Transboundary legal issues in CCS

Economics, cross border regulation and financial liability of CO_2 transport and storage infrastructure

Prepared by:	Tom Mikunda	ECN
	Avelien Haan-Kamminga	RUG
	Joost de Wolff	KEMA
	Jeroen de Joode	ECN
	Wouter Meindertsma	TNO
	Manuel Nepveu	TNO
Reviewed by:	Tom Mikunda	ECN
	Jeroen de Joode	ECN
Approved by:	J. Brouwer (CATO-2 director)	

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Executive Summary

A number of recent documents have stressed that if CCS is to make a significant contribution to the European Union's climate change targets towards 2050, CO_2 transportation networks that span across European boundaries will be necessary (IEA, 2009: Neele et al, 2011). During the demonstration phase of the technology, it is likely that CO_2 pipelines will be built on a point to point basis within the national boundaries of the Member State. However, the general move towards offshore storage due to communication challenges with the general public in certain countries, the cost of characterising suitable offshore storage complexes and the potential demand for CO_2 for the purposes of enhanced oil recovery in the North Sea, could mean that pipeline infrastructures and potentially CO_2 shipping routes will be required to cross national boundaries.

However the transboundary movement of CO_2, and the development of the infrastructure needed to make this happen, can only be realised once a number of legal issues have been resolved. A review of a number of pending transboundary legal issues, including financing and ownership, third-party access and financial liability form the basis of this report. In addition to these legal issues, potential ownership and investment approaches for CO_2 transportation infrastructure are reviewed, and economic theories have been tested using a survey completed by industrial stakeholders.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Distribution List

(this section shows the initial distribution list)

External	copies	Internal	Copies

Document Change Record

(this section shows the historical versions, with a short description of the updates)

Version	Nr of pages	Short description of change	Pages

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Table of contents

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

List of tables

List of figures

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Abbreviations

CEF	Connecting European Facility
BCM	Billion cubic metres
BOO	Build, operate and own
CAPEX	Capital expenditure
CCSA	Carbon Capture and Storage Association
CCS	Carbon capture and storage
CO_2	Carbon dioxide
EC	European Commission
ECT	Energy Charter Treaty
EEZ	Exclusive economic zone
EIA	Environmental impact assessment
EIB	European Investment Bank
EU ETS	European Union Emissions Trading Scheme
EU	European Union
EUA	European Union Allowance
EEPR	European Energy Programme for Recovery
GTA	Gas transportation agreement
GHG	Greenhouse gas
IEA	International Energy Agency
IFC	International Finance Corporation
IPCC	Intergovernmental Panel for Climate Change
IPO	Initial public offering
IPPC	Integrated pollution prevention control
LNG	Liquid natural gas
MW	Megawatt
NER	New Entrants Reserve
Nm	Nautical mile
NOK	Norwegian krone
NPV	Net present value
OPEX	Operational expenditure
OSPAR	Oslo/Paris Convention (for the Protection of the Marine Environment of the North-East Atlantic)
RAMF	Risk assessment and management framework for CO_2 sequestration in sub-seabed geological structure
SPE	Special purpose entity
SPV	Special purpose vehicle
BBL	The Balzand Bacton Line
TPA	Third-party access
TEN-E	Trans-European Networks for Energy
TFEU	Treaty on the Functioning of the European Union
TSO	Transmission system operator
UK	United Kingdom
UNCLOS	United Nations Convention on the Law of the Seas
ZEP	Zero Emissions Platform

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Summary

Dependent on the success of European CCS demonstration projects and a continuation of political support for ambitious CO_2 reduction targets in Europe, large scale transportation networks for captured CO_2 may be required in certain parts of Europe. Due to a lack of suitable storage sites, or demand for CO_2 for the purposes of enhanced oil recovery, the cross-border transportation of CO_2, and the development of transboundary infrastructure to facilitate this is a distinct possibility. However, the regulatory and legal framework to allow the construction of such infrastructure is underdeveloped.

Demand for CO_2 transportation capacity is likely to grow gradually, however the economies of scale of pipelines favour over dimensioning in expectation for future demand. However, experiences from the natural gas transportation industry indicates that pipelines are only built once long term capacity contracts are agreed between the pipeline owner and users of the capacity. Given the current lack of a business case for CO_2 transportation, some form of public investment will be required if over dimensioning is to take place. The government can intervene in a number of ways, such as lending or providing subsidies to pipeline developers, or guaranteeing a return on investment to raise private equity in projects. Furthermore, long-term 'take or pay' contracts provide the greatest security to investors, and Member State governments need to clarify how the setting of transportation tariffs for third party users will be regulated.

The most important legal issue when considering the development of a CO_2 pipeline onshore, is the fact that each Member State has jurisdiction over the part of the pipeline situated on its territory. This means in the case of a cross border transport infrastructure, several regulatory regimes may be applicable for the same pipeline network. As Member States are permitted to create more stringent demands than issued in EU law, potential operators may have to deal with multiple authorities with potentially conflicting permit demands.

Offshore, the regulation of CO_2 pipelines depends on the maritime zone in which the pipeline is planned and the extent to which the pipeline is connected to an installation over which a coastal State may have functional jurisdiction. When an Exclusive Economic Zone (EEZ) is established, the coastal State may have functional jurisdiction over CO_2 storage and as a result of that over the pipeline connected to it. In case of transboundary transport, conflicting jurisdiction may arise with regard to siting and construction and environmental and safety demands.

In case of transboundary pipelines, experiences from the gas sector indicate that it may be necessary deal with multiple authorities and varying legislation. This can be a time consuming process. For certain cross-border gas transportation projects, bespoke companies are created which deal with the relevant authorities to ensure that all requirements of the stakeholders are met. If necessary, bilateral and multilateral agreements are concluded. In the Nord Stream pipeline project, for example, the consortium was faced with 5 transit states implementing EU Directives in their national law as well as international law such as the Espoo Convention (cross border Environmental Impact Assessment requirements) and the Helsinki Convention (the Convention on the Protection of the Marine Environment of the Baltic Sea Area).

Another potential barrier for the development of transboundary transport networks concerns financial liability. Financial liability can be divided into two general categories, obligatory expenditures and damages related to unexpected leakage events. Obligatory expenditure includes the monitoring during operation, the decommissioning of the site, monitoring after closure, and the payment to the Competent Authority for monitoring after transfer. If an unexpected leakage event may occur, in addition to the obliged corrective measures, the financial damage following a CO_2-leakage event can be divided in three main categories, and for these three categories it is practically impossible to quantify the financial damage:

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

- EU-ETS
  Given an accidental leakage event, the equivalent amount of EUA's must be surrendered. Since it's likely that the amount of accidental leakage is not measured within the required uncertainty (7,5% following the CCS Monitoring & Reporting Guidelines), an additional 'adjustment' has to be applied and in case the emission rights cannot be transferred timely an additional penalty might follow

- Health/property third party, direct or indirect
  The leakage of CO_2, or the event resulting in CO_2-leakage, might result in damage to health and / or property of third parties.

- Environment
  Exposure to CO_2 might result in direct damage to the local flora and fauna, and changes in the quality of ground- and surface water. The effect can be a temporary disturbance or last for a longer period of time.

From a transboundary perspective, with regard to the liabilities for damage, some liabilities are managed on a European level. For those liabilities that are not managed on a European level, national and possibly conflicting regulation may apply. This means that for different Member States, the liabilities for the possible operator will differ. When a Member State chooses to take on some of the liabilities, for example contributing to a long-term insurance fund, it becomes more attractive to possible investors. On the other hand, by not managing liability, the Member State might also discourage CCS. This might provide operators with an incentive to choose storage locations in countries with a favourable regime. Divergent regulation on financial liability across EU Member states cannot be considered desirable, as the selection of storage sites should be based on safe storage, minimum impact to the environment, and the lowest cost to society. In other words, a level playing field for CCS infrastructure operations should apply.

An industry survey has been conducted to gain an insight on the issues of pipeline financing, ownership and financial liability. All of the respondents stated that over-dimensioning of CO_2 pipelines to meet future demand is necessary. National CO_2 pipeline networks are considered by the respondents as either essential or important to facilitate the deployment of CCS in the Netherlands, the UK, Norway and Germany. Transboundary CO_2 networks were given less importance, given the availability of suitable storage locations in the respective countries.

Only 10% of the respondents held the opinion that the EU CCS Directive had sufficient guidance to ensure a harmonized approach to the development of CO_2 transport pipelines across EU Member States. The CCS Directive does not regulate the issues dealt with adequately elsewhere, but the respondents apparently see a need for more harmonization. Furthermore approximately 60% of the respondents indicated that the presence of publicly owned companies with the ability to transport CO_2 in a country represents a competitive advantage to potential CCS investors. 60% of the respondents held the opinion that divergent CO_2 transport tariffs between EU countries could imply a distortion of competition between states, and that variable levels of financial support for transport infrastructure between countries could hinder the development of a pan-European network.

Recommendations for policy-makers

In addition to addressing the specific research objectives, based on the research conducted and the legal barriers and challenges identified, a number of policy recommendations have been devised:

- Further guidance must be provided to Member States to prevent the emergence of divergent national regulation regarding these issues which could affect the development of CO_2 transportation infrastructure. Member States should enter cross-border dialogue on consistent regulatory approaches to be applied to future transboundary CCS infrastructure.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

- A European support fund to support the development of cross-border transport infrastructure must be considered for future implementation, dependent on the progression of CCS as a climate mitigation technology.

- A possible source of funding for European transboundary CO_2 transportation infrastructure could become available through mechanisms within the EU's energy infrastructure policy. Funding may become available under the "Connecting Europe Facility (CEF)". Member State governments and potential project developers should look towards possible cross-border CO_2 transportation projects with common interests in different Member States towards 2020.

- A standard model for cross border cooperation on siting and construction of CO_2 pipelines would be useful, in order to save time and money for the interested market parties. However, Member States are likely to object to this, as they did in the case of the electricity grids.

- A useful way to regulate transboundary CCS and to harmonize national rules is to form bilateral and multilateral treaties.

- The European Commission should specifically choose a regime for liability of the emission allowances in case of transboundary transport, based on international law, the storage state taking responsibility seems to be the most reasonable.

- In terms of financial liability for CCS infrastructure, for extremely low probability events entailing extremely high financial liabilities, it is suggested that governments should be involved in providing insurance or the establishment of a common fund.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

1 Introduction

A number of recent documents have stressed that if CCS is to make a significant contribution to the European Union's climate change targets towards 2050, CO_2 transportation networks that span across European boundaries will be necessary (IEA, 2009: Neele et al, 2011). During the demonstration phase of the technology, it is likely that CO_2 pipelines will be built on a point to point basis within the national boundaries of the Member State. However, the general move towards offshore storage due to communication challenges with the general public in certain countries, the cost of characterising suitable offshore storage complexes and the potential demand for CO_2 for the purposes of enhanced oil recovery in the North Sea, could mean that pipeline infrastructures and potentially CO_2 shipping routes will be required to cross national boundaries.

The European Commission recognises in the recent communication 'Energy infrastructures for 2020 and beyond – A blueprint for an integrated European energy network'[1], that CCS technologies can reduce CO_2 emissions on a large scale, however due to the uneven distribution of storage sites pipeline infrastructures spanning State borders and the maritime environment may become necessary. A European CO_2 transport infrastructure is highlighted as longer term network requirement, with a priority area to achieve this being identified as "the examination and agreement on the technical and practical modalities of a future CO_2 transport infrastructure". The document states that research on the above area should allow a timely start to infrastructure planning and development in line with the foreseen commercial rollout of CCS after 2020 (EC, 2010).

However the transboundary movement of CO_2, and the development of the infrastructure needed to make this happen, can only be realised once a number of legal issues have been resolved. A review of a number of pending transboundary legal issues, including financing and ownership, third-party access and financial liability form the basis of this report. In addition to these legal issues, potential ownership and investment approaches for CO_2 transportation infrastructure are reviewed, and economic theories have been tested using a survey completed by industrial stakeholders.

The current legal provisions of the EU Directive on the geological storage of carbon dioxide[2] governing the development and access to CO_2 transport pipelines and storage sites in, provide freedom to European countries to adopt their own laws governing third-party access[3] and to a certain extent on financial liability. However the non-prescriptive regulatory approach in the EU CCS directive could possibly lead to a variety of third-party access regimes, and the emergence variable tariff structures and investment conditions across EU European countries. Furthermore, existing approaches to infrastructure investment between European countries, primarily the orientation and presence of suitable public and private stakeholders, could contribute to the prevalence of heterogeneous national CO_2 infrastructure regimes across Europe.

The potential for a variety of CO_2 transport and storage access regimes could create uncertainty for project developers considering investing in a CCS project that requires the transboundary movement of CO_2,. Moreover, experiences in the electricity sector learn that divergent national policies can be a barrier to the development of a sustainable and harmonized (internal) market since non-harmonised network access policies tend to distort the level playing field between electricity generators. Although the potential market for CCS cannot be compared to the electricity market, the basic principles will still apply. Likewise, with the uptake of CCS a lack of harmonized rules for CO_2 infrastructure charging may imply distortion of competition between CO_2 emitting industries (Harmelink et al, 2011). This report will also assess the potential problems that may arise from divergent approaches to third-party access, national public funding and financial liability.

[1] COM(2010)0677
[2] Directive 2009/31/EC
[3] So long as it is conducted in an open and non-discriminatory manner

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

1.1 Research objectives

The research conducted has been structured both to provide an overview of the latest developments on a number of legal issues relevant to the transboundary movement of CO_2, but also to answer a number of specific research objectives. The specific research objectives are formulated as:

1. Investigate the possible ownership and investment models that may be suitable for national and transboundary CO_2 pipelines. Identify sources of funding.

2. Summarize the potential permitting, construction and environmental and safety issues that are applicable to the transboundary movement of CO_2, and the development of transboundary CO_2 infrastructure.

3. Provide a status quo on the issue of financial liability regarding the transport and storage of CO_2, and highlight the possible impacts of divergent regulation becoming adopted by different Member States.

4. Gain an insight from potential CCS investors within Europe, regarding network needs, ownership and investment models, public funding and coordination and harmonizing regulation across Member States to avoid barriers to cross-border CO_2 transportation networks.

Research has been compiled through a combination of existing knowledge from with the project team, literature reviews and an industry survey.

1.2 Reader guide

This report begins by reviewing a number of salient issues regarding ownership and investment in CO_2 transportation pipelines, and identifies sources of funding. Such issues are considered important for understanding some of the legal issues to be covered later in the report. Section 3 focuses on cross border regulation including, siting and construction, environment and safety demands and infrastructure use. Section 4 covers financial liability in CO_2 transport and storage. Section 5 highlights the results of the industry survey, which covers a number of issues including perceived network needs, investment and funding, European coordination and project sponsor/Member State liability transfer. This report concludes with a set of concise recommendations for policy makers based on the research completed.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

2 Investment and funding of CO_2 transportation infrastructure

The legal and regulatory approach adopted within a Member State towards the development of CO_2 transportation infrastructure, and the availability of Member State funding will have a significant impact on the speed and scale of national infrastructure development. The following chapter aims to explain how regulatory decisions on ownership and third-party access can influence the development of CO_2 transportation infrastructure.

2.1 Economies of scale

Pipelines exhibit strong economies of scale. Mckinsey & Company (2008), state that a saving in CO_2 transport cost of 30% can be achieved, if two emitters combine their output into one 36 inch pipeline instead of two pipelines with diameters of 24 inches each. Pipeline infrastructure projects have characteristically very high fixed investment costs, approximately 80% of total costs. These costs comprise of the excavation of the pipeline corridor, the engineering of the pipeline, the compressor unit, metering and flow control systems. Therefore, the marginal costs of increasing the pipe diameter by a number of inches are relatively minor in comparison, which would support any decision to oversize a pipeline in anticipation of future demand.

However, there are a number of economic barriers that may inhibit the deployment of an oversized CO_2 transport network. Firstly, private investors cannot be expected to build a transport infrastructure that is beyond current or guaranteed near-term capacity requirements. Without long-term contracts that third-parties would purchase capacity rights, it will be very difficult to build a business case and raise equity and debt to fund the project. In short, the uncertainty of external capacity demand, in terms of volume and timing would pose great financial risks to the project developer.

2.2 Third-party access and tariff setting

Third-party access is an important legal issue with both national and transboundary CO_2 transportation projects. The EU CCS Directive recognises that, given a significant increase in the price of emitting CO_2 under the EU ETS, access to CO_2 transport networks as well as storage sites, could become a condition for entry into or competitive operation within the internal electricity and heat market. Article 21 of the directive states that Member States should take necessary measures to ensure that potential users are able to access transport facilities, and that the granting of access will be done in a transparent and non-discriminatory manner determined by the Member State. The article also states that access to the network will follow the objectives of fair and open access.

Given the development of a CO_2 pipeline by a consortium or single entity, whether the tariff set for capacity procurement by third-parties would be regulated or not would also lead to uncertainty that the developer could be able to recover the costs of the additional investment. Regulation that sets a tariff based on the incremental costs of capacity will provide a disincentive for ‘early adopters’, as incremental costs are far less than the average costs of the pipeline. For the initial project developer, a tariff based on just less than the new entrant costs (i.e. the cost of a new pipeline) represents the most economically efficient outcome (NERA, 2009).

There are methods for reducing the financial risks brought about by demand uncertainty. For example, long term contracts can be established between the project developer and secondary users that commit to capacity requirement at a given tariff. Similarly, the UK offshore oil and gas regimes oblige pipeline developers to ‘market test’ the demand for new capacity, thus encouraging the formation of investment coalitions that pool their pipeline capacity requirements. The US interstate pipeline regulations impose an obligation to hold ‘open seasons’, encouraging multilateral investment from the project outset. Joint implementation of a pipeline project utilising near full capacity, removes the incentives for a ‘late comer’, while still exploiting economies of scale. In the case that interest is

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

expressed from multiple parties, the project developer would have to rank bids based on the project NPV, accounting for capacity requirement, commencement date, transport distance and the duration of capacity requirement (NERA, 2009).

The formation of coalitions and joint implementation maybe limited in the case of CCS, especially in the early stages of the technology's proliferation. This is primarily due to the low probability of more than one CCS project coinciding with another within close proximity, both requiring capacity within a similar timeframe. Given a time lag between pipeline completion and capacity requirement, the project feasibility will thus be governed by a cost-benefit analysis between pipeline savings and the cost of temporarily unused assets. Nevertheless, in point source clusters such as the Rotterdam harbour and the Ruhr area, such coalitions could prove fruitful.

2.3 Public and Private sector involvement in CO_2 transport networks

With the average lead time for the permitting and construction of a new coal power plant in Europe estimated at approximately 6 years (IEA, 2007), demand for a CO_2 transport network will develop over a large time scale. In light of this, experts have argued the necessity of the government to invest directly in CO_2 transport infrastructure, or strongly intervene via regulations, in order to spread the burden of risk between private and public entities.

Government intervention in the form of regulations and/or direct investment in CO_2 transport infrastructure has been widely commented on in recent literature (Broek et al. 2010, Chrysostomidis et al. 2009, NERA, 2009). From a broad perspective, unlike the existing utility and service transport networks, market-led investments into CO_2 infrastructure are currently unfeasible due to the low price of carbon, and the lack of demand from CO_2 utilising industries (horticulture, carbonated beverages). Assuming greater incentives for CCS deployment in the future, individual project developers will likely focus on investing in point-to-point pipelines at high capacity utilization, assuring short term economic efficiency. In some cases, this may not lead to an optimized transport network. In order to utilize CCS as a means to meet the EU's climate targets, an argument exists for government intervention, and perhaps investment to overcome the risk of demand uncertainty and promote long term economic efficiency.

In a report produced for the UK government, NERA (2009) argues against the case for direct public investment. The report states that the only way in which public investment will improve efficiency is if the government is better informed about the probability of future demand of CO_2 than private entities. The only information the government may poses that private entities would be unaware of, is the future value of government policy support for CCS. This case of asymmetric information could be overcome by publishing all known policy commitments or by offering long-term financial commitments to back up its statements (NERA, 2009).

2.4 Sources of finance for CCS infrastructure

A CCS project, like any other large infrastructure or industrial investment will involve the acquirement of sufficient capital from the private sector. Capital could be provided as equity from pension, insurance or specialist equity groups, or as debt from corporate lending or structured finance. Figure 2.1illustrates that the expected costs and revenue, and the associated financial risk of a project will determine the financeability of a CO_2 pipeline project.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

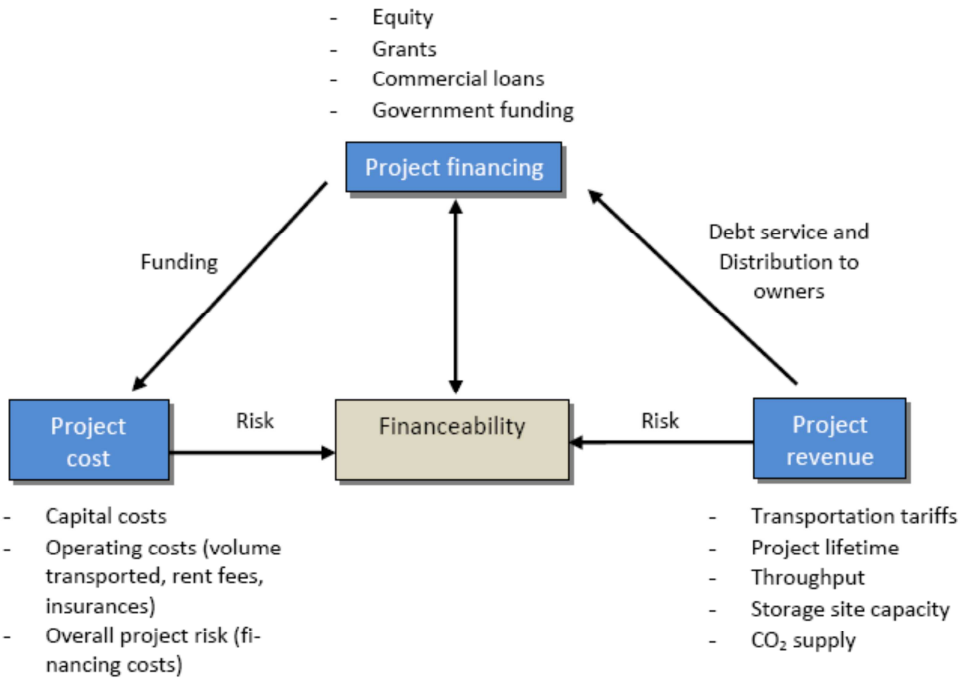

Figure 2.1 A basic business model for a CO_2 pipeline

Chrystostomidis and Zakkour (2008) state that there are two types of financial models that may be applicable for CCS projects; corporate finance and project finance models. A corporate finance model involves the provision of capital directly to the project sponsors through equity or loans. In this case, investors are exposed to the credit risk of the project developers rather than project itself. In the view of Chrystostimidis and Zakkour (2008), corporate finance models are not often applicable to large scale infrastructural projects, and that a project finance model would be the most likely structure used for large scale CCS projects.

A standard project finance model would lead to the formation of a new company normally called a special purpose entity (SPE) or special purpose vehicle (SPV) to develop, finance and operate a project (Chrystostomidis and Zakkour, 2008). From current observations of proposed large scale CCS demonstration projects, the view of Chrystostomidis and Zakkour (2008) that the project finance seems most suitable for such developments appears validated.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

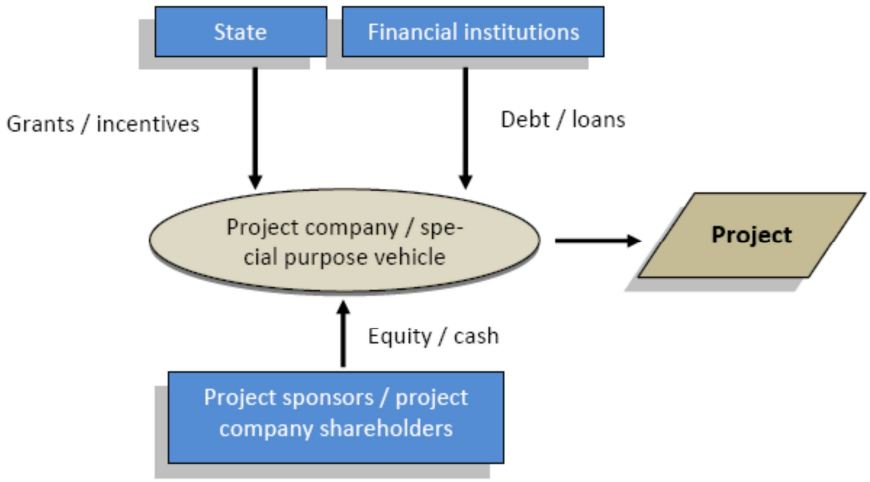

Figure 2.2 A project financing model (Chrystostomidis and Zakkour, 2008)

The project financing model with the establishment of a special purpose vehicle allows the financial risk of the project to be spread amongst a number of parties. Furthermore a consortium of smaller companies may be able to raise more capital from third-parties than if they acted alone.

Table 2.1 outlines a range of possible forms of finance that could be acquired from the private and public sector.

Table 2.1 Private and public funding sources for project finance (Chrystostomidis and Zakkour, 2008)

Type	Description	Investment objectives
	Private funding sources for project finance	
Project sponsor investment	Project sponsors are part of the special purpose entity, and provide cash, equity, guarantees and other capital contributions.	Carbon acquisition for trading or compliance
Commercial bank loans	Commercial loans can be used to finance all or part of the investment. For large infrastructure projects, multiple banks may combine to lend the required amount.	Interest, certainty on cash-flows
Third-party funds	These funds, also known as infrastructure funds, stem from investors that are willing to co-invest with the original project sponsors, although they are not actively part of the special purpose entity.	Stable long-term yield
Bonds and capital market funding	Project funding is raised through an initial public offering (IPO) of debt securities (bonds) or equity securities (stocks). The main benefit of the bond market is that it offers fixed rate funding at generally cheaper rates than bank loans.	Diversification
Mezzanine debt	Mezzanine capital is a form of debt that is subordinate to normal bank loans. In the event of a loan default, the mezzanine capital is unlikely to paid in full until all the senior obligations have been satisfied. Mezzanine debt is a cheaper form of capital than equity, however it is more expensive than senior bank loans given the	Relative certainty on cash flows

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

	additional risks involved. Therefore the use of mezzanine capital is often used when the risks of a project are not acceptable to commercial banks.
Public funding sources	
Loans	Governments can share the risk of an infrastructure project by providing loans through designated financial institutions such as multilateral agencies and development banks such as the European Investment Bank (EIB), the World Bank, the International Finance Corporation (IFC) and the European Bank for Reconstruction and Development.
Grants/subsidies	A subsidy is a form of financial assistance to be paid to a business or economic sector. The rational for the disbursement of a subsidy can be that of national or supranational strategic interest. In Europe, an example of a subsidy is the New Entrants Reserve 300 (NER300), an EU subsidy programme that has 300 million EU ETS credits currently worth approximately €4,5 billion in order to co-fund up to 12 CCS projects.
Guarantees	Guarantees can be provided by multilateral agencies to help facilitate financing of a project by providing risk coverage. The provision of guarantees to large infrastructure projects helps to lower the risk and may help the project sponsors raise long-term financing from lenders/equity institutions which in the absence of government guarantees would have not been willing to cooperate.

For potential European CCS projects, the main source of public funding in the foreseeable future may stem from the New Entrants Reserve 300[4] (NER300). As mentioned in the table above, the NER300 has been devised to kick-start the initial deployment of both CCS and innovative renewable projects through the European Union. To receive funding, applicants must submit proposals to the European commission, of which 12 CCS project will be selected. Only power stations with an electrical output of 250MW and industrial applications able to capture and store at least 500 kilo tonnes per year are eligible to apply. The allowances, the disbursement of which is managed by the EIB, can be used to covers the costs of 50% of each chosen CCS project. However, the NER300 funding is restricted to individual CCS demonstration plants, and any over dimensioning of pipeline capacity within a project is not applicable for funding.

A possible source of funding for European transboundary CO_2 transportation infrastructure could become available through mechanisms within the EU's energy infrastructure policy. A recent proposal[5] to overhaul the existing Trans-European Networks for Energy (TEN-E) policy and financing framework, could see additional funding becoming available for trans-European energy infrastructure projects of common interest (EC, 2011). In additional to priority corridors for gas, oil and electricity, smart grids and CO_2 pipeline may be eligible for financing assistance. Funding, which would become available under the "Connecting Europe Facility (CEF)", could include financing options such as the use of risk sharing instruments (including project bonds and guarantees); risk capital instruments (including equity participations); grant support for project studies and construction; or a combination of grants, risk sharing and risk capital instruments.

Annex I of the proposal (EC, 2011), highlights "cross-border carbon dioxide network" as a "priority thematic area", namely "the development of carbon dioxide transport infrastructure between Member States and with neighbouring third countries in view of the deployment of carbon dioxide capture and storage." Annex II of the same proposal indentifies the energy infrastructure categories concerning the transportation of CO_2, which could be eligible for support:

(a) dedicated pipelines, other than upstream pipeline network, used to transport

[4]Decision 2010/670/EU
[5]Proposal for a Regulation of the European Parliament and of the Council on guidelines for trans-European energy infrastructure and repealing Decision No1364/2006/EC

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

anthropogenic carbon dioxide from more than one source, i.e. industrial installations (including power plants) that produce carbon dioxide gas from combustion or other chemical reactions involving fossil or non-fossil carbon containing compounds, for the purpose of permanent geological storage of carbon dioxide pursuant to Directive 2009/31/EC;

(b) facilities for liquefaction and buffer storage of carbon dioxide in view of its further transportation. This does not include infrastructure within a geological formation used for the permanent geological storage of carbon dioxide pursuant to Directive 2009/31/EC and associated surface and injection facilities.

(c) any equipment or installation essential for the system in question to operate properly, securely and efficiently, including protection, monitoring and control systems

Of the total €50 billion CEF, €9.1 billion has been earmarked for the energy industry, where it is expected that any funding for CO_2 pipelines could be included. In June 2011,the European Commission reported to the Energy Council that the estimated total investment required for CO_2 transportation infrastructure up to 2020 is €2.5 billion. Of course there is a number of criteria which must be met which are outlined in Article 4 of the proposal (EC, 2011), and the general requirements are included below:

(a) the project is necessary for the implementation of the energy infrastructure priority corridors and areas set out in Annex I; and

(b) the project displays economic, social and environmental viability; and

(c) the project involves at least two Member States, either by directly crossing the border of one or more Member States or by being located on the territory of one Member State and having a significant cross-border impact.

The proposal, if adopted, would come into force in January 2013, with the first list of projects with a common interest being compiled by July 2013.

2.5 Transboundary gas transport pipelines

The transportation of natural gas across national borders to reach markets is essential for the functioning of the European economy. Such pipelines often involve co-investment of the gas exporters, and stakeholders such as national gas suppliers which receive and sell the gas to local markets. Although the transportation of CO_2 from sources to sinks has very obvious logistical and physical differences, given an increase in price of the European Union Allowances (EUA's), business cases for the transboundary movement of CO_2 could appear. At this point, ownership and investment models similar to those observed in natural gas transport may be suitable for adoption by potential CO_2 transportation providers. Below, three brief case studies of large transboundary natural gas pipelines are provided.

2.5.1 NordStream

The NordStream is an offshore natural gas pipeline stretching 1,222 kilometres from Vyborg in Russia to Greifswald in Germany. The project involves two pipelines in parallel, with the first pipeline inaugurated on the 8th of November 2011. The second line will be laid during 2011 and 2012.At full capacity, the pipeline will be able to deliver 55 billion cubic metres (bcm) of gas from Russia to Germany and further to other European countries each year.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

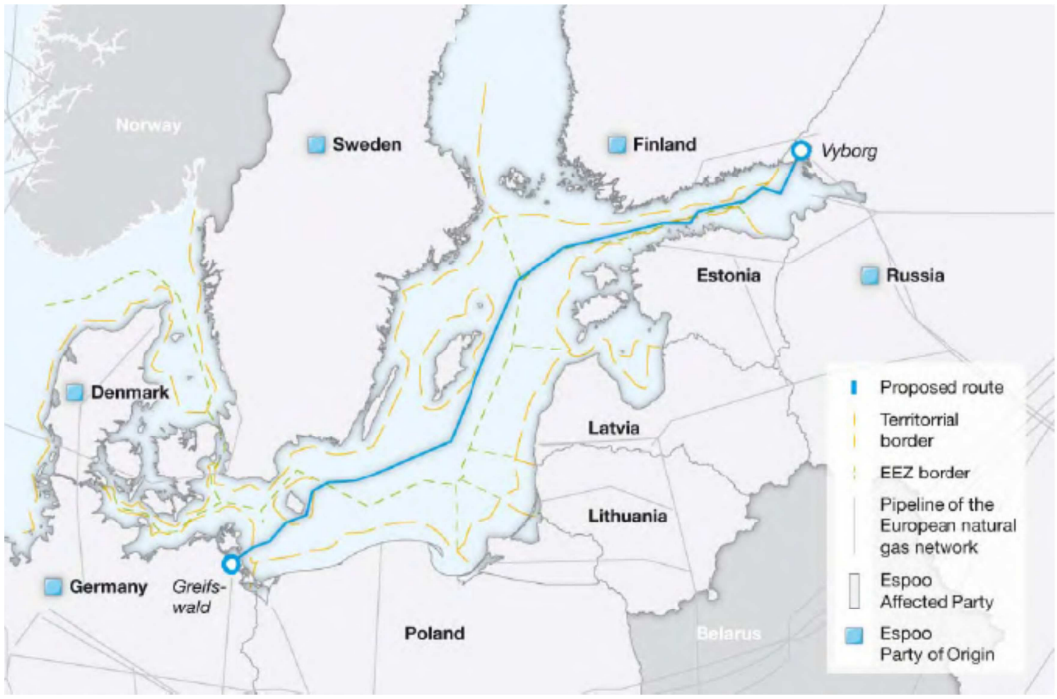

Figure 2.3 The route of the Nord Stream pipelines (Nord Stream AG, 2009)

The NordStream pipelines are operated by the special purpose company, NordStream AG, which was incorporated in 2005. The project was classified by the European Union as a 'Project of European Interest', and is supported by EU Member States (Nord Stream AG, 2009). The project has five shareholders; the Russian gas company Gazprom (51%), German gas companies Wintershall and E.ON Ruhrgas (15,5% each), Dutch gas infrastructure company Gasunie (9%) and French gas company GDF Suez (9%).

Between 2005 and 2006, prior to the implementation of the project, Gazprom's export arm Gazprom Export signed long-term contracts to transport approximately 22 billion cubic metres of natural gas per year through the NordStream to Danish, British and German energy companies. A contract between Gazprom and Wintershall for 9 (bcm) per year was agreed for a period of 25 years, while a contract between Gazprom and Danish Dong Energy was signed for 20 years. Gazprom Export has agreed a Gas Transportation Agreement (GTA) with the NordStream which:

- Governs the transportation tariff which NordStream will be paid by Gazprom Export
- Defines NordStream's future cash flow
- Acts as a ship-or-pay agreement
- Is a crucial document for the leverage of external equity and financing

The costs of the project are understood to be approximately €8,8 billion, €1,4 billion more expensive than expected during the planning phase. 30% of the financing was provided through equity from shareholders in proportion to their stakes in the project, with 70% of the project expenditure provided by banks (NordStream AG, 2009).

The total financing is provided by 27 banks, including a €3.1 billion, 16-year facility covered by export credit agencies and the Federal Republic of Germany under its Untied Loan Guarantee Programme called "UFK" which covers political and commercial risk. The covered loan is split between a €2.1 billion worth of loans from export credit agencies and a€1 billion UFK loan. There is also an €800 million 10-year uncovered commercial loan from banks which will be serviced from income generated from the transportation contracts (Reuters, 2010).

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

2.5.2 Langeled Pipeline

The Langeled pipeline stretches for just under 1,200 km, which is the second longest underwater pipeline after the Nord Stream. The pipeline which was built between 2004 and 2006, transports Norwegian natural gas from the Nyhamna terminal to Easington in England. The pipeline, which has a diameter of 48 inches can transport a maximum of 25.5 bcm of gas per year, roughly 20% of Britain's peak gas consumption.

The owner of the pipeline is Gassled, a partnership which owns the offshore natural gas infrastructure on behalf of oil and gas companies operating at sites on the Norwegian continental shelf of the North Sea. Gassled has a board, but has no employees or operations (Upstream Online, 2011). The Langeled Joint Venture shareholders are included in Table 2.2.

Table 2.2 Ownership of the Langeled pipeline(Chrystostomidis and Zakkour, 2008)

Company	Share (%)
Norsk Hydro	17.61
Gassco	0*
Shell	16.50
Petoro	32.95
Statoil	10.84
DONG Energy	10.22
ExxonMobil	6.94
ConocoPhillips	0.78

** operator for the construction phase*

The Langeled pipeline joint venture project, comprising by the Ormen Langefield licensees as well as ConocoPhillips and Gassco, has been structured according to the build, operate and own model (BOO). Statoil was responsible for the planning along with Hydro that is involved in the development phase of the Ormen Lange field. From September 2006, Gassco, the Norwegian state owned company, is the operator of the pipeline and Statoil manages the gas export pipeline project in cooperation with Hydro. British Centrica provides the technical service provider at Easington.

Capital costs for the Langeled pipeline are estimated close to NOK17 billion or US$3.2 billion. The principal funding of the project was provided by a syndicated loan structured by ABN AMRO (syndication agent) and subscribed by several banks, among them Barclays Bank, Royal Bank of Scotland and Defoe Fournier & Cie.

2.5.3 The Balgzand Bacton Line (BBL)

The BBL is a 235 kilometer pipeline connection between Balgzand on the Dutch North Sea coast and Bacton in the UK. Bacton is also the landing point of the interconnector with Belgium and an offshore pipeline bringing in gas from small fields in the UK North Sea. The pipeline has a forward flow towards the UK. The pipeline includes a compression facility on the Dutch coast, a five kilometer pipeline section onshore, a 230 kilometer offshore pipeline, a pipeline section crossing the beach in Bacton (UK) and an onshore pipeline section connecting to the existing gas terminal in Bacton. The connection consists of a 36 inch pipeline which had an initial capacity of 16 billion m^3 per year at the start of commercial operations in December 2008. In autumn 2010 capacity of the pipeline was further increased with about 3.2 billion m^3 per year with the installation of a fourth compressor station at the Dutch site of Anna Paulowna.

The rationale for this pipeline project is the declining gas reserve base in the UK. Given the continuing high gas demand the UK needed to develop new gas supply infrastructure in order to achieve sufficient levels of security of supply in the future. Other projects that aimed at bringing in new gas supplies to the UK are the earlier described Langeled pipeline and a number of LNG import terminal investments (such as the Isle of Grain and Milford Haven). Under the European TEN-E programme

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

the BBL was labeled a project of European interest. It basically serves as an extension of the much larger NordStream pipeline project that transports gas from Russia to Germany. Part of the gas transported with NordStream is destined for UK consumers.

The owner of the BBL is BBL Company, which was established in summer of 2004 to design, construct, operate and exploit the BBL. The company is a joint venture of three partners: Gasunie BBL, Fluxys BBL and Rhurgas BBL. The three partners are subsidiaries of respectively Dutch Transmission Systems Operator (TSO) Gasunie, Belgian TSO Fluxys and Energy company E.On Ruhrgas.

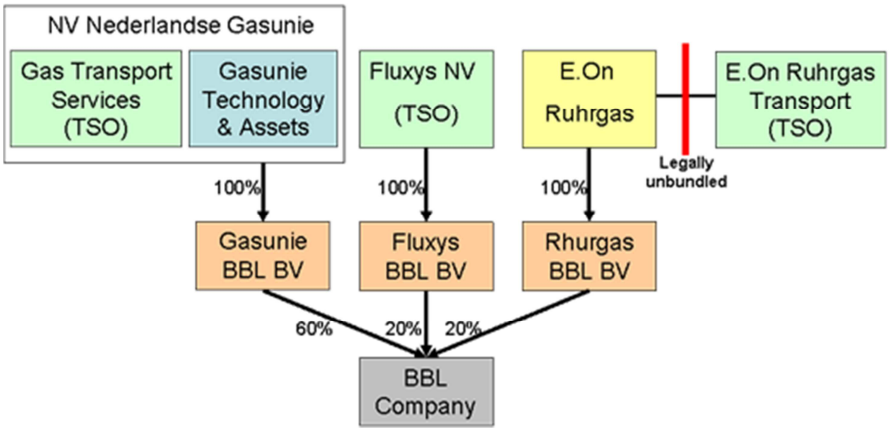

Figure 2.4 Overview of BBL Company shareholding structure (De Joode, 2006)

As an international pipeline the BBL had to comply with a range of different national and supra-national legislation. A separate Treaty has been concluded between the UK and Dutch governemnts to deal with matters such as health, safety, environmental aspects and taxation.

The BBL succesfully applied for the status of merchant project under EU legislation. Whereas the default regime for new pipeline investments concerns a regime based on TPA and regulation of tariffs of revenues projects can apply for an exemption from this default regime when meeting a set of strict conditions. The rationale behind the exemption regime as defined in EU legislation is the possible lack of investment incentive for certain 'exceptional' projects that are subjected to substantialy higher market risks. This was judged to be the case for the BBL. The status of merchant project allowed BBL Company to conclude long-term capacity contracts (10-15 yrs) with a limited number of shippers. An open season was organised to test interest for such contracts. Total BBL capacity was initially allocated to three shippers: GasTerra (formerly known as Gasunie Trade & Supply), E.On Ruhrgas, and Wingas. The long-term contracts provided sufficient long-term certainty for BBL investors to recoup investments in the long-term. Long-term capacity remains freely tradable on a secondary market. BBL investment involved an estimated €500 million and was project financed.

2.6 Summary

The basic economics of any sort of pipeline indicates that increasing the diameter of a pipeline to expand the marginal capacity and combining gas flows can have significant savings when compared with the construction of two separate pipelines. This is because the fixed project costs of constructing a pipeline, including project planning, excavation and engineering account for approximately 80% of the overall project costs. Marginal increases in the diameter of a pipeline are relatively low cost, but can greatly increase the maximum capacity.

However, taking advantage of such economies of scale in CO_2 pipelines faces a number of barriers. Unlike natural gas transport, the 'demand' for CO_2 pipeline capacity in Europe is dependent on the

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

success of individual CCS demonstration projects, a sufficient incentive to deploy mature capture technology, and the intermittent financial support for CCS from European and national governments. Therefore, over dimensioning of CO_2 pipelines projects face a number of uncertainties, whereby raising equity and gaining access to finance will be very difficult, without guarantees that additional capacity will be sold using profitable tariffs in the future. In comparison with the Nord Stream natural gas pipeline project, the project consortium had long-term 'take or pay' contracts with the gas exporter prior to pipeline construction, with the gas exporter agreeing 20 to 25 year contracts with wholesale gas companies at the receiving end. Such contracts were essential to raise the 70% of external equity and commercial loans need to finance the project.

Given the current lack of a business case for CO_2 transportation, some form of public investment will be required if over dimensioning is to take place. The government can intervene in a number of ways, such as lending or providing subsidies to pipeline developers, or guaranteeing a return on investment to raise private equity in projects. From research and the industry survey conducted, a public-private partnership structure, with the formation of a special purpose vehicle (SPV) receiving funds from pipeline developers/energy companies, external financiers and the state is understood to be the most appropriate ownership/investment model. Furthermore, long-term 'take or pay' contracts provide the greatest security to investors, and Member State governments need to clarify how the setting of transportation tariffs for third party users will be regulated.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

3 Cross-border regulation and governance

This chapter discusses the legal issues that might arise in case of transboundary CCS. Transboundary CCS occurs when CO_2 is being transported over borders, or a storage location is situated under the territory of more than one State. The most likely situation is transboundary transport, as not all European States have their own storage facilities. In the Netherlands, one project is being developed in which transport by ship is considered. Transport by ship and transport by pipelines are regulated in different sets of law. This report focuses on transport by pipeline, transport by ship is regulated by legislation on shipping and the transport of hazardous substances.

Several types of pipelines can be identified: upstream pipelines, transmission pipelines and distribution pipelines. Offshore the following qualification of pipelines is often used:

- pipelines between fields (interfield)
- pipelines in a field (depending on the characteristics and wells - intrafield)
- field to coast
- coast to coast, possible crossing more than one state

The qualification of the offshore pipelines is thus directly related to how closely the pipeline is linked to an installation and/or field. However, CO_2 is not extracted from the ground, but captured near industry and then transported to a storage site. This is in reverse to the operation of the gas industry. This pipeline can be a direct line, but it is possible that a situation emerges whereby several industries will feed into a single pipeline and, moreover, that some CO_2 is stored in one field and the rest is stored in another field. This can occur both onshore and offshore. The greatest difference as compared to gas transport is that in gas transport, the field is the starting point, where for CCS the field is the end of the line. CO_2 pipelines therefore might be viewed as reverse upstream pipelines (Havercroft et al., 2011).

In this section we will explore the possible legal barriers to the transboundary transport of CO_2. The first question to be addressed is whether or not it is legally possible to engage in transboundary CO_2 transport (onshore and offshore), and which state will have the competence to regulate the transport and storage (Section 3.1). After sketching the legal framework, we will analyse which aspects will be regulated in pipeline transport (Section 3.2). In Sections 3.3, 4, 5 we will look into the aspects of regulation into more detail, also looking to the solutions found in the gas sector. In Section 3.6 we conclude which legal barriers exist and how they can be solved in order to facilitate transboundary CCS.

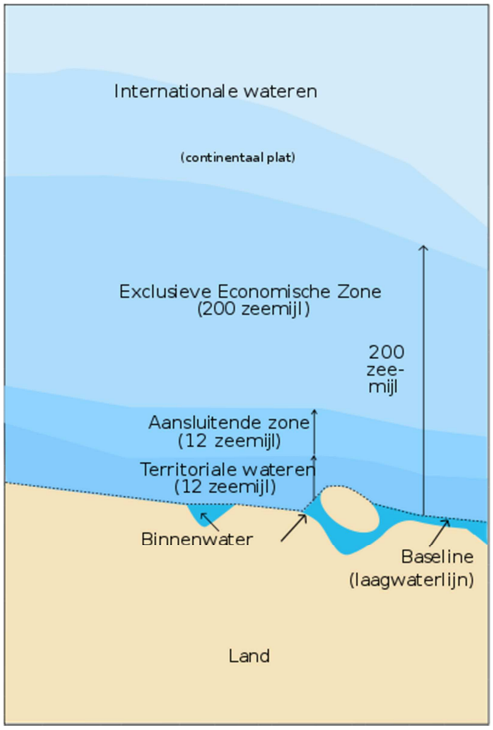

Figure 3.1 Zones of offshore jurisdiction

3.1 Enabling transboundary transport and storage

3.1.1 Jurisdiction

When transport and storage occurs in the territory of a state, the applicable legislation is easily determined: it is the law of the sovereign state that applies to all aspects of the transport and storage facility. In case of offshore transport and storage, the situation is far more complex. International law determines which State has the competence to regulate the transport and storage. Offshore, several maritime zones are identified for which international

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

law recognises different rights and obligations. The UNCLOS (United Nations Convention on the Law of the Seas of 1982) has defined the different maritime zones:

- Baseline, coast at low water, sovereign rights of the coastal state (Art. 5 UNCLOS)
- Territorial waters, 12 nautical miles (nm) out of the coast, law of the coastal State applies (Art. 2 UNCLOS)[6]
- Continental shelf, a natural prolongation of the land territory where coastal states have functional jurisdiction regarding the exploration and production of oil and gas, including the right to establish the necessary installations and the right to construct and regulate pipelines transporting the hydrocarbons to shore (Art. 79 UNCLOS, limited rights to lay pipelines)
- EEZ, 200 nm (if proclaimed it gives coastal states the rights to explore and exploit minerals and other types of energy and to establish all necessary installations/cables (Art. 56 UNCLOS) (in the North Sea area the EEZ and the continental shelf overlap)
- High seas, Art.112 UNCLOS which provides for the freedom to lay pipelines)

The global legal framework for offshore activities is found in the UNCLOS (1982; Raine, 2008). The UNCLOS merely determines who has the right to undertake what activities in the different zones. A first question would be whether or not CCS offshore is an activity governed by the Treaty and which state has the right to regulate this activity. With regard to storage offshore, UNCLOS determines that the coastal state has jurisdiction in the territorial waters. If storage is located in the territorial waters, the coastal state has jurisdiction. Such a clear norm is not present for storage in the EEZ or in the continental shelf. With regard to these maritime zones, UNCLOS states that the coastal state has the right to exploit the national resources and conduct other economic activities in the EEZ. Furthermore, UNCLOS determines that the coastal state has the right to exploit and explore natural resources on the continental shelf. It is questionable whether or not CCS can be qualified as either of these. If one assumes that CCS qualifies as an economic activity or as exploiting a natural resource (highly unlikely), the effect will be that based on Art. 56, 77 UNCLOS, the coastal state may exercise jurisdiction and thus has the exclusive right to determine whether or not and under which conditions storage will take place in its subsoil. The coastal state has to exercise this right due regard to the rights and duties of other states and in accordance with the provisions of UNCLOS. Although there is no explicit rule in international law that deals with the right of the coastal state to undertake offshore storage (Roggenkamp 1998, 2009, p. 33), States may claim this right, but other States might disagree. In that case, the conflicting states will have to negotiate over a new regime for the purpose of offshore CCS (looking into general rules of international law or the regimes for environmental protection). When considering the situation in the EU/North Sea it seems that most coastal states assume that they may exercise functional jurisdiction over CO_2 storage.

If a coastal State has jurisdiction it is also entitled to establish the installations to carry out the activity. It means that injection facilities can be regulated by the coastal state. This functional jurisdiction also applies to the pipelines connecting the installation to shore as long as this is within the jurisdiction of the same coastal state. A coastal State has after all also full jurisdiction in the territorial waters and onshore. If there is no direct link to an activity in the EEZ which is subject to a State's functional jurisdiction, the freedom of the high seas applies and anyone is entitled to lay such a pipeline. The rights of the coastal state are limited to protecting its marine environment, safety and other interests.

3.1.2 International treaties

In addition to UNCLOS (and based on UNCLOS) several international treaties have developed aiming at protecting the marine environment. There treaties have usually a regional impact and include:

- London Convention (1972)
- The Protocol to the London Convention (1996)
- The Convention for the Protection of the marine Environment of the North-East Atlantic Convention (1992) (The OSPAR Convention)

[6] Additional territorial waters, 24 nm out of the coast (limited rights, not relevant in the North Sea)

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

The London Protocol is a protocol to the London Convention (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter). Under the protocol, CO_2 is considered as waste (Art. 1(8): "material and substance of any kind, form or description"). The protocol prohibits storage by injection into sub-seabed repositories from vessels or platforms at sea, and allows storage by injection of CO_2 by pipeline from a land-based source into a sub-seabed repository. Annex I to the protocol was amended in 2006 (Art. 1(8) and Art. 4), the amendments entered into force in 2007, in order to enable CCS. CO_2 streams may only be considered for dumping if:

- Disposal is into a sub-seabed geological formation; and
- They streams consist overwhelmingly of CO_2. They may contain incidental associated substances derived from the source material and the capture and sequestration processes used; and
- No wastes or other matter are added for the purpose of disposing of those wastes or other matter.

In addition to the amendment, the Scientific Group produced two sets of detailed guidelines on geological storage of CO_2 in marine environment. One for risk assessment and management (Risk Assessment and Management Framework for CO_2 Sequestration in Sub-seabed Geological Structure [RAMF]) and the other consist of CO_2 specific guideline (Specific Guidelines for Assessment of CO_2 Streams for Disposal into Sub-seabed Geological Formations). It is important to underline that the London Protocol Guidelines are non-binding. Both guidelines drew on the Intergovernmental Panel for Climate Change (IPCC)'s 2006 Guidelines for GHG Inventories.

Also applicable and relevant for the Dutch CCS case is the OSPAR Convention. The OSPAR (1992) covers the North-East Atlantic area. The OSPAR Commission is the body managing the work under the OSPAR Convention, made up of representatives of the governments of 15 contracting parties and the European Commission, representing the EU. Like the London Protocol, OSPAR Convention prohibited certain CO_2 storage configurations (onshore CO_2 going to a storage site via an offshore petroleum-related platform, transport by ship for offshore injection). The criteria of the OSPAR are slightly different that the London Protocol. The first three criteria are exactly the same, but the fourth criterion goes further:

- CO_2 streams must be intended to be retained in these formations permanently and will not lead to significant adverse consequences for the marine environment, human health and other legitimate uses of the maritime area.

Amendments to Annexes II and III have not entered into force yet: 7 parties needed, and at the time of publication, still two parties are required to ratify. Guidelines were developed under OSPAR as well:

- the OSPAR Framework for Risk Assessment and Management of Storage of CO_2 Streams in Geological Formations (FRAM)
- Guidelines cover how to use the FRAM: OSPAR Guidelines for Risk Assessment and Management of Storage of CO_2 Streams in Geological Formations

The guidelines prescribe permit requirements similar to those in the London Protocol. However, the rules of the London Protocol and the OSPAR convention have only been accepted by a limited number of states, and it is not ratified by enough countries until now. This means that there are still considerable uncertainties with regard to the international legal rules that apply to offshore CCS.

3.1.3 Regulation on transboundary transport

The issue of transboundary transport and storage still needs to be addressed. Transboundary transport and storage are the situations in which:

- A pipeline crossing more than one international border (onshore as well as offshore)
- A storage location is located in more than one jurisdiction (onshore as well as offshore)

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

This report will only deal with the most common situation, a pipeline crossing at least one international border. If an operator of a single pipeline is faced with more jurisdictions, the risk is that the states through which the pipeline crosses have different rules and demands. Although the CCS Directive regulates both onshore and offshore storage, each Member State will implement these provisions in national law. Moreover, the CCS Directive is designed in a way that Member States have considerable freedom in how to regulate some important issues, such as composition of the CO_2 stream and the access regime. The risk of having diverging demands thus is a distinct possibility. With regard to possible transboundary situations, the CCS Directive requires competent authorities to cooperate and jointly meet the requirements of the CCS Directive.

Other regulation specifically dealing with transboundary CCS is the London Protocol. Article 6 of the London Protocol prohibits the transport of CO_2, with the aim of dumping the CO_2 as interpreted by the contracting parties (IEA, 2011). In 2009 the protocol was amended to enable transboundary transport of CO_2, and storing it in the seabed as not all parties to the convention have suitable storage options. However, this amendment is not yet ratified, and probably will not be in the near future. The London Protocol thus still forms an obstacle to transboundary transport of CO_2 offshore. In its working paper, the IEA (2011) 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 agreement from the contracting parties; the latter three are resolutions between specific contracting parties.

A short conclusion can be that with regard to offshore CCS, there is a degree of uncertainty as to the fact whether or not coastal states may exercise jurisdiction and thus the degree in which coastal states have jurisdiction with regard to laying and using CO_2 pipelines. However, in practice, this jurisdiction is assumed to exist. In case of transboundary transport, several States may have (some degree of) jurisdiction over the pipeline, either based on the functional jurisdiction relating to the subsoil storage in the EEZ or based on the full jurisdiction of a coastal State in the territorial waters or resulting from its protective jurisdiction (environmental protection and safety). When these states have different interests and possibly different demands, an operator operating the transboundary pipeline faces more difficult and costly negotiations. Furthermore, transboundary transport offshore for the purpose of dumping CO_2 is even prohibited based on the status of the London Protocol. Only by entering into bilateral or multilateral treaties can this obstacle can be overcome.

Onshore, States have jurisdiction over storage facilities and pipelines situated on their territory. If a pipeline crosses borders, then the jurisdiction of each of the involved states is limited to the part situated on their territory. For the operator this means that the same pipeline has to comply with regulation from more than one jurisdiction, which complicates the process of laying and using the pipeline. In order to solve these issues of conflicting jurisdiction, the CCS Directive states that the competent authorities of the involved Member States shall cooperate and jointly meet the requirements of the CCS Directive. In the following section, we will explore the possible issues over which conflicting jurisdiction might exist into more detail, focusing on the aspects that will be regulated regarding pipeline transport networks.

3.2 Aspects to be regulated

When analyzing the different aspects that will be regulated in opting for pipeline transport, we can distinguish the following aspects (Havercroft, Macrory, Stewart, 2011, p 108, Haver, Bugge, 2007):

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

- Siting and construction
- Environmental and safety standards
- Use of the infrastructure

The first issue deals with the location and construction of the pipeline. With regard to siting and construction, national law will usually regulate where and how the pipeline will be built, which permits have to be required and which authority is allowed to oversee the construction process. The same applies to environmental and safety requirements, but in this case also, the EU environmental impact provisions and the EU ETS are relevant. The use of the pipeline is also a matter of national law, although EU law affects the access regime that is applicable and the conditions that might be required, such as the CO_2 stream.

With regard to transboundary CCS, we have an activity that crosses borders, but the jurisdiction is within borders. In case of offshore CCS, offshore transboundary transport might result in a situation where more than one State has the right to exercise some degree of jurisdiction and regulate some of the aspects of transport (use, siting and construction, environmental demands). This may cause problems for a potential operator, with regard to investor certainty and clarity, and with regard to important aspects of operation of the pipeline. More than one regime may apply to parts of the pipeline and there may even be the possibility of concurring jurisdiction which makes operating it more complex and costly. Furthermore, in preventing environmental damages, States will want to have some kind of certainty that the other part of the pipeline is also regulated and controlled in such a way that damage can be prevented. States might want to extend their jurisdiction outside their maritime zone.

In the following sections, each of the aspects of involving pipeline transportation will be discussed more in depth, by analyzing whether or not there might be conflicting jurisdiction, what the possible risks are if there is conflicting jurisdiction and how the issues might be solved. For solutions we look to the gas industry in which there is ample experience with transboundary transport.

3.3 Cross border issues in siting and construction

3.3.1 Onshore

Within their borders, Member States, have the jurisdiction to determine the regulation with regard to siting and construction of storage facilities and pipelines, taking into account some EU laws, most particularly the need for an EIA before construction takes place. The consequence of this is that in case of cross border transport, the applicable rules vary per Member State. The main risk for the potential operator is that it has to deal with multiple authorities and possibly different permit demands.

When we analyse how this issue is dealt with in the gas sector, we see that it is the responsibility of the company to arrange the siting and construction so that all requirements of all relevant states are met. If necessary, a bilateral or multilateral agreement is included, either between companies and States, or between States (World Bank 2003).

In the EU, the need to stimulate the laying of transboundary pipelines has been recognised some time ago. The Maastricht Treaty introduced the policy on Trans-European Networks aiming, amongst other, the harmonisation of technical standards and permitting procedures. The latter has been hampered by the subsidiarity principle. Recently, the European Commission proposed an updated regulation on guidelines for trans-European energy infrastructure (COD 2011/0300) (EC, 2011). This regulation appoints projects of common interest, for which a specific procedure can be used, in order to facilitate the process of laying and financing the pipelines for a better energy infrastructure. This regulation does not deal with the specific demands for siting and construction, but supports the development of transboundary networks on a priority basis.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

3.3.2 Offshore

The extent to which the laying of offshore pipelines is governed will depend on the location of the pipeline and the extent to which it is connected to an installation subject to a coastal States' functional jurisdiction. Only when a pipeline is planned in the territorial sea, the coastal State has sovereignty and clear control over the demands for siting and construction. If the pipeline is located in an EEZ or on the continental shelf, it depends on the extent to which the pipeline is connected to an installation in the same maritime zone.

An example of the complex jurisdiction can be found in the Nord Stream pipeline. In order to establish this specific pipeline, the specifically installed company had to deal with several bilateral and multilateral treaties on an international level, with several EU directives and regulations on the national level and with the law of five different states. The Nord stream pipeline crosses 5 EEZ and 3 territorial waters. It dealt with one Danish, one Swedish, two Finnish, two German and several Russian acts and regulations. Is has been the largest ESPOO process ever (ESPOO being the regional international convention dealing with the Baltic sea). More than 100 million was invested into studies, planning and route design. Just the environmental impact assessment took three years.

When we analyse the regulation of offshore pipelines for gas transport, we see that the qualification of pipeline influences the jurisdiction over the pipeline. There are interconnectors (pipelines between two states, in which there is no relation to production or another activity) and coast to field pipelines. In case of a coast to field pipeline, there is functional jurisdiction over de pipeline, by the State in which the field is located. However, as the pipeline enters the territorial waters of another State, that State also has jurisdiction. Both the State initiating the pipeline and the State through which waters the pipeline crosses want to exercise jurisdiction. In general, the different States involved in developing and operating transboundary gas and oil pipelines in the North Sea enter into a treaty which regulates the applicable rules in construction and use. It concerns treaties between a sending and a receiving State. With regard to the balance in negotiations over the applicable regime, the receiving States (coastal States) become more and more influential (Roggenkamp, 1999, p 656). If there is no connection to an installation the pipeline is qualified as a transit pipeline, and functional jurisdiction does not exist.

With regard to CCS and assuming that a coastal State has functional jurisdiction over the storage activity, the State has also the right to regulate the siting and construction of that pipeline. However, when the pipeline crosses the EEZ of another State, that (coastal) State has to consent to the location of the pipeline. Furthermore, the transit State has the right to regulate the construction process, from the perspective of the preservation of the environment and its own rights to explore and exploit the EEZ. The demands of the State having functional jurisdiction and laying the pipeline, might conflict with the demands of the coastal State. In order to deal with these issues, a treaty or contract per pipeline seems a solution. With regard to siting, a possible transit State in between the coastal State and the field has to provide its consent. This consent of transit States is often added in a Memorandum of Understanding.

3.4 Cross border issues in environmental and safety demands

3.4.1 Onshore

For environmental and safety issues, the situation is approximately the same as the previously described case of siting and construction. Member States have jurisdiction within their territory. Environmental demands are regulated through European Directives, but for some of these Directives Member States are allowed to create more stringent demands. Especially with regard to environmental demands, the regulation per Member State differs. For the operator of a cross border transport network this means that the possibly different demands have to be met in each State. This complicates the operation and use of the pipeline.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Specific attention should be paid to the ETS allowances in case of transboundary transport and storage. Up to this moment installations falling under ETS have only operated within countries, falling under the national cap of emissions. The situation of cross border transport of CO_2 has not occurred yet. It is possible to view a cross border network as separate networks, split at the border. This would mean that the network operator would need more monitoring points and a more complex administration, but each Member States can choose its own regime. An alternative would be to issue a single permit for the entire network. This would mean that emissions would count in only one of the participating countries in the network. When it comes to define the State that would be responsible for the allowances in case of leakage, there are four options (Havercroft, Macrory, Stewart, 2011, p 128):

1. The state on whose territory or EEZ it occurs
2. The state in which the pipeline owner resides
3. The state in which the CO_2 was captured
4. The state in which the CO_2 will be stored

Option 4 entails that the State under whose jurisdiction the storage site falls would be responsible for the emissions of all the pipelines towards that field. Another option would be to use the same mechanism that is used for aviation, the only other situation in which cross border emissions are dealt with under ETS. Art. 18 of the ETS Directive states that on administrative authority is appointed, either the State in which the aviation organisation has received its aviation permit (option 2), or the State in which is assumed that the most emissions take place (option 1). Option 2 would mean that the State in which the network operator has received its storage permit or the State in which most emissions are expected also will be responsible for the ETS permit and the allowances. Option 1 does not seem reasonable; as it is hard to predict where leakage occurs. Furthermore, as a network might contain multiple capture locations, for parts of the network, it is not clear 'whose' CO_2 has leaked, so option 3 also does not seem reasonable. Option 4 and option 2, seem to be the most reasonable options.

3.4.2 Offshore

Offshore, UNCLOS regulates the jurisdiction. Art. 208 of UNCLOS determines that the coastal State is responsible for preventing, reducing and controlling pollution from activities on the seabed. When an EEZ is established, the coastal State has the right to explore the zone for economical use, but also has the responsibility to ensure a safe environment. Each coastal State has functional jurisdiction in the EEZ and sovereignty in its territorial waters. The question is whether or not CO_2 would fall within the definition of pollution under the UNCLOS, since the coastal State also has the right to exercise jurisdiction over polluting activities (Art. 208 UNCLOS). A transboundary pipeline between different coasts and possibly crossing the EEZ or territorial waters of a third state thus is faced with multiple competent authorities that regulate and enforce environmental and safety demands. As the issue of environmental and safety demands is regarded as highly important, all of the involved States have jurisdiction and will be willing to exercise jurisdiction. For a potential operator this might result in different demands per State exercising jurisdiction and different requirements in enforcing the regulation. This results in higher costs for the operator. In the gas sector, we see that the treaties that are established for specific pipelines also determine which environmental and safety demands apply. The development is that the rights of coastal States, where the pipeline enters land, become more and more important.

3.5 Cross border issues in use of infrastructure

With regard to the use of the pipeline, there is no difference between onshore and offshore. The actual function of the pipeline is to transport CO_2 to the storage location. Central to a potential operator thus is the question is which authority has jurisdiction and will regulate the use or access to the pipeline. If the sending State has a different regime than the receiving State, this might cause problems for the operator for example in defining the situations in which access has to be provided. In the gas sector, the treaties used in transboundary transport often specify which regime is applicable.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Two possible objects of regulation are central in the use of the CCS pipeline: the degree of regulation of the access regime and the possible requirements for the CO_2 stream. The scope for Member States to adopt stricter CO_2 stream purity criteria seems rather narrow (Holwerda, 2011).

With regard to the possible third party access (TPA) regimes, the CCS Directive does not explicitly prescribe a TPA regime, and leaves it up to Member State to create more regulation than the basic demands in the CCS Directive itself. There are three possible regimes: rTPA (regulated TPA), nTPA (negotiated TPA) and sTPA. In essence rTPA is the situation in which access is allowed, based on published tariffs (set or approved by a regulator in advance). These tariffs apply to all customers objectively and without discrimination. Access can only be denied on limited grounds, such as lack of capacity. This regime is currently applied in gas transmission and distribution pipelines. In contrast nTPA is the situation in which network operators are obliged to provide indicative tariffs and conditions before negotiations on the use of available pipeline capacity can start. Next to rTPA and nTPA there is also sTPA which is the situation where the regulator has not regulated anything but has declared there is open access: that parties should negotiate access and if there is a complaint about the access, there is recourse to a complaint handling institution. With regard to offshore CCS, determining which institution is competent as complaint handling institute, is more complex, as judicial jurisdiction still has to be determined. This institute will judge the issue between the party wanting access and the operator. In sTPA information about tariffs and conditions is not published in advance.

For carbon transportation, the question is which regime is applicable based on the CCS Directive as implemented in national legislation. The CCS Directive addresses the possible access to pipelines and storage facilities in Art. 20 and 21. Article 20 states that access shall be provide in a transparent and non discriminatory manner, applying the objective of fair and open access and shall take into account available capacity, domestic requirements, technical specifications and the interests of the owner and users of the infrastructure. Operators may refuse access (with reasons) if there is no available capacity. Member States must ensure that in those cases the operator is required to enhance the network if it is economic to do so and has no negative impact of environmental security. Furthermore, Member States are required to have a dispute settling mechanism in place. Member States have the competence to regulate this aspect in greater detail. The CCS Directive does not prescribe a specific TPA regime, although the wording of the article is similar to the essential facilities doctrine as stated in Art. 34 of the Gas Directive. This article describes the regime for sTPA as applicable to upstream pipelines. Roggenkamp and Haan argue that CO_2 pipeline can be seen as reversed upstream pipelines (Havercroft, Macrory, Stewart, 2011, p 121), which would entail a sTPA regime for CO_2 pipelines.

In case of transboundary transport and storage, there is the possibility that the demands of Member States with regard to the CO_2 stream criteria, as well as with regard to TPA regime differ. The consequence of this is that the potential operator has to deal with different demands, which complicates or even hinders the use of the pipeline, both onshore and offshore.

Based on the reasoning and practice as applied in the oil and gas industry offshore, we see that the jurisdiction of the pipeline is with the State having functional jurisdiction (the right to produce) also referred to as the sending State, the State that has jurisdiction over the field. In case of CO_2 storage, the function is storage, so not the sending, but rather the receiving state should be the one with functional jurisdiction. This would mean for CO_2 transport, that the use and exploitation of the pipeline is regulated by the state that has the jurisdiction over the storage location.[7] This reasoning could also be applied in a transboundary transport network onshore. In a cross border network, the storage State could be the State having jurisdiction to regulate the use of the pipeline.

However, the reasoning above is based on practice. As mentioned earlier in this chapter, UNCLOS does not contain clear provisions on the use of the pipelines offshore. Different States might want to claim jurisdiction, such as the territorial sea State, the State in which the operator resides or the State

[7] In the situation of an interconnector, in which there is no field involved, another mechanism of appointing jurisdiction should be used. The state in which the network is licensed, the flagstate seems to be a good solution.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

in which the field is located. The different States will have to negotiate and as the economic relations between the States with CCS are not the same as in the gas sector, it can be questioned whether or not the same outcome can be expected.

3.6 Legal barriers and possible solutions

In this section the legal issues to be dealt with in cross border CO_2 pipelines have been addressed. Transboundary transport of CO_2 is envisaged in the CCS Directive, but is not yet possible offshore, due to the non ratification of the London Protocol. However, bilateral and multilateral agreements are means to overcome this barrier. Aspects that will be regulated are:

- Siting and construction;
- Environmental and safety demand;
- Use of the infrastructure.

In case of transboundary transport, all of these issues are complicated, as there might be conflicting jurisdiction over these issues. In the oil and gas industry, there is already experience with regulating cross border pipelines. For the different pipelines and networks, bilateral or multilateral treaties are established in which these issues are dealt with.

From these treaties and from international law, the general practice with regard to jurisdiction over transboundary pipelines can be established. In general it is assumed that the State responsible for the storage location has functional jurisdiction over the pipeline and is able to regulate the use of the pipeline. Offshore, the storage State has functional jurisdiction, but when the pipeline enters the EEZ or territorial waters of another state, the coastal state has concurring jurisdiction with regard to siting and construction and environmental and safety demands. The State through whose EEZ or territorial waters the pipeline passes also has to consent to the location of the pipeline and may have conflicting environmental demands.

Onshore, the same solution is found in the oil and gas sector. With regard to siting and construction, national demands apply, which complicates the process of permitting for the potential operator. With regard to environmental and safety demands, the CCS permit requires the different national supervisors to cooperate. How and on which terms is not yet established.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

4 Financial liability in CO_2 transport and storage

The purpose of this chapter is to provide an overview on the existing financial liabilities related to possible future CCS infrastructure operations as well as providing insight in the possible ways of regulating these liabilities and tackling the issue of uncertainty for investors. Section 4.1 will provide an overview on the possible regulatory strategies that can be applied in regulating the financial liabilities. Section 4.2 will give an overview on the financial liabilities when applying for a CCS permit. In this overview different scenario's will be used which indicate possible situations in the future with regard to operational costs, minor events and major events. Section 4.3 describes the regulatory framework with regard to these liabilities as well as the gaps in that framework. In section 4.5, the possible scenarios and regulatory strategies will be combined to provide insight into the consequences of different strategies for possible investors. As dealing with long term arrangements and activities with a certain amount of uncertainty is not new or unique to the CCS sector operators, we will draw upon experience in other sectors, such as oil and gas and nuclear activities.

4.1 Regulatory Strategies

In regulating the financial liabilities several strategies can be chosen. In general regulatory strategies can be scored on the degree to which the government intervenes in the market. Relevant aspects are:

- The certainty that is provided by regulation;
- The binding force of the regulation;
- The degree of detail of the regulation.

When the government chooses not to regulate at all, the initiative and uncertainties are to be dealt with by the market parties themselves. The expectation then is that the market will either avoid the activity or start regulating the activity itself. At the other end of the spectrum is the situation in which the government has regulated an activity into great detail, and has laid down these rules in binding regulation. Market parties have no choice but to follow legislation in that situation. This offers a high degree of certainty, but takes away all flexibility and initiative from the market participants which may be considered undesirable as well. Below we analyze the possible options that Member States have in regulating financial liabilities. They have the following options:

- Provide for more detail in legislation
- Provide for more detail in more flexible forms of regulations (such as decrees of ministerial regulations)
- Provide for more detail in policy statements
- No further explication of the regulation

The options are ordered from strong intervention in the market to less intervention in the market. In general more certainty and less flexibility are provided by a stronger intervention and less certainty and more flexibility by less intervention. As the object of regulation in essence is the allocation of price and volume risk between companies and government, the certainty and flexibility provided by the regulation directly influence the business case of future operators.

Below we turn to analyze these rather general set of options and apply them to the case of financial liabilities in CCS. The starting point is that the EU CCS Directive already regulated this object to a certain extent. The CCS Directive only states that a financial security should be paid, that a financial contribution should be paid and that the liabilities for the climate and the environment are regulated. No further detailed regulation exists. The regulation as laid down in the CCS Directive is binding to the Member States, which are obliged to transpose the rules into national legislation. Besides the binding rules, the EU also adopted guidance documents with regard to the financial security and the financial

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

contribution. These guidance documents are not binding, but advisory and are far more detailed in determining the different elements that build up the financial securities. However, as they are not binding, not much certainty is provided to the market participants. The Member States are the layer of government that is competent to regulate the financial liabilities into more detail.

There is also the general risk that each Member State will make different regulatory choices regarding financial liability. This means that in case of transboundary transport and storage, for each of the financial liabilities different national regimes might be developed, with possibly different imposed requirements for the operator. This potentially leads to large differences in business cases across Member States for similar physical projects. If one Member State for example takes on some of the liabilities, where another Member State doesn't, the operator will most likely choose the Member State with the most attractive regime.

At the Member State level, for example in the Netherlands, the Dutch Mining Act one-on-one transposes the CCS Directive regarding the regulation of the financial liabilities. The binding legislation states that the financial security has to be paid, that a financial contribution has to be paid and that certain aspects of liability are regulated. The regulation does not go into further detail but announces that in the future more detailed regulation might follow, in the form of a decree. A Mining decree in general contains more detail, but has less binding force as it only binds the government and can be replaced without consulting the parliament. With regard to the financial liabilities the decree determines that the permit contains the amount of financial security and prescribes how the amount is calculated.

Furthermore, procedural aspects of the financial security are defined and that further rules might follow in the ministerial regulation. The calculation of the amount is related to the plans to be admitted in applying for the storage permit (risk control, measures, monitoring operations, monitoring post closure, closure plan, possible emissions and financial contribution). The costs of the most severe measures determine the amount of security. As the elements for the financial contribution are not yet defined in regulation, there still are uncertainties for the potential operator. Furthermore, a decree will not explicate the assessment standards by which the competent authority will judge the proposed plans and securities. The new regime of the Mining Act is applicable to all permit holders that have applied for a permit after the coming into force of the Mining Act (June 25th 2011). Permits that have been granted before this date have been granted under the general regime of the Mining Act. According to Article II (1, 2) of the adopted proposal, holders of such a permit are obliged to request the competent authority to adapt the permit to the new regime. The competent authority revises the permit and adapts it to the new regime.

In the regulation in the Netherlands as it is now, the initiative for further elaboration of securities and dealing with the uncertainties is left to the potential investors. On the one hand one might say that the regulation thus does not stimulate CCS developments, on the other hand, dealing with the uncertainties is left up to the party with the information and knowledge. This chapter explores which options in regulation are available and how Member States might provide the degree of certainty needed for potential operator to realize CCS infrastructure projects. For each of the financial liabilities, the purpose of regulation will be examined, as well as the effect of the regulation on the pricing and allocation of risks. The next section analyzes the object of the regulation in more detail.

4.2 Financial liabilities

Financial liability starts right at the onset of operation of the CO_2-storage site. The EC Storage directive requires specific financial securities to be in place as part of the permit application. The preceding site exploration phase that resulted in the operation permit does also have its share of mandatory expenditures and possible liabilities. In general these exploration phase liabilities will be limited in time and extent. The same is true for the other elements in the CCS chain: the operation of the capture plant and the transport infrastructure. The risks (defined as the product of probability and consequences) are considered relatively low for capture and transport operations. For the CO_2

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

storage sites however, it is possible to formulate low-probability scenarios that can result in considerable damages. This section provides an effort to give an overview of the different liability items, possible scenarios and costs estimates. The sketch in
Figure 4.1 below shows the different stages in the 'life cycle' of aCO_2 storage reservoir.

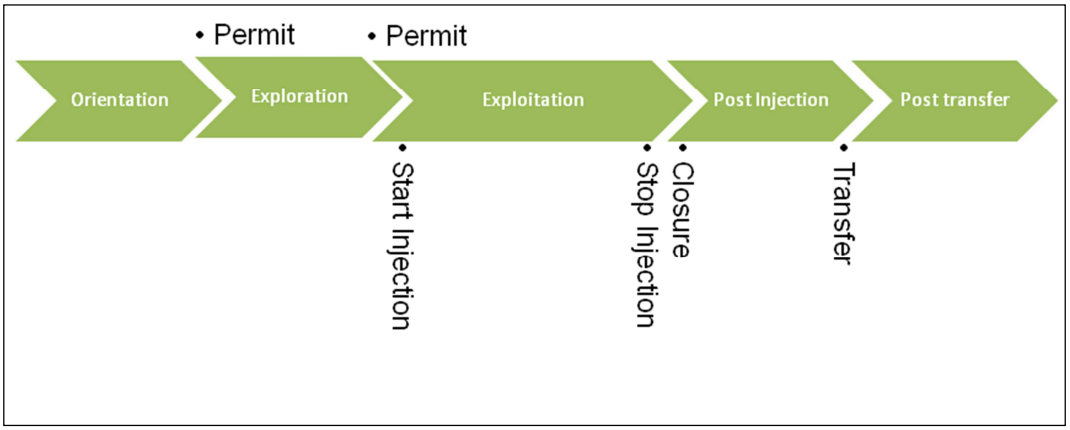

Figure 4.1 The different stages in the 'life cycle' of a storage reservoir

4.2.1 Obligatory expenditures

The various liabilities can be discriminated on their corresponding likelihood. Some will certainly have to be met, whereas others have an extremely remote chance to occur. The obligatory expenditures that have to be made directly follow from the CCS directive:

- *Monitoring during operation (until closure)*
  The CO_2injection activities during the exploitation phase of the storage site require two kinds of monitoring: The amount and composition of the CO_2stream injected in the underground reservoir has to be measured with high accuracy within the framework of EU ETS, just like any fugitive emissions form installations on the storage site. Furthermore, the behavior of injected CO_2 in the underground reservoir has to be monitored to verify that the reservoir behaves as expected from the modeling in the exploration phase. These two monitoring activities are costly but inevitable for the proper and profitable operation of the site. A significant part of the necessary equipment will already be in place from the exploration phase.

- *Decommissioning of the site*
  Although the exploitation phase may last for a period of some decades, at a certain point in time the CO_2injection will be terminated. After this point the injection well will be sealed permanently and the installations decommissioned. A financial reservation for these foreseeable costs will have to be provided by the permit holder during the operation phase, whereas the directive requires some form of financial security from the onset of operation.

- *Monitoring after closure until transfer*
  After termination of the active injection phase the operator has the obligation from the directive to continue the monitoring of the behavior of the injected CO_2 in the underground reservoir. Again, a financial reservation for these costs will have to be provided by the permit holder during the operation phase, whereas the directive requires some form of financial security from the onset of operation. This post-closure phase will last for a minimum period of at least twenty years.

- *Payment to competent authority for monitoring after transfer*
  After a successful post-closure period the responsibility for the storage site is transferred to the competent authority of the member state. Although the intensity of the monitoring of the storage site will be considerably reduced at this stage, the directive requires a payment of future

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

monitoring costs by the operator at the moment of transfer. Again, a financial reservation for these costs will have to be provided by the permit holder during the operation phase, whereas the directive requires some form of financial security from the onset of operation.

4.2.2 Financial damage

In addition to the obligatory expenditures connected with the deployment of a storage site there is a range of possible costs that might occur during or after the operation phase of the storage site. In general these costs result from a 'low-probability undesired' event. Such unwanted events can for instance be noticed from the extensive monitoring at the site[8]. Possible costs include any damage from the unwanted event and / or actions required for recovery and limitation of any further damage from the event. Following the CCS directive the site operator has the obligation to take corrective actions in case of such an event. It is highly likely that the operator would have taken these corrective measures anyhow as part of his damage control actions since there is a large common interest. Again, a financial reservation for these costs will have to be provided by the permit holder and the directive requires some form of financial security from the onset of operation. In contrast with the 'certain' costs these costs can potentially rise to seriously substantial amounts. The combination of substantial financial securities and highly unlikely events creates a challenge.

Any form of CO_2leakage is a serious consequence of such unwanted events. In addition to the obliged corrective measures, the financial damage following a CO_2leakage event can be divided in three main categories:

- *Climate EU-ETS*
  following the emission permit each CO_2 emission has to be reported annually and an equal amount of emission rights has to be transferred. Since it's likely that the amount of accidental leakage is not measured within the required uncertainty (7.5% following the CCS Monitoring & Reporting Guidelines) an additional 'adjustment' has to be applied and in case the emission rights cannot be transferred timely an additional penalty might follow (however unlikely this might seem after an accidental release!).

- *Health/property third party, direct or indirect*
  The leakage of CO_2, or the event resulting in CO_2leakage, might result in damage to health and / or property of third parties. It is possible to formulate dramatic scenarios although such disasters require an extraordinary concurrence of circumstances.

- *Environment*
  Exposure to CO_2 might result in direct damage to the local flora and fauna, and changes in the quality of ground and surface water. The effect can be a temporary disturbance or last for a longer period of time. Again it is possible to formulate dramatic scenarios.

For these three categories it is practically impossible to quantify the financial damage. Certainly for the last two categories the amounts can vary over a sheer endless range, even for comparable leakage scenarios. In the next sections a tentative calculation is performed to obtain some first estimates of the climate ETS damage. Another outcome with major financial consequences of such an unwanted CO_2leakage incident could be the premature closure of the storage site. Not only would the complete investment in storage and infra become worthless overnight but also replacement capacity has to be created.

4.2.3 Low probability events

[8] Within CATO2 WP 4.5 is focusing on the monitoring part of risk management of CO_2 storage. Currently a tool for the planning of (risk-based) monitoring systems is under development.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

During the exploration and exploitation phase many efforts are aimed to achieve a permanent storage facility and to reduce the chances of a CO_2-leakage to occur to a minimum. Still, a range of different low-probability leakage scenarios is conceivable, three of these are:

1) *Diffuse geological leakage*
In spite of the fact that the storage reservoir site is likely selected on the presence of a sealing cap rock layer, it cannot be completely excluded that some leakage along minor faults can occur (certainly on geological timescales). Since it will almost be impossible to detect such a leakage on the surface, detection has to follow from the geological monitoring. As a result the amount of CO_2leakage (if any leakage at all) will be assessed only with a high degree of uncertainty.

2) *Leakage along the injection well bore or existing bore holes*
Before and during operation of the reservoir considerable effort will be invested to prevent such events, but still they cannot be totally excluded. The discharge opening can probably be well localized. The detection of the leakage event might result from direct monitoring, including a good estimate of the leak rate and the duration of the event.

3) *Catastrophic failure of the underground storage and / or sealing layers*
Immediate detection of such a disaster is likely, the potential leakage rate is large. Abandonment of the storage site, including transfer of the stored CO_2 to another site, could be the ultimate corrective action. However this is easier said than done, especially in the early development phase without pan-European CO_2 infrastructure.

As indicated before the probability of such leakage events is low. First the operator has carefully selected the potential site for exploration. Based on all gathered available data on the site the operator was able to build a strong case for the permit application. Next the Competent Authority (including the European Commission according to the directive) has critically reviewed all available information to arrive at the same conclusion: the site is suited for permanent CO_2storage. Intuitively one accepts that the probability for a minor event is higher than that for a catastrophic event, resulting in the following table:

Table 4.1 Obligatory expenditures and leakage events

Class of event	Indicative Probability	'Damage'
1) Obligatory expenditures	**1 (=100%)**	**Reliable cost estimates included in operating budget** **1a) Monitoring during operation** **1b) Decommissioning of the site** **1c) Monitoring after closure until transfer** **1d) Payment to CA at transfer**
2) Low probability	$<< 10^{-2}$	'Low' costs for controllable damage including corrective measures. Elements: a) Climate, b) health/property, c) environment, d) measures
3) Very low probability	$<< 10^{-4}$	'Significant' costs for uncontrolled damage + corrective measures Elements: a) Climate, b) health/property, & c) environment, d) measures
4) Extremely low probability	$<< 10^{-6}$	Extremely high costs for major 'off scale' disaster Elements: a) Climate, b) health/property, & c) environment, d) measures

The indicative probabilities in the table cover the wide range from absolute certainties to once in a million year events. It is impossible to quantify the costs in detail since they are obviously directly site-

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

and project size specific. An example of a low probability failure event is a minor equipment failure in combination with a delayed operator response. Such low probability events may result in damages significantly smaller than the annual exploitation budget for the site. Undesirable of course, but the operator is likely to recover. The very low probability events may result in damage costs in the same order of magnitude with the annual exploitation budget. Even more undesirable, and only surmountable if the site operator belongs to a multi-unit organization. The extremely low probability scenario's may result in damage costs exceeding the total investment costs. Such events can have a lasting impact on the company operation.Figure 4.2 below presents a graphical illustration for these scenario categories.

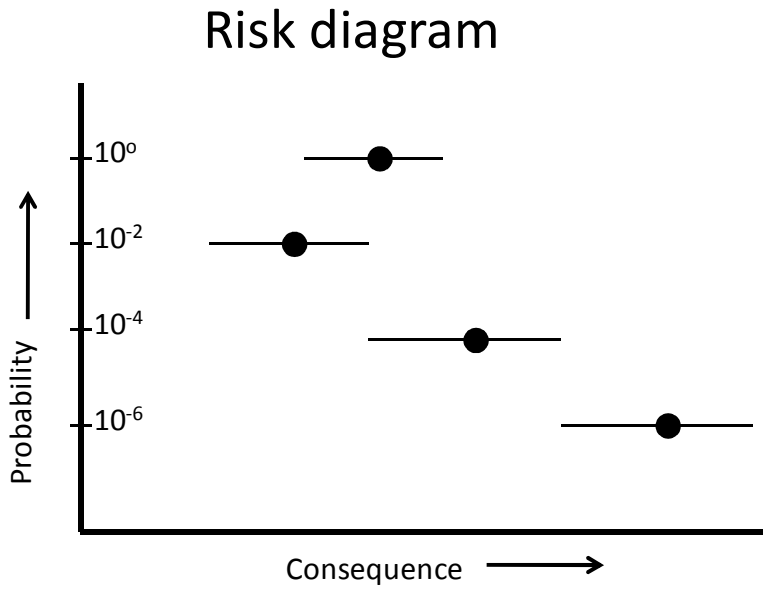

Figure 4.2 Schematic illustration of the range of consequences (expenditures) versus probability for the four scenario categories

4.2.4 Value comparison

An interesting attempt to arrive at quantitative numbers is to see how the value of the amount of CO_2 stored in the reservoir and quantities assumed in leakage scenario's compares with the financial exploitation figures for a power production plant equipped with a capture unit.

The selected business case is a 600 MW coal fired power plant. Since it is combined with a capture unit the number of annual operation hours is high and set here to 6.500 hr/yr (or 75%). Without capture such a unit produces almost 4.000 GWh of electricity and just over 3 megaton of CO_2. For the power plant alone the current annual costs (CAPEX, OPEX incl. fuel) are calculated to be just under 200 MEuro. The current annual costs for the capture unit (CAPEX, OPEX incl. power consumption) are calculated at around 110 MEuro. The capital investment required for the combined units is set equal to 1.500 MEuro. These results are obtained using a set of assumptions which could all be scrutinized, but the final result of total annual costs of 300 MEuro is a good starting point for this tentative analysis.

With an annual capture and storage of 3 Mton CO_2, the 'value' of the CO_2 in the reservoir is quickly increasing to impressive numbers. Assuming a price of for example 20 Euro per ton of CO_2 the reservoir value is quickly larger than the total annual costs of the combined plant. At CO_2 values in the order of 50 Euro, which are required to make CCS a viable option, the reservoir value is larger than the original total investment for the combined plant within a decade. This direct calculation shows that

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

the financial security as originally required in the CCS Directive goes beyond the capital investment in the combined plant. Since the CO_2value is the most decisive parameter in the analysis, the unpredictability of the future CO_2value is the justification for this simple and straightforward analysis. Figure **4.3** below shows the value of the CO_2 stored in the reservoir in comparison with the original total investment and the annual exploitation budget. CO_2injection starts in the year 2020 with an initial CO_2 price of 36.6 Euro per ton. The CO_2price is assumed to rise 2% annually which results in a price of 44.6 Euro in 2030 and 54.3 Euro in 2040. These numbers are just arbitrary chosen to arrive at a first quantitative estimate for comparison. In spite of the possibly conservative CO_2values the figure clearly demonstrates that the value of the stored CO_2 in the reservoir rises rapidly over the annual exploitation budget for the combined power plant and within a decade even the total investment costs for this unit.

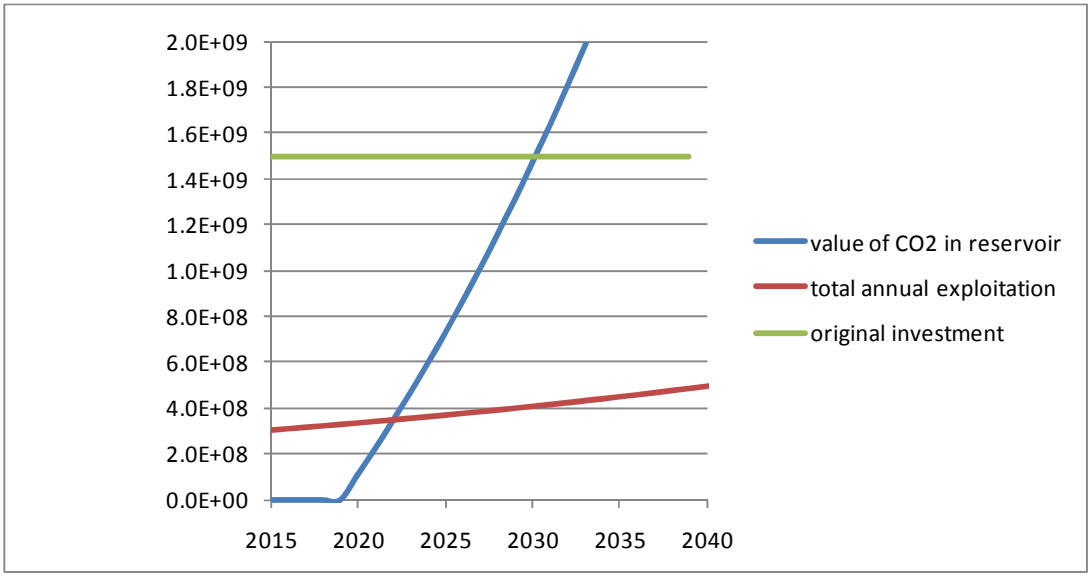

Figure 4.3 Illustration of the value of the CO_2 stored in the reservoir in comparison with the original total investment and the annual exploitation budget.

4.3 Applicable Regulatory Framework

This paragraph will focus in more detail on the regulatory framework for the financial liabilities. Financial liabilities can be divided in categories. Not all of these categories are regulated. The CCS Directive mentions the following financial obligations for operators:

- Liability for damages to the environment and the climate (consideration 30)
- Costs for corrective measures (consideration 30)
- Costs for maintenance and measures after closure (consideration 32)
- Other liabilities (consideration 34)
- Financial securities for closure and post closure period (consideration 36)
- Financial contribution for transfer of responsibility (consideration 37)

Not all of these financial liabilities are regulated in the CCS directive itself. In general three main categories are regulated:

- The liabilities for damages (Art. 34 CCS Directive)
- The financial security (Art. 19 CCS Directive)
- The financial contribution (Art. 20 CCS Directive)

Below we consecutively discuss these categories.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

4.3.1 Liabilities for damage

With regard to the liabilities for damages, the CCS Directive provides that the liability for damage to the climate is to be dealt with on the basis of the EU ETS system. Furthermore, the CCS Directive requires that the damage to the environment is to be dealt with according to the Environmental Liability Directive[9]. The other possible liabilities are to be regulated in Member State regulation[10]. When analyzing the liabilities for damages, we see that the with regard to climate and environment, the operator is liable for the damages, until the responsibility for the storage site is transferred to the competent authority. With regard to the other liabilities, the Member States are to regulate these liabilities. This means that in case of cross-border transport, the liability regimes per member state might differ. When there is no specific regulation with regard to liability for CCS, the uncertainties remain until an actual case occurs and a court given judgement on the matter. Until then, the possible legal basis for liability and compensation is uncertain. The compensation of damages, the liability horizon and the liable party might differ.

When looking at the categories of risks and possible costs, we see that the regulation of liabilities for damages is in place in case of the low probability, very low probability and extremely low probability events. The purpose of the regulation of these liabilities is to ensure that someone will be accountable for the costs of the repair and compensation for damages. With regard to the climate damage and environmental damage, the operator is liable until the transfer of the responsibility. For the other liabilities it is still unsure on which basis and for how long the operator will be liable. In this case the risks are divided in time between the operator and the competent authority.

Article 19 Financial security

1. Member States shall ensure that proof that adequate provisions can be established, by way of financial security or any other equivalent, on the basis of arrangements to be decided by the Member States, is presented by the potential operator as part of the application for a storage permit. This is in order to ensure that all obligations arising under the permit issued pursuant to this Directive, including closure and post-closure requirements, as well as any obligations arising from inclusion of the storage site under Directive 2003/87/EC, can be met. This financial security shall be valid and effective before commencement of injection.
2. The financial security shall be periodically adjusted to take account of changes to the assessed risk of leakage and the estimated costs of all obligations arising under the permit issued pursuant to this Directive as well as any obligations arising from inclusion of the storage site under Directive 2003/87/EC.
3. The financial security or any other equivalent referred to in paragraph 1 shall remain valid and effective:
(a) after a storage site has been closed pursuant to points (a)or (b) of Article 17(1), until the responsibility for the storage site is transferred to the competent authority pursuant to Article 18(1) to (5);
(b) after the withdrawal of a storage permit pursuant to Article 11(3):
(i) until a new storage permit has been issued;
(ii) where the site is closed pursuant to Article 17(1)(c), until the transfer of responsibility pursuant to Article 18(8),provided the financial obligations referred to in Article 20 have been fulfilled.

With regard to the liabilities for damage, we see that some of the liabilities are managed on a European level. For those liabilities that are not managed on a European level, national and possibly different regulation will apply. This means that for different Member States, the liabilities for the possible operator will differ. When a Member State chooses to take on some of the liabilities, it becomes more attractive to possible investors. On the other hand, by not managing liability, the Member State might also discourage CCS. This might provide operators with an incentive to choose storage locations in countries with a favourable regime, thereby stimulating transboundary transport and storage. On the other hand, it also creates uncertainty. Issues of liability for transboundary events are relatively rare, and there is hardly regulation with regard to this issue. Liability is established after damage has occurred and depending on the applicable regime (strict or fault based) several requirements have to be met. These requirements differ per possible ground for liability. In essence, the thresholds for establishing liability

[9] Directive 2004/35/EC
[10] For a more elaborate discussion of the liabilities, see deliverable CATO 2 4.1.1, 2010.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

are determined in courts, and as there is hardly jurisprudence, these thresholds are not clear yet. Not only will the possible existing national liabilities make one country more attractive than another, there are also questions on international law. Could the Member State whose CO_2 is stored for example be held liable for possible damages of that CO_2 in another country? This question could be an issue for further research. Furthermore, liability for damages to health and property offshore is also an issue that needs to be researched more in depth, as private law does not apply offshore.

4.3.2 Financial Security

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). Member States are to ensure that in the application for a storage permit the potential operator proves that it is able to fulfil all financial obligations, which actually have to be in place before injection starts. The financial security will be periodically adjusted, as there are many uncertainties with regard to site itself, the long term nature of the activity and the price of CO_2 in the EU ETS system. Thus the EU CCS Directive determines that this issue must be regulated, but it is up to Member States to actually determine which arrangements for financial security (or equivalent) are allowed. When analysing the wording of the article, a few terms provide for some uncertainties for potential operators:

- Financial security or any other equivalent: this means that Member States are to decide on the form or arrangement, a variety of which will be discussed in section 4.5
- All obligations arising under the permit issued pursuant to this Directive, including closure and post-closure requirements: since Member States are free to adopt more stringent demands both in the permit as well as in the requirements for closure and post closure, the situations for which security must be provided is not yet clear.
- As well as any obligations arising from inclusion of the storage site under Directive 2003/87/EC: this is the EU ETS system, the biggest uncertainty of course is the price of the allowances

For the potential operator, the CCS Directive itself does not provide much certainty with respect to the amount of security and form of security, all of which has to be determined by the Member State. The Directive, to some extent, does define in which situations the security might be called upon by the competent authority (Art. 11, 16, 17) although the criteria for each of these situations are to be elaborated by Member States too.

In order to facilitate the Member States, the EU legislator has issued a guidance document on the matter (European Commission, 2011b). This document is not binding, only advisory to Member States. The guidance document discusses the form/types of financial security, as well as the amount (for which categories of costs) and the options in updating the financial security. In regulating the issue of financial security, Member States have several options, by which more certainty can be provided to the potential operators. Possible regulatory strategies as recognised in the guidance are to list specific types of security (or the equivalent) or to define not the type, but the main characteristics that the security has to meet (the assessment standards). The guidance document contains many different options in further regulation and assessment of the financial security. With regard to the financial security the regulation might focus on different aspects:

- Obligations for which the security is to be provided: from the directive several obligations can be distinguished, the more detailed the regulation on these specific national demands with regard to the obligations, the more accurate the amount of security can be determined.
- Instruments that can be used to provide certainty: instruments should be adapted to the legal system in the Member State, and might differ with respect to the amount of certainty provided, liquidity, duration and flexibility. Specific instruments might also be linked to specific

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

obligations. Member States might also regulate whether or not one instrument is used per obligation, or multiple obligations per instrument, or even multiple instruments per obligation.

- Phasing: as not all obligations are relevant in all phases of storage, the security for the different obligations might be phased too. The Directive states that the security, as regulated by Member States, should be valid and effective before injection starts. In regulating the security, the guidance document interprets this so that Member States may choose for phasing in regulating the security. Phasing is not based on risk assessment. An example of allowed phasing is that the operator has to provide security for post closure monitoring, which will only be relevant in the post closure phase, and has to be provided with more certainty in a later phase. Another example is that the amount of security will be connected to the amount of injected CO_2 as the storage site reaches it ultimate size over time, rather than having to provide security for the ultimate size in advance.
- Calculation of the amount: in the amount of security, many uncertainties must be taken into account. Member States might explicate by which standards the calculations are judged, or which basic principles will be used, how the calculations will be updated etc.
- Procedural aspects: Member States might regulate the process of providing the securities, for example by setting demands for the issuers of different instruments, and regulating how to deal with changes in issuers, operators or instruments.

The Guidance Document advises Member States to consider at least the following aspects in regulating the financial securities (European Commission, 2011b, p11,12, 17, 29):

- Preferably allow phased financial security
- Do not allow for changes in the instruments unless the competent authority has approved of these changes
- In calculating the amount, also consider overhead costs (third party costs) for the situation in which the competent authority has to intervene, by either premature decommissioning or continuing injection
- Amount should not be adjusted by multiplying with an estimated probability to calculate an expected value (full funding, rather than funding based on risk calculation)
- No credit should be allowed for presumed salvage value
- A bottom line of 25% contingency is reasonable, except for the surrender of allowances in case of leakage
- Assumptions regarding inflation and cost escalation should be clarified
- Forms of security can be linked to specific obligations

However, as the Guidance Document is not binding, Member States are allowed to deviate from the suggested approach. Currently, the possible investors see this full funding, rather than risk based approach as an obstacle to the development of CCS in Europe (Zakkour, 2011).

The purpose of regulating the financial security is to ensure that the operator is able to fulfil its obligations from the start of storage to the transfer of responsibility and that in case of non-compliance of the operator; the competent authority has the means to intervene. How the Member States regulate the financial security influences the business case of the potential operator. In regulating the obligations for and form in which the financial security has to be provided, Member States divide the possible risks between themselves and the operator. Member States, for example might decide to limit the security to the first three categories as mentioned in paragraph 3.3, an approach which is advocated by the Carbon Capture and Storage Association (CCSA) (Philips, 2010) and is used in several US states (Pollack, 2010).

In regulating the amount or the calculation of the amount of the security, Member States influence the pricing of risks. Furthermore, Member States can offer certainty to potential operators by regulating the financial securities. When we apply the regulatory strategies to the object of financial security, we can distinguish several types of possible Member State regulation with regard to this issue. Member States might choose not to further regulate the issue. Potential operators then have the initiative in proposing specific types of security, and Member States approve or disapprove of the securities. On

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

the opposite end of the spectrum we might find a Member State that regulates the possible instruments and obligations into great detail in legislation.

An example is the proposed (and discarded) legislation for implementation of the CCS directive in Germany, which prescribes phased security with specific types linked to specific obligations. In between we find the Member States that do not further explicate in legislation, but that provides for information on the assessment of the securities in policy guidelines, or more flexible forms of regulation. Which regulatory strategy is chosen, depends on the regulatory style that is natural to a Member State and the political considerations that are relevant in the legislative process.

Member States thus have many regulatory choices in further defining the regulation on financial securities. Since so much of the detail and content of the regulation is left up too Member States, the chances are likely that in case of cross border CCS the regulation of the financial securities differs per Member State. As in case of transboundary transport and storage, more than one Member State might have jurisdiction, these possibly conflicting demands complicate the situation for the operator.

4.3.3 Financial contribution

As the structure of the financial contribution is highly the same as the financial security, although concerning fewer obligations, the options in regulation are the same. The EU legislator has the possibility to adopt guidelines for the calculation of the amount of contribution, but has not done so yet, other than the advisory guidance document. Member States thus may regulate:

- obligations
- instruments
- calculations
- phasing
- procedural aspects.

Article 20 - Financial mechanism
1. Member States shall ensure that the operator, on the basis of arrangements to be decided by the Member States, makes a financial contribution available to the competent authority before the transfer of responsibility pursuant to Article 18 has taken place. The contribution from the operator shall take into account those criteria referred to in Annex I and elements relating to the history of storing CO_2 relevant to determining the post-transfer obligations, and cover at least the anticipated cost of monitoring for a period of 30 years. This financial contribution may be used to cover the costs borne by the competent authority after the transfer of responsibility to ensure that the CO_2 is completely and permanently contained in geological storage sites after the transfer of responsibility.
2. The Commission may adopt guidelines for the estimation of the costs referred to in paragraph 1 to be developed in consultation with Member States with a view to ensuring transparency and predictability for operators.

In comparison to the financial security, the phasing is of less importance, as the contribution is meant to provide the competent authority with the means to carry out monitoring and perhaps other activities after the transfer of responsibility. Until there are binding guidelines from the EU legislator, the possibility remains that the Member States regulate the contribution differently: this might encourage or discourage potential operators in specific Member States.

The purpose of regulating the financial contribution is to ensure that the competent authority is able to fulfil any obligations that might rise after the transfer of responsibility as well as to account for the costs of monitoring for 30 years. The key issue in the financial mechanism is the type of obligations the contribution is meant for. Article 19 states that at least the costs of thirty years of monitoring are to be taken into account, Member States might price the contribution for more than the costs of monitoring. As is the case with the financial contribution, the Member States possibly divide the risks and price the risks by regulating the financial contribution. When Member States decide that the contribution should also be meant for intervening in case of an extremely are but high cost event, the amount of the contribution will be rather high. The amount of the contribution might be one of the triggers for operators to choose a specific Member State for storage and stimulate transboundary transport and storage

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

4.4 Available options

Security can be provided using different instruments, all with their own advantages and disadvantages. For the purpose of this chapter, the possible instruments will be classified in the following categories (European Commission, 2011b; Zakkour, 2011):

- Deposits: the operator deposits the amount of the security as a whole. An example of this is the deposit to the competent authority, deposit on an escrow account or the deposit in a fund. Central characteristic is that somewhere the amount of money needed for the security is set aside.
- Guarantee: the competent authority gets some form of guarantee that if anything happens, there will be money to pay for the costs. The guarantee can be provided by the company itself, by a bank or other institution. Known forms are: bank guarantee, letter of credit, surety bonds.
- Insurance: the risk is transferred to the insurance company; in turn the operator pays a premium. When there is an incident, the insurance company takes on the costs. Insurance can be provided by the market or by government.

Within the different categories different forms of the instruments can be distinguished. As they share the main characteristics, these forms will only be discussed separately if the differences affect the division of risks or create less certainty.

The first category of instruments is the deposit. The amount of security is set aside for the situations in which it is needed. This is used in situations in which it is certain that in the future specific activities need to take place and the government wants to be sure that money will be available to do so, such as is the case in the decommissioning of offshore installations. Relevant is where the money is set aside and who has control over the money. If the money is set aside on one of the companies accounts, it still counts as capital of that company and is available to creditors in case of bankruptcy. It is possible to set the money aside on an escrow account. However, this only solves the bankruptcy issue if the government gets preference rights in case of a bankruptcy. The issue will be definitely solved if the money is set aside in some form of fund (if not under the control of the company) or is paid to the competent authority directly. From a company perspective, this is the most costly option. When money is set aside in some form of fund, government might also contribute to that fund. In doing so, Member States must also take into account the rules regarding State aid. The fund also has as an advantage that more CCS operators might participate in the fund, thereby spreading the risks further. However, for first movers a fund does not seem possible. One of the advantages of a fund is that it is rather flexible, and could be positioned on a European level, if CCS would occur cross borders for example. The larger the pool, the more useful the fund will be.

The second option is to provide some form of guarantee. In this case some institution guarantees that the money will be available if needed. By its nature, the guarantee is used in cases in which unforeseen circumstances might lead to costs, and the guarantee ensures that these costs will be paid. It is used to cover some of the risks that might occur in doing business. Where in the deposit option, the company itself was responsible for the entire amount of security, in this case issuer of the guarantee declares that the amount of security will be available and that it has made arrangements with the company to ensure this. Thereby extra certainty is provided, at some extra cost for the company. Between the issuer and the company, a contract will be made up, with the conditions for the guarantee. There are several forms, a payment guarantee by the bank if the company fails to fulfil its obligation, or a letter of credit by which the competent authority can draw from the funds of the company, or surety bonds, making bonds available to creditworthy parties. Of course, the issuer of the guarantee will check the company's creditworthiness regularly. The competent authority might want to set up demands for the issuer of the guarantee, in order to make sure that the issuer will be able to fulfil its obligations if necessary.

A guarantee should not be subject to demands of creditors for the company. Some form of property right for the competent authority should ensure that in case of bankruptcy the competent authority has the first right to claim the money. The higher the amount of the guarantee; the more stringent the

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

demands will be of the issuer providing the guarantee. The company might also provide for security, as is often done in case of large operations undertaken by joint ventures. Each of the companies in the joint venture guarantees a specific amount of money. Of course, the certainty is less than in the case that an independent issuer provides for the guarantee. Furthermore, the company itself is responsible for the money, and in case of bankruptcy, company creditors might also claim the money. Finally, issuers of a guarantee will not be likely to guarantee sums for larger amounts than the yearly turnover of a company.

A last category of instruments that might be used to provide security is insurance. In that case, risk is transferred from the party not willing to take on the risk to a party willing to take on the risk, where the first party pays a premium (De Figueiredo, 2007, p 62). Environmental liability insurance often functions different than other forms of insurance due to the fact that there is hardly information on the manifestation of risks and it is insurance for future possible unknown risks. The party carrying the risk will have to deal with the financial responsibility for the risk. When little is known and few projects are actually going on, it is harder to create an insurance pool and premiums will be high. Insurance is used for events that are not likely to occur, but if they occur, costs might be high. It is not used for situations that are likely to occur. Professional risk bearers manage the risks through the conditions and premiums. Especially the conditions might be tricky as they do not always cover all events or claims. Furthermore, third parties might also claim from this pool. Private insurance shifts the risk between parties in the market, but the government might also take on some of the responsibility. Instead of having the private sector manage the risks by itself, the government could function as a risk bearer. In doing so, Member States are to take into account the rules regarding State aid, Art. 108 of the Treaty on the Functioning of the European Union (TFEU) (EU, 2008).

In Table 4.2 below, the use of the instruments and the certainty provided by them are summarised.

Table 4.2 Financial instruments to cover obligatory expenditure and possible events

Instrument	Used for:	Controlled by:	Certainty:
Deposit	Reservation for costs certain to occur	Company	Low
		Competent authority	High
		Independent fund	High
Guarantee	Extra certainty for events that preferably do not happen and have moderate costs	Bank/institution	High
		Company	Low (unless non-affiliates company issues the guarantee)
Insurance	More risky events, less likely to happen	Insurance company	Moderate
		Government	High

When we analyse the different categories of costs these securities are used for, we can come up with the following costs for which the operator has to provide security for. In order to facilitate the analysis further on in this section, the phase in which it is relevant and the certainty of occurrence is also added.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Table 4.3 Obligatory and possible cost categories relative to storage phase

Costs	Phase	Category
Monitoring	during injection	Certain to occur
Remediation	during injection	Low probability, low costs
Minor events (EUA)	during injection	Very low probability, significant costs
Major events (EUA)	during injection	Extremely low probability, high costs
Decommissioning	closure	Certain to occur
Premature Decommissioning	during injection	Very low probability, significant costs
Monitoring	post injection	Certain to occur
Remediation	post injection	Very low probability, low costs
Minor events (EUA)	post injection	Very low probability, significant costs
Major events (EUA)	post injection	Extremely low probability, high costs
Financial contribution	post handover	Certain to occur

It is up to Member States to decide for which costs, according to which calculation, security has to be provided for at which time. The possible instruments that can be used to provide security do fit certain types of costs, as the instruments are applicable for situations that are certain to occur (deposit in advance) or events that are not certain to occur (insurance). With respect to insurance, it is highly unlikely that an insurance market will be available for extremely low probability events.

Another selective criterion is that a company guarantee will be closely related to the revenue (smaller than the annual exploitation budget) and therefore is only applicable in low probability events. A bank guarantee will never exceed the annual turnover, which makes it also applicable for very low probability events (drawing from the costs as mentioned in 4.2). With regard to a fund, depending on the characteristics, it can be made suitable for almost any event that occurs in the future and for which money has to be reserved. The result of the combination of time of occurrence, probability and features of the instrument is summarised in the table below. It is up to Member States to define the desired amount of certainty and type of instrument.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Table 4.4 Suitable instruments to cover obligatory expenditures and possible events

Categories of costs		Possible instruments				
		Deposit	Company Guarantee	Institutional guarantee	Insurance	Fund
Certain to occur	Monitoring injection	✓	✓	✓		
	Decommissioning	✓	✓	✓		✓
	Monitoring post injection	✓	✓	✓		✓
	Financial contribution	✓	✓	✓		✓
Low probability	Remediation injection		✓	✓	✓	✓
Very low probability	Premature decommissioning[11]			✓	✓	✓
	Minor events injection			✓	✓	✓
	Remediation post injection			✓	✓	✓
	Minor events post injection			✓	✓	✓
Extremely low probability	Major events injection					✓
	Major events post injection					✓

Table 4.4 above shows suitability of instruments, but has not yet discussed the possible role of government in taking on some of the risks and costs for risks. For this we will draw upon the opinions of relevant institutions and common practice in comparable markets. In essence, providing security for future costs is used to ensure government that the company is able to fulfil all obligations in the future. This is normally done in risky and long term situations, such as mining, gas storage and transport, waste management and the nuclear industry. Depending on the private company business case and the public interest, government decides to take on some of the risks as well. With regard to waste, we see that government indemnifies the operator after a specified amount of years (Harmelink, et al. 2010).

With regard to mining and gas transport and storage, we see that Government ensures that a fund is available for specific types of damages, and that in this fund a small amount is deposited, and company guarantees provide for the rest of the security. For nuclear, a fund is set up, with a larger amount of deposits, and company guarantees. As soon as the possible damages exceed a certain sum, government takes on liability. As CCS is not yet a profitable activity for companies, a line of reasoning comparable to waste management or nuclear seems reasonable, although the scale of damages is much lower than in the case of nuclear. We see that in comparable situations, government participates and takes on some of the risks and that a combination of all types of instruments is used to provide security.

When analysing the guidance document and the reactions from industry and institutions to the guidance document, we see that the European Commission advocates an approach in which security is provided with a high degree of certainty, possible phased, taking into account all possible situations,

[11] The guidance document also claims that security might be calculated taking into account the possible continuation of injection by the competent authority based on art 11 -4 CCS Directive, however, art 19 CCS Directive only applies the need for security towards art 11-3 CCS Directive (premature decommissioning). Therefore, continued injection is not presented as a possible cost in this table.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

but with a large contingency. The EC explicitly states that a full fund approach is better than a risk based approach. Within the IEA regulators network, several organisations have adopted a different position. Ian Philips of CCSA claims in his presentation (Philips, 2010) that for the industry it is unacceptable that for extremely rare, large scale events, the industry itself should be liable, and should provide security for in advance. Zakkour, (2011) claims this is a major obstacle to CCS deployment in Europe. The Zero Emission Platform (ZEP) has issued a comment on the guidance documents[12]. In its comment it states that governments should be involved in insurance and it also states that if the permitting procedure is applied in order, leakages should be nil and are not as risky as other industrial activities, so providing security for large scale events in terms of EUA does not seem reasonable.

4.5 Summary

The chapter on financial liability can be summarized in the following series of bullet points:

- Following the CCS directive CCS permit applicants are required to provide concrete financial liabilities, securities and contributions.
- However, the 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 also means that in different Member States different choices will be made, which will make one Member State more attractive than the other, thereby violating the principle of a level playing field, which presumably could give rise to the development of CCS infrastructure at lowest cost for society.
- When transboundary transport and storage occurs, the operator might face different regimes with regard to the financial security that has to be provided, and the financial contribution that has to be paid, as well as the liabilities that might exist, which creates uncertainty for possible investors. .
- Member States might regulate which party has to deal with the uncertainties by regulating the financial liabilities. As of now, none of the Member States have done so, thereby by leaving the initiative for dealing with the risks and uncertainties by the potential operator that is expected to have the most detailed knowledge on these risks and uncertainties.
- When analysing the uncertainties and financial liabilities facing these potential operators, the analysis demonstrates that the financial consequences of a set of scenario's covering a wide range of probabilities can go beyond the annual exploitation budget and even the total CCS chain investment.
- The financial obligations for which security has to be provided can be divided in four costs categories:
  - Costs certain to occur
  - Low probability costs
  - Very low probability costs
  - 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.

[12] EU CCS Directive Guidance Documents – A Step Forward, ZEP May 2011

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

- 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. The logical solution is to cover each cost category with the best suited financial instrument. Member States should take into account that each specific category requires specific demands in regulation, in order to guarantee the desired amount of certainty.

- For the extremely low probability cost category it is suggested that governments should be involved in providing insurance or the establishment of a common fund. In other sectors it is common that the costs of these extremely low probability events are shared between potential investors and government.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

5 Industry survey on European transboundary network developments

In order to gather an insight into the viewpoints of stakeholders on a number of issues covered in this report, and to review some of the general economic theories examined in Section 2, an industry survey has been conducted. The survey has been completed by 10 respondents, and although the results are treated anonymously, participants included representatives from a number of large European power generation, shipping, gas transportation and industrial production companies including E.ON UK, E.ON Benelux, RWE, KEMA and NUON. Although the surveys were distributed to prospective stakeholders in 8 European Member States, the survey has only been completed by stakeholders located in the Netherlands, Germany, the United Kingdom and Norway.

The survey contained multiple choice and open questions on the following topics:

- Over-dimensioning CO_2 transportation pipelines in anticipation of future demand
- The presence of public or private companies with the technical capacity to develop a CO_2 transportation pipeline network
- The organizational model, in terms of access regimes, liability and the level of regulation foreseen
- The role of public funding in CO_2 transportation infrastructure
- The need for EU coordination and harmonization of regulation and investment between Member States
- Liability of storage site

The results of the above areas are covered in the following subsections.

5.1 Network needs

The first part of the survey focused on the assessing the viewpoints of the participants regarding the requirement for a CO_2 transportation network, both in their Member State and on a transboundary European scale. The participants were asked to what extent they agreed with the argument that CO_2 transport pipelines built today should be over-dimensioned in anticipation of future capacity requirements. All of the survey participants either agreed (78%) or strongly agreed with this the argument that CO_2 pipelines should be over-dimensioned in anticipation of future capacity demand.

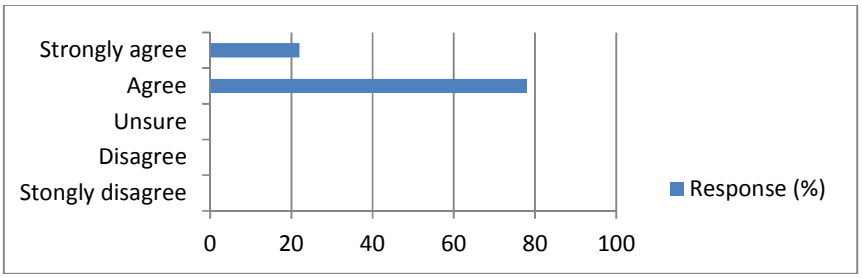

Figure 5.1 Should CO_2 pipelines between built over-dimensioned to meet future demand?

Further questions within this section covered the importance of national multi-user CO_2 pipeline networks in facilitating CCS in the participant's individual Member State, and the importance of transboundary CO_2 transport networks in facilitating CCS in the participants' respective Member State. The results of these questions can be found in Figure 5.2 and Figure 5.3 below.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

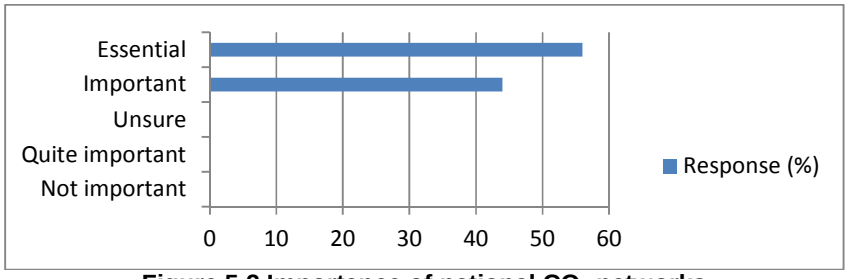

Figure 5.2 Importance of national CO_2 networks

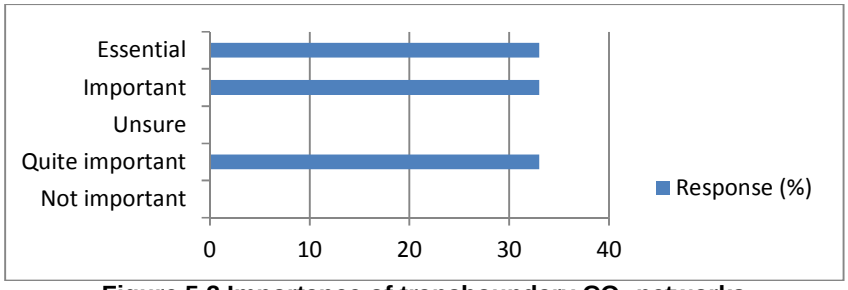

Figure 5.3 Importance of transboundary CO_2 networks

All the survey participants indicated that national CO_2 networks are either essential (56%) or important (44%) in facilitating the overall deployment of CCS in their respective Member State. However, the importance of transboundary CO_2 received a more distributed response, indicating that in some countries cross border networks are considered less important. Such countries may include the UK, the Netherlands and Norway, whereby suitable offshore storage sites can be identified.

5.2 Investment and funding

The second section was structured to test some of the investment models and theories covered in Section 2 of this report. Questions in this section covered potential investors and owners of national CO_2 pipelines, access regimes and public support for network development.

The initial questions in this section concerned the presence of fully privately owned and publically owned (fully or partly) in the respondent's respective country, suitable placed in terms of financial, human and technical capacity to develop and operate a multi-user CO_2 pipeline network. Examples such as natural gas transport companies, or a bespoke CO_2 transport company were provided. In both questions, the response was identical, with 78% of respondents indicating that both fully privately owned and publically owned entities suitably placed to develop and operate CO_2 transport networks were present in their country.

This issue of CCS projects becoming vertically integrated, with the capture, transport and storage parts owned and operated by a single entity, was also covered by the survey. It has been argued that vertical integration in certain cases may be detrimental to the long-term development of CO_2 transportation networks, as a monopoly position could be adopted by a single entity, restricting access to transport and storage facilities by third-parties. The participants were therefore asked to comment on the perceived probability of a vertical CCS chain emerging in their Member State.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

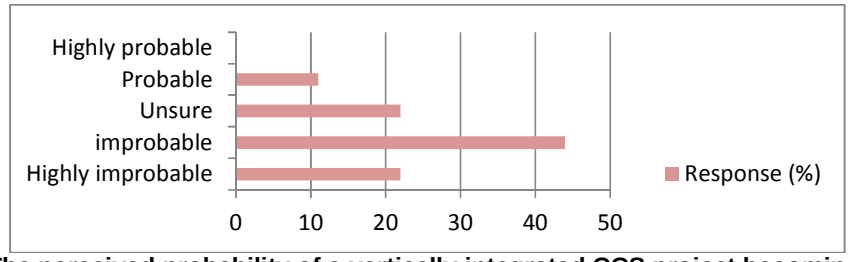

Figure 5.4 The perceived probability of a vertically integrated CCS project becoming implemented in the UK, the Netherlands, Germany or Norway.

Although the responses were distributed amongst 4 of the available choices, 66% of the respondents indicated that the development of vertically integrated CCS projects were either improbable (44%) or highly improbable (22%). 11% of the respondents indicated that vertically integrated projects were probable (11%), and 22% of respondents were unsure. Following on from this question, the survey attempted to assess which ownership models appeared most feasible in the Member States investigated. The respondents were able to indicate multiple answers. Two ownership structures, a public-private partnership, and a regulated decentralised approach (multiple private owners) were highlighted as most feasible by the respondents.

The most appropriate form of access to CO_2 transportation networks is a current form of contention between Member States. The survey asked respondents to indicate the form of access to CO_2 transportation networks which appeared most appropriate for their Member State. Figure 5.6 conveys that respondent opinions are equally split between regulated access, and negotiated access between users. One respondent indicated that access should be organized according to the 'common carrier principle'.

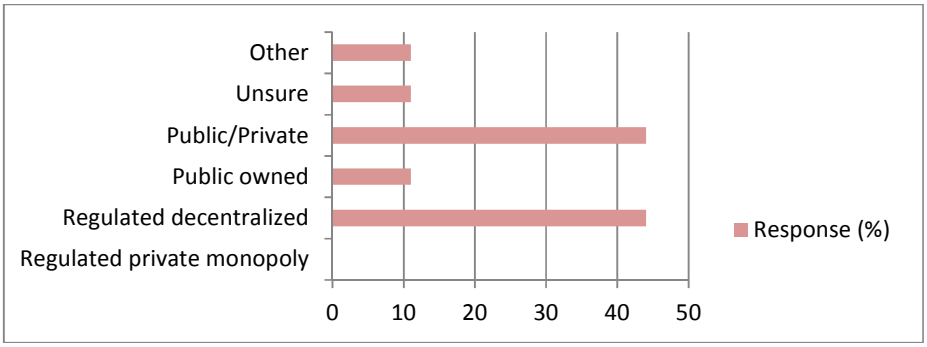

Figure 5.5 Feasible ownership structures for national CO_2 transportation networks

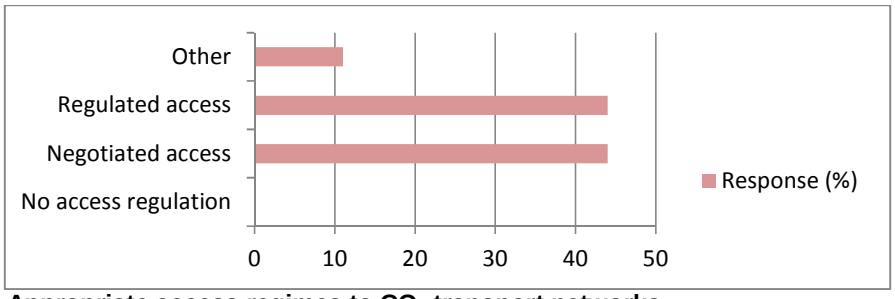

Figure 5.6 Appropriate access regimes to CO_2 transport networks

Respondents were also asked whether in their Member State, market parties would invest in over-dimensioned CO_2 transport pipelines to meet expected future capacity requirements, either for own

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

use or to supply to others. The respondents were also asked that given the current sub-commercial conditions for investing in the majority of CCS applications, should forms of Member State public funding be made available for CO_2 transport infrastructure in addition to funding for individual demonstration projects.

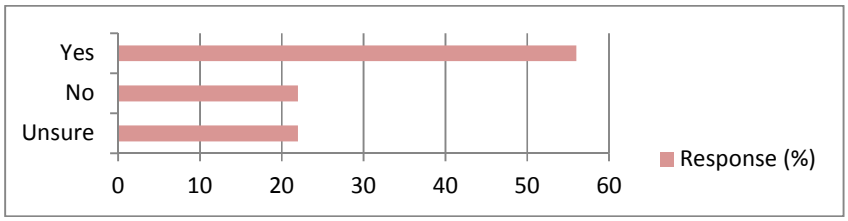

Figure 5.7 Would market parties invest in over-dimensioned CO_2 transport pipelines to meet expected future demand?

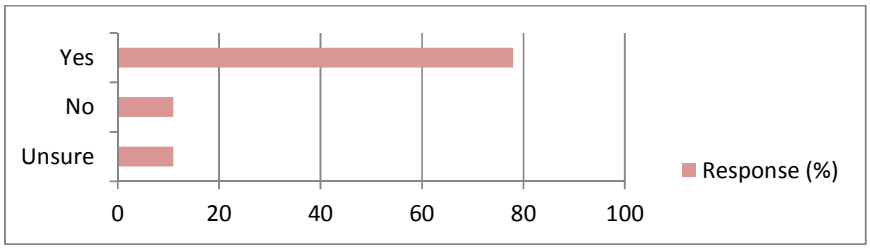

Figure 5.8 Should forms of Member State funding be made available for multi-user CO_2 transport infrastructure in addition to funding for individual demonstration projects?

44% of Respondents indicated that within their Member State, market parties would invest in over-dimensioned CO_2 transport pipelines to meet future demand. This response as higher than expected given the current market conditions for CCS, however the question did not stipulate a timeframe or the availability of public funding at the time an investment decision could take place. Figure 5.8 illustrates that 78% of the respondents hold the opinion that Member State funding should be made available for multi-user CO_2 transport infrastructure in addition to individual demonstration projects.

Participants were also asked for their opinion on how likely Member State funding in addition to EU support through the European Energy Programme for Recovery (EEPR) and/or the New Entrants Reserve 300 (NER300) scheme. 56% of the respondents held the opinion that additional Member State funding would become available, primarily through subsidies or grants, emission standards or capture obligations (see Figure 5.9)

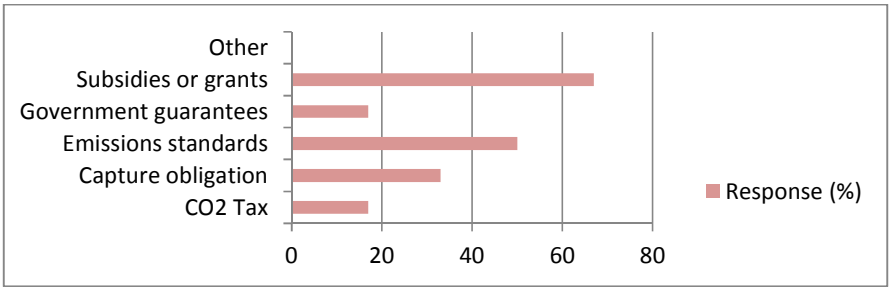

Figure 5.9 Possible Member State funding or incentives to support CCS demonstration

Continuing on the same topic of Member State funding, the participants were also asked to comment on the perceived probability of support schemes for the development of CO_2 transportation infrastructure becoming available in their respective country. In comparison to the question regarding

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

funding for individual CCS demonstration projects, the respondents were less optimistic that such funding would become available, with only 33% of the responses indicating that public support would be made available for transportation infrastructure alone. The following question indicated that if such funding would be made available, direct public investment and subsidies would be the most likely forms of support.

The final question in the 'investment and funding' theme of the survey, asked participants whether public funding through an EU wide mechanism/scheme should be made available for CO_2 transportation networks in addition to individual demonstration projects. 89% of the respondents indicated that such bespoke European wide funding should be made available for multi-user CO_2 transport networks. This observation is in line with the recent proposals for regulation of the EU which include a European fund for energy infrastructure investments, covering gas, electricity and CO_2 infrastructure investments.

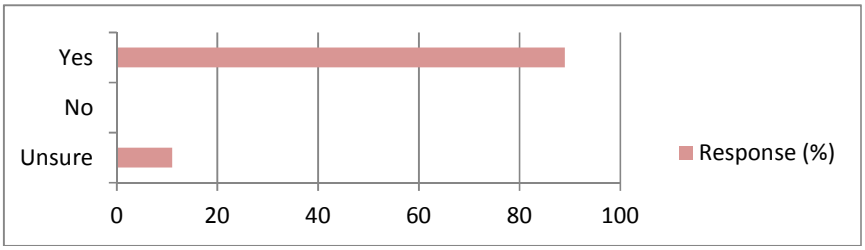

Figure 5.10 Should funding for CO_2 transportation networks in addition to individual demonstration projects be made available through an EU wide mechanism or scheme?

5.3 European coordination and regulatory harmonization

The survey also incorporated a number of questions focusing on possible European coordination of transboundary CO_2 networks, and the potential need for Member State regulation on CO_2 transport to be harmonized. The primary piece of European legislation which directs Member States on how to regulate the transportation of CO_2 and the development of CO_2 transport infrastructure is the EU Directive on the geological storage of carbon dioxide (the EU CCS Directive). The survey participants were asked to comment on whether the Directive provides sufficient guidance to ensure a harmonized approach (in terms of funding, ownership, tariffs and other regulation) to the development of CO_2 transport pipelines across EU Member States.

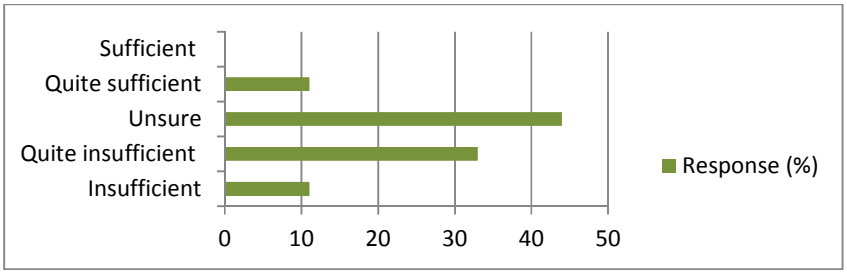

Figure 5.11 Does the EU CCS Directive provide sufficient guidance to ensure a harmonized approach to the development of CO_2 transport pipelines across EU Member States?

The results indicate an element of uncertainty regarding the sufficiency of the Directive on the issue of regulatory harmonization regarding CO_2 transport infrastructure development. Notably, no respondents indicated that the current Directive provided sufficient guidance on the development of pipelines to ensure a harmonized approach across EU Member States.

This section of the survey also covered whether the presence of publicly owned (partially or fully) gas transport entities capable of developing and operating CO_2 transport pipelines in certain Member

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

States, presented a competitive advantage to potential CCS investors operating in such states, compared to Member States with an absence of such entities (thus reliant on market parties).

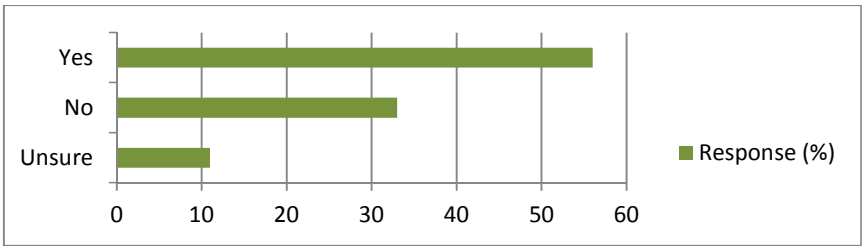

Figure 5.12 Does the presence of publically owned gas transport entities in certain European countries present a competitive advantage to CCS investors operating in such states?

56% of the respondents indicated that the presence of publicly owned (partially or fully) gas transport entities in certain Member States provides a competitive advantage to potential CCS investors in such countries. The participants were also asked to what extent would a lack of harmonized rules for CO_2 infrastructure charging (i.e. transport tariffs), potentially brought about by different investment models across European countries, imply distortion of competition across the EU? The opinions regarding this question were quite distributed, with no dominating opinion apparent. Following on from this question, the participants were asked whether the variable availability of public funding across EU countries may hinder the development of an EU wide CO_2 transportation network. 67% of the respondents held the opinion that divergent approaches to public funding between European countries could hinder the development of a pan-European network.

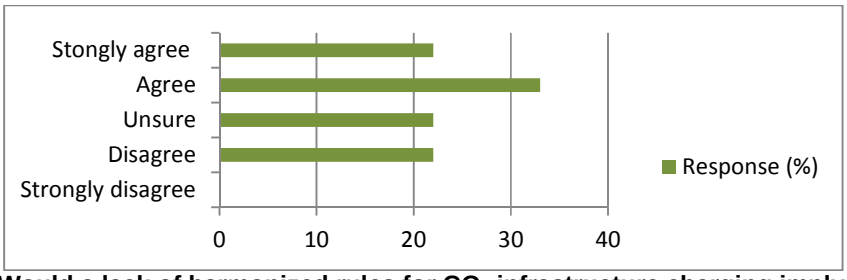

Figure 5.13 Would a lack of harmonized rules for CO_2 infrastructure charging imply a distortion of competition across the EU?

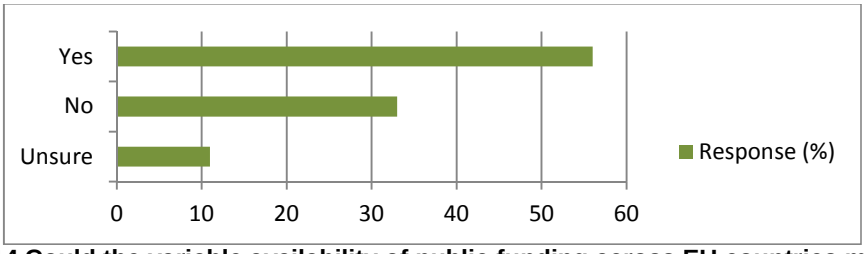

Figure 5.14 Could the variable availability of public funding across EU countries may hinder the development of an EU wide CO_2 transportation network

Additional questions in this section were structured to assess the perceived role of the European Commission in the development of CO_2 transport infrastructure.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

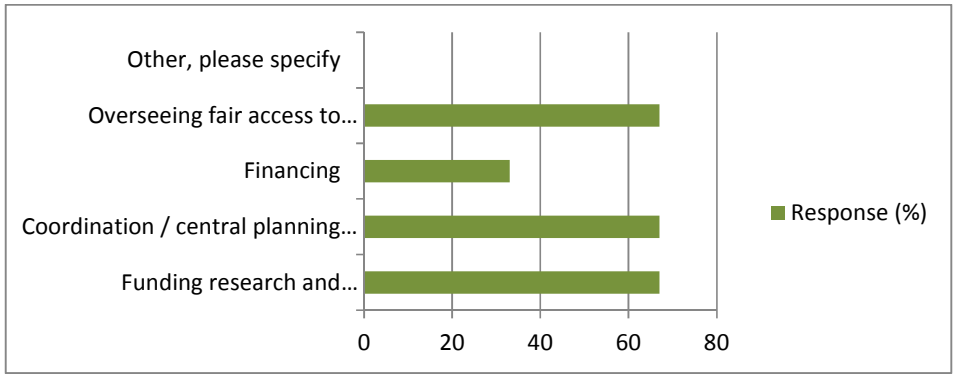

Figure 5.15 The perceived role of the European Commission in the development of CO_2 transport infrastructure

The respondents, who were able to choose multiple answers, expressed equal importance for the European Commission to oversee fair access to infrastructure, coordinate and centrally plan network developments, and to continue to fund research and knowledge dissemination. Direct financing of CO_2 transport infrastructure appears to be considered as a less prominent role for the European Commission. The above question was further expanded, as the respondents were asked to comment on if and when CO_2 transport and storage infrastructure should be coordinated at an EU level. 44% of respondents stated that EU coordination should occur in the future and 33% stated that it should commence immediately.

5.4 Liability of storage sites

The survey also contained one question regarding the transfer of liability of CO_2 storage sites to the respective Member State. The CCS directive prescribes that the liability for environmental damages and the obligations based on the ETS scheme are transferred to the competent authority after 20 years. The participants were asked to provide their opinion on this time frame. 44% of the respondents agreed with the CCS Directive, with the remaining responses split between a longer and shorter period of project sponsor liability.

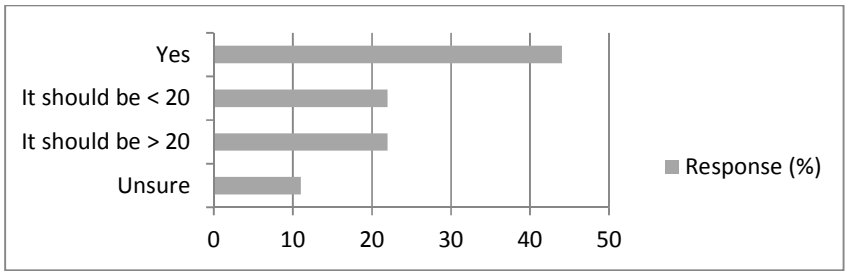

Figure 5.16 Is the current project sponsor liability period prior to Member State transfer as prescribed in the CCS Directive suitable?

5.5 Summary

All the respondents of this survey agreed with the argument that over-dimensioning of CO_2 pipelines to meet future demand is necessary. National CO_2 pipeline networks are considered by the respondents as either essential or important to facilitate the deployment of CCS in the Netherlands, the UK, Norway and Germany. Transboundary CO_2networks were given less importance, given the availability of suitable storage locations in certain countries.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

The majority of respondents indicated that vertically integrated CCS projects, whereby the capture, transport and storage components are all owned by a single entity are improbable. A regulated decentralized (private) or public-private ownership structures appear most feasible in the countries investigated. The respondents were equally divided in their opinions regarding suitable access regimes, either negotiated (i.e. minimum regulation) or regulated access.

In terms of investments, the majority of respondents stated that support for CO_2 transport infrastructure could be provided via an EU wide mechanism, in addition to current schemes to support individual demonstration projects. Only 10% of the respondents held the opinion that the EU CCS Directive had sufficient guidance to ensure a harmonized approach to the development of CO_2 transport pipelines across EU Member States. Furthermore approximately 60% of the respondents indicated that the presence of publicly owned companies with the ability to transport CO_2in a country represents a competitive advantage to potential CCS investors. 60% of the respondents held the opinion that divergent CO_2 transport tariffs between EU countries could imply a distortion of competition between states, and that variable levels of financial support for transport infrastructure between countries could hinder the development of a pan-European network.

Finally, approximately 50% of the respondents specified that the transfer of liability of storage site from operator to Member State after a period of 20 years, 20% had a preference for a longer period, and 20% for a shorter period.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

6 Policy recommendations

In addition to addressing the specific research objectives outlined in Section 1.2, based on the research conducted and the legal barriers and challenges identified, a number of policy recommendations have been devised:

Financing

- The adoption by national governments of divergent and possibly conflicting regulation concerning issues such as third-party access issues, pipeline permitting and financial liability could complicate the development of transboundary CO_2 transportation infrastructure. Further regulation must be provided to Member States to prevent the emergence of divergent national regulation regarding these issues which could affect the development of CO_2 transportation infrastructure. This should be taken into account in the review of the CCS Directive in 2015.

- The industry survey suggests that unilateral support for national pipeline projects, through either direct financial support or the involvement of publicly owned entities in the development and/or operation of pipeline project could cause conflicts when combining pipelines into transboundary networks. Therefore, a European support fund to support the development of cross-border transport infrastructure must be considered for future implementation, dependent on the progression of CCS as a climate mitigation technology.

- A possible source of funding for European transboundary CO_2 transportation infrastructure could become available through mechanisms within the EU's energy infrastructure policy. Funding, which would become available under the "Connecting Europe Facility (CEF)", could include financing options such as the use of risk sharing instruments (including project bonds and guarantees); risk capital instruments (including equity participations); grant support for project studies and construction; or a combination of grants, risk sharing and risk capital instruments. Member State governments and potential project developers should look towards possible cross-border CO_2 transportation projects with common interests in different Member States towards 2020.

Transboundary legal issues

- For the storage permit, the EU CCS Directive states that the competent authorities shall cooperate, but for the different aspects of regulating pipelines, this is not yet the case. A standard model for cross border cooperation would be useful, in order to save time and money for the interested market parties.

- The most common and useful way to regulate transboundary CCS and solve issues of competing jurisdiction is to form bilateral and/or multilateral treaties.

- The European Commission should specifically choose a regime for liability of emission allowances in case of transboundary transport and storage, if for example a leakage event were to occur. The most reasonable option seems to be that the storage state assumes responsibility for the allowances.

Financial liability

- Member States are able to divide risks and suggest calculation methods by regulating the specific financial obligations and securities in more detail. In doing so, Member States would provide more certainty to potential investors, which would help develop an infrastructure for carbon transport. Especially since the respondents indicate that the guidance as it is, is not sufficient.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

- In regulating the financial security the report advises Member States to provide regulation which links specific cost categories to specific instruments for security. There is no single financial instrument that can realistically cover all four costs categories. The logical solution is to cover each cost category with the best suited financial instrument. Member States should take into account that each specific category requires specific demands in regulation, in order to guarantee the desired amount of certainty.

- For extremely low probability events entailing extremely high financial liabilities, it is suggested that governments should be involved in providing insurance or the establishment of a common fund. The respondents of the survey also seem to think that more government involvement is necessary.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

7 Literature

Broek, M., Ramirez, A., Groenenberg, H., Neele, F., Viebahn, P., Turkenberg, W., Faaij, A. (2010). Feasibility of storing CO_2 in the Utsira formation as part of a long term Dutch CCS strategy An evaluation based on a GIS/MARKAL toolbox. International Journal of Greenhouse Gas Control **4** (2), 351-366.

Conan, L. (2011). The Trans-Saharan gas pipeline: and overview of the threats to its success and the means to prevent its failure, Utah Environmental Law Review, vol 31, no 1. 205-240.

Chrysostomidis, I. &Zakkour, P. 2008. Assessment of the range of potential funds and funding mechanisms for CO_2 transportation networks. May 2008. Available at (07/11/2010): http://www.co2captureproject.org/pubdownload.php?downid=18

Chrysostomidis, I., Zakkour, P., Bohm, M., Beynon, E., de Filippo, R. and Lee, A., 2009.Assessing issues of financing a CO_2 transportation pipeline infrastructure.Energy Procedia, 1.

De Hauteclocqeu, Talus. (2011). Third Party Access: a comparative study on access regimes in EU electricity grids and natural gas pipelines, OGEL 2011-3,

De Joode, J. (2006) Gas interconnector regulation: the trade-off between competition and security of supply, proceedings of the USAEE/IAEE North American Conference 2006, Ann Arbor, MI, United States, 24-27 September 2006.

Den Dulk, J.L. unofficial translation of the Dutch Mining Act, Available at (23-11-2011): http://www.nlog.nl/resources/Legislation/Engelse%20vertaling%20Mijnbouwwet1.pdf
European Commission, (2011), Guidance Document 4, Financial Security (art 19) and Financial Mechanism (art 20), Available at (23-11-2011): http://ec.europa.eu/clima/policies/lowcarbon/ccs/implementation/docs/gd4_en.pdf

European Commission, (2010). Communication "Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network" [COM(2010)0677]. Available online (21/11/2011): http://ec.europa.eu/energy/infrastructure/strategy/2020_en.htm

European Commission, (2011). Proposal for a Regulation of the European Parliament and of the Council, on guidelines for trans- European energy infrastructure repealing decision no 1364/2006/EC, 2011/0300 (COD). Available online (21/11/2011): http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0658:FIN:EN:PDF

European Commission, (2011b). Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide – Guidance Document 4 - Article 19 Financial Security and and Article 20 Financial Mechanism. Available at (21/11/2011): http://ec.europa.eu/clima/policies/lowcarbon/ccs/implementation/docs/gd4_en.pdf

European Union, (2008). Consolidated version of the treaty on the functioning of the European Union. Available at (21/11/2011): http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:115:0047:0199:en:PDF

G. Haver, H.C. Bugge, (2007) Transboundary chains for CCS: allocation of rights and obligations between the state parties within the climate regime, JEEPL 5, p 367-377.

Harmelink, M., van der Welle, A., Lako, P., Groenenberg, H., van der Kuip, M., Nepveu, M., Blank, F., de Wolff, J., Haan Kamminga, A., Roggenkamp, M. (2010). Support to the implementation of the CCS Directive Overview and analysis of issues concerning the implementation of the CCS Directive in the Netherlands. Availble at (18/11/2011): http://www.co2-cato.nl/cato-2/publications/publications/-

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

support-to-the-implementation-of-the-ccs-directive-overview-and-analysis-of-issues-concerning-the-implementation-of-the-ccs-directive-in-the-netherlands

Havercroft, I., Macrory, R., Stewart, R. (2011). Carbon capture and storage, emerging legal and regulatory issues, Hart Publishing, ISBN 978-1-84113-268-6.

Holwerda, M. (2011). Deploying carbon capture and storage safely: the scope for Member States of the Eu to adopt more stringent CO_2 stream purity criteria under EU law, Climate Law 2, 37-61.

IEA, (2007). CO_2 capture ready plants. IEA Greenhouse Gas R&D Programme.Technical study, report No. 2007/4.

IEA, (2009).Technology roadmap – Carbon capture and storage.International Energy Agency, Paris.

IEA, (2011). Carbon Capture and Storage and the London Protocol. Available at (18/11/2011): http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2446

Mckinsey& Company, (2008). Carbon capture and storage: Assessing the economics. Mckinsey& Company, Inc.

Neele,F., Koenen, M., Seebregts, A., Deurzen, J., Kerssemakers, K. and Mastenbroek, M. (2010). Development of a large-scale CO_2 transport infrastructure in Europe: matching captured volumes and storage availability. CO_2Europipe project. Available on (01/12/2010): http://www.zeroemissionsplatform.eu/library/publication/129-towards-a-transport-infrastructure-for-large-scale-ccs-in-europe.html

NERA, (2009). Developing a regulatory framework for CCS transportation infrastructure (Vol, 1of 2). Prepared for the UK Department of Energy and Climate Change (DECC). Report URN 09D/596.

Nord Stream AG, (2009). Nord Stream: Secure gas supply for Europe. Proceedings of Meeting of the Energy Charter Trade and Transit Group – Amsterdam, 14th May 2009.

Oxburgh, L., Gibbins, J., Sweeney, G., White, T.(2010)Working Party Report on the arrangements needed to develop the Infrastructure for CCS in the UK. UCL Faculty of Laws**.**Available at (18/11/2011): http://www.ucl.ac.uk/cclp/pdf/Oxburgh_thinkpiece-1.pdf.

Philips, I. (2010) An industry perspective, presentation at the IEA webconference on financial mechanisms to support long term liability for CCS, available at (23-11-2011): http://www.iea.org/work/workshopdetail.asp?WS_ID=469

Pollack, M. (2010) A US perspective, presentation at the IEA webconference on financial mechanisms to support long term liability for CCS, available at (23-11-2011): http://www.iea.org/work/workshopdetail.asp?WS_ID=469

Roggenkamp, M. (1998) Petroleum pipelines in the North Sea: Questions of Jurisdiction and Practical Solutions, Journal of Energy and Natural Resources Law, vol 16 no. 1, 92-109

Roggenkamp, M.(1999) Het juridisch kader van pijpleidingen in de olie- en gasindustrie, Intersentia, ISBN 90-5095-064-7 (in Dutch).

Roggenkamp, M.M. and Woerdman, E. (2009) Legal Design of Carbon Capture and Storage,Intersentia, ISBN 978-90-5095-801-1.

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing

Raine,A(2008).Transboundary transportation of CO_2 associated with Carbon Capture and Storage, an analysis of issues under international law, Carbon Climate Law Review 4, 353-365.

Reuters, (2010). RLPC – Nord Stream project financing signing – sources. Reuters, published March 12th 2010. Available at (18/11/2011): http://uk.reuters.com/article/2010/03/12/nordstream-loan-idUKLDE62A20X20100312

Upstream Online, (2002).GasLed leads way. Upstream Online, published 20th December 2002. Available at (18/11/2011): http://www.upstreamonline.com/live/article38491.ece (Restricted)

Vinogradov, S.V. (2011). Challenges of Nord Stream: streamlining international legal frameworks and regimes for submarine pipelines, OGEL volume 9, Issue 3.

World Bank (2003) Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) Cross-Border Oil and Gas Pipelines:Problems and Prospects.

Zakkour, P (2011), Financial Assurance for long term stewardship, presentation at the 3rd IEA International CCS Regulatory Network Meeting, March, 1,2, 2011), available at (23-11-2011): http://www.iea.org/work/workshopdetail.asp?WS_ID=507

This document contains proprietary information of CATO 2 Program. All rights reserved

Copying of (parts) of this document is prohibited without prior permission in writing