Overcoming national and European legal barriers to CO_2 transport and storage in the North Sea

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Executive Summary

Developers of carbon capture and storage (CCS) demonstration projects in Europe continue to face a multitude of complex and interrelated barriers. The introduction of an enabling regulatory framework for CCS in Europe has provided certainty on many aspects of the technology, but it has also introduced a number of legal concepts, which are unfamiliar to potential CCS project developers. This report takes the perspective of the project developer initiating a CCS project in the North Sea. The purpose of the report is to provide an overview of the legal issues that the project developer will encounter, as well as a comparison of the rules and legislation of the countries surrounding the North Sea with regard to these issues.

Through discussions with potential CCS project developers in Europe, a number of salient legal barriers have been identified. By far the most pressing legal barrier relates to the obligation for storage operators to surrender CO_2 allowances, officially termed European Union Allowances (EUAs), in case of leakages pursuant to the EU Emissions Trading Scheme Directive. This contingent liability is potentially very large compared with the value of the storage activity and creates an imbalance between the risk of financial exposure and the commercial opportunity expected for CCS storage. A number of options to overcome this barrier are presented in this report.

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Document Change Record

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Abbreviations

CCGT	Combined Cycle Gas Turbine
DECC	UK Department for Energy and Climate Change
EC	European Commission
EEA	European Economic Area
EERP	European Energy Programme for Recovery
EFTA	European Free Trade Association
EHR	Enhanced Hydrocarbons Recovery
EOR	Enhanced Oil Recovery
EGR	Enhanced Gas Recovery
EU	European Union
EU ETS	European Union Emissions Trading System
EUA's	European Union Allowance Units
GCCSI	Global CCS Institute
GISZ	Gas Importation and Storage Zone
IGCC	Integrated Gasification Combined Cycle
NER 300	New Entrance Reserve
NSBTF	North Sea Basin Task Force
TCE	The Crown Estate
ZEP	Zero Emissions Platform

Summary

This report takes the perspective of the project developer initiating a CCS project in the North Sea. The purpose of the report is to provide an overview of the legal issues that the project developer will encounter, as well as a comparison of the rules and legislation of the countries surrounding the North Sea with regard to these issues. Furthermore, possible solutions are explored and an analysis is made on which level these issues are to be dealt with (i.e. the national or European level).

This report contains an inventory of planned CCS activities in the North Sea. As part of the analysis, a workshop was organised with potential project developers and other relevant stakeholders and legal experts, barriers and possible solutions were discussed. A number of key barriers have been identified; ETS liabilities, the provision of financial security, the long-period of transfer of responsibility of a CCS storage site to the competent authority, and aspects related to the business case (such as the possibility for EOR/EHR and the co-firing of biomass and CCS).

The legal framework for CCS in the countries surrounding the North Sea is reviewed with regard to the key barrier identified. The liability arrangements for each of the countries differ, but none of the countries have dealt with the uncertainties regarding the ETS liabilities. With regard to the financial security, most states have implemented the CCS Directive as it is, and have left room for the government to create more specific rules with regard to the financial security. In all cases the competent authority has the initiative and freedom to choose the type, form and amount of financial security, which is decided upon in the individual permit per case, although the UK has the most far reaching legislation on this issue.

Based on the information above, the countries surrounding the North Sea view CCS differently. Where in Norway, the UK and the Netherlands, CCS is seen as important abatement technology, the German and Danish attitude towards CCS is more restricted. All countries participate in the EU ETS, which theoretically provides an incentive for CCS. In Denmark and Norway an extensive CO_2 tax also provides for incentives (although EU ETS and the tax regime do not cumulate for emissions, once the climate is compensated through the EU ETS, a less stringent tax regime applies).

The combination of CCS and EOR/EHR is not possible in the Netherlands, but is recognised in all other countries and even is the preferential option for Denmark. The combination of CCS and biomass is not regulated in any of the counties, although it is very real possibility for the project developers. What has become apparent through the analysis of the current regulatory framework, both on a European and Member State level, is that it is political willingness that will play the decisive factor in the speed at which CCS develops in Europe.

Recommendations for policy makers
This report has attempted to identify solutions for the issue of the climate liability, whereby the storage operator is exposed to high financial risk due to the obligation to purchase EUA's at an unknown price in the future in the case of leakage. We have also examined the issue of the operator providing financial security to the competent authority, of which the lack of a standard approach to the calculation creates uncertainty, and the requirements to calculate the liability on a 'worst case scenario' (no probability factor may be used), means that the amount of financial security may be unattainable for the storage operator. From this analysis, a number of recommendations are provided, with the objective of informing policy makers of the necessary adjustments required in regulation in order to support the roll out of CCS in Europe. The recommendations as addressed in chapter 6 are to:

- Link the period of transfer of responsibility to the performance of the storage site
- Manage the uncertainty related to the ETS liabilities
- Rethink the scenario's to be taken into account in determining the amount of financial security
- Investigate the possibilities for EOR/EHR
- Facilitate the biomass/CCS combination

1 Introduction

Developers of carbon capture and storage (CCS) demonstration projects in Europe continue to face a multitude of complex and interrelated barriers. The introduction of an enabling regulatory framework for CCS in Europe has provided certainty on many aspects of the technology, but it has also introduced a number of legal concepts, which are unfamiliar to potential CCS project developers. The long-term liability of stored CO_2 and the provision of a financial security are important examples of issues where CCS stakeholders from multiple Member States have raised questions and concerns. The regulation and policy concerning the combination of CCS with enhanced hydrocarbon recovery, and the use of biomass in CCS installations are other areas where regulatory barriers or uncertainties are acknowledged.

1.1 Research objectives

This report takes the perspective of the project developer initiating a CCS project in the North Sea. The purpose of the report is to provide an overview of the legal issues that the project developer will encounter, as well as a comparison of the rules and legislation of the countries surrounding the North Sea with regard to these issues. Furthermore, possible solutions will be explored and an analysis will be made on which level these issues are to be dealt with (i.e. the national or European level).

The research question as formulated for this report is:

Which national and European legal barriers to CO_2 transport and storage in the North Sea need to be solved on the short term, and how should possible solutions be approached?

In order to answer the primary research question, the following sub-questions will be addressed in this report:

1 What CCS activities are planned in the North Sea in the near term?
2 Which national and trans-national legal barriers are prioritized by project developers?
3 How are these issues addressed in the legislation of the countries surrounding the North Sea?
4 How can these issues be resolved and on which level should they be resolved?

In order to answer the primary research question, information from project developers is combined with a legal comparative approach. In order to prioritize the issues to be solved, a series of interviews with project developers were conducted. Based on these interviews an interactive workshop was organised in which the issues and possible solutions were addressed. Combining this information with the legal comparative analysis, has resulted in a set of recommendations for policymakers on how to address the most pressing issues in enabling CCS in the North Sea.

1.2 Approach

The process of identifying and prioritizing national and European legal barriers to CCS has been conducted through a combination of interviews with potential project developers in the UK and the Netherlands, a survey of existing literature and two workshops which took place in December 2011 and September 2012. These workshops were attended by potential project developers, policy makers and other relevant stakeholders. Table 1.1 highlights the businesses/organisations/entities that have contributed to the identification and prioritization of the legal barriers discussed in this report. Commercial and non-commercial entities (such as University College London, Alberta Energy) have also been consulted in relation to the development of possible solutions to the barriers identified. No specific names are provided due to confidentiality agreements.

Table 1.1 Entities that have provided input during the scope if this work

The Netherlands
Air Liquide*
Anthony Veder Group*
DCMR Environmental Protection Agency
E.ON Benelux*
Essent RWE*
Maasvlakte CCS Project C.V. (ROAD)*
Ministry of Economic Affairs
TAQA Energy*
United Kingdom
Carbon Capture and Storage Association (CCSA)
National Grid*
University College London
International
Bellona Europe/ZEP Taskforce Policy and Regulation
Alberta Energy

* potential project developers

In order to address sub-question 3, a legal review of British, Dutch, Danish, German and Norwegian legislation has been conducted, focusing on relevant legislative acts relating to the salient legal barriers identified in sub-question 2. Furthermore, several country reports were used, from the IEA, the Global CCS Institute and the University College London. The objective of this legal review is to assess if different national approaches to regulating certain elements of CCS are more appropriate in facilitating deployment of the technology.

Identifying possible solutions to the legal barriers recognized (sub-question 4), has been achieved through a combination of team expertise, brainstorming during workshops and the assessment of existing literature. Through individual interviews with stakeholders primarily in the Netherlands, we also gained insights into the suitability of possible solutions from a commercial perspective. These insights are also documented in the analysis.

1.3 Reader guide

Chapter 2 highlights the current and planned CCS activities in the North Sea, providing a current status of EU and national funding possibilities. Chapter 2 also includes an inventory of proposed CCS projects in the UK and Netherlands that plan to store CO_2 in the North Sea. Chapter 3 consists of an analysis of possible barriers for CCS in the North Sea. Chapter 4 compares the regulation of these issues of the countries surrounding the North Sea. Chapter 5 focuses on the analysis of issues and possible solutions and chapter 6 concludes with recommendations for policy makers.

2 CCS activities in the North Sea

2.1 Introduction

If CCS is to play a significant role in meeting the European Union's long-term CO_2 abatement ambitions of an 80% reduction in the CO_2 emissions compared to 1990 levels, utilizing the CO_2 storage potential of the North Sea will be necessary. The EU GeoCapacity project completed in 2009, estimates the total geological storage potential for CO_2 across Europe in hydrocarbon fields and saline aquifers as being 300 Gt. Of this storage capacity, 60% is found within the territories of the Norway, Germany, United Kingdom, the Netherlands and Denmark, in order of storage potential (Vangkilde-Pedersen, 2009). For the countries above, approximately 80% of the sink capacity is located under the North Sea (ElementEnergy, 2010).

In addition to the storage capacity of the North Sea, both political and economic reasons increase its importance for European CCS projects. The Netherlands and Denmark for example have announced not to facilitate/allow onshore CO_2 storage, and the recently passed German CCS law allows individual states/provinces to opt out of storage projects (BEST, 2012), with one of the most important states in terms of storage capacity, Schleswig-Holstein, is already preparing a provincial law to ban CO_2 storage within its territory (Argus Media, 2012). Public opposition against CCS in certain countries is forcing potential project developers to look offshore for storage locations.

The existing oil and gas industry operating within the North Sea supports the suitability of its use to safely store CO_2. Expended hydrocarbon reservoirs are theoretically the most suitable storage structures; they have already stored gases for geological timescales prior to extraction, and geological data is already available for site characterisation and dynamic modelling purposes. Additional benefits of the pre-established oil and gas industry in the North Sea is the possibility to utilize existing infrastructure, and the potential for conducting enhanced hydrocarbon recovery.

2.2 Funding for CCS in Europe

In order to support the demonstration of CCS in the Europe, both the European Commission and certain individual Member States have made funding available to offset the high capital investment costs of the initial demonstration projects. The European Energy Programme for Recovery (EEPR) launched in 2009, involved financial assistance to a total of €4 billion, targeted towards gas and electricity infrastructure, offshore wind energy and CCS. €1 billion of co-financing has been earmarked for CCS. The funding for CCS through the EEPR was supposed to precede the New Entrants' Reserve 300 (NER 300 - see below) funding mechanism which would follow in 2011, making funding available for already mature projects which were aiming for operation by 2015. The funding was split between six CCS projects (dependent on overall project cost); Compostilla (Spain), Hatfield, now known as Don Valley (UK), Rotterdam (the Netherlands), Belchatow (Poland), Jänschwalde (Germany), Porte Tolle (Italy). To date, the Jänschwalde project has been cancelled due to a lack of public support for CO_2 storage. At the time of writing (September 2012), Belchatow and the Don Valley projects have experienced various delays and look set to miss the originally planned 2015 operational start date. The Rotterdam project has been delayed indefinitely due to financing reasons, despite funding from the EU and the national government.

The 'NER 300' is a financing mechanism established through Article 10 of the revised Emissions Trading Directive[1], which facilitates the set-aside 300 million allowances (European Union Allowance Units or EUAs) in a New Entrants Reserve of the EU Emissions Trading Scheme[2]. Jointly managed by the European Commission, the European Investment Bank (EIB) and Member States, the allowances are auctioned through the EU ETS in order to raise capital which is then used to co-

[1] Directive 2009/29/EC
[2] Directive 2003/87/EC

finance (to a maximum of 50% of relevant costs) innovative renewable energy technology and CCS projects.

The NER 300 is a bidding process, whereby the projects to receive funding are ranked by a 'cost per unit performance', i.e. for CCS the most CO_2 stored per euro of funding requested. At the announcement of the NER 300 Decision[3] in November 2010 which outlined the legal principles of the mechanism, the 300 million allowances were expected to generate approximately €4.5 billion, sufficient for 8 CCS and 30 innovative renewable projects. However, the first tranche of €200 million allowances was auctioned gradually between December 2011 and September 2012, when the market price for EUA's had dropped from approximately €15 in 2010 to less than €8 at the time of auction. With the available funding for projects in the first tranche estimated at between €1.3 and €1.5 billion at the time of writing, a maximum of three CCS project will now receive co-funding as well as 16 innovative renewable projects (European Commission, 2012). In July 2012 the European Commission and the European Investment Bank released the provisional ranking table for all entries. The ranking table for CCS can be found in Table 2.1.

Table 2.1 Outcome of the initial NER300 shortlist

Project category	Member State	Project
Pre-combustion	UK	Don Valley Power Project*
Post-combustion	PL	Belchatow CCS Project
Industrial application	NL	Green Hydrogen*
Pre-combustion	UK	The Teeside CCS Project
Oxyfuel	UK	UK Oxy CCS Demo
Pre-combustion	UK	C.GEN North Killingholme Power Station
Post-combustion	IT	Zero Emission Porto Tolle
Industrial application	FR	ULCOS-BF**

* Withdrawn - Project not supported financially by national government
** Withdrawn – Citing technical issues

In addition to co-funding for CCS demonstration projects from the European Commission, individual Member States have also committed to support projects primarily via the provision of grants for capital investments. The Dutch government has committed €150 million to the post-combustion ROAD CCS project in Rotterdam, and €90 million to the industrial CCS project Green Hydrogen. In both cases the grant is only for investment in capture, transport and storage related investments. The UK government has also recently announced up to £1 billion worth of funding to be competitively allocated to projects that are able to be implemented between 2016 and 2020.

2.3 Activities in progress

At present the Sleipner CO_2 injection project is the only large scale CCS project operating in the North Sea. On a set of offshore platforms on the Norwegian continental shelf operated by Norwegian oil and gas company Statoil, natural gas is extracted and processed to meet production specifications. The processing involves the removal of CO_2 from the raw natural gas. Common practice is to vent the captured CO_2 to the atmosphere. The amount of CO_2 separated is approximately 1 million tonnes (Mt) per annum, but instead of venting it, the CO_2 is transported 12.5 km from the treatment platform to the wellhead and injected into a saline formation roughly 1000 meters below the sea floor. Since the project became operational in August 1996, more than 8 Mt have been injected, with the plan to inject another 12 Mt prior to the closure of the project.

[3] Decision C(2010) 7499

The project has been incentivized through the introduction of a national offshore CO_2 tax by the Norwegian authorities in 1991. By storing the CO_2, the operators can avoid payment of the CO_2 tax. However the Sleipner project has had many additional benefits for the development of CCS, such as facilitating significant research into the behaviour of injected CO_2 into saline aquifers, with a number of large Norwegian and European research projects deploying different monitoring tools and strategies to gain an understanding of CO_2 plume migration. To date there have been no significant deviations from the expected behaviour of the CO_2.

A similar, however much smaller scale project is operating in the Dutch North Sea, approximately 150km North-west of Amsterdam. Here CO_2 is separated from a stream of natural gas produced at the platform K12-B operated by GDF Svez. Unlike Sleipner, where the separated CO_2 is injected into a nearby saline aquifer, at K12-B the CO_2 is injected into the same reservoir from where it was originally produced. This provides the opportunity to understand the dynamics of injecting CO_2 into a nearly depleted gas field, and could provide insights into the efficiency of enhanced gas recovery (EGR). The operation commenced in 2004, and as of January 2009 60,000 tonnes of CO_2 have been injected.

In addition to the actual CO_2 storage activities highlighted above, a multi-national task force has been established to discuss common principles for regulating the CO_2 storage under the North Sea. The North Sea Basin Task Force (NSBTF) includes representatives from government departments of the Netherlands, the United Kingdom, Norway and Germany. Recently the Flemish region of Belgium has joined the NSBTF, as CCS is considered potentially important mitigation option for heavy industry located close to the port of Antwerp. The group meets bi-annually and so far activities have primarily focused on the commissioning of various reports to identify regulatory barriers, and to estimate the potential storage capacity requirements under differing policy and energy demand scenarios.

2.4 Activities planned in the North Sea

There are numerous plans for CO_2 storage activities in the North Sea, primarily from the United Kingdom and the Netherlands.

2.4.1 Planned activities in the United Kingdom

On the 3rd of April 2012 the UK Department for Energy and Climate Change (DECC) launched a CCS Commercialization Programme. £1 billion of capital funding will be made available to support project developers with the upfront costs of developing projects, with additional support for increased operating costs potentially being provided by 'Contracts for Difference', whereby power generated by low carbon technologies can receive a feed-in tariff to compensate the higher costs. The programme has raised significant interest by potential CCS project developers in the UK, with multiple consortia submitting bids to what is commonly known as the UK CCS competition. In October, four short listed bids, all full chain capture, transport and storage projects, were announced. The short-listed projects are the Captain Clean Energy Project, the White Rose CCS project, Teeside Low carbon and the Peterhead CCS project. Details of all the proposed CCS projects in the UK can be found in the table below.

Project	**Don Valley Power Project**
Location	Stainforth, Yorkshire
Owner/Consortium	2Co Energy Ltd
Description	An IGCC (pre-combustion) coal-fired power station with a capacity of 650MW, and an anticipated 90% capture rate, approximately 5Mt CO_2 per annum. The captured CO_2 will be transported 300km and used for enhanced oil recovery in the North Sea. 150 million barrels of additional oil could be recovered. The

	investment requirement for the power plant is £3 billion. An investment decision is expected in 2013, with commissioning planned for end 2016.
Funding application	- The project will receive €180 million from the EU European Economic Recovery Programme (EERP) if it continues. - Applied for NER300 funding, ranked 1st in award decision (July, 2012). It is likely that a maximum of approximately €350 funding will be made available to the project through the NER300[4]. - Has not been selected for the UK DECC CCS competition, and will likely withdraw from the NER300.
Website/source	http://www.2coenergy.com/don_valley_power_project.html
Project	**Captain Clean Energy Project (CCEP)**
Location	Grangemouth, Scotland
Owner/Consortium	CO2DeepStore (Petrofac)/Summit Power/ National Grid
Description	A planned IGCC (pre-combustion) coal-fired power plant to be located in the Port of Grangemouth, west of Edinburgh. The power plant is stated to have a capture rate of 90%. Plans state that the CO_2 will be transported via an onshore pipeline to St Fergus (near (Peterhead) approximately 250km North-east of the capture site, before being transported offshore for storage in the Outer Moray Firth. Injection is expected to start in 2018 The project will also involve enhanced oil recovery.
Funding application	This project has been selected by the UK DECC CCS competition
Website/source	http://co2deepstore.com/ccs-projects/co2-storage-for-caledonia-clean-energy-project
Project	**White Rose CCS Project**
Location	Selby, Yorkshire
Owner/Consortium	Capture Power Ltd (Alstom, Drax, BOC)
Description	A 426MW oxyfuel coal-fired power plant, with a 90% capture rate equivalent to 2Mt CO_2 per annum. The plant is also expected to have the potential to be co-fired by biomass. The capture CO_2 will be transported via pipeline which is expected to be operated by the National Grid and be stored offshore.
Funding application	- This project has been selected by the UK DECC CCS competition - Applied for NER300 funding, ranked 5th in award decision (July, 2012). Unlikely to receive funding in this first round withholding project cancellations.

[4] The NER300 is expected to generate between €1.3 and €1.5 billion through the auctioning of 300 million EUAs. However a single project may not receive more than 15% of the total amount of income generated (European Commission, 2012). Although it's not publicly available, it is expected that CCS project proposals would have applied for between €600-700 million (NER300.com, 2012).

Website/source	http://www.whiteroseccs.co.uk/
Project	**Teeside Low carbon**
Location	Middlesborough, North Yorkshire
Owner/Consortium	Teesside Low Carbon (BOC, International Power, National Grid, Fairfield Energy, Premier Oil, Progressive Energy)
Description	Pre-combustion coal gasification project, which will produce a hydrogen rich synthesis gas made available for industrial users in Teesside. The primary use of the synthesis gas would be a new high efficiency combined cycle gas turbine (CCGT) which will be built to replace an existing power plant. It is planned that 2.3Mt CO_2 will be separated each year. The CO_2 will be compressed and transported a short distance to a booster station at the shoreline, from where it will be transported by a pipeline to a depleted oil field in the North Sea.
Funding application	- This project has been selected by the UK DECC CCS competition - Applied for NER300 funding, ranked 4th in award decision (July, 2012). Unlikely to received funding in this first round withholding project cancellations.
Website/source	http://www.teessidelowcarbon.com/index.htm
Project	**C.GEN**
Location	Killingholme, Lincolnshire
Owner/Consortium	C.GEN Group
Description	Plans include combining CCS with an IGCC, with a capacity of 470MW. The project is expected to have the potential to capture 10kt CO_2 per day, approximately 3.3Mt CO_2 per year based on a 90% annual capacity factor (author's assumption). The storage of the CO_2 will take place in the North Sea, whether this will be completed by ship or pipeline, or whether EOR/EHR will take place is not yet clear from publicly available information.
Funding application	- Applied for NER300 funding, ranked 6th in award decision (July, 2012). Unlikely to received funding in this first round withholding project cancellations. - No application to the UK DECC CCS competition
Website/source	http://www.cgenpower.com/kgh/index.html
Project	**Peterhead CCS Project**
Location	Peterhead, Scotland
Owner/Consortium	Peterhead CCS Project (SSE CCS Limited, Shell UK Limited)
Description	A post-combustion capture retrofit from one existing CCGT with a capacity of 385MW. It is planned that the captured CO_2 will then be transported to the

	Shell operated Goldeneye gas field, 100 km offshore in the North Sea. The aim is to use existing infrastructure to transport the CO_2 as far as this is possible. The Peterhead CCS Project is the only planned project in the UK which aims to capture CO_2 from a gas-fired power plant.
Funding application	- The project has been selected by the UK DECC CCS competition
Website/source	http://www.sse.com/PressReleases2011/JointDevelopmentAgreementCarbonCapture/

2.4.2 Planned activities in the Netherlands

There have been numerous plans for CCS projects in the Netherlands, many of which being cancelled due to public opposition to onshore CO_2 storage. In 2010, a storage project from a hydrogen production unit operated by Shell was eventually cancelled by the Dutch government because of public protest. The cancellation of Barendrecht was followed by a decision by the Dutch Ministry of Economic Affairs, Agriculture and Innovation not to allow any onshore CO_2 storage due to a lack of public support. This caused the further cancellation of onshore storage projects including a proposed capture and enhanced coal bed methane (ECBM)/storage project from an ammonia production facility (Suez/GTI, Vito and DSM), a capture unit at a IGCC (under construction) by energy company Nuon, and a 250MW equivalent post combustion capture unit at a coal-fired power plant operated by RWE/Essent. The RWE/Essent project had applied for NER300 funding but has since withdrawn because a new offshore storage strategy must be developed, which is also expected to increase the project costs considerably. Nevertheless there remain two CCS projects in the planning phase located around the industrialised port area of Rotterdam, however it is not clear when these projects may commence.

Unlike the United Kingdom, the Netherlands has no structural CCS funding mechanism, however will provide individual grants to offset capital start up costs.

Project	**ROAD**
Location	Rotterdam, Zuid Holland
Owner/Consortium	Maasvlakte CCS Project C.V. (E.ON Benelux, GDF Suez Energie Nederland)
Description	A 250MWe post-combustion capture unit will be built on a 1070MW pulverized coal power plant. The project is anticipated to capture 1.1Mt CO_2 per annum, which will be transported via pipeline for storage in a depleted gas field operated by TAQA Energy B.V. The offshore gas field in the North Sea is just 20km North-west of Rotterdam.
Funding application	- The project will receive €180 million from the EU European Economic Recovery Programme (EERP) if it continues. - The Dutch government will also provide a subsidy to a maximum of €150 million, so long as the entire chain is completed and a minimum of 4 Mt CO_2 are stored - The project has not applied for the NER300 programme
Website/source	http://www.road2020.nl/en/
Project	**Green Hydrogen**
Location	Rozenburg, Zuid Holland
Owner/Consortium	Air Liquide

Description	Air Liquide is building a hydrogen production plant that will produce up to 130,000 Nm^3 of hydrogen per hour. This €160 million project has come on line in 2011. The plant is being built capture ready with the possibility of capturing 0,5 $MtCO_2$ per annum. The project as submitted to the NER300 programme, involved the liquefaction and transport of CO_2 by ship to offshore oil fields in Denmark for the purpose of EOR/EHR. However, this storage option is no longer available in the short term (due to the London Protocol barrier), and thus the project may look to utilize a depleted gas field operated by TAQA Energy B.V. 20 km North-west of Rotterdam. The costs of the capture project are understood to be approximately €50 million.
Funding application	- Applied for NER300 funding, ranked 3rd in award decision (July, 2012). It is understood that there is a possibility for funding through the NER300. - The Dutch government will also provide a subsidy to a maximum of €90 million if the project is successful in the NER300 programme.
Website/source	Only third-party sources available.

3 National and trans-national legal barriers

3.1 Introduction

With reference to the proposed CCS projects in Chapter 2, the importance of storing CO_2 in the North Sea is clear. In addition, a number of the projects include the combination of CCS with enhanced oil recovery, and the transportation of CO_2 across national boundaries. Even though the CCS Directive has provided for a legal framework (IEA, 2012, Global CCS Institute 2012), a number of legal barriers have emerged during interviews with (potential) project developers and during workshop activities. A list is provided:

- Long-term climate liability
- Prohibition of transboundary CO_2 transportation*
- Financial security, financial contribution and transfer of responsibility
- Permitting issues when combining CCS with enhanced hydrocarbon recovery (EHR)
- Lack of incentives for combining CCS with the co-firing of biomass

Of all the legal barriers identified, long-term liability for CO_2 storage has been identified as the most salient legal barrier by all project developers and other stakeholders. Regarding the other 4 identified legal barriers, there was less of a clear consensus, and they should not be considered to be ordered in terms of their perceived importance.

In order to redefine and elaborate these issues and explore possible solutions, an expert meeting was organized in September 2012, in which these issues (excluding trans-boundary CO_2 transport) were addressed. The sections below provide a summary of the discussions which took place during the expert meeting.

** As cross-border transportation of CO_2 is understood to be necessary given the location of suitable sinks in the North Sea, many project developers expressed during interviews and workshops that the prohibition of cross-border CO_2 transportation for the purposes of storage by the London Protocol is a serious legal concern. However, this issue has been fully documented and solutions sort in previous documents (Mikunda et al., 2011; IEA, 2011). Given that this issue has recently received significant attention in existing reports, it will not be covered in this report. However for a brief overview of this issue, please see Annex I.*

3.2 Long term climate liability

The EU Directive on the geological storage of carbon dioxide (2009/31/EC), referred to as the CCS Directive in the remainder of this document, sets out a comprehensive framework to mitigate the environmental and health impacts of CO_2 storage. Storage in accordance with the CCS Directive also provides the economic incentive for investment in CCS, in that captured CO_2 stored in accordance with the CCS Directive, counts as not-emitted for the purposes the EU Emissions Trading System (ETS) Directive[5] so long as the CO_2 is not subsequently emitted during transport or storage. The combination of these policy instruments creates a value for CO_2 that, providing the value of ETS allowances is sufficient, justifies the additional investment and efficiency penalty of CCS as a CO_2 abatement measure. When the balance of risks and rewards created by this incentive is sufficient then the private sector should theoretically invest in the development of CCS.

The CCS Directive also creates liabilities and obligations. The majority of these are standard features of environmental permitting arrangements and implement the polluter pays principle. They require storage site operators to monitor the storage site, implement corrective measures and remediate any damage to the environment in the event of unforeseen circumstances. This applies to the whole of the CCS chain.

[5] Directive 2003/87/EC amended by Directive 2009/29/EC

However, the EU regulation for the storage of CO_2 creates an additional obligation to surrender CO_2 allowances, officially termed European Union Allowances (EUAs), in case of leakages pursuant to the ETS Directive. This contingent liability is potentially very large compared with the value of the storage activity and creates an imbalance between the risk of financial exposure and the commercial opportunity expected for CCS storage. This can have serious consequences for the viability of CCS projects.

It is very difficult for CO_2 storage operators to accept liability for the surrendering of EUAs in the extremely unlikely event of a leakage from the storage complex. Although the EU ETS provides an incentive for operators to capture CO_2, there is little incentive for storage operators to store CO_2. The majority of the reward stays with the operator capturing the CO_2, whereas the storage operator receives a negotiated service fee. The captured and potentially stored CO_2 provides the emitter with tradable EUA's, where the storage operator gets a fee and needs an ETS permit for the possible leakages, but does not receive tradable EUA's for the stored CO_2. Since the EUA price at the moment is at a minimum level, the EU ETS provides insufficient incentives for CCS. It should be further noted that the incentive/reward for the operators storing the CO_2 in aquifers or depleted pressure gas fields is relatively small if compared to operators using CO_2 for EHR (as those operators would have the potential reward for the produced oil or gas).

The EU ETS provides an additional level of liability for transport and storage operators, which is unquantifiable due to the inherent uncertainty in the fluctuation of the EUA price. In other transport and storage operations, in the event of liquid or gas leaks, the problem is rectified as quickly and safely as possible and in the absence of damage to the environment or third-parties, there are no further consequences for the operators. If CO_2 leaks, the volume of CO_2 that leaked has to be calculated and then the corresponding amount of EUA's must be procured from the market at the market price at the moment of or soon after such leakage (a price unknown at the time of injection).

In all cases the storage operator will be facing a higher potential exposure than a transport operator, as sections of pipelines can be isolated, and the maximum amount of CO_2 released therefore limited (although the transport operator also has to surrender EUA's at a price at the moment of future leakage). Initial indications point towards no economically feasible solution from the private insurance market to insure liabilities related to CO_2 leakage, at least not in the demonstration phase time span.

3.3 Financial security, contribution and transfer of responsibility

Before a permit for storage is issued, the operator has to prove that it is able to carry the financial burden of the operation. The CCS Directive provides a number of rules on how to deal with the financial security. However, Member States are free to regulate this issue into more detail. It is clear and commonly agreed that security has to be provided. The central question is who decides on the financial security and under which conditions? Based on the interviews with operators the financial security was seen as a potential showstopper, because it is not clear for which costs the security is to be provided and in which form. What terms and conditions are to be used in calculating this security? The amount of the financial security and financial contribution is relevant for project initiators in making the business case for CCS.

The financial security is regulated in art 19 of the CCS Directive. In essence it obliges the Member States to only award permits (art 7, 9 CCS Directive) if the operator proves to be able to finance the storage operation and in the future will be able to maintain it, pay for closure and will be able to finance corrective measures. When there is an incident during operation, the competent authority might use the financial security to fulfil the necessary obligations (art 11) and it will use the security in case of corrective measures and premature closure (art 16, 17). However it must be noted that the liability of an operator is not limited to the amount of financial security. Member States are to ensure that in the application for a storage permit the operator proves that he is able to fulfil all financial obligations, which actually have to be in place before injection starts.

The CCS Directive does not provide detailed specification or regulation in this area. Individual Member States have the opportunity to provide additional specification and regulation, but the first indications are that it is left to projects to come up with proposals. This creates uncertainty for project developers. Project initiators mention the following important uncertainties:

- Financial security has to be provided for measures in case of leakage events and thus deals with the same uncertainty as the ETS liabilities
- Lack of specific regulation on the financial security and contribution
- The risk of changing demands regarding the financial contribution and transfer of responsibility during the long term operation

The competent authority can and will ask some form of financial security for the following activities or events (based on art 19 CCS Directive):

- Obligations arising under the permit (monitoring, remediation)
- Closure and post closure obligations (premature decommissioning, decommissioning. Financial contribution, monitoring, remediation)
- Obligations under the ETS system (monitoring and costs for minor and major events)

These activities and events can be divided into four costs categories: (i) costs certain to occur, (ii) low probability costs, (iii) very low probability costs and (iv) extremely low probability costs. The existing categories of options for the required financial instruments are deposits, guarantees, insurances and funds, each with their own specific characteristics. Member States are able to divide risks and suggest calculation methods by regulating these specific obligations and securities in more detail. There is no single financial instrument that can realistically cover all four costs categories. Most Member States have not further specified the components that build up the financial security and contribution, and the types of security that can be provided for them.

The main issue regarding the amount of financial security to be provided is that the financial security has to be based on a worst case scenario occurring, regardless of the probability of such an event actually taking place (although a risk based approach for the amount of EUA's that must be surrendered in case of leakage is accepted). This can be hypothetically compared to taking out a car insurance policy, whereby the premium is calculated on the driver having at least one serious accident in a year. In reality, this would make such insurance unaffordable.

There is also regulatory uncertainty related to the financial contribution. The financial contribution is regulated in article 20 of the CCS directive. The financial contribution replaces the financial security after the responsibility is transferred. The operator has to provide an amount of money to pay for the expenses of monitoring for the next 20-30 years by the authorities. In summary you are 100% certain that you will have to pay but it's quite uncertain what you have to pay, what the monitoring requirements are and for how long the monitoring will continue. It was also discussed that in certain cases, such as storage in a depleted gas field, there is very little monitoring that can or needs to take place after the well has been permanently sealed. Seismic monitoring can be conducted but is unlikely to show movement of CO_2 outside the reservoir, and will only be appropriate for aquifer storage only.

Since the well is sealed after injection has stopped, no down-hole measurements can be taken. The well should be sealed as soon as possible after injection ceases because it is the only leakage pathway and a reasonable and prudent operator would insist on immediate closure. If the close-in pressure has only reached a proportion of the original reservoir pressure, for example 75%, then for any potential leakage paths the most likely direction of flow would be into the reservoir from the surrounding higher-pressure zones. After injection has ceased and the well plugged, the infrastructure around the site will be removed, meaning that continued monitoring will be from the sea surface or on the seabed. A variety of novel monitoring techniques could be tried thereafter. The expectation is that for all practical purposes the time between closure and transfer of responsibility to the competent authority will be much shorter than the notional 20 years.

The CCS Directive states that all available evidence should indicate permanent storage, before a transfer can take place. Due to the long term nature of CCS, it is expected that technologies and

techniques will have changed by the time the financial contribution becomes relevant. As of now, the regulation on the transfer of responsibility and the financial contribution is not really detailed. How can project developers be certain that in 30 years from now, the demands have not changed to the extent that it is almost impossible to comply?

All of this is decided upon by the competent authority and companies are hesitant that the decisions that are made will change over time and under political pressure. The CCS Directive only gives directions on the issues to include in permits, and it was anticipated by certain commercial stakeholders that national legislation would provide further details.

3.4 Aspects related to the business case

The EU CCS Directive sets out a regulatory framework for CCS. The EU sees CCS as a transition mechanism needed to reach the climate mitigation objectives, assuming broad deployment of the technology in power generation and industry after 2035. However, whether or not large scale CCS will become reality depends on willing project developers in the private domain. In theory, the primary driver for project developers is the EU ETS system, as stored CO_2 counts as not emitted for the purpose of the EU ETS Directive. Besides the primary driver, project developers might have other incentives to engage in CCS projects (development of new techniques, acting environmentally responsibly, using the storage for enhanced oil/gas recovery, possible developments as a carbon tax or more stringent performance indicators). The question is whether or not the legal framework as developed by the EU and implemented in the Netherlands does sufficiently accommodate the practical issues that project developers encounter in making their business case.

Based on interviews with different project developers at least two issues came up, for which the legal framework does not yet provide for a solution. A first issue is the origin of the CO_2 that is being stored. Emissions from biomass in power plants are valued as zero emissions in the EU ETS system. If emissions captured from biomass combustion are captured and stored, this creates negative emissions, but as they have no additional value compared to CO_2 from fossil fuels. The capture operator does not have any additional incentive to use biomass instead of coal. In some cases coal may be much cheaper than biomass, or the biomass can be used in part of the power station not equipped with CO_2 capture to reduce the overall amount of EUAs that must be surrendered. Furthermore when there is CO_2 leakage from the storage location, it could be assumed that EUAs must also be purchased for the CO_2 related to biomass, even though such emissions would actually be CO_2 neutral according to the ETS Directive. This issue has not been addressed yet, so whether or not this potential liability exists is uncertain for operators.

A second issue is the utilization of enhanced oil/hydrocarbons recovery in the North Sea to offset the high costs of CCS technology and regulatory compliance. The project developers that we have interviewed indicate that the most likely business development option is to demonstrate CCS small scale, then engage in enhanced oil/gas recovery, followed by large scale CCS. However, the option to combine (ETS valid) CO_2 storage with EOR/EHR is not foreseen in all sets of legislation. The following sub-sections highlight these issues further.

3.4.1 Biomass

Currently, EU legislation does not provide an incentive for capturing CO_2 from a power plant which is (co)-fired by biomass, as no negative emissions can be credited to the operator. The use of biomass may be more costly, or have technical drawbacks (i.e. lower energy content, ash deposition/corrosion) compared to conventional fossil fuels, and although use in a non-capture installation could be economically feasible, it make no financial sense in a capture equipped power station. This means operators will avoid striving for negative emissions, which are becoming more relevant as a mitigation measure given the delay in tackling climate change. It was discussed during the expert session that at present, a number of national and European policies relating to biomass use and CCS are in conflict. In the Netherlands, there is a tax on the use of coal, equivalent to €5,40/ton CO_2. This, in combination with the exclusion of biomass emissions from the EU ETS, means that there is a strong case for

operators to use biomass in power production and industry. However, as mentioned above, the combination of CO_2 capture with biomass is not economically favourable. The ROAD CCS project in Rotterdam has the potential to co-fire up to 20% biomass in the power plant unit (MPP3), which is expected to be equipped with post-combustion capture. Under the current situation, the operator is incentivized to only fire coal in units that have CCS and shift the available biomass to units that do not have CCS, whereby the goal to maximally reduce CO_2 emission is no longer leading, foregoing the opportunity to achieve 'negative emissions'.

The lack of a reward for achieving negative emissions however, is not the only issue. The CO_2, including the biomass CO_2, might leak out of the storage location. Leakage is regarded as an emission under the EU ETS and allowances will have to be surrendered, perhaps even at higher costs as the ETS price might have risen after a few years. As the origin of these emissions does not matter for the CCS Directive, the project developer is to surrender allowances for emissions. From the perspective of the project developer this is an additional risk.

3.4.2 CCS and EOR/EHR

Based on interviews with potential project developers, members of the power sector and other industries see the development of CCS as moving from demonstration projects to EOR/EHR, and then to large scale CCS. Although it is allowed to inject CO_2 for EOR/EHR, the combination of injecting CO_2 for storage, while producing gas or oil is not yet possible in all countries surrounding the North Sea. The Dutch Mining Act for example prevents the operator of an oil/gas field to simultaneously hold a storage license and a production license (art 26 – 6 Mining Act). In Denmark and the UK however, the combination is possible, although no such activities have taken place. The legislation on the European level does not explicitly mention the combination of CCS and EOR/EHR. Based on the formulation of the EU ETS Monitoring and Reporting Guidelines (MRGs) it seems feasible that storage and EOR/EHR can be combined, as an 'Activity Specific Guideline' is provided for monitoring emissions for CCS activities combined with EOR/EHR.

From the perspective of the operator of a producing field this option is very interesting, as the injection of CO_2 might increase production at first, and the field can be re-used as a storage location once the production ends. However, the CCS Directive determines that there should be a level playing field for parties interested in CCS, and that therefore the exploration permit[6] should be issued in competition. This means that the operator of the production phase cannot be guaranteed to also receive the storage licence. Furthermore, the production license comes with obligations for closure and removal of the equipment. Not fulfilling these obligations creates risks and liabilities for the licensee. These uncertainties complicate the transition from production to EOR/EHR and eventually storage.

3.5 Preliminary conclusions

At this point, it is important to establish which legislative act or acts, are leading to regulatory uncertainty or creating the legal roadblocks experienced by project developers. The barriers identified stem from legislation which has been formulated on an international, European and national level.

The issues relating to long-term climate liability are brought about by the CCS Directive, and indirectly by the inherent workings of the EU emissions trading system. In this case, the CCS Directive clearly places full liability for leakage on the storage operator and obligates the operator to surrender allowances pursuant to the ETS Directive. If solutions to the issue of climate liability were sought through legislative alterations, both the CCS Directive and/or the ETS Directive would be the focus of attention. Through the CCS Directive, the climate liability attached to the storage operator could either be removed, or more realistically, limited to a certain extent. Alternatively, the ETS Directive could be revised to allow the creation of a 'CO_2 leakage reserve', a set-aside of emission allowances in the

[6] It is possible to skip the exploration phase, which is likely in case of an existing and active though almost empty gas field. However, if the exploration phase is skipped, the storage license should be issued in competition.

case of significant leakage from CO_2 storage locations operating within the scheme. These possible solutions are documented fully in Chapter 5.

The CCS Directive provides the minimum requirements for CCS legislation that should be transposed into Member State national legislative acts. However, as long as the minimum requirements are met, the Member State is free to impose stricter regulations, for example in terms of the financial security required, the length of operator liability prior to the transfer of responsibility, or in the case of the Netherlands documented above in Section 3.4.2, prevent an operator from simultaneously holding an hydrocarbon production license in combination with a CO_2 storage license.

National legislation, and/or policy, could also be adjusted to reduce climate liability faced by operators. The CCS Directive is clear that operators must assume liability in case of leakage, and therefore any national legislation that would aim at reprieving an operator from such liability may be in breach of the CCS Directive (ClientEarth, 2010). However there are no restrictions in the competent authority becoming involved or contributing to the financial security, dependent on EU state aid protocol.

Chapter 4 continues with an analysis of how various states have approached regulation relevant to the legal barriers identified in Chapter 3. The purpose of this exercise is to investigate if certain states have adopted policy and regulation which is more effective in facilitating the deployment of CCS than others.

4 Regulatory developments

4.1 Introduction

Several CCS projects are planned in the North Sea, which is seen in Europe as an area having the largest potential for actually starting CCS since the public opposition to onshore CCS (Global CCS Institute 2012, IEA, 2012). Although the North Sea Basin Task Force aims to further adapt regulation and create coherent legislation, the area is regulated by the different countries surrounding the North Sea (the UK, Norway, the Netherlands, Denmark and Germany) (ElementEnergy 2012). All of these countries have their nation specific regulation and carry out activities in their adjacent exclusive economic zones. It is possible and highly likely that the regulation of CCS will also differ, as the CCS Directive leaves significant room for Member States to adopt more specific regulation.

This chapter aims to provide an overview of the regulatory and policy developments of the countries surrounding the North Sea as well as to provide insight in the way in which the countries address the obstacles for CCS as concluded in the previous paragraph (liability, financial security, business case). Each of the countries is described, first focusing on the regulatory and policy developments, as derived from secondary sources such as reports from the IEA and the GCCSI. After that, the way in which the obstacles are addressed (if addressed) will be described, using a combination of secondary and primary sources. For the comparison on the regulation of these obstacles, for each of these obstacles several questions were formulated, as elaborated below.

4.1.1 Long term climate liability

The CCS Directive distinguishes three different types of liability (climate, environment and health/property). Since CCS is an activity that goes on for decades and after that aims for permanent storage, the liabilities are unpredictable. The CCS Directive has managed the liabilities for the climate and the environment, and States are to regulate the liabilities for health and property. The regulation of the national liabilities might differ between the States surrounding the North Sea. The central question is: who should be liable for what and for how long? Are the liabilities channeled towards the emitters or do States take on some of the liabilities as well? Is this different per type of liability? Based on the interviews with project developers, the real question is: who will be liable for the leakages of CO_2 and who will have to buy credits to compensate leakages in the long term? This is an issue because of the likely time difference between the injection of CO_2 and the possible leakage and the uncertainty with regard to the ETS price, the costs are unpredictable.

For the comparison the following aspects are of interest:
- How are the different liabilities divided over the parties involved in CCS (emitter, transport operator, storage operator, government)
- Are the liabilities managed, and how are they managed (fund, insurance, transfer)?
- Is the insecurity of the ETS price development managed and how?

4.1.2 Financial security/contribution and the transfer of responsibility

Before a permit for storage is issued, the operator has to prove that it is able to carry the financial burdens of the operation. The CCS Directive provides for a number of rules on how to deal with the financial security. However, States are free to regulate this issue into more detail. The central question is who decides on the financial security under which conditions? And does this make CCS more or less attractive for project developers?

Based on the interviews with operators the financial security was seen as a roadblock, because it is not clear for which costs the security is to be provided and in which form. Which scenarios are to be taken into account in calculating this security?

Elements for the comparison of the sets of regulation of states surrounding the North Sea are:
- Who decides on the form and amount of the financial security and are there elaborate conditions?
- For which obligations does security have to be provided and based on which scenarios?

- Are the types of instruments defined and related to the specific obligations?
- Does the financial security have to be paid directly or in phases?
- How are the financial security and financial contribution calculated?
- How does the procedure deal with the long term nature and expected changes in best available techniques?

4.1.3 Aspects related to the business case

In order to incentivise CCS, the CCS Directive has chosen the ETS system as the main driver. Furthermore, States might find other ways of incentivising CCS, such as tax benefits and subsidies. However, for project developers to invest in CCS the activities should fit within their business case for the long term. Based on interviews with project developers, the most likely development of CCS in the North Sea is from demonstration; to CCS for EOR/EHR to large scale CCS. The question is whether or not this is made possible in the different sets of regulation. Furthermore, the project developers indicate that the use of biomass in CO_2 production is more and more common. The way in which biomass is dealt with in the ETS system determines whether or not this will become a roadblock for further development.

Elements for comparison are:
- How is CCS incentivised by the state (ETS, subsidies, tax benefits)?
- Is EOR/EHR made possible?
- How does the regulation deal with biomass?

4.2 UK/Scotland

4.2.1 Regulatory development

Due to the ambitions of the UK government to become a front runner in the development of CCS technologies, legal preparations for the implementation of the technology had already begun prior to the establishment of the EU CCS Directive. The Energy Act 2008 established a licensing framework for offshore CO_2 storage, based primarily on the existing licensing regime for oil and gas activities, however was flexible enough to allow changes in expectation of Directive. Once released, a number of bespoke regulatory pieces were developed to fully transpose the details of the Directive, most importantly (UCL, 2012):

- **Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010** - primarily modifications to implement Article 31 of the Directive regarding the requirements for Environmental Impact Assessments for CCS infrastructure

- **The Storage of Carbon Dioxide (Licensing etc.) Regulations 2010** – regulations to partially transpose the Directive into domestic UK law, including granting licenses, exploration permits, obligations of storage operator, post-closure and financial security.

- **The Storage of Carbon Dioxide (Termination of Licenses) Regulations 2011** – Implements Article 18 of the Directive on the transfer of responsibility from the operator to the competent authority, and Article 20 of the Directive on the financial contribution to monitoring costs into UK law.

- **Storage of Carbon Dioxide (Amendment of the Energy Act 2008 etc.) Regulations 2011** – these regulations extend the geographical scope of a prohibition of CO_2 storage activities to onshore site and internal waters in England, Wales and Northern Ireland.

- **Storage of Carbon Dioxide (Access to Infrastructure) Regulations 2011** – implements Articles 21 and 22 of the Directive, concerning third party access to storage sites and CO_2 pipelines

- **Storage of Carbon Dioxide (Inspections etc.) Regulations 2012 –** these regulations provide for the routine and non-routine inspections of CO_2 storage sites, giving power to inspectors to enter, at any reasonable time (or, in an emergency, at any time) any premises, which the inspector has reason to believe it is necessary to enter.

The UK government has also conducted 12 consultations with industry stakeholders covering a number of aspects regarding the regulatory approach taken for CCS in the UK. In the UK the main competencies for CCS have been assigned to the Secretary of State, or the Scottish Ministers dependent on where the activity takes place (Armeni, 2011).

4.2.2 Long term liability

In the implementation of the CCS Directive the UK has provided for a more specific definition of leakage liabilities. Regulation 15 (3b) of the Storage of Carbon Dioxide (Licensing etc) Regulations 2010, defines leakage liabilities as any liabilities, whether future or present, actual or contingent, arising from leakage from the storage complex to which the relevant license relates and includes liabilities or personal injuries, damage to property and economic loss (Armeni, 2011). This means that at least the liabilities caused by leakage are managed by including them in the transfer of responsibility, liabilities resulting from other causes are not managed, Furthermore, if there are already existing obligations based on court rulings, these are also excluded from the transfer of responsibility. The long term liabilities thus are partially managed (Armeni, 2011).

The requirements for the operators liability in relation to the surrendering of EU ETS credits in the case of leakage, is transposed in Regulation 14 of The Storage of Carbon Dioxide (Licensing etc.) Regulations 2010. After site closure the operator must continue with the obligations of the EU ETS Directive. In the consequence of the revocation of a storage permit by the authority, Regulation 11 states that the authority must either close the site, or consider any application for a new lease. In the meanwhile, the authority is deemed to be the operator of the site for all obligations, including the surrender of allowances under the ETS Directive. Costs incurred must be recovered from the operator by the authority. Regulation 14 of The Storage of Carbon Dioxide (Termination of Licenses) Regulations 2011 includes in the transfer of obligations (after the minimum period), the surrender of allowances in the event of leakages under legislation implementing EU ETS Directive. In general, there are no major deviations from the EU CCS Directive in terms of the exposure to risk by the operator brought about by the necessity to surrender allowances in case of a leakage event.

4.2.3 Financial security

Regulation 5 of The Storage of Carbon Dioxide (Licensing etc.) Regulations 2010 transposes the requirement for details of the financial security to be put in place prior to injection, to be provided in the application for a storage permit. According to the definition used in the licensing regulations, “Financial security” includes:

(a) a charge over a bank account or any other asset;
(b) a deposit of money;
(c) a performance bond or guarantee;
(d) an insurance policy;
(e) a letter of credit;

Schedule 2 of the 2010 licensing regulations outlines the required nature of the financial security. The financial security should be sufficient to ensure the obligations of the operator, including the ETS obligations can be met, be in force until the commencement of injections, and continue until the license is terminated. There are no details provided on the estimation of the financial security, such as amounts, durations and terms and conditions (Armeni, 2011). The regulations also state that the authority must periodically assess the adequacy of the financial security, in line with the requirements of the EU CCS Directive.

4.2.4 Business case

Through the Energy Act 2008, the UK has sovereign rights to explore and exploit the seabed, its subsoil and waters above it within the UK's 200 nautical miles zone. The UK's 200 nautical miles zone includes the territorial waters (to 12 nautical miles from the coast), and the newly designated Gas Importation and Storage Zone (GISZ), which extends a further 188 nautical miles from the edge of the territorial water. Through section 1 of the Energy Act 2008, the exclusive right to store CO_2 in the area from the edge of the territorial water until the limits of the GISZ has been vested to the Crown[7], via the Crown Estate. The Crown Estate (TCE) is a statutory body which acts on behalf of the Crown in its role as landowner within the area of the territorial sea and as owner of the sovereign rights of the UK sea bed beyond territorial waters (DECC, 2009).

The Crown Estate has stated the intention to lease specific sub-seabed formations based on three-dimensional coordinates, together with related areas of the seabed and water column for the platform. The lease from the Crown Estate and the storage license issued by DECC must be applied for simultaneously. The lease and license allows the operator to undertake certain activities, such as exploration for the purposes of long term storage, and provides a time-limited right to apply for a storage permit. Whereas the lease and storage license are common to UK oil and gas explorations, the storage permit represents the additional requirements of storing CO_2 in accordance with the EU CCS Directive (Armeni, 2011). However, the use of three-dimensional coordinates for CO_2 storage is dissimilar to oil and gas licenses, which define the area by reference to a two dimensional plan view. This means that separate leases could be granted at different geological depths to allow activities to partially or fully overlap one another (DECC, 2009).

Section 33 of the Energy Act 2008 does not extend to the use of carbon dioxide for the purposes of enhanced oil recovery, unless they are so extended by an order made by the Secretary of State, subject to negative resolution procedure[8]. The use of this power, is to ensure that operators undertaking EOR/EHR activity and wishing to claim credits under the EU ETS also comply with the additional requirements of CO_2 storage (above normal oil and gas operations), such as the specific Crown Estate lease and the CO_2 storage permit. This arrangement will allow EOR/EHR to continue to be licensed solely under petroleum licensing arrangements if the injection of CO_2 is genuinely ancillary to petroleum production. However, where EOR/EHR is being carried out also with the intention of permanent storage then the storage arrangements will apply in parallel with those for petroleum licensing (DECC, 2008). The parallel application of both petroleum and storage licensing is referred to as the 'dual license' regime.

The UK regime therefore allows a CO_2 storage license to be granted for an area which is already subject to a petroleum license, as long as the storage activities do not prejudice the pre-existing rights of the petroleum license holder (Armeni, 2011). However, The Crown Estate and DECC has declared that the co-existence of such activities will only be permitted when 'there is evidence that suitable liability and operational liability arrangements are in place' (DECC, 2010). The Petroleum Act 1998 allows the use of CO_2 as an ancillary purpose to getting petroleum. If the operator wishes to store the CO_2 permanently for the purposes of gaining credits under the EU ETS Directive, the operator would then have to apply for a storage license under the Storage of Carbon Dioxide (Licensing etc.) Regulations 2010. Until a storage permit is granted (or not), this does not prevent the operator continuing to use CO_2 for the purpose of getting petroleum.

In terms of the prior rights of petroleum license holders, paragraphs 46 to 48 DECC 2009 Consultation on the proposed offshore carbon dioxide storage licensing regime (DECC, 2009), states that,

> *"The Crown State considers that it would be able to grant an exclusive Agreement for Lease to holders of existing petroleum licences who wished to carry out CO_2 EOR/EHR under the "dual*

[7] The Crown includes Parliament, government ministers and its servants. Generally core central government departments fall within the definition of the Crown.
[8] The instrument must be passed before parliament for a period of 40 days. If it is not disapproved the instrument can be made.

licence" regime…because the carbon storage would be ancillary to petroleum production and only the holder of the petroleum licence would have the legal right to carry out EOR/EHR.

Furthermore,

> *"The Crown Estate also considers that it would be able to treat holders of existing petroleum licences who wished to cease petroleum production and convert to carbon storage in the same way as those carrying out EOR/EHR, provided that they apply for leases before their petroleum licences expire. However, no automatic right to transfer these rights is recognised, and leases may be dependent on the individual merits of each project put forward."*

Importantly paragraph 50 of the same document states,

> "DECC therefore envisages that, where the licensee of a field still in production wishes to redevelop it for carbon storage, it will be able to seek a storage licence on an exclusive basis, provided that it does so sufficiently early to ensure that the redevelopment will move ahead at the earliest point in time."

In order for the storage license to be considered on an exclusive basis, the application will be made while the field is still in production and at least twelve months before the expiry of the license. The reason for the exclusivity for petroleum licensees is that it is foreseen that the incumbent operators are best placed to bring forward a storage development at the earliest point in time. If the incumbent operator does not make an application for a storage license, The Crown Estate and DECC will then progress with arrangements for lease and license of the formation for carbon storage or other purposes. Industry stakeholders were asked whether the proposed regime for exclusivity for incumbent operators was appropriate.

In the government statement to the response received from a DECC consultation released in 2010 (DECC, 2010), it was stated that some had suggested that any preference would be "anti-competitive or contrary to the EU Directive on geological storage of carbon dioxide". The DECC response was that although any arrangements introduced must meet the requirements of the Directive, they also have to strike a balance between competition for the new rights and the potential benefits of incentivizing operators of existing fields to integrate initial work on a storage development with continuing operations.

The issue of exclusivity for incumbent operators is not raised in either the Energy Act 2008 or Storage of Carbon Dioxide (Licensing etc.) Regulations 2010. The EU Directive states that "[exploration] permits are granted or refused on the basis of objective, published and non-discriminatory criteria. DECC, (2009) does state that lease may be dependent on the individual merits of each project put forward, and that more information would be provided via The Crown Estate website. At the time of writing, no information of this sort could be retrieved. In the DECC CCS Roadmap, The Regulatory Framework (DECC, 2012), it states that although some "high level principles" have been set about the transition from oil and gas production to storage, the government intends to further develop policy in this area by 2015.

4.3 Netherlands

4.3.1 Regulatory development

The implementation of the CCS Directive entered into force by the amendment of the Mining Act, the mining decree and the mining regulation.[9] The Mining Act was published on June 6th in the Dutch official Law Journal (Stb 2011-381) and entered into force on September 10th 2011. The provisions of the mining act apply both onshore and offshore. However, the Dutch government has announced not to issue any permits for onshore CCS. Until 2010 there were two projects planned in which onshore

[9] All available in English on the following link: http://www.nlog.nl/en/legal/legislation.html.

CCS was included. Due to public resistance, the onshore storage of CO_2 has been cancelled. However, the government still is in favor of developing the technique and support initiatives for offshore storage.

In its implementation the government has strictly implemented the requirements of the CCS Directive. It did not issue any guidance or more specific regulation than described in the CCS Directive. The implementation aims to follow the existing licensing regime, although a specific license needed to be created due to the introduction of the exploration permit, which did not exist as a specific permit in Dutch law (chapter 3 of the mining act). Another difference of the CCS permit in comparison to the already existing mining permits is the integral character of the CCS permit, in which detailed information for the whole lifecycle already has to be addressed in the storage permit. In the other mining permits this information is required at a later stage. (Haan-Kamminga, 2011, p 127). The aspects of the CCS Directive have also been implemented in several other laws and decrees, in order to make a fit with the existing regimes.[10]

4.3.2 Long term liabilities

In regulating the long term liabilities, the CCS Directive is strictly implemented. The liabilities for climate and the environment are implemented in existing legislation and liability for health and property is dealt with according to the national private law regime. Both the liabilities for the environment and the climate are transferred (in principle) 20 years after the closure of the storage location. However, the national liabilities for health and property are not managed. In the first place, several possible grounds for liability exist, and the duration of the liability depends on the ground chosen to address the liability (see also Haan-Kamminga, 2011). The possible regimes are part of the Dutch Civil Code. The Dutch ministry of Economic Affairs has announced that a specific regulation of liabilities will be developed, but is has not been published yet (IEA, 2012, p. 47).

4.3.3 Financial security

Based on art 31b of the Dutch Mining Act the operator has to provide financial security before a permit can be issued. In the Mining Decree more specific information is provided in art 29j. Elements incorporated in the financial security are the estimated costs for the different plans to be handed in (operation, monitoring, closure, post closure). The Minister of Economic Affairs is the authority that decides whether or not the financial security is sufficient. The memorandum accompanying the Mining Decree states that the worst case scenario that has to be incorporated in the calculation is a leakage that continues for three months. The memorandum also addresses the type of security that might be accepted, although the initiative for providing the type and form lies with the operator. The memorandum states that a bank guarantee or an escrow with preferential rights for the government is acceptable. Other forms are possible, but have to be equal in guarantee for the government. This means that insurance alone is not enough, a more material security should be added to insurance. Once there is experience with this type of activity and permit, the minister may create more regulation in the Mining Regulation, in order to provide certainty to the operators.

4.3.4 Business case

The issue of biomass in combination with CCS has not yet been actively addressed. Biomass is seen as increasingly important for the transportation sector (including planes and ships) and small businesses. The possibility of combining CCS and biomass as a means to lower emissions is recognised, however, the regulatory frameworks are separate and the combination as such has not been anticipated in law, though in the proposed ROAD CCS project (Rotterdam) bio-CCS is a likely option.

CCS for EOR/EHR has not been addressed yet and is seen as not yet relevant. The current licensing regime makes the combination of CCS and EOR/EHR impossible. Art 26 of the Mining Act prevents having an exploitation permit and a storage permit for the same storage location at the same time.

[10] The regulation and decision on air contamination, the Environmental Management Act, Electricity Act, Act on economical offences.

The possibility of EOR/EHR has not been centrally discussed during the development of CCS regulation.

4.4 Denmark

4.4.1 Regulatory development

Denmark has a very ambitious climate policy. Not only the government, but the energy sector itself aims for a carbon neutral Denmark in 2050 (DEA, 2009). CCS, especially in combination with biomass is seen as an important mechanism in realizing carbon neutrality. Characteristic to the Danish regime is the distinction between public services and commercial activities. Transport and distribution are viewed as monopolies and are therefore subject to State regulation and production and trade are seen as market activities (Roggenkamp et al, 2007, p442).

The use and exploitation of Danish subsoil is governed by the Subsoil Act. The competent ministry is the ministry of Economic and Business affairs. The CCS Directive is implemented by changing this act. The Act applies both onshore and offshore.

The Danish energy committee stated that the Government will strive to introduce CCS in the North Sea oil fields with a view to enhancing oil production. Onshore storage will only be endorsed when experience with large scale CCS is available. In March 2010 an application by Vattenfall was for this reason rejected. In fact, CCS for other purposes than EOR/EHR would require a parliamentary decision.

Most of the CCS Directive is implemented in the Subsoil Act by its amendment in May 2011. The more technical aspects of the Directive have been implemented in an executive order on the geological storage of CO_2. Along with the implementation the Subsoil Act was amended to make it possible to prioritize in the use of the subsoil (such as geothermal heating).

4.4.2 Long term liabilities

Denmark has a well-developed regime for safety in offshore activities. The companies are responsible for ensuring that the health and safety risks are as low as reasonably practicable. There is an Act on Safety for Offshore Installations for Exploration, Extraction and Transport of Hydrocarbons. (Roggenkamp et al, 2007, p 474). Its scope of application is the Danish territorial waters and the continental shelf. The Act contains a liability regime. This regime can be characterized as strict and unlimited (and jointly and severally in case of a group) and includes personal injury as well as injury to property. The liability must be covered by insurance. The insurance must cover injuries to employees, injuries and damages of third parties and pollution damages caused by the activities (which includes climate liabilities) (section 35 Subsoil Act, section 30 Model License).

4.4.3 Financial security

Before a license is granted, the applicant's expertise and financial base will be assessed (section 23q Subsoil Act). Part of the assessment might be the amount the applicant is willing to pay for the license (licenses can be given out in auctioning rounds). The government has stated that it is possible to issue more specific criteria than it has done so far. The Subsoil Act states that the licensee shall provide financial security for the estimated costs of all obligations related to the storage license. Responsibility for the storage locations can be transferred 20 years after closure of the storage location. Furthermore, the model license contains information obligations on a quarterly and yearly basis (section 21 Model License). The relevant authority is the Energy Authority.

4.4.4 Business case

Denmark actually only allows CCS combined with EOR/EHR. The main driver for CCS thus is the possible profit in oil production. Furthermore, there is a rather complex scheme of CO_2 taxes (Energy law in Europe p 515). The CO_2 tax is a levy on energy consumption, specified for different types of

usage and activities. Companies addressing the CO_2 emission through ETS or by way of storage avoid these taxes. The Danish Government is known for using subsidies to stimulate green initiative, but CCS is not seen as a sustainable option and there are no specific stimulation programmes for CCS. The combination of CCS and biomass is viewed as a more green option, but is not regulated specifically yet.

4.5 Germany

4.5.1 Regulatory development

Germany is known for its rather ambitious climate change strategies and CCS was part of that strategy. However, public opposition to CCS has influenced the political agenda and Germany did not manage to implement the CCS Directive in time. A first bill was proposed in 2009, but rejected by the first chamber (Bundestag). A second bill was introduced in April 2011 and was heavily debated as well. A conciliation committee between the two chambers of parliament was necessary to finally adopt a proposal for implementation of the CCS Directive (June 2012).

The Act on the Demonstration and Use of the Technology for the Capture, Transport and Permanent Storage of CO_2 (KSpG) entered into force on 24 August 2012. The KSpG shall ensure a permanent storage of CO_2 in underground rock layers in a way that protects mankind and the environment and takes the responsibility for future generations into consideration. The law regulates the exploration, testing and demonstration of the permanent CO_2 storage technology.

In accordance with the compromise found in the Mediation Committee of Parliament and the Federal Council, the act provides for an annual storage of no more than 1.3 million tons of CO_2 and a maximum storage capacity of 4 million tons of CO_2 per year in Germany. Section 2 - 5 KSpG lays down the compromise on the so-called “state clause”, which was finally found in the Mediation Committee. According to this provision the federal states can decide on the areas of their state territory in which testing of the CCS technology and demonstration projects can or cannot be carried out. Thereby they have to take account of other potential options for the use of the potential storage sites, the geological particularities of the area and “other aspects of public concern”.

The objection of the public to the bill was new for Germany, in which the public usually supports EU environmental laws. Three issues were new to German energy law:

- The non-binding Commission opinion for draft permits
- The option not to authorize CCS for specific regions
- The transfer of responsibility

The bill provides for cooperation between the different governmental layers in Germany. On the federal level, conditions for storage sites will be elaborated and the ministry for economic affairs and the ministry for the environment will determine the safety, where the regional governments issue the permits for transport and storage.

4.5.2 Long term liabilities

Chapter 4 of the bill (article 29) sets out the provisions on liability. The operator is strictly liable for personal injury and property damage. The maximum amount of damages is high (85 million euros) and the injured person has extensive information rights towards the operator. Furthermore, the operator is liable for negligence. Even after the transfer of responsibility the operator remains liable. However, after the transfer it is an indirect liability, the operator then is liable towards the competent authority. The indirect liability applies when the operator was at fault or in negligence. The liability provisions are laid down in the German Liability Act.

Liability for damages to the environment is laid down in the Act on Damage to the Environment. This liability expires after 30 years unless the competent authority has taken measures towards the operator. Climate liabilities are addressed in the German Act on Greenhouse Gas Emission Trading,

which implements the EU ETS regime (for CCS no specific exemptions were regulated). In effect, all liabilities are transferred to the competent authority, but the operator has to meet the most stringent demands. If not met, the operator will be held liable.

4.5.3 Financial security

The financial security has to be provided for the first year of operation and is meant to demonstrate the operators financial capacity. The exact amount and form of the security shall be determined by the competent authority and is updated annually. German law does not know any legal provision by which the responsibility for a facility is transferred, although it has happened in the past, for example for abandoned industrial sites or landfills. In the adopted bill, the period for transfer is 40 years after closure of the site. The operator has to prove that the storage site is permanently sealed, that there are no leakages or significant irregularities, that the long term safety is ensured according to the state of science and technique (the most stringent criterion). Furthermore, the operator pays a financial contribution in the form of 3% of the value of the CO_2 emissions that were saved by the storage. It should at least cover the costs of monitoring for thirty years after the transfer of responsibility.

4.5.4 Business case

When there is conflicting use of the subsoil or more than one application for a permit, the application that fits the purpose of the law best, will be decided first. If the applications are equal, the first one will be decided upon first. This means that in cases in which two types of permit are required (such as is the case with EOR/EHR/CCS, the competent authority has the freedom to decide which option fits the objectives of legislation best. However, the combination of EOR/EHR and CCS, or the combination with biomass did not play a role in the public debate in Germany.

4.6 Norway

4.6.1 Regulatory development

Norway is widely supportive of CCS technologies and benefits from a large offshore storage capacity. It has ambitious goals with regard to climate change mitigation and both state and industry has been willing to invest in the development of CCS technologies. The first two CCS project on the European continent are in Norway: Sleipner and Snovit. The main focus on the development of CCS in Norway nowadays is on the offshore storage of CO_2 from gasworks. The state had reserved a budget of €351 million for CCS in 2011.

Norway is not an EU member, but as being a member of the EEA (European Economic Area), it still has to implement the CCS Directive, because it qualifies as EEA relevant. By governmental decree of March 13th 2009 the Norwegian government stated that it would aim to develop rules comparable to the CCS Directive's regime. Key issues were already addressed in the well-developed body of oil and gas legislation. Two issues are new to the Norwegian regime:

- The European Commission's right to give non-binding opinions on national permits
- The provisions regarding the transfer of responsibility to the competent authority

The EEA agreement is an agreement between the European Community and its Member States on the one side and the European Free Trade Association (EFTA) on the other. The agreement makes the EFTA countries part to the European internal market. Relevant EU law has to be incorporated in the EEA agreement. It has not officially been decided upon yet, although it has been qualified as EEA relevant. Norway has chosen to implement the Directive or at least adopt a system similar to the Directive. The implementation is carried out by three different ministries: the Ministry of Petroleum and Energy, the Ministry of Labour and the Ministry of the Environment.

4.6.2 Long term liabilities

According to Bugge (2011) the implementation of the provisions on long term liability will not entail challenges to the current Norwegian tort and environmental law. These provisions are seen as an

expression of the polluter pays principle which is also the basis of Norwegian environmental law. The scope of the ETS liabilities for leakages is below the current legal standard of economic liabilities towards third parties. The Norwegian regulation is more stringent towards the operator than the EU ETS system and the operator is fully liable. The Pollution and Waste Act imposes a duty to take measures to prevent, abate and repair pollution, including accidental emissions and discharges, irrespective of fault or negligence. In addition the Petroleum Activities Act imposes strict liability on operators for environmental damage, and any type of damage to actors in the fishing industry.

Both acts contain forms of management of the long term liabilities. On the one hand there is a discretionarily upper limit as to the operators duty of action in case of leakage: the word reasonable is used in article 7-1 Petroleum Activities Act, Pollution and Waste Act article 7. There is also a restriction in the Petroleum Activities Act in case of a force majeure. Such a limitation is not present in the Pollution Control Act. The private liabilities towards third parties however, are not managed. These liabilities remain with the operator, to the extent that the damage is directly linked to the operator.

4.6.3 Financial security

The Norwegian Petroleum Act also contains a provision which is meant to provide security to the Norwegian government. There is a Financial Security Act in Norway (since 2004) which defines a financial security as an agreement by which the ownership of an asset is transferred for the purpose of securing the fulfillment of other financial obligations. It is likely that this act will apply to CCS as well. The Financial Security Act leaves wide autonomy to the parties involved in determining the conditions related to the financial security. The Norwegian government is expected to have the same attitude towards the most likely large companies that will undertake CCS. Furthermore, the Norwegian government will impose stringent requirements because it not only considers the commercial interest, but the interest of the public and the nation at large as well.

Norwegian law does not contain any provision where the authorities are obliged to accept the transfer of environmental liability from private commercial actors. It has happened in practice though, in cases in which the operator could not be held accountable (when an exploitation permit expires or an activity comes to a close), because private actors do not exist anymore or the liability is time barred. There has not been much discussion with regard to this issue yet. The financial contribution which is related to the transfer of responsibility is not completely new to Norway, section 20 of the Pollution and Wastes Act also contains such as provision. In the proposal for implementation of the CCS Directive, the transfer is implemented as in the Directive. The financial contribution does not cover any other costs than the costs mentioned in the Directive (30 years monitoring and decommissioning etc) .

4.6.4 Business case

The main driver for CCS in Norway is the high carbon tax that is imposed on oil and gas companies. By storing CO_2, the tax can be avoided. On the Norwegian continental shelf, the capture, transport and injection of CO_2 in the form of EOR/EHR has been practice for the last 30 years. EOR/EHR processes not combined with CCS are regulated in the Petroleum Activities Act. It seems clear that if EOR/EHR is combined with CCS, the regulation for CCS does apply. This means that possibly two sets of regulation of EOR/EHR might exist next to each other. However, it is likely that the Petroleum Activities Act will be amended in order to match the regulation of CCS.

4.7 Summary

All of the countries have implemented the CCS Directive or have adopted legislation similar to the demands of the Directive. In this report three issues were compared more specifically:

- Long term liabilities;
- Financial security;
- Business case issues.

With regard to the long term liabilities, the liabilities are derived from the CCS Directive for as far as it concerns climate liability and environmental liability. Furthermore, the liabilities for health and property

are addressed in national legislation. The main question for the comparison was whether or not the liabilities were managed either by dividing the liabilities or by transferring them. In all cases the responsibility for the storage location is transferred, including the climate and environmental liabilities as prescribed by the CCS Directive. However, the period for transfer in Germany is the longest (40 years). Furthermore, in Germany, the operator remains indirectly liable towards the competent authority. The way in which the different states handle the private liabilities is rather different. In the Netherlands, the private liabilities are not managed and several possible grounds for liability exist. In Denmark, the private liabilities are included in the Subsoil act and linked to the other liabilities, and managed by obliging operators to purchase insurance. Norway has a stricter liability regime than the Directive prescribes, but does not manage or regulate the private liabilities. Germany links all liabilities and transfers all liabilities, but under stringent conditions. The UK partially manages the long term liabilities, at least those resulting from leakage, by transferring them to the competent authority. All other liabilities remain with the operator, and in case of fault or negligence the competent authority has recourse on the operator. None of the countries have dealt with the uncertainties regarding the ETS liabilities.

With regard to the financial security, most states have implemented the CCS Directive as it is, and have left room for the government to create more specific rules with regard to the financial security. In all cases the competent authority has the initiative and freedom to choose the type, form and amount of financial security, which is decided upon in the individual permit per case, although the UK has the most far reaching legislation on this issue. The review period for the financial security is either 5 years or 1 year (Denmark), in line with the Directive.

Based on the information above, the countries surrounding the North Sea view CCS differently. Where in Norway, the UK and the Netherlands, CCS is seen as important abatement technology the German and Danish attitude towards CCS is more restricted. All countries participate in the EU ETS, which theoretically provides an incentives for CCS. In Denmark and Norway and extensive CO_2 tax also provides for incentives (although EU ETS and the tax regime do not cumulate for emissions, once the climate is compensated through the EU ETS, a less stringent tax regime applies).

With regard to EOR/EHR, Norway and Denmark have made EOR/EHR explicitly possible; in Denmark EOR/EHR is actually the only possible way to conduct CCS. In Norway the CCS licensing regime prevails in case of EOR/EHR, and EOR/EHR as a separate activity is also regulated. In the UK EOR/EHR is recognised as possible, and a dual licensing regime will apply if EOR/EHR is conducted. In Germany there is no discussion on EOR/EHR and in the Netherlands EOR/EHR is not yet made possible in the licensing regime. With regard to biomass, most countries recognise the possibility of combining biomass and CCS, but no specific legislation has been developed yet.

5 Analysis of key issues

5.1 Introduction

In the previous chapters, the proposed projects, possible obstacles and the various interpretations of the CCS Directive by a number of Member States have been described. This chapter further analyses the issues and focuses on finding solutions to be incorporated in regulation.

5.2 Assessment of these issues

Based on interviews with stakeholders, three main issues were identified:
- Long term liability
- Financial security
- Aspects related to the business case (EOR/EHR and biomass restrictions)

With regard to long term liability, the main issues were presumed to be the long term nature of the liabilities, especially the private liabilities for which the CCS Directive did not provide any form of management. Based on the analysis of the regulation in the countries surrounding the North Sea, it can be concluded that the countries differ in the way in which the private liabilities are managed. In some cases the liabilities are linked and transferred, but the conditions for the transfer differ. It seems as though the characteristics of existing legislations have determined whether or not a form of liability management is chosen. None of the countries have addressed the ETS liabilities specifically. The countries have followed the Directive, by transferring the ETS and environmental liabilities at some point. For operators, the uncertainty with regard to the ETS price makes this liability most difficult to accept. It is specifically this issue that needs to be solved, as insurance of this risk is not an option (Climate Wise, 2012).

The uncertainty related to the ETS prices also plays a role in the issue of financial security. Stakeholders indicate that it is impossible to calculate the amount of security needed for a worst case scenario in which leakage of CO_2 occurs, as a result of the uncertainties in development of the ETS price. With regard to the financial security, most of the sets of regulation has provided really detailed information on the transfer of responsibility and more specific regulation regarding type, form and amount of financial security. Only the UK specifies specific types, and the memorandum accompanying Dutch regulation indicates a preference for certain types. All countries seem to have implemented the Directive and nothing else. Although the uncertainty with regard to type and form of security do not seem to be a challenging issue for stakeholders, a discussion on the period for transfer of the responsibility seems necessary.

With regard to the aspects related to the business case, the attitude of countries towards possibilities such as EOR/EHR and biomass seems to dictate whether or not this is regulated and facilitated. The countries have adopted different positions on the possibility of EOR/EHR, and in some countries existing legislation with regard to double or conflicting use of the site for which permits are granted seems to complicate the business case. None of the countries have adequately dealt with the lack of incentive for the combination of CCS and biomass, where all countries recognize the possibility of this combination. A further development of regulation is necessary for this issue (ZEP, 2012).

In the next paragraph possible solutions for these issues will be addressed. These solutions are a result of the discussion with stakeholders (see Table 1.1).

5.3 Possible solutions

5.3.1 Liability

Industrial operators who produce power or industrial gases know little about subsurface gas storage, and therefore are unwilling to assume such liabilities. On the other hand, storage operators have no

experience at all with EUA's and already operate under a regime of liabilities that encourages them to conduct operations as safe as possible. Given sufficient incentives, in an ideal economic scenario, liabilities should be incorporated into a storage fee and added to the total cost of storage. However this would push the price of CCS projects even higher and thereby increase the price of power or industrial products to uncompetitive levels and therefore the alternative will be to simply continue emitting and paying the price for emission rights. From the perspective of the storage operator, a tariff for potential exposure could be built in, but it depends on the perception from time to time of a worst-case scenario. The storage operator insists that the probability of a catastrophic leakage event occurring is less than negligible in a depleted gas field, particularly for a reservoir that is only partly re-pressurised with CO_2 (i.e. the field pressure with CO_2 remains lower than the original field pressure with natural gas). However, as long the storage operator is expected to carry this additional EU ETS price exposure both if leakage occurs and also in the financial security required by the competent authority then the perception of size of potential exposure will far exceed the perception of probability, and the resulting tariffs will be high.

There are examples of pollution liability regimes, where the entire penalty does not sit with the operator. This holds for nuclear accidents. The operator of a nuclear power plant has a financial responsibility (recently upped to €1.2 billion), and the government has an additional financial responsibility in this case. However the decision for the needs of public financial responsibility was an ex-post requirement and this situation of long-term liability is not suitable or desirable to compare with CO_2 storage. The incentives and risks involved are completely different and the environmental consequences for a CO_2 leak are insignificant.

A number of potential options were discussed to overcome the CO_2 storage EU ETS price liability issue. Some of the options were based on fundamental alterations in the relevant EU Directives, others focused on possible workarounds based on the existing legislative boundaries.

5.3.1.1 A de-coupling of CO_2 storage from the EU ETS

A view was expressed during the meeting that storage operators will do whatever it takes to prevent any chance of a leak and stop as quickly as possible any actual leak, and hence the extra penalty of the liability for ETS is in their opinion unnecessary, if the goal of the liability is seen as an incentive for the storage operator to act as a reasonable and prudent operator. Opting CO_2 storage out of the EU ETS Directive as a regulated activity could solve the issue of the ETS liability.

A view from industry is that although the EU ETS provides an incentive to capture and store CO_2 from an emitter perspective, for a storage operator there is very little incentive to take on the exposure associated with CO_2 storage. Furthermore, there are many responsibilities placed on storage operators for limited reward. The storage industry stressed that no CO_2 storage operator would undertake such an operation if there would be any possibility of leakage. There are a number of safeguards for effective CO_2 storage, without placing the burden of liability to purchase EUA's on storage operators in the event of leakage. Firstly, the risk assessment as part of the CCS Directive must prove that the storage complex is safe prior to injection taking place, which has to be agreed upon by the competent authority supported by third-party experts. Furthermore, the rectification of any leakage is likely to entail very high costs to the operator, which in itself represents a huge incentive to operate as safely as possible. Finally, the reputation of the storage operator would be badly damaged in the case of a leakage occurring. Given the fact that the majority of potential CO_2 storage operators will have activities in the oil and gas industry, the third point above is very important.

On the other hand, this de-coupling might be interpreted as the operator being released from full liability for its activities. It could be viewed by certain stakeholders and opponents to CCS that significant exceptions are being made for the technology, and that a shift away from the polluter pays principle is occurring. As this requires a change in both the CCS Directive and the ETS Directive, a political debate on the EU level is needed.

5.3.1.2 Reduce the period before the transfer of responsibility

The decision of the transfer of responsibility could be changed from an arbitrary number of years to one based on the performance-based test of the storage site. The selection of the site, site characterisation and monitoring strategy are based on scientific insights, and this principle should be extended to the closure and post-closure project phases. The transfer of responsibility phase could for example, be reduced from 20 to 3 years (assuming storage integrity), providing sufficient time for an intensive post-closure monitoring survey, completed by the operator under adjudication of third-party experts assigned by the competent authority, and the competent authority itself. The reduced period for the transfer of responsibility facilitates a more effective use of both financial resources of the operator, and the resources of the competent authority, which reduces the costs of CO_2 abatement to society as a whole. A reduction in the period of transfer of responsibility will help to significantly ease the liability exposed to the operator, as well as the financial security to be provided. This solution can be applied on a (Member) State level.

5.3.1.3 Liability cap based on historic EUA price

In terms of options to limit the EU ETS liability faced by storage operators during their term of custodianship, there could be a way to link the EUA price applicable when CO_2 leakage takes place, to the historic price of an EUA when CO_2 was injected. In this way the exposure for the storage operator could be reduced, with the financial exposure being linked to the decision to store CO_2 at a specific point in time, rather than the financial exposure being subject to the unpredictable EU ETS market price. This means that the storage operator can make a decision on injecting CO_2 using a more certain NPV on which to base an investment decision.

However, this option would require alterations in the regulation, and ultimately lead to a reduction in the liability of CCS project developers which could be argued against is inequitable and discriminatory in favour of CCS against other technologies. This option is currently in conflict with the CCS Directive.

5.3.1.4 Spreading the ETS liability over the whole chain

The long term EU ETS liability associated with CO_2 storage could be spread horizontally over the capture, transport and storage operators. Here the risk faced by each entity is reduced. This would require a change in the CCS Directive that currently channels the long-term liability only towards the storage operator.

However, it was mentioned that this option could get very complicated if multiple use infrastructure were to develop for CCS, such as multi-user pipelines and platforms. It may be difficult to assign and administer liability in such circumstances, and still the incremental potential exposure associated with participating in CO_2 storage is not removed. Already the situation for a potential storage site in the Netherlands (the P18-4 field owned by TAQA Energy B.V., and to be used as part of the ROAD project) is complicated, with two partners holding the license to the reservoir and well but four partners owning the platform and an unknown number of potential partners in the pipeline each holding different shares. Combine with this the possibility of two or more parties holding capacity just for the P18-4 storage and then add more parties for a future reservoir and wells serving more customers and you have a very complex combination of players each tracking their separate EU ETS liability position.

Furthermore such a system of spreading the risk over the complete chain, assumes that ‘diluting’ the risk will be an improvement. However, imposing risks upon parties, which cannot be evaluated properly (as these risks are not part of their core competences), will lead to higher barriers in the chain instead.

5.3.1.5 Member State involvement

Here the Member State could act as last-resort insurance for some of the EU ETS liability, for example when the EUA price increases a certain amount, or the cumulative value of CO_2 underground exceeds a threshold. This cap could encourage private insurers to insure a project to a certain value. Other Member State involvement could include a contribution to a national financial security pool also funded by operators.

Member State involvement may be desirable from an operator perspective; however it is contrary to the CCS Directive and would have to be assessed under state aid regulations.

5.3.1.6 EU Financial Security Support EU ETS

All of the options outlined above require a party, either industry or the government to reserve funds for a very low probability event. To support projects in the demonstration phase, for example the projects under the EEPR and NER300 in the EU, the EU ETS liability could be managed by withholding an amount of EUA's each year from the EU ETS auction process, with this reserve used as a security in case of leakage from one of the CCS demonstration projects. This would not be the first time an amount of EUA's has been reserved, as the NER300 is also a reserve of 300 million EUA's. However the reserve for possible leakage differs from the NER300, in that if no leakage occurs within the demonstration phase (say 5 years), then the auction of EUA's can continue as planned. If something happens, the number of credits released back to the auction in the following year is reduced by the equivalent volume of CO_2 leaked in the year before. Therefore, all participants to the EU ETS pay *pro rata* in case of CO_2 leakage.

Although many in the workshop thought this approach to be an attractive one, a number of questions may remain. For example, with 1 or 2 demonstration projects the possible reserve of EUA's from the auction will be relatively small, however with a greater number of demonstration projects operating for multiple years, the EU ETS liability may be more substantial and therefore the reserve might need to be increased annually. On the other hand the probability of all storage sites leaking is rather unlikely and therefore the joint leakage risk might still result in relatively limited costs. It is also unclear whether this is a sustainable solution for long-term CCS development, and another solution will still have to be found for the commercial phase, but if it works for the demonstration phase then this could be a potential solution.

5.3.1.7 Different approach needed for demonstration phase

To summarize this session, it was generally agreed that a distinction between the demonstration stage and the commercial stage of CCS in terms of ETS liability should be made. In the demonstration phase additional support is needed, where in the commercial phase more options such as risk spreading or insurance could become possible. There is no clear winner from the options mentioned; all have their own advantages and disadvantages. The reserve of EUA's from the EU ETS as leakage security option was found potentially useful by many members of the expert session, possibly restricting it to the demonstration phase. This option allows the consequences of CO_2 leakage to be spread across all entities exposed to the ETS, and any use of this option would in most circumstances have a very minimal price impact, which would not be noticed (especially in the early demonstration project years). It was also agreed by the participants that investigating how liability is dealt with in Norway, Australia and Alberta, Canada, which either have CCS projects running, or at an advanced stage of planning, can be beneficial to provide insights for European projects.

5.3.2 Financial security

Three issues concerning financial security can be distinguished: (i) the uncertainty that is a result of the coupling of the financial security to a worst case scenario in which leakage occurs and large amounts of EUAs have to be purchased, (ii) the uncertainty on the duration between storage site closure and handover to the Member State (which is 20 years or earlier based at the discretion of the Minister) and (iii) the regulatory uncertainty that is related to the amount, form and timing of the financial security, financial mechanism and the transfer of responsibility. Generally speaking, many of the stakeholders thought that the existing legislation within the CCS Directive to be sufficient. The competent authority has a level of freedom to deal with each storage case, and tailor each financial security to the particular risks of a project. There are however a number of areas where additional guidance could be provided regarding the financial security and the financial mechanism.

Guidance and justification could be provided on methods to calculate and provide a financial security. In what form the financial security is to be provided should also be clarified. For example, the European Commission has specified bank guarantees as preferential. However the operators

themselves may have a lower risk of insolvency than the bank. Although it would be possible to adopt more specific regulation with regard to the type and amount of security, the participants in general feel that there is no need to do so. The flexibility and site-specific solutions that can be negotiated with the competent authority are valued higher than more specific regulation.

The transfer of responsibility now is set on 20 years, which most countries have taken over in their respective sets of regulation (only Germany has altered this term). This term however, has no scientific basis. Once injection has ceased and the well has been plugged, it is understood that the storage site will become stabilised within a period of much less than 20 years. As Member States are able to adopt more specific regulation with regard to the financial securities issues, the solutions can be applied on a Member State level.

5.3.3 Business case issues

In terms of encouraging the use of biomass combined with CCS, the most expedient solution would be for the European Commission to develop a system, that CO_2 derived from biomass that is stored in line with the CCS Directive is rewarded with 'negative emission credits'. This would mean that operators would be 'given' EUA's for every ton of CO_2 stored from biomass fuel. As yet, there have been numerous calls for such an implementation; however nothing has been heard from the European Commission on this matter. The current EU ETS regulations, which exclude biomass emissions to be reported under the system, will be in place until 2020.

Another possibility is to make it possible to trade biomass percentages. An administrative swap would be conducted by companies storing CO_2 partially from biomass, to swap that percentage with a company that does not have emissions from biomass. The company storing CO_2 would benefit because all emissions stored would count as not emitted, the other company would benefit because part of the emissions would be considered as biomass emissions. However, the general feeling among the participants was that this would lead to too much red tape. A relative easy first step could be that operators, who co-fire coal and biomass while at the same time partially emit CO_2 via a stack and partially store CO_2 at a CCS project, will be allowed to above proposed swap within their own company within an annual period.

The complications in combining CCS with EOR/EHR appears to be specific to Dutch regulations. The issue of the legal prohibition in the Netherlands of holding a CO_2 storage license in combination with an oil/gas production license was discussed briefly. There are no restrictions on using CO_2 for EOR/EHR; however no EU ETS credits can be acquired, as the process will be considered as an industrial activity. It was mentioned that this issue is primarily a national issue, as Denmark and other countries has interpreted the EU CCS Directive differently. Furthermore the EU ETS monitoring and reporting guidelines actually provide an activity specific guideline for monitoring CO_2 emissions from the storage of CO_2 in combination with enhanced oil recovery. This was agreed as an issue for potential Dutch oil and gas operators considering implementing CO_2 enhanced oil or gas recovery. The most direct solution would be for the Dutch government to alter this prohibition, looking at examples from other Member States such as the UK and Denmark with regulatory arrangements that support the CCS/EOR/EHR combination.

6 Recommendations

CCS is a technology with a significant abatement potential for conventional power generation and industrial production processes. In Europe, the roll-out of the technology continues to be delayed due to a lack of financial incentives for a long-term business case and public protest for the onshore storage of CO_2. As covered in this report, there are also legal and regulatory barriers which complicate or introduce additional hurdles for potential project developers. In relation to high investment costs and public opinion which are relatively more challenging barriers, it would be highly unfortunate for regulatory uncertainty to negatively influence the outcome of such an important technology.

What has become apparent through the analysis of the current regulatory framework, both on a European and Member State level, is that it is political willingness that will play the decisive factor in the speed at which CCS develops in Europe. Is has also become apparent, that the CCS Directive, which outlines the regulatory framework for CCS in the EU, is conflicting in it's reliance on the scientific understanding on geological storage. For example, regarding the transfer of responsibility of the closed storage site from operator to competent authority, the site must remain the responsibility of an operator for an arbitrary timeframe of 20 years. 20 years has no scientific relevance in terms of geological stability or safety, however this decision has significant impacts on both the liability and financial security arrangements laden on the operator, and represents a significant barrier to a business case in Europe.

This report has attempted to identify solutions for the issue of the climate liability, whereby the storage operator is exposed to high financial risk due to the obligation to purchase EUA's at an unknown price in the future in the case of leakage. We have also examined the issue of the operator providing financial security to the competent authority, of which the lack of a standard approach to the calculation creates uncertainty, and the requirements to calculate the liability on a 'worst case scenario' (no probability factor may be used), means that the amount of financial security may be unattainable for the storage operator. From this analysis, a number of recommendations are provided, with the objective of informing policy makers of the necessary adjustments required in regulation in order to support the roll out of CCS in Europe.

- **Link the period of transfer of responsibility to the performance of the storage site -** The decision of the transfer of responsibility should be changed from an arbitrary number of years to one based on the performance-based test of the storage site. Reducing the period of transfer from, for example, 20 to 3 years (assuming storage integrity), would still provide for sufficient time for an intensive post-closure monitoring survey, completed by the operator under adjudication of third-party experts assigned by the competent authority, and the competent authority itself. A reduction in the period of transfer of responsibility will help to significantly ease the liability exposed to the operator, as well as the financial security to be provided. This solution can be applied on a (Member) State level, and is possible under the CCS Directive.

- **Manage the uncertainty related to the ETS liabilities** – The potential ETS liability for storage operators is hard to determine as there is no certainty with regard to the price development of EUA's. In this study, several possible solutions were proposed (see Section 5.3), from issuing leakage certificates to a form of government re-insurance. The different solutions can be applied on both the European and Member State level. It should be clear that for the demonstration phase more government involvement is required, where as in the commercial phase other solution become more viable.

- **Rethink the scenario's to be taken into account in determining the amount of financial security** - It must be recognised that for the storage operators, the amount of financial security to be provided will significantly outweigh the expected revenue stream given the current price of EUAs. The main reason for this is that in the financial security, the liabilities for a worst case scenario have to be incorporated, and given the lengthy liability and the

uncertainty with regard to the ETS price, this will always be an significant amount for which security has to be provided. This solution can be applied on a Member State level.

- **Investigate the possibilities for EOR/EHR** – EOR/EHR might provide for an extra incentive for CCS, as the operator will also have revenues from the extracted oil or gas. Any legal issues having to do with the permitting system should be adapted to facilitate the possibility of EOR/EHR. Any barriers can be removed on a Member State level.

- **Facilitate the biomass/CCS combination** – As the use of biomass in power generation will increase, the combination of biomass and CCS is probable. As of now, the combination is not incentivised and may possibly cause extra liabilities for the storage operator. Now, nothing is regulated with regard to this combination, but regulation is needed, at least to provide certainty with regard to the possible liabilities in case of leakage. Regulation could be used to incentivise the combination of CCS and biomass. The different possible solutions can be applied on both the Member State level and the European level.

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8 References

Argus Media, 2012. German state to ban CCS. Available on (24/08/2012): http://www.argusmedia.com/pages/NewsBody.aspx?id=806377&menu=yes

Armeni, Chiara, 2011. United Kingdom - Case studies on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide, UCL, November 2011.

Baker & McKenzie, 2010. Report to the Global CCS Institute on legal and regulatory developments related to carbon capture and storage between November 2010 and June 2011.

BEST, 2012. German parliamentary committee approves CCS law. Bellona Environmental CCS Team. Available on (24/08/2012): http://bellona.org/ccs/ccs-news-events/news/article/german-parliamentary-committee-approves-ccs-law.html

Bugge, Hans Christian, Andre Lamark Ueland, Norway, Case studies on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide, UCL, November 2011.

ClientEarth, 2010. Final Hurdles: Financial Security Obligations Under the CCS Directive. October, 2010.

ClimateWise, 2012. Managing liabilities of European carbon capture and storage. University of Cambridge, 2012.

DECC, 2009. A consultation on the proposed offshore Carbon Dioxide storage licensing regime. Report URN 09D/753. The Department for Energy and Climate Change, London

DECC, 2010. Developing Carbon Capture and Storage (CCS) Infrastructure: Consultation on Implementing the Third Party Access Provisions of the CCS Directive and Call for Evidence on Long Term Development of CCS Infrastructure. Report URN 10D/989. The Department for Energy and Climate Change, London.

DECC, 2012. CCS Roadmap – The regulatory framework. Report URN 12D/016c. The Department for Energy and Climate Change, London.

Danish Energy Association, 2009. Power to the people. Report 09-06-09.

ElementEnergy, 2010. One North Sea – A study into North Sea cross-border CO_2 transport and storage. Available on (23/08/2012): http://nsbtf.squarespace.com/storage/OneNortSea_Fulldoc_Final_LoRes.pdf

European Commission, 2012. NER300 - Moving towards a low carbon economy and boosting innovation, growth and employment across the EU. Commission staff working document. SWD(2012) 224 final. Brussels, 12.07.2012.

Global CCS Institute, CCS ready policy and regulation – The state of play, progress towards the implementation of the CCS ready policy and regulatory frameworks. August 2012.

Global CCS Institute, 2012. The global status of CCS – 2012. Canberra, Australia.

Haan-Kamminga, A., 2011. CO_2 Opslag in en om Nederland: Wie is bereid het financiële risico te dragen? Nederlands Tijdschrift voor Energierecht, Volume 10, no 3 2011, p. 126-134. (CCS in the Netherlands, who is prepared to take the financial risks? Dutch Journal for Energy Law.

IEA, 2011. Carbon capture and storage and the London Protocol – Options for enabling transboundary CO_2 transfer. Working paper. Paris, France.

IEA, 2012. Carbon capture and storage legal and regulatory review - Edition 3, July 2012. Paris, France.

Krämer, Ludwig, Germany, Case studies on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide, UCL, November 2011.

Mikunda, T., Haan-Kamminga, A., de Wolff, J., de Joode, J., Meindertsma, W. and Nepveu, M. Transboundary legal issues in CCS - Economics, cross border regulation and financial liability of CO_2 transport and storage infrastructure. CATO2, Deliverable D4.1.05. Available on (01/12/2012): http://www.co2-cato.org/publications/publications/transboundary-legal-issues-in-ccs-economics-cross-border-regulation-and-financial-liability-of-co2-transport-and-storage-infrastructure

NER300.com, 2012. Initial analysis of first call results. Available on (24/08/2012): http://www.ner300.com/?page_id=199

Notenboom, Jos, Pieter Boot, Robert Koelemeijer, Jan Ros, 2012. PBL Netherlands Environmental Assessments Agency, Climate and Energy Roadmaps towards 2050 in north-western Europe, September 2012.

Planbureau voor de leefomgeving (Netherland Environmental Assessment Agency (NEAA)), Climate and Energy Roadmaps towards 2050 in north-western Europe, PBL Publishers, 2012.

Roggenkamp, Martha, Catherine Redgwell, Anita Rønne, and Iñigo del Guayo, 2007. Energy Law in Europe, Oxford University Press.

UCL, 2012. Offshore CO_2 Storage - National Marine Legislation - The UK Regulatory Framework. UCL Carbon Capture Legal Programme. Available on (02/11/2012): http://www.ucl.ac.uk/cclp/ccsoffnational-UK.php

Vangkilde-Pedersen, T., 2009. Storage capacity, D16, WP2 Report. EU Geocapacity. Available on (23/08/2012): http://www.geology.cz/geocapacity/publications/D16%20WP2%20Report%20storage%20capacity-red.pdf

ZEP Zero Emissions Platform, 2012. Biomass with CO_2 Capture and Storage (Bio-CCS) - The way forward for Europe, June 2012.

Appendix I: Transboundary CO_2 transport

The North Sea contains a lot of possible storage locations. It is likely that project initiators select storage locations beyond the jurisdiction of the state from which the CO_2 originates. If so, the CO_2 for storage will have to be transported, crossing the borders of one or more states. However, the transboundary movement of CO_2 is prohibited, based on art. 6 of the London Protocol. A resolution is adopted to overcome this difficulty, but the resolution has not been ratified by enough members. Therefore, art 6 of the London Protocol still is an obstacle for the development of CCS. In its working paper, the IEA explored possible ways to resolve this and distinguished five possible approaches to enable transboundary CCS:

- to issue an interpretative resolution based on the general rules of interpretation
- resolve to provisionally apply the 2009 amendment, until it is ratified
- to enter into bilateral or multilateral agreements
- agree to modify the operation of the relevant aspects of the London Protocol between specific contracting parties
- agree to suspense the operation of the relevant aspects of the London Protocol between specific contracting parties

The first two of these options entail a general agreements from the contracting parties; the latter three are resolutions between specific contracting parties. However, as the parties to the London Protocol did not ratify, the questions remains whether they are willing to enter into agreements that might solve the issue. Under the London Protocol, the transboundary transportation of CO_2 for EOR/EHR is possible, as it is defined as an industrial process. It seems that there is no real objection towards the transportation of CO2, but solving the issue does not seem to get high priority.

In some of the project proposals, transport by ship is proposed. As the CCS Directive is written assuming that transport will take place by pipeline, there are many uncertainties as to how the regulation applies to transport by ship. The main issue mentioned by project initiator is the integrity of the monitoring of emissions through transport and storage. Shipping companies are confident that this is technologically possible. Legally, the monitoring should ensure that from capture to storage the demands for the ETS permit are met, as the CO_2 is transferred and each new operator in the CCS chain has to obtain the ETS permit. If transport is done by ship, a distinction must be made between the emissions from the ship itself and the emissions from the CO_2 that is being transported. The emissions of the ship itself do not seem relevant for the ETS permit regarding the transportation of CO_2. However, if politics would decide otherwise, a problem might rise as ships do not currently fall under the EU ETS system. The emission from the transported CO_2 are of relevant for the integrity of the CCS chain. The question at stake here is whether the activity 'CO_2-transport by ships' is, should and/or can be included within ETS. For the purpose of the ETS Directive, it does not matter whether the transport by ship is seen as a form of transport (including the liquefaction process) or as a form of temporarily storage. Crucial is that the possible leakages are detected and emissions are accounted for. The relevant question thus is, whether or not the shipper takes over the responsibility for the CO_2. If so, the shipper needs an ETS permit. However, the shippers that we have interviewed all indicate that they will not accept liability for the ETS. Therefore, it is questionable whether or not the shippers should have a separate permit, as long is guaranteed that the quantity in the complete chain is monitored.[11] As this discussion has not yet taken place and the relevant regulation has not been identified or designed yet, there is a high degree of uncertainty for project initiators (which authority is competent? how should the permit be designed, per fleet or vessel?).

[11] The same cannot be said for the environmental permits that might be needed.