would not only allow the operator accurately to predict its financial exposure (thereby facilitating investment decisions) but also ensure that it is able to find and purchase appropriate insurance products. As de Figueiredo argues, this approach can allow 'the various instruments that are available for managing liability [to] be used according to their strengths' and in this respect, insurance is particularly suitable for the management of short-term and quantifiable risks.[149] The difficulty of establishing such a cap through an EU instrument could be addressed by allowing Member States a degree of discretion as to the case-by-case setting of the cap, limited by a set of EU-wide criteria, which, for instance, link the value of the cap to a proportion of the quantity of CO_2 stored at any given site.

The second layer would consist of a national operators' common fund created, for instance, through financial contributions which are calculated based on the quantity of CO_2 stored at each site.[150] Importantly, payments from this fund would only be made when a particular operator's liability exceeds the first layer

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[146] This is the approach taken in the US in relation to nuclear liability by the Price-Anderson Act. Mark Anthony de Figueiredo, 'The Liability of Carbon Dioxide Storage' (DPhil thesis, Massachusetts Institute of Technology 2007) 65-66.

[147] In the context of CCS, transferring this idea has been suggested by several commentators: David E Adelman and Ian J Duncan, 'The Limits of Liability in Promoting Safe Geologic Sequestration of CO_2' (2011) 22 DELPF 1; de Figueiredo (n 146); Stuart Haszeldine, 'Geological Factors in Framing Legislation to Enable and Regulate Storage of Carbon Dioxide Deep in the Ground' in Ian Havercroft, Richard Macrory and Richard B Stewart (eds), *Carbon Capture and Storage: Emerging Legal and Regulatory Issues* (Hart Pub 2009) 20; Rudiger P Tscherning, 'Long-term Liabilities for Carbon Dioxide Capture and Storage in Germany: What Contribution Can Developments in the United States of America Make to a Revised Draft Carbon Capture and Storage Law?' (University of Dundee) <www.dundee.ac.uk/cepmlp/gateway/files.php?file=cepmlp_car14_20_551876070.pdf> accessed 23 March 2015; CATO 2 (n 95) 91; Tysoe (n 135) 285.

[148] David E Adelman and Ian J Duncan, 'The Limits of Liability in Promoting Safe Geologic Sequestration of CO_2' (2011) 22 DELPF 1, 65.

[149] de Figueiredo (n 146) 393.

[150] Such a method would arguably avoid the difficulty of basing the contribution on the probability of leakage, as suggested by Tysoe (n 135) 285.

cap.[151] Again, this is a well-known and flexible mechanism for the pooling of risk in the context of various industries.[152] Similarly to the first layer liability cap, there is value in setting the general rule, drafting a set of criteria at EU level for calculating contributions and leaving a degree of discretion to Member States as to how the fund is to be set up and managed.

The third layer would be comprised of the Member State. Its financial contribution would be required to compensate for leakage which exceeds both the first layer cap and the capacity of the common fund, an event which, as highlighted throughout chapter one, is extremely unlikely for carefully chosen sites.

ii. Advantages of the approach

This proposal would address a number of concerns that could be raised in relation to the structure of the liability regime and would arguably ensure both the achievement of balance and legal certainty.

Firstly, it is often emphasised that the risk and magnitude of potential leakage is generally low, therefore one possible argument would be that operators should have no difficulty in simply accepting unlimited liability for leakage until transfer to the competent authority takes place.[153] Such an argument, however, ignores the idea outlined in chapter one; that there always remains an element of uncertainty and a possibility of knowledge failure. This type of uncertainty would either prevent insurers from accepting the risk on behalf of operators or would dictate a prohibitively expensive premium.[154] As Professor Abraham notes, 'compensation of victims, deterrence of catastrophic loss, and even the symbolism entailed in imposing legal responsibility are important goals […]. But each of these goals depends in some measure on a functioning liability insurance market'.[155] Even if the operator had sufficient financial strength to self-insure, the possibility of unquantifiable liability on four different levels (obligations under the CCS Directive, environmental liability under the ELD, purchase of allowances under the ETS Directive and liability under delict/tort law) cannot form the basis of any wise investment decision unless the financial gains from CCS are extremely high (which, at the moment, they are not).[156] In this context, the layered approach would ensure that the liability of the operator is predictable and quantifiable by setting a cap, an aspect of significant importance for the obtainment of insurance at reasonable premiums.

Secondly, there are two advantages of a layered approach to liability that have an attractive cumulative effect. On the one hand, it reflects a hierarchy of exposure to the risk that is mindful of proximity to and control over the source of leakage (from the primary exposure of the operator in question, to the secondary exposure of the mutual operators' fund, to the 'last resort' type of exposure of the

[151] de Figueiredo (n 146) 392.
[152] ibid.
[153] Haan-Kamminga (n 83) 325.
[154] ClimateWise (n 91) 31.
[155] Kenneth S Abraham, 'Environmental Liability and the Limits of Insurance' (1988) 88 Columbia Law Review 942, 945.
[156] Meadowcroft and Langhelle (n 70) 234 – it is 'doubtful' that the current price of CO_2 will be able to incentivise investment.

Member State).[157] On the other hand, it is based on a realistic assessment of the risk of leakage. Since this is considered low to begin with, then it is even lower for the parties further down the hierarchy of exposure and should therefore cause little objection on the part of Member States.

Thirdly, it is important not to overlook the sole purpose for which CCS is being pursued at all, that of addressing the global danger that is climate change. If CCS is deployed at commercial scale and proves to be generally successful, with no significant leakage occurring at any stage, it is not only individual operators who stand to benefit but the EU as a whole and perhaps humanity in general. The current EU regulatory approach of requiring operators to be prepared for the possibility of leakage of the whole quantity of stored CO_2 not only reflects an unrealistic assessment of the risk but also reflects an unwillingness on the part of society to accept some of the risk associated with an activity that is ultimately undertaken for its benefit. The Member State does indeed relieve the operator of at least three out of four types of liability upon transfer of responsibilities for the storage site, but the precise terms of this transfer are currently surrounded by uncertainty, to the point where it may not occur at all.[158] In this context, the layered approach can be considered a balanced allocation of the burden of uncertainty that encourages investment while ensuring that there is still a significant incentive to avoid moral hazard.

5. Conclusion

The creation of an EU liability framework for CO_2 storage, contained in the 2009 CCS Directive, undoubtedly represents a positive first step towards addressing a difficult regulatory and political question. The approach taken to the division of responsibilities for the risk of leakage has secured the adoption of an EU instrument governing CCS projects where none would have existed. An emphasis on ensuring the environmentally safe deployment of CCS through minimisation of leakage must remain a priority, if the full benefits of the technology are to be achieved and if climate change mitigation efforts are to be supplemented, rather than undermined. In this respect, liability is a powerful risk allocation instrument with great potential for incentivising safe operation of storage sites.

However, there is arguably a level beyond which liability will start to lose its positive effects and simply act as an insurmountable barrier for investment. Particularly through its provisions on financial security, financial contribution and the obligation to surrender emission allowances in the event of leakage, the CCS Directive can be said to exceed this level and places the pre-transfer burden of uncertainty exclusively on CCS operators. The necessity of avoiding moral hazard, of requiring operators to exercise high standards of care and of penalising them should they fail to do so cannot be denied. However, it is unreasonable to require guarantees of complete and permanent storage where no entity, private or public, would be able to provide such guarantees. The collective EU interest in climate

[157] de Figueiredo (n 146) 400.
[158] As argued above in section 2.

change mitigation justifies a redistribution of the burden of uncertainty that is reflective of the ultimate purpose and importance of CCS. A layered approach to liability could provide a better balance and more legal certainty in this respect.

Nevertheless, in proposing reforms it is important to be mindful of the political dynamics which characterise the EU legal system. The challenge is to find appropriate solutions for CCS that are also politically acceptable. Member States may be reluctant to accept amendments which may place a higher burden on public funds, regardless of how unlikely the event of significant leakage actually is. Still, the argument must be emphasised that Member States retain their freedom to decide whether to allow CCS on their territory. If a decision is made to deploy CCS, then it must be done properly, in light of the broader European and global interests involved. It is hoped that the upcoming Commission review and proposals for amendment of the CCS Directive will achieve the difficult task of correcting its shortcomings in a politically acceptable manner.