FIELD
3 Endsleigh Street
London
WC1H 0DD
United Kingdom
www.field.org.uk

T +44 (0)20 7388 2117
F +44 (0)20 7388 2826
E field@field.org.uk

Ecofys BV
P.O. Box 8408
NL-3503 RK Utrecht
Kanaalweg 16-G
NL-3526 KL Utrecht
The Netherlands
www.ecofys.com

+31 (0)30 280 83 00
+31 (0)30 280 83 01
info@ecofys.com

IMPACTS OF EU AND INTERNATIONAL LAW ON THE IMPLEMENTATION OF CARBON CAPTURE AND GEOLOGICAL STORAGE IN THE EUROPEAN UNION

Chris Hendriks (Ecofys)
M.J. Mace (FIELD)
Rogier Coenraads (Ecofys)

JUNE 2005
ECS04057

by order of the European Commission, Directorate General Environment

Foreword

Ecofys and **FIELD** jointly carried out the study 'The Impacts of EU and International Law on the Implementation of Carbon Capture and Geological Storage in the European Union'.

The objectives of this study were twofold. Firstly, to prepare a proper and adequate characterisation of the environmental and safety risks associated with carbon dioxide capture and storage activities. Secondly, to analyse relevant EU and international law and provide a set of recommendations for the further development of legislation to adequately address these associated environmental and safety risks.

The attached study provides a comprehensive overview of the EU and international law frameworks that are particularly relevant to carbon dioxide capture and storage activities. It identifies barriers to the implementation of carbon dioxide capture and storage activities that arise from existing legal frameworks, and highlights significant legal issues that need to be addressed if carbon dioxide capture and storage is to proceed on a large scale.

The study is restricted to *geological* storage, and thus does not address the ocean disposal of carbon dioxide or possible uses of captured carbon dioxide.

SUMMARY

This report addresses the main risks related to carbon dioxide capture and geological storage activities (CCS), and legislative and regulatory issues related to these risks.

Environmental and safety risks related to CCS can be divided into two categories: risks on a local level and risks on the global level. Local risks are related to possible impacts of CO_2 release on people, living organisms and the local environment. Global risks include the impact of possible CO_2 releases on the global climate and on biodiversity. A useful tool to address these risks is the Environmental Risk Assessment, which is developed to deal with uncertainty by allowing decisions to be made on the basis of assessed risks.

Risks associated with carbon dioxide handling at the capture site and with onsite storage are well-established in the processing industry; various standards exist to assure safe and environmental sound operation. Until now, few studies have been conducted to assess the risks of carbon dioxide capture from engineered systems. One such study has, however, concluded that multiple fatality risks are very unlikely.

The main risk involved with transport of carbon dioxide is leakage and accidental release. CO_2 that leaks from a pipeline is a potential asphyxiant for humans and animals.

Risks associated with geological storage can be divided between short-term risks during injection of the CO_2 and the long-term risks of CO_2 release during the period of storage. During injection, corrosion of casing and tubing or blocking of wellbore poses the largest risks, but may be counteracted by taking proper measures. CO_2 stored underground is most likely to escape through abandoned wells or wellbore failure; diffusion through the caprock, e.g. along faults; and by dissolution and transport of CO_2 charged waters. Legislative procedures and requirements may need to be put in place to adequately address these two categories of risks.

CCS activities should be undertaken in a manner consistent with relevant legal frameworks. EU and international legal frameworks are particularly important where transboundary impacts can be anticipated. States have the sovereign right to exploit their own resources. At the same time, they also have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or damage to areas beyond the limits of their national

jurisdiction. In the context of CCS, these international law principles are implicated in two ways. First, emissions of CO_2 from fossil energy use will have impacts beyond areas of national jurisdiction. Second, CCS activities may themselves lead to damage to the environment.

The report reviews 56 international conventions, regional conventions, and EU Directives for their potential impact on CCS activities. Appendix 2 to this paper provides an overview of each of these individual frameworks and their applicability to CCS activities, highlighting significant definitions and hazard classifications (e.g. 'waste', 'pollution', 'dumping'), as well as issues of geographic scope, jurisdiction and liability. These international conventions and EU Directives are reviewed in thematic groups (e.g., waste management; marine pollution; climate change; transport and liability; access to information, public participation and access to justice; water; liability for transboundary impacts; nature conservation).

The main conclusions of this review are as follows:

1. Many international, regional and EU legal frameworks are relevant to CCS activities and many definitions and prohibitions within these frameworks are sufficiently broad to encompass and regulate various CO_2 capture and geological storage activities.
2. However, only a few of the frameworks reviewed (notably the UNFCCC, Kyoto Protocol and the EU's Monitoring and Reporting Guidelines) explicitly address CCS activities and either include them or exclude them from their scope. Clear inclusion in, or exclusion from, legal frameworks will increase transparency, provide regulatory certainty, and facilitate CCS activities and methodologies that are agreed to be consistent with international, regional and EU frameworks.
3. International legal frameworks are particularly relevant in the context of potential transboundary impacts, and transboundary transport and offshore storage activities.
4. The creation of a clear regulatory framework for CCS will allow for the realistic pricing of the costs and benefits of the technology's use. Regulatory certainty will facilitate use of CCS in cost-effective situations. However, in view of the polluter pays principle and the precautionary principle, the calculation of the cost of CCS should encompass related externalities.
5. Legal barriers and inconsistencies are present in existing legal frameworks that either preclude certain CCS activities or cast doubt on their legality. See Chapter 3.5 and Table 11.
6. The lack of information on the long-term impacts of CO_2 storage on the environment, the absence of information on the storage effectiveness of particular sites, and the absence of information on the potential human and environmental impacts of accidental releases from pipelines and indi-

vidual storage sites. The precautionary principle requires that conservative measures be taken where scientific knowledge is not complete.

7. Substantial information is needed to issue permits with appropriate permit conditions. Substantial information is also needed to determine that there is not 'a likelihood of significant environmental impacts' from CCS activities undertaken in particular locations.
8. The lack of existing criteria for monitoring and reporting captured and stored CO_2 presents a barrier to large-scale CCS activities. Monitoring systems are needed for three major purposes: (1) to protect health and safety by confirming the integrity of geological reservoirs; (2) to enhance public confidence; and (3) to provide data in support of accounting for GHG emissions, to verify credits for CO_2 emission reductions.
9. A significant barrier to CO_2 capture and storage is the important political and practical issue of whether the avoidance of emissions to the atmosphere through long-term geological storage should be treated as equivalent to emissions reduction at the source. This issue has not yet been resolved. A sound policy justification would have to be made for such treatment.
10. The absence of an appropriate liability regime for CCS presents a barrier to its large-scale implementation. While the EU Environmental Liability Directive addresses certain aspects of liability, others are not.
11. A system will need to be created to address ownership and responsibility issues for CO_2 stored within geological storage sites, and for the purposes of public access to information on storage sites and risk. The system may also involve the tracking of ownership issues related to the CO_2 stored within these sites.
12. The development of a framework to address CCS issues could take two basic forms. It could be a new stand-alone framework that addresses the unique aspects of CCS. Such a framework could be created either outside or within an existing legal framework (for example, through a new treaty, or an Annex or Protocol to an existing treaty). Alternatively, CCS issues could be integrated into existing regulatory frameworks though amendment of these frameworks, or through agreed interpretations, decisions or guidance documents. A stand-alone framework may be easier to draft, amend and update as new information becomes available or as policy changes. It may also be more transparent.

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1. Introduction

Global warming is considered by many politicians and scientists to be one of the most serious environmental problems of our time. Emissions of greenhouse gases have been rapidly increasing since the start of industrialisation in the second half of the 19th century. The main contributor to the increase of carbon dioxide concentration in the atmosphere is combustion of fossil fuels (coal, oil, natural gas) for power generation, transport, industry, and private households.

Stabilization of the concentration of carbon dioxide in the atmosphere will be essential in combating the risk of climate change. One option identified for reducing the emission of carbon dioxide to the atmosphere is carbon dioxide capture and storage. As with other carbon dioxide emission reduction options – such as renewable energy and energy efficiency – certain barriers will have to be removed if this technology is to be employed on a large scale and contribute significantly to climate objectives. Main barriers are

- *Costs of the technology and financing schemes*. New capture and injection technologies need to be developed or existing technologies need to be improved to reduce costs and improve reliability of the technology. Generally CCS will add to the costs of an industrial activity. It will therefore be important to create proper financial incentives to stimulate research, demonstration and implementation of the technology. One such financial incentive may be the potential inclusion of CCS in the European Union's emission trading system.
- *Public attitude*. The implementation of CCS will directly and indirectly affect the public, for example, by increasing the cost of energy to the consumer or by increasing safety and environmental risks due to the pipeline transport or underground leakage of carbon dioxide. Support from the public will therefore be essential for the implementation of the technology.
- *Legal and regulatory issues*. Carbon dioxide capture and storage is a relatively new technology. The legal and regulatory implications of the implementation of this technology, especially in the areas of transport and geological storage, are not yet broadly understood.

This report will address legislative and regulatory issues. Because a primary goal of environmental legislation is to minimise environmental risks, the first part of this report describes and evaluates the main risks associated with CCS. The second part of this report addresses the possible implications of existing international conventions and EU legislation on the implementation of CCS in light of these risks. This section draws upon the contents of Appendix 2 to this report, which contains an extensive review and analysis of over 50 international conventions and EU Directives that are relevant to CCS. Based on

this review and analysis, the report identifies the main legislative barriers to CCS and provides some initial recommendations to overcome these barriers.

1.1. Position of CCS in reducing emissions of carbon dioxide

Methods to reduce carbon dioxide emissions can be classified as follows: (i) prevention of the formation of carbon dioxide; and (ii) prevention of the emission of carbon dioxide to the atmosphere (carbon dioxide capture and storage). A wide range of technical options exists for the first category, e.g. a shift towards a consumption pattern requiring less energy, accelerated development of energy-efficient technologies, a shift to energy sources which have no or lower carbon dioxide emissions (e.g. renewables or shift from coal to natural gas) and reducing deforestation.

These options differ in terms of reduction potential, state of technology, implementation rate of the technology, and costs. Especially, the widespread introduction of renewable energy sources in competition with conventional energy sources may be time consuming.

In the transition period towards an energy supply and demand system with an acceptable level of carbon dioxide emissions, implementation of additional measures might be required. An intermediate and supplementary reduction option to bridge the gap between a fossil fuel-based energy system and a renewable energy system is carbon dioxide capture and storage. Developments in the application of carbon dioxide capture and storage should be integrated into a strategy geared to sustainable development of the energy supply. To a certain extent the development of this option creates also the possibility for continuing the use of fossil fuels without high carbon dioxide emissions.

In recent years, increasing attention has been given to strategies for extracting energy from fossil fuels, in particular by large industrial users such as power plants, with substantial less emissions of CO_2 into the atmosphere. A number of options for CO_2 capture and storage are under discussion, including storage underground, storage in minerals and deep ocean disposal. Another form is sequestration of carbon though enhanced formation of forests.

Whether CO_2 capture and storage might play an important role in achieving Kyoto Protocol targets in the Protocol's first commitment period or in subsequent commitment periods depends upon many questions – many of which have not yet been solved. To be viable as a transition technology, CCS should meet the following criteria:

- Contribute substantially to CO_2 emission reduction
- Be economically feasible
- Be efficient, both in the use of material and energy
- Be acceptable to society/the public
- Fit into the total energy supply picture
- Be environmentally sound in its application and be safely applied

1.2. Carbon dioxide capture and storage[1]

In this report we will use the term carbon dioxide capture and storage and its abbreviation CCS. To avoid confusing what is meant by this term, we define and describe the term in this section.

Carbon dioxide capture and storage can be defined as any process or combination of processes in which carbon is recovered from an energy conversion process and subsequently utilised, stored or disposed of outside the atmosphere in such way that it reduces the net emission of carbon dioxide to the atmosphere.

The carbon dioxide capture and storage process can be split into four separate steps. The first step is the *capture* process: separation of the carbon dioxide from fuels or from flue gases. The second step is *compression* of the captured carbon dioxide. The third step the *transport* of the carbon dioxide to a location where it is handled further. The fourth step is the *utilisation*, *storage* or *disposal* of carbon dioxide.

The capture step is the actual separation of the carbon dioxide (or carbon) from an energy conversion process. Because of scale considerations, capture from processes that generate large amounts of carbon dioxide is most cost-effective. Such large sources are, for instance, power plants and heavy industry. In principle the carbon dioxide can be separated at two stages: before combustion (also called pre-combustion or decarbonisation of fuels); and after combustion (post-combustion) from flue gases. In a few industrial processes, a rich carbon dioxide stream is already released, without the necessity of further (significant) processing.

Because of the large quantities involved, captured carbon dioxide can be transported most economically in liquid form through pipelines. For transport over sea, in some case it might be attractive to use tankers. In almost all cases, compression and liquefaction is required.

Carbon dioxide can be used for enhanced oil recovery and for greenhouse horticulture. It can also be fixated in minerals or stored underground, e.g. in aquifers, empty natural gas fields or oil fields. Alternatively, carbon dioxide can be disposed of in the ocean.

[1] Sometimes the wording carbon dioxide *sequestration* is preferred for essentially the same type of activity. The IPCC in the preparation of its Special Report on Carbon Dioxide Capture and Storage has decided to use the wording *Carbon Dioxide Capture and Storage* (abbreviated as CCS), to describe the total chain from capturing, compression, transporting and storage/use/disposal of the carbon dioxide. The term CCS does not include sinks of carbon, such as the sequestration of carbon in trees or soils.

For a more extensive introduction to carbon dioxide capture and storage we refer to Hendriks et al. [2003], which gives a comprehensive description of CCS. At the end of 2005 the IPCC Special Report on Carbon Dioxide Capture and Storage will be published.

2. Risk Assessment

2.1. Introduction to risk assessment

Risk assessment is the procedure in which the risks posed by inherent hazards[2] involved in processes or situations are estimated either quantitatively or qualitatively. *Environmental* risk assessment is the examination of risks resulting from technology that threatens ecosystems, animals and people.

Risk assessment methodologies have traditionally been based on the examination of effects to human health, but in the scope of carbon dioxide capture and storage more emphasis is now being placed on environmental damage. Risk assessment is a scientific process that consists of the following steps:

1. Hazard identification
2. Hazard characterization
3. Exposure assessment
4. Risk characterization

Risk assessment is one of the elements of risk analysis. Risk analysis can be understood as a process that consists of risk assessment, risk management and risk communication.

- Risk management is the process of weighing policy alternatives in light of the results of risk assessment and, if required, of selecting and implementing appropriate control options, including regulatory measures.
- Risk communication is becoming increasingly important and concerns the way in which information relating to risks is communicated and is closely linked to risk perception.

The risk analysis may include an evaluation of what the risks mean in practice to those affected. This will depend heavily on how the risk is perceived. Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable".
During the life cycle of a chemical for instance, risks can arise during manufacture, distribution, use, or the disposal process. Risk assessment of the chemical involves the iden-

[2] Hazard is commonly defined as 'the potential to cause harm'. Carbon dioxide can be classified as a hazard, as it may cause asphyxiation at certain concentration in the air. The term risk is commonly used as 'the combination of the probability of occurrence of a defined hazard and the magnitude of the consequences of the occurrence". From this we can see that the hazard of carbon dioxide is in the nature of the substance, while the term risk can only be used in the context of an activity. It is therefore not possible to speak about risk of carbon dioxide but only about risk of storage of carbon dioxide in underground reservoirs.

tification of the inherent hazards at every stage and an estimation of the risks posed by these hazards. Risk is estimated by incorporating a measure of the likelihood of the hazard actually causing harm and a measure of the severity of harm in terms of the consequences to people or the environment.

In the use of risk assessment complex methodologies have been developed to attempt to deal with uncertainty. These are used so that uncertain data can still be used in assessment and decisions can be based on those assessments.

The use of risk assessment and management at regional or international levels can cause difficulties due to varying social, economic and environmental conditions in different nations.

2.2. Classification of carbon dioxide and types of risk

2.2.1. Classification of carbon dioxide

The classification of carbon dioxide depends on the physical state (gas, liquid or solid), concentration of carbon dioxide, impurities present, and existing and future national legislative classification in the regions of the world. During the capture and concentration process, the quality properties can change the classification of the substance.

The classification system of Transport Dangerous Goods, International Maritime Organization / International Maritime Dangerous Goods and International Civil Aviation Organization / International Air Transport Association, all classify carbon dioxide in class 2.2 which are non-flammable, non-corrosive and non-poisonous gases. In US federal regulations, carbon dioxide is not listed as a product in the Clean water act (CWA 307 and 311), Clean air act (CAA 112) or the Toxics Release Inventory. In Canada, carbon dioxide is classified as a compressed gas (class A) and is included in the Canadian Energy Pipeline Association Dangerous Substances List (HSDB, 2002). It is also listed in the US Environmental Pollution Control Agency Toxic Substances Control Act Inventory, 1980 [Sax (1984)]. In other international regulations though, carbon dioxide does not receive any special designation, such as in the European Inventory of Existing Commercial Chemical Substances.

2.2.2. Classification of types of risk

Risks related to releases of CO_2 during the process of capture, transport and storage can be divided into two categories:

- Risks on local level
- Risks on global level

Local risks are related to possible impacts of CO_2 release on people, animals and the local environment. Usually local risks are the topic of analysis when performing risk assessments in the scope of HSE (Health, Safety and Environment). Global risks comprise

the impact of possible CO_2 release on global climate. In this way, global risks of CO_2 capture and storage are an indication of the effectiveness of this technology to reduce global CO_2 emissions.

In this assessment both local and global risks of CO_2 releases are taken into account. Local risks are primarily related to capture, transport and the injection in reservoirs of CO_2, whereas the focus is mainly on global risks as far as storage of CO_2 is concerned.

Local consequences of CO_2 release

Local risks are related to the impact of CO_2 release on, among others, people, fauna, flora, soil and water systems at a local level. An assessment of local risks is often referred to as exposure assessment.

Table 1 gives an overview of the impact concentrations of CO_2 and its consequences for various environments, as reported by Saripalli [Saripalli (2002)].

Table 1. Consequences of specific CO_2 concentrations in different media [Saripalli (2002)]

((X) IS CONCENTRATIONS OF CO_2 ; [X] IS MAGNITUDE OF CONSEQUENCE)

	Consequences		
Media*	**Severe [1]**	**Moderate [0.5]**	**Low [0.1]**
Air (280 ppm)	lethal, habitat loss (>10%)	Injuries (> 5%)	Discomfort (> 1%)
Bldgs (280 ppm)	Injury, evacuation (> 5%)	Irritation, discomfort (> 2%)	Noticeable, no harm (> 1%)
Groundwater (10^{-4} M or 0.2%)	Acidity, well corrosion, irrigation loss (> 6%)	Mild acidity and corrosion (> 2%)	Elevated, low acidity without significant impacts (> 0.2%)
Surface water (10^{-5} M; 0.022%)	Acidity, CO_2 explosion, fish kills (> 2%)	Higher acidity, mild toxicity Effect on irrigation (> 1%)	Elevated, low acidity with no significant impacts (> 0.022%)
Soils (1-2%)	Low pH, tree kills, animal deaths (> 8%)	Moderate acidity, tree/ crop/soil cover loss (> 3%)	Mild suppression in pH with no significant impacts (> 2%)
Biota (10^{-5} M)	O_2 depletion, lethal (>4%)	Injure life functions (> 2%)	Mild toxicity (> 0.5%)

*Normal concentration shown for each medium within ( ).

To human beings, high concentrations of CO_2 can cause headache, respirational problems and asphyxiation. Several people are reported to have died from CO_2 asphyxiation around volcanoic regions in the USA emitting CO_2. The most devastated incident related to CO_2 asphyxiation dates back from 1986, when 1700 people died due to sudden CO_2 release from Lake Nyos in Cameroon.

Locally, a sudden release of CO_2 combined with insufficient dispersion can lead to oxygen deficiency with severe consequences for human beings. Table 2 shows possible effects of CO_2 concentrations for specific times of exposure on people's health. For comparison with the concentrations stated, one should bear in mind that normal concentrations of CO_2 in the air are around 280 ppm.

Table 2. Acute health effects of high concentrations of carbon dioxide [DNV (2003)]

CO_2 concentrations		Time	Effects
Percentage	**ppm**		
17-30	170,000 - 300,000	Within 1 minute	Loss of control, unconsciousness, convulsions, coma, death
> 10-15	100,000 - 150,000	1 minute to several minutes	Dizziness, drowsiness, severe muscle twitching, unconsciousness
7-10	70,000 - 100,000	Few minutes 1.5 minutes to 1 hour	Unconsciousness, near unconsciousness Headache, increased heart rate, shortness of breath, dizziness, sweating, rapid breathing
6	60,000	1 - 2 minutes < 16 minutes Several hours	Hearing and visual disturbances Headache, difficult breathing Tremors
4 –5	40,000 - 50,000	Within a few minutes	Headache, dizziness, increased blood pressure, uncomfortable and difficult breathing
3	30,000	1 hour	Mild headache, sweating, difficult breathing at rest
2	20,000	Several hours	Headache, difficult breathing upon mild exertion

Global consequences of CO_2 release

Global consequences of CO_2 release are related to the effect these releases have on the increase of global atmospheric concentrations of CO_2. Higher concentrations of CO_2 may lead to an increase of global warming and indirectly to increased acidification of the oceans by increased uptake of the carbon dioxide by ocean water. However, assessing the possible effects of global warming or acidification on people and the environment does not form part of the scope of this study.

An important question is how much leakage may be tolerated in order not to consume a considerable amount of the emission budget in, e.g., 2100, by leakage from underground reservoirs.

Assuming that CCS is implemented gradually and linearly from 2010 onwards and that in 2100 25 $GtCO_2$ is yearly captured and stored underground, the cumulative amount of CO_2 stored in geological formations in 2100 amounts to 1140 $GtCO_2$. Assuming a fixed leakage rate of carbon dioxide from underground storage of 0.1% per year, the total amount of CO_2 stored is reduced by approximately 1 $GtCO_2$, as this amount has been escaped during this period from the reservoirs. If we assume furthermore that the acceptable annual CO_2 emission rate is 5 $GtCO_2$ (i.e. 80% emission reduction of CO_2 emission worldwide in 2100 compared to current levels), the leakage in 2100 accounts for about 25% of the total emission budget in 2100. Figure 1 presents the share in the emission budget for leakage rates varying from 0.5% to 0.01% per year. From this graph it can be seen that for an emission level of 20% compared to current levels, the emission budget

consumed by leakage is less than 20% for annual leakage rates smaller than 0.1%. Based on current knowledge, experts believe that an annual leakage rate of 0.1% is already very high.

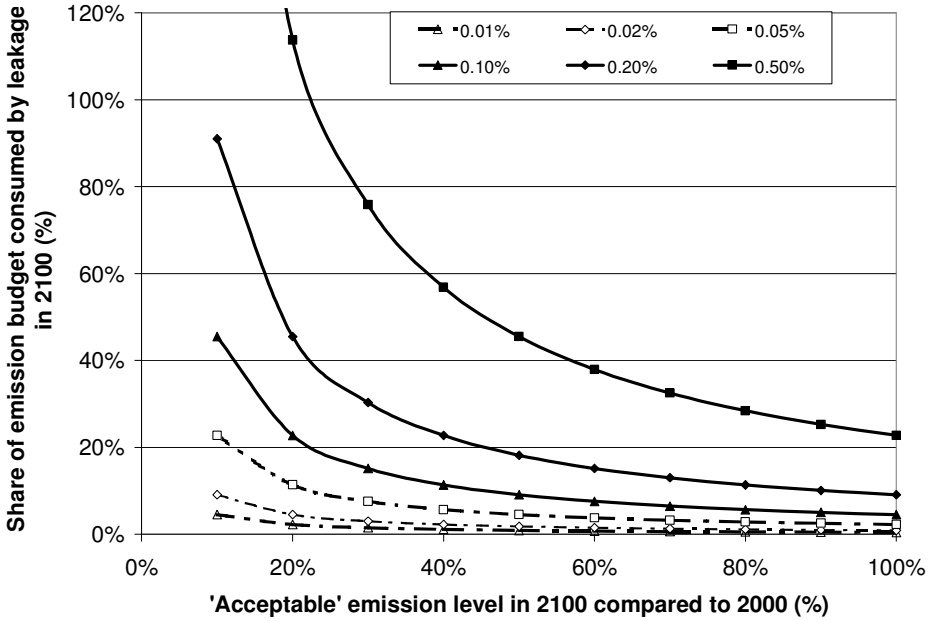

Figure 1. Share of emission from leakage from underground storage in the emission budget in 2100 for various fixed leakage rates.

2.3. Risk assessment for carbon dioxide capture and storage

2.3.1. Risk assessment and capture facilities

The risk assessments of plants equipped with facilities to capture and compress carbon dioxide show many similarities with current practice in the chemical industry. The risk aspects associated with carbon dioxide handling and onsite storage are well established in the processing industry, although much larger volumes are targeted for carbon dioxide processing for purpose to capture and storage than the present experience with carbon dioxide.

Plant facilities, like those envisioned for carbon dioxide capture, are subject to design guidelines for the petrochemical industry as determined by relevant authorities, and carbon dioxide capture and compression processes are listed in several guidelines as gas processing facilities. One example is the European Unions' Integrated Pollution Prevention and Control (IPPC) directive requiring the application of best available techniques. National and regional legislation for plant design and specifications from organizations like the US Environmental Protection Agency are available to guide the development of technology.

The management of carbon dioxide inside factory battery limits will be in accordance with the relevant practices applied in individual countries. Well established and externally audited management systems such as International Standards Organization's (ISO) 14001 (environment) and ISO 9001 (quality), and Occupational Health and Safety (OHSAS 1800) exist to provide assurance that environment, safety, health and quality management systems are in place. Tools like life cycle assessment (ISO 14040 series) with the necessary boundary expansion methodology are useful to determine the overall issues associated with a facility and assist with selection of parameters such as energy carriers, operational conditions and material used in the process. The life cycle assessment will also indicate if a trouble free capture system does generate environmental concerns elsewhere in the product life cycle.

It is not anticipated that carbon dioxide capture will result in a legacy of polluted sites requiring remediation after plant closure, assuming that standard operating procedures and management practices are followed.

2.3.2. Risk assessment and pipeline transport

Carbon dioxide is transported by various means: by tanker, by pipeline, by tank lorry, in gas cylinders and as dry ice (solid carbon dioxide). However, transport of large amounts of captured carbon dioxide is usually most conveniently done by pipelines. In cases of large distances over sea, sometimes tanker transport might be more attractive.

At present, large amounts of CO_2 are supplied by pipelines for enhanced oil recovery projects. Approximately 3000 km of pipeline is in operation, mainly in the United States of

America. To put this number in perspective, in the USA in 2000 there were some 514,000 km of natural gas and some 248,000 km of hazardous liquid pipelines in operation.

The main risks involved with transportation of carbon dioxide are leakages. Carbon dioxide might leak gradually from pipelines or escape in a short time by large amounts, e.g. because of a pipeline rupture. CO_2 leaking from a pipeline is a potential asphyxiant for humans and animals. The consequences of CO_2 incidents can be modelled and assessed on a site specific basis using standard industry methods, taking into account local topography, meteorological conditions, population density and other local conditions. A property of CO_2 that needs to be considered when selecting a pipeline route is the fact that CO_2 is denser than air. It can therefore accumulate to potentially dangerous concentrations in low-lying areas.

If substantial quantities of impurities, particularly H_2S, are included in the CO_2 transported, this could affect the potential impacts of a pipeline leak or rupture. The exposure threshold at which H_2S is immediately dangerous to life or health according to the National Institute for Occupational Safety and Health (NIOSH) is 100 ppm, compared to 40,000 ppm for CO_2.

If CO_2 is transported over significant distances in densely populated regions, the number of people potentially exposed to risks of CO_2 transportation facilities may be greater than the number exposed to potential risks of CO_2 capture and storage facilities. Hence public concerns about CO_2 transportation may be a significant barrier to large-scale use of CO_2 capture and storage. At present most electricity generation and other fuel conversion plants are built close to energy consumers or sources of fuel supply. New plants with CO_2 capture could be built close to CO_2 storage sites, to minimise CO_2 transportation. However, this may necessitate greater transportation of fuels or electricity, which have their own environmental impacts, potential risks and public concerns.

The incidence rate of pipeline failure is relatively small. Studies show that the incidence of failure has markedly decreased, and most of the incidents refer to very small pipelines, principally in gas distribution systems. There is substantial variation in incidence occurrence between pipelines, reflecting factors such as system age and inspection frequency. Statistics on pipeline incidents indicate that CO_2 pipelines are no less prone to incidents than natural gas pipelines. At this stage, however, solid conclusions are difficult to draw due to the relative small amount of CO_2 pipelines presently in operation [Gale (2002)].

A study in Europe, based on natural pipeline failure data from 1970-1987 showed that out of 664 notable incidents, 50% were due to external interferences (accidental breach of the pipe by an external agency), 18% due to construction defects (e.g. failures in welds), 16% due to corrosion, and 16% due to other activities. In the USA, reported data showed similar results; failures were due to outside force (35%), corrosion (32%), other (17%), weld and pipe failures (13%) and operator error (3%) [EGPIG (1995)].

The design implications of transporting CO_2 appear to be well understood. This comprises the need for dehydration to prevent corrosion, avoidance of some petroleum-based lubricants because they are sensitive to CO_2, and the need to design to minimise the potential for flow transients. Pipeline control methodology may use an automatic control system to monitor the volumetric flow rates and pressure fluctuations in the pipeline, coupled with block valves set at distances along the pipeline that can be shut off in the event of a pipeline failure. A European study showed that the safety distances of 150 m was required for pipelines with valves at 5 km intervals. These distances increased to 600 m for valve intervals distance of 30 km [Kruse (1996)].

Another possible method of large-scale transportation of carbon dioxide is by ship. Ship systems may fail in various ways, including by collision, foundering, stranding and fire. An accident to a liquid carbon dioxide tanker might release liquid carbon dioxide onto the surface of the sea. Liquid carbon dioxide would behave differently from LNG, because carbon dioxide is less cold than LNG and much denser. Its interaction with the sea would be complex; hydrates and ice might form, and temperature differences would induce strong currents. Some of the gas would dissolve in the sea, but some would be released to the atmosphere. If there were little wind and a temperature inversion, clouds of CO_2 gas might lead to asphyxiation and might stop the ship's engines. These risks can be minimised by careful planning of routes, and by high standards of training and management.

Regulation of CO_2 pipelines

Transportation of CO_2 by ships, by subsea pipelines and transportation across national boundaries is governed by various international legal conventions. The design and operation of pipelines for transportation of CO_2 is also governed by national codes and standards.

In the USA, issues relating to the safe and environmentally acceptable operation of CO_2 pipelines are covered under the 2001 Code of Federal Regulations, Parts 190-199. A point to note is that in terms of their classification under Federal Regulations in the USA, CO_2 pipelines are classified as *high volatile/low hazard and low risk*. In particular Part 195: Transport of Hazardous Liquids by Pipeline, specifically covers issues relating to CO_2 pipelines. The federal pipeline safety regulations are framed to ensure safety in design, construction, inspection, testing, operation and maintenance of pipelines. In addition, it sets out procedures for administering pipeline safety programmes and incident response plans. Similar regulations are in place in Canada, therefore a considerable body of expertise exists on the regulation of CO_2 pipelines.

2.3.3. Risk assessment of generic engineered systems

To date few studies have been executed to risks of carbon dioxide capture from engineered systems. A relatively extended study has been performed by DNV [2003] to (quantify) risks associated with capture and storage of carbon dioxide. In this study, the

risk assessment for a (generic) engineered carbon dioxide capture and storage system was made taking four steps, which are summed up below and shortly described thereafter.

- identification of hazard and frequency analysis
- consequence assessment of the engineered system
- analysis to risks for humans and environmental impact
- risk of fatality of the engineered system

Identification of hazard and frequency analysis
The first stage is to identify the potential accidents that could result in the release of a hazardous material, in this case significant quantities of carbon dioxide, from its normal containment. Process failure data are well established and available to define representative accident scenarios for generic engineered system components like pipelines, flanges, valves, vessels, pumps and compressors. The range of possible releases covers a broad spectrum from a pinhole leak up to a catastrophic pipe or vessel rupture. Next to the occurrence itself also the frequency of (classes) of occurrence is relevant. DNV used in their study their library of failure data based primarily on hydrocarbon failure data.

Consequence assessment of the engineered system
A possible release of carbon dioxide results in dispersion of the substance. The potential release is classified in representative leak sizes, and the release rate is used to determine a representative probability of detection and isolation (by either 'automatic' or 'manual' means). These different event outcomes determine the duration of the release. Combined with the release rate, which result in an inventory of carbon dioxide releases. This information in combination with dispersion models, which take into account variations in weather and surface conditions, determines the subsequent cloud formation and dispersion of the carbon dioxide.

Analysis to risks for humans and environmental impact
The risks of impacts to people and environment are determined by the combination of the identified release events and their failure rates with consequences.

Risk of fatality of the engineered system
As shown in section 2.2.2, the concentrations of carbon dioxide that may result in fatality are assumed to be in the range 7% (70,000 ppm) to 10% (100,000 ppm) or higher. The risk of fatality increases with the exposure time to the carbon dioxide. The widely used maximum tolerable risk for public is 10^{-4} per year and the broadly acceptable risk 10^{-6} per year. Between these two levels, the risk must be reduced to a level which is as low as reasonable practicable (ALARP principle), taking account of the costs and benefits of any further risk reduction.

Conclusion
The conclusion by DNV was that multiple fatality risks from the engineered system are very unlikely, while the risk of fatalities to an individual has the potential to exceed typical risk criteria for industrial facilities. In addition, the generic risk assessment included a

relatively high degree of conservatism and that there is significant scope for the individual risks associated with actual applications to fall within acceptable limits.

Possible risks during CO_2 capture, compression and transport have been gathered in Table 3 and Table 4.

Table 3. Risks and remediation during capture and compression[3]

	Occurrence	Remediation
1	Any installation failure	Careful design; design guidelines
2	Sudden break-out of carbon dioxide	Dispersion facilities (fans)
3	Gradual release of carbon dioxide	Monitoring

Table 4. Risks and remediation during transport

	Occurrence	Remediation
1	Any pipeline failure	Careful design; design guidelines
2	Pipeline failure by outside force	Improved maps, databases, communication
3	Sudden break-out of carbon dioxide	Automatic control system coupled with block valves that can shut off in the event of pipeline failure; increase valve density in more populated areas
4	Gradual release of carbon dioxide	Addition of artificial odour (e.g. mercaptans); visual monitoring
5	Accumulation of carbon dioxide (leakage)	Careful selection of route (e.g. siting them along windswept area)

2.3.4. Risk assessment of geological storage

This section investigates the risks on CO_2 releases associated with geological storage of CO_2. Distinction has been made between the short-term risks of CO_2 release during injection of CO_2 into the reservoir, and the long-term risks of CO_2 release during the period of storage.

Injection phase

The process of geological storage of CO_2 can be distinguished into two phases, i.e. the injection phase and post-injection phase. Identifying the injection of CO_2 as an industrial process with a relatively limited period of duration (e.g. 50 years), allows for making estimations of involved risks based on other industrial processes. In this way, the frequency of significant leaks during the CO_2 injection period was estimated as 10^{-3} per reservoir per year, based on experiences from off-shore oil and gas production sites. A significant

[3] Risks have been put in order of decreasing risk, according to assessment of the authors

leak was defined as greater than 10 tonnes/day, while a storage capacity of 40 Mt was assumed [DNV (2003)]. Sudden releases of CO_2 like blow-outs or a leakage due to mechanical failure of the injection equipment, can mean potential risks for humans and nearby environment. In order to characterize the direct local risks for people and the environment during the injection phase, experiences available from oil and gas industry can provide guidance. An overview risk during injection has been gathered in Table 5.

Corrosion of injection equipment is one of the reasons for leakage of CO_2 during injection. Dissolution of CO_2 into water gives carbonic acid, which has the ability to corrode most carbon steels, thus forming a potential danger for the integrity of the casing and tubing of the well. In order to prevent corrosion of the tubing, it can be lined with polyethylene. Until date linings have not been used yet [DNV (2003)]. Using a polyethylene lining would reduce corrosion to less than 2.5 µm/year [DTI (2003)]. The annulus between casing and tubing can be filled with inhibitor fluid for corrosion prevention. After shutting a well, filling it with inhibitor fluid also acts as corrosion prevention.
A reduced moisture content of the CO_2 will lead to less formation of carbonic acid, thus decreasing the risk of inner corrosion of the injection equipment. Also lower concentrations of H_2S, NO_x and SO_x in CO_2, will decrease risks of corrosion.

Table 5. Risks and remediation during injection period

	Occurrence	**Remediation**
1	Outer corrosion of casing and tubing (by CO_2 dissolved in water)	Tube lining with polyethylene; annulus between casing and tubing filled with inhibitor fluid; during shut-off filled with inhibitor
2	Inner corrosion of tubing (by moisture in CO_2)	Reduction of moisture content in CO_2 Reduction of H2S, NOx and SOx in CO_2
3	Blocking of wellbore	Constant CO_2 phase (control of temperature, pressure, moisture content) to ensure that CO_2 stays in super-critical phase to minimise hydrate and ice formation [DNV(2003)]

Formation of hydrates and ice may cause stresses and may block valves of the injection equipment [DNV (2003)].

Post-injection phase
Main difficulties for a quantitative assessment of generic risks of CO_2 releases from geological storage sites are the lack of detailed long-term monitoring of field trials or modelling at date, and the fact that the conditions, which determine the risks of CO_2 releases, are extremely site specific.

CO_2 stored in oil and gas fields is most likely to escape via [Gallo (2004)]:

1. abandoned wells / wellbore failure
2. diffusion flow through the caprock (along faults / by buoyancy through permeable zones (capillary failure))

3. dissolution and transport of CO_2 charged waters in the aquifer by groundwater flow

Except for the risk of CO_2 release via abandoned wells, the same leakage paths are valid for storage of CO_2 in deep unminable coalbeds and aquifers. For the latter type of storage reservoir, transport of dissolved CO_2 by underground waterflow will usually be the most important mechanism.

The leakage paths are described in more detail as follows. An overview of possible occurrences is given in Table 6.

Table 6. Risks and remediation of leakage of CO_2 from geological reservoirs

	Occurrence	**Remediation**
1	Leakage via unknown wells	Detailed knowledge of reservoir (location of wellbores)
2	Degradation of sealing of well	Periodic inspection of sealings Improved quality of cement sealing
3	Fault in caprock	Detailed knowledge of reservoir (location of faults)
4	Buoyancy	Detailed knowledge of reservoir (low permeability of caprock)
5	Chemical interaction	Mechanism of chemical interaction not fully understood until date. Difficult to indicate appropriate remediation measures
6	Human activities (e.g. drilling)	Assure that no potentially harmful activities take place at the site of the storage reservoir
7	Transport of dissolved CO_2	Detailed knowledge of reservoir (location of underground water flows)
8	Activated seismic activities	Prevent overpressure in reservoir by continuous monitoring of injection pressure
9	Natural seismic activities	Avoid seismic active regions

1. Wellbore

The single most important risk of leakage when storing CO_2 in older depleted oil and gas fields is the presence of former wells with poor sealing. The possibility that the exact location of former wells cannot be traced anymore, cannot always be excluded. Of course, if a well sealing is inadequate or absent, then this means a high potential risk of leakage. Well sealings are usually made of cement, which can degrade due to the presence of CO_2 [DNV (2003)].

2. Migration through caprock

The integrity of the caprock of the reservoir is of utmost importance to allow for long-term storage of CO_2. Together with CO_2 releases through wellbores, leakage through failed caprocks is considered to be the most important source of CO_2 release [Saripalli (2002)]. The presence of an unidentified fault in the caprock reservoir can seriously decrease the long-term storage capability of the reservoir. Therefore detailed knowledge of

the geology of the reservoir is a primary condition for CO_2 storage reservoirs. Detailed data on oil and gas fields are often available from the experiences of exploration companies, whereas such data usually are not available for coal beds and aquifers.

Another possible leakage mechanism is the upward migration of CO_2 due to buoyancy. The lower density of CO_2 compared to that of aqueous formation fluids and other waters in the overburden, will result into an upward driving pressure for CO_2 migration [Streit (2004)]. The actual migration depends strongly on the permeability of the overburden. According to Lindeberg molecular diffusion of CO_2 through the overburden of the aquifer (700 m between aquifer and seafloor) at the Utsira formation (Sleipner CO_2 storage project operated by Statoil), is too slow to have any climate impact at a time-scale shorter than 100,000 years [Lindeberg (2002)].

The effects of chemical interaction of CO_2 with the caprock are not fully understood until date. Supercritical CO_2 acts as a very good solvent for minerals, which might affect the caprock. On the other hand, CO_2 leaked into the caprock could possibly mineralize again [DNV (2003)].

Injection of CO_2 could lead to overpressure in the storage reservoir, with seismic activities as a consequence. Seismic activities in their turn could lead to fractures in the caprock, thus creating an escape for stored CO_2. Overpressure in the storage reservoir could also lead to an upward migration of toxic minerals in the soil to the surface, where they might cause harm [AER (2004)]. Finally, in order to prevent damage to the caprock, potential reservoirs for long-term CO_2 storage should be located in regions with very low probability on natural seismic activity.

3. Transport of dissolved CO_2

CO_2 dissolved in underground water flows could migrate away from the storage reservoir. Especially in the case of storage in aquifers this could be a potentially important mechanism of CO_2 release [DNV (2003)]. Also aquifers present in oil fields could cause migration of CO_2 from the reservoir, although modelling of aquifer migration at the Forties oil-field indicates that no significant CO_2 release is to be expected during the first 1000 years of storage [Espie (2004)].

4. Quantitative analyses of CO_2 releases from geological reservoirs

Generally speaking few quantitative data on probabilities and amounts of leakage from CO_2 storage reservoirs are available from literature sources. DNV carried out a risk assessment using a Delphi technique among a panel of experts, seeking quantitative data for risks of CO_2 releases from geological reservoirs. Despite the high-level expertise present in the panel, most of the experts felt unable to provide quantitative data on risks [DNV (2003)]. This illustrates that unambiguous reliable quantitative data on risks of CO_2 release from geological reservoirs are not available today.

Nevertheless, in the literature several types of quantitative analyses can be found:

1. *Assessment of consequences of CO_2 release*: according to Saripalli [Saripalli (2002)] well-head failure (during injection) and caprock failure are the two major sources of risk of CO_2 storage in geological reservoirs. In analogue with the operational record of gas storage facilities in the USA and Canada, one serious incident in 25 years over 500 storage facilities was assumed, giving a probability of $2*10^{-5}$. Similarly, five moderate leaks ($P = 1*10^{-4}$) and 50 minor leaks ($P = 1*10^{-3}$) of joints in 25 years were assumed, both again taking 500 storage facilities into account. Regarding the caprock integrity, 1% of the caprock area was assumed to be fractured, whereas 1% was assumed to be highly permeable. Risks related to the geological storage of CO_2 are derived from the formula Risk = Probability * Consequence. In this way, the relative risks of releases of CO_2 to air, buildings, ground water, surface water, soil and biota have been quantified, see Table 7. The assessment indicates that leakage through a failed caprock poses the highest risk to all environmental media. Second highest risks are related to diffusion of CO_2 to high permeable zones of the caprock.

Table 7. Assessment of risks of geological storage of CO_2 [Saripalli (2002)]

FREQUENCIES OF (P_H) OF HAZARDS, CONSEQUENCE AND RISK. (GW = groundwater; SW = surface water)

Hazard event	P_H	Consequence [Risk = P_H x Consequence x 100,000]					
		Air	Bldg.	GW	SW	Soil	Biota
1. Well-head failure							
1A. Major wellhead failure	0.00002	1 [2]	1 [2]	0.5 [1]	0.5 [1]	1 [2]	1 [2]
1B. Moderate, sustained leak	0.0001	0.5 [5]	0.5 [5]	0.2 [2]	0.2 [2]	0.5 [5]	0.5 [5]
1C. Minor leaks of joints	0.001	0.1 [10]	0.1 [10]	0.05 [5]	0.05 [5]	0.1 [10]	0.05 [5]
2. Cap rock failure							
2A. Fractured cap rock	0.01	0.3 [300]	0.3 [300]	0.3 [300]	0.3 [300]	0.3 [300]	0.2 [200]
2B. High permeability zones	0.01	0.1 [100]	0.1 [100]	0.2 [200]	0.1 [100]	0.1 [100]	0.05 [50]
2C. Seismic induced failure	0.0001	0.8 [8]	0.8 [8]	0.8 [8]	0.8 [8]	0.8 [8]	0.8 [8]

2. *Relative amount of CO_2 release*: regarding climate change mitigation, a maximum leakage rate of approximately 0.001 - 0.01% of stored CO_2 per annum has been suggested as being acceptable. A leakage rate of 0.01% would ensure that 90% of the carbon dioxide would remain underground over a 1000 year time period [Savage]. For off-shore oil reservoirs it has been estimated that during the first 1000 years of storage the probability-weighted release quantity is 0.2% of the total amount of CO_2 stored [DNV(2003)]. A similar release quantity of 0.2% of the overall amount of stored CO_2 was estimated for the Weyburn aquifer simulating a storage period of 5000 years, while assuming leakage via one wellbore sealing [Walton (2004)].
3. *CO_2 release rate*: based on measurements of CO_2 soil concentrations near natural CO_2 accumulations, Streit provides calculated CO_2 fluxes (tonne CO_2/year*m^2) from natural CO_2 reservoirs. Table 8 gives an overview of calculated CO_2 fluxes from several natural CO_2 reservoirs in Australia and Europe.

Table 8. Calculated leakage rates from natural CO_2 accumulations [Streit (2004)]

Location	Leakage mechanism	Calculated CO_2 flux ($t/y*m^2$)	Data source
Otway , Penola (Australia)	Fault conduit	$5.7 * 10^{-3}$	Streit (2004)
Otway, Pine Lodge (Australia)	Fault conduit	$1.5 * 10^{-2}$	Streit (2004)
Otway, Pine Lodge (Australia)	Permeable zone	$3.7 * 10^{-3}$ to $7.5 * 10^{-3}$	Streit (2004)
Vorderrhon (Germany)	Fault conduit	0	NASCENT
Matraderecske (Hungary)	Fault conduit	< 6.4	NASCENT
Matraderecske (Hungary)	Permeable zone	0.1 - 0.2	NASCENT
Latera, Tuscany (Italy)	Permeable zone	39.4	NASCENT
Central Italy	Permeable zone	$1.76 * 10^{-5}$ to $3.96 * 10^{-4}$	Chiodini (1999)

In order to put the CO_2 release rates calculated by Streit into perspective, we have compared these values with CO_2 release rates, which are likely to be found for aquifer storage of CO_2. Assuming a typcial aquifer height of 100 m, as well as 20% porosity and 10% filling of the aquifer's pores with CO_2, a storage capacity of 1.6 t/m^2 is calculated[4]. The calculated CO_2 release rate when assuming a release quantity of 0.2% during the first 1000 years of storage, would then be $3.2 * 10^{-6}$ $t/y * m^2$. This is a factor 10 to 1000 less than the release rates found by Streit for most of the natural CO_2 reservoirs.

Lindeberg has calculated CO_2 release rates from an aquifer with an overburden of 700 m between seafloor and aquifer. Time-scale of the analysis is up to 7,000,000 years. It is concluded that molecular diffusion of CO_2 through the overburden rocks is too slow to have any impact on climate during at least the first 100,000 years [Lindeberg (2002)].

4. *Distance of CO_2 migration*: modelling based on CO_2 migration through waterflows at the Forties Formation (off-shore oil field in the North Sea) indicated that during the first 1000 years CO_2 could diffuse 50 m (base case scenario). CO_2 could migrate 350 m in worst case scenario (complete failure of caprock capillary barrier) [Gallo(2004)], [Espie(2004)]
5. *Storage retention time*: taking into account that hydrocarbons have been stored in geological reservoirs for tens to hundreds of millions of years, the storage time for CO_2 will be in the order of many millions of years under the condition of appropriate site selection and careful injection, according to Bradshaw [Bradshaw (2004)]. Shorter storage times and high leakage rates are more likely to be associated with failures at wellbores than with natural subsurface processes.

Existing regulations of underground injection wells in the USA [DNV (2003)]:

- operators of hazardous waste injection wells must **demonstrate** to the US EPA, through the use of computer models, that hazardous wastes will not migrate out of the injection zone for at least **10,000 years**. This demonstration can be based

[4] Own calculation, taking into account a storage density of 0.8 ton CO_2/m^3

either on flow modelling or on the modelling of waste transformation within the injection zone.

- **existing monitoring requirements** for Class I injection wells on land (USA): see p. 79. Class I injection well comprises injection of municipal or industrial waste below the deepest USDW (underground sources of drinking water). 'It is likely that CO_2 storage will be required to be below the deepest USDW. This is consistent with the desire for deep injection to store CO_2 in a supercritical state, which avoids the adverse effects from the separation of CO_2 into liquid and gas phases in the injection zone'. Critical point of CO_2 is at 73.82 bar and 31.04 °C. This situation exists at a depth below 800 m.
- based on the existing EPA-UIC regulations and monitoring requirements for injection wells (USA), a proposal was made indicating which elements a regulatory framework for CO_2 injection should have.

Local risks of CO_2 releases from geological reservoirs

Impact on global climate is not the only risk associated with CO_2 releases from geological reservoirs. Long-term gradual leakage of CO_2 can also have consequences on a local scale. Table 9 gives an overview of possible occurrences for people and the environment.

Table 9. Risk to people and environment

	Occurrence	Remediation
1	Contamination of drinking water	Detailed knowledge of reservoir (location of wellbores, faults, high permeable zones)
2	Migration of toxic minerals to surface due to dissolution by presence of CO_2	Prevent overpressure in reservoir by continuous monitoring of injection pressure in order to reduce migration of minerals

2.4. Summary

In chapter 3 we have discussed the most important risks associated with CO_2 capture, transport and storage as well as potential ways of how these risks can be addressed. Table 10 gives an overview of suggestions of where future legislation should focus in order to address the same risks.

Table 10. Suggested scope of legislation related to potential risks of CO_2 capture, transport and storage

Local risks (short term)	**CO_2 release from capture, transport and injection**
Scope of legislation	• **safety procedures**: appropriate safety procedures and monitoring requirements at capture and injection site • **material requirements**: minimum requirements on pipeline material, capture equipment and material of lining and sealing (injection) • **safety requirements**: pipeline protection (e.g. coating, cathodic protection), requirement of periodic inspection of pipelines • **selection of pipeline route**: conditions regarding populated areas
Global risks (long term)	**CO_2 release from reservoir**
Scope of legislation	• **selection of reservoir**: conditions regarding level of knowledge of wellbores and caprock (faults and permeability) and maximum seismic activity of the region • **material requirements (injection)**: minimum requirements on type/material of lining and sealing • **operational requirements (injection)**: minimum requirements on procedures of injection (e.g. maximum injection pressure, obligatory continuous monitoring of injection pressure) and sealing (e.g. application of inhibitor fluid). • **operational requirements (post-injection)**: responsibility of periodic inspection of sealings • **future activities:** which authority will supervise that no potentially harmful human activities take place at the location of the reservoir in the short and long term? • **liability**: who is liable in case of contamination of water and soil due to CO_2 leakage? who is liable in case of subsidence or induced seismic activities? what happens to obtained emission reduction credits when CO_2 leakage occurs?

3. Overview of EU and international law relevant to carbon dioxide capture, transport and geological storage

3.1. Introduction to international legal frameworks

International law addresses the relationship between States, or the relationship between persons or entities in different States. There are a number of sources of international law, as recognized in Article 38(1) of the Statute of the International Court of Justice. These include treaties (international conventions, protocols etc.), international custom, general principles of law recognized by civilized nations, and a variety of subsidiary sources, including decisions by tribunals and the writings of jurists.

Treaties are the most important source of international environmental law. Treaties are written agreements governed by international law, entered into two or more States, that create or restate legal rights and duties.[5] Treaties only bind States that have agreed to be bound by them, and treaties only bind Parties once they have entered into force. After a multilateral treaty has been signed, it typically only enters into force when it has been ratified by States (often by a parliamentary act at the State level), and when the number of States depositing their ratifications reaches the minimum number stipulated in the treaty itself. After ratification, States give formal notification of their consent to be bound by the treaty by depositing their instruments of ratification with the treaty's depositary. Once the required number of Parties has ratified the treaty, the treaty enters into force and becomes binding upon its Parties.

Treaties may be amended where allowed by their provisions. However, an amendment will generally not enter into force unless ratified or accepted by all Parties. Because this is a very demanding procedure, a number of environmental treaties are tiered into two or three parts to facilitate more flexibility in responding to new developments and technologies.[6] This tiering can consist of: (1) 'framework treaties', which contain general principles; (2) 'protocols' that supplement or implement the framework treaty; and (3) technical and scientific 'annexes' containing details that may need quick alteration according to changing needs.[7]

[5] Guruswamy, L.D. and Hendricks, B.R. 'International Environmental Law in a Nutshell', West Publishing Co. (1997), p. 17. Treaties may by their own terms permit other Parties, such as international organisations or regional economic integration organisations (such as the EC).
[6] Id, p. 19.
[7] Id, pp. 19-20.

3.2. Implementation into national law

Many treaties require Parties to take domestic measures to ensure compliance with obligations or take measures to ensure implementation. For this reason, once a State has formally adopted an international environmental obligation, it will likely need to develop, adopt or modify relevant national legislation.[8] Treaty obligations bind Parties, and are generally not enforceable against private actors at the national level until they have been incorporated or adopted into national law. Treaty obligations that have not been implemented domestically will be difficult to enforce in national courts.[9] It has been said that EC law presents a notable exception, as it can create rights and obligations that are enforceable in national courts without being implemented domestically, provided these rights and obligations fulfil certain conditions – for example, if they are clear and unconditional.[10] The failure by EU member States to adopt measures implementing EU environmental law can be the subject of enforcement measures taken at the European Court of Justice.[11]

There are two broad approaches to the implementation of international agreements at the national level. First, a State can choose to ask its parliament to accept a treaty as it is and give it 'direct effect', in which case the treaty will not be rewritten or changed, but simply be adopted by reference and join national legislation. This can pose challenges if the treaty contains aspirational provisions, or takes the form of a framework convention. Alternatively, a State can choose to incorporate a treaty's provisions into existing national law, or pass an entirely new law based on the treaty's provisions. Once the treaty has been incorporated into national legislation, that national legislation becomes binding upon private actors within that particular State's jurisdiction.

3.3. Carbon dioxide capture and storage and international law

It is a general principle of international environmental law that States have the sovereign right to exploit their own resources, but also the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or damage to areas beyond the limits of their national jurisdiction.[12] In the context of transboundary environmental damage, this principle has two parts. First, a State has a responsibility to take measures to *prevent the occurrence* of transboundary environmental harm. Second, a State has a responsibility to *redress damage* if and when transboundary harm occurs. Numerous EU legal frameworks reflect and apply these international law principles in the areas of air pollution, groundwater pollution, marine pollution, waste

[8] See Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 143.
[9] Id.
[10] Id. at 144.
[11] Id.
[12] Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 183, citing Principle 21 of the Stockholm Declaration and Principle 2 of the Rio Declaration. See also the preamble to the 1992 UN Framework Convention on Climate Change, citing the Charter of the United Nations and the principles of international law.

management, land and marine transportation of dangerous and hazardous substances, and natural resource protection.

In the context of carbon capture and storage (CCS), international law principles are implicated in two ways. First, industrial activities within EU Member States that generate carbon dioxide will have impacts beyond areas of national and EU jurisdiction. Increasing carbon dioxide concentrations in the atmosphere will have impacts on the global environment, and that many of these impacts will be negative. Carbon dioxide capture and storage represents a means to prevent or minimize these expected impacts, and therefore a means of complying with international law principles by preventing transboundary harm.

Second, efforts undertaken to capture, transport and store carbon dioxide may themselves lead to damage to the environment in areas beyond the territorial limits of national jurisdiction. The degree and nature of this risk will largely depend upon the systems used to capture carbon dioxide, the means used to transport carbon dioxide, the routes used for this transport, and the location and integrity of the geological storage sites selected for the long-term storage of carbon dioxide. If environmental damage may result from carbon dioxide capture and storage activities, there is a responsibility to consider both ways to minimize this possibility and ways to redress damage that may occur. The regulation of these activities should be consistent with existing legal frameworks, yet tailored to the unique circumstances, risks, requirements and objectives of carbon dioxide capture and storage.

The UN Framework Convention on Climate Change, the Kyoto Protocol, and a number of EU Directives encourage the reduction of CO_2 emissions and encourage removals from the atmosphere in order to prevent dangerous climate change and reduce the impacts of greenhouse gases on the environment. It must also be emphasized that CCS does not reduce the generation of CO_2. At best, it creates a means of disposing of CO_2 so as to avoid the greater harm to the environment that would result from its emission into the atmosphere. Until cleaner technologies are found and utilized, CCS may offer a means to keep unavoidable CO_2 emissions out of the atmosphere for a period of time. Nevertheless, how CCS fits with the principle that States must not transfer damage or hazards, or transform one type of pollution into another, requires some consideration.[13]

To maximize the benefits of carbon dioxide capture and storage and minimize its risks, it is necessary to thoroughly assess these technical and environmental risks and consider ways to regulate these risks. Similarly, to determine the legal consequences of CCS activities under international and EC law, it is important to define the potential risks and

[13] See UNCLOS Article 195 ("taking measures to prevent, reduce and control pollution of the marine environment, States shall act so as not to transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another"); London Protocol Article 3.3 (Contracting Parties "shall act so as not to transfer, directly or indirectly, damage or likelihood of damage from one part of the environment to another or transform one type of pollution into another").

potential environmental impacts of carbon dioxide capture and storage, and consider the legal frameworks that address these risks. Some conventions concern the process before permission to commence an activity is granted, e.g. Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention). Other conventions take a more 'after-the-fact' approach, such as the 1992 Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention). The potential risks that CCS activities pose, and the environmental damage that may result from accidental releases and storage site leakage, will affect the way this area will be regulated in the future.

The sections below draw upon the contents of Appendix 2 to this report, which reviews a broad range of international and EU legal frameworks for their relevancy to CCS.

Section 3.4, below, highlights key issues that determine the applicability of existing EU and international law frameworks to CCS activities. Section 3.5 assesses barriers to the implementation of CCS activities arising from these existing legal frameworks, and considers gaps in these frameworks. Section 3.6 then makes recommendations for approaches to address these gaps in order to adequately address the environmental and safety risks identified in earlier portions of this report.

3.4. Overview of relevant EU and international legislation

The sections below highlight a number of key legal issues and repetitive themes emerging from Appendix 2's review of relevant international and EU legal frameworks. Section 3.5, below, and Table 11 provide a summary of the most significant barriers to CCS resulting from that review.

A. Definitions, hazards, risk classifications

Many of the international conventions and EU directives reviewed for their relevancy to carbon capture, transport and storage activities use defined terms to delineate their scope of coverage. Commonly-used terms include: 'pollution', 'land-based pollution', 'wastes', 'hazardous wastes', 'industrial wastes', 'liquid wastes', 'harmful substances', 'dangerous substances', 'dangerous activities', 'operator', 'ship', 'sea', 'dumping', 'disposal' and 'storage'. These terms (and differences in their definitions and usage in different regimes and contexts) will determine whether a particular activity related to CCS is covered by a particular regime, and if so, how it is to be regulated. Where it is not clear whether a CCS activity falls within or outside the scope of a defined term in a particular legal regime, this may need to be clarified to provide regulatory certainty. This may be done through amendments, policy guidance or the creation of a distinct regime for CCS activities, either within or outside existing legal regimes.

Some regimes use 'positive lists' to describe their scope of coverage, using annexed lists of substances, groups of substances, characteristics of substances, or categories of activities that are covered, with varying degrees of specificity. They may also refer to lists

contained in other Conventions, or to regionally-determined or nationally-determined lists. Other regimes may use 'negative lists', in which everything is included unless it is expressly excluded. These lists permit the flexibility to add or delete regulated substances or activities. Still other regimes define their scope and coverage by the risks that a substance's handling, storage, shipment or accidental release may pose (e.g., transboundary risks, significant risks), or the risks that a particular activity may pose.

Some examples of the defined terms and issues that determine the regulation of CCS activities under particular legal frameworks and contexts are provided below.

In the ***waste management context***, is CO_2 a '*waste*' for purposes of the Waste Directive, such that it is regulated as a waste under the many EU Directives that incorporate aspects of the Waste Directive by reference?[14] Is CO_2 ever '*emitted into the atmosphere*' in the CCS process such that it is exempted from the scope of the Waste Directive? Or, if CO_2 is not 'emitted into the atmosphere', and is therefore regulated as a 'waste' under the Waste Directive, how is it captured and handled prior to injection? Is captured CO_2 handled and injected in such a way that it becomes a '*liquid waste*', which is banned from underground storage under the Landfill Directive? Are there other physical states in which it may be injected? Can CO_2 be 'accepted' at a landfill in a non-liquid form? Is captured CO_2 ever emitted 'into the atmosphere' for purposes of the Emissions Allowance Trading Directive? Are there situations in which CO_2 could be considered a '*hazardous waste*' for purposes of the Basel Convention or the Hazardous Waste Directive? Under what situations and to what organisms might liquid CO_2 be '*toxic*'? What range of impurities might be contained in CO_2 destined for geological storage, in what amounts, and how might this affect its characterisation or the impacts of CCS activities?

In the ***marine pollution context***, is CO_2 an '*industrial waste*' prohibited from dumping under the London Convention? Is it nevertheless distinguishable from other industrial waste so that an argument might be made for its exclusion from this prohibition? Does the geological storage of CO_2 constitute '*dumping*' or '*disposal at sea*' if it occurs from a ship or platform at sea under the London Convention or Barcelona Convention? Under the OSPAR Convention? Is CO_2 'dumped' if it is injected into a sub-seabed repository directly from a land-based pipeline under OSPAR? Is injection by this means regulated under the Barcelona Convention? The Helsinki Convention? Does injection from a land-based pipeline constitute '*land-based pollution*' that must be 'prevented' and 'eliminated'? Where 'placement' is allowed for certain purposes under these conventions, what does 'placement' mean? Could CO_2 injection into a geological cavity constitute '*placement of a matter for purposes other than the mere disposal thereof*' under UNCLOS or OSPAR? If so, under what circumstances? What are the limits of '*scientific and technical research*' allowable under OSPAR? Could CO_2 transported by ship for injection into geological storage sites ever be a '*harmful substance*' within the mean-

[14] These include the Hazardous Waste Directive, the Landfill Directive, the IPPC Directive, the Environmental Liability Directive, and Council Regulation (EEC) No 259/93 on the supervision and control of shipments of waste within, into and out of the EC.

ing of MARPOL or the HNS Convention? Does the 'marine environment' (UNCLOS) or the 'sea' (London Convention, London Protocol) includes sub-seabed repositories? Is pollution *from* sub-seabed repositories addressed by these conventions in any way?

For purposes of ***environmental impact assessments***, how is the likelihood of a '*significant adverse transboundary impact*' to be determined for a proposed CCS activity, and for consultations between States under the EIA Convention? At what stage are CCS activities '*proposed activities*'? How might the criteria set out in the EIA Convention and the EIA Directive for determining significant adverse impact (size, location and effects) apply to CCS? How might the likelihood of '*significant adverse effects on biological diversity*' be evaluated for purposes of the Convention on Biological Diversity?

For purposes of ***public participation and access to information in decision-making***, 'may' CCS activities have a '*significant effect on the environment'* sufficient to trigger Aarhus Convention requirements? When are the rights of access to information, public participation and access to justice required for CCS activities under the Aarhus Convention? What private and public '*projects*', '*plans, programmes and policies*' relating to CCS should be exposed to the public for participation and input? Will these activities have a '*significant effect on the environment, including health*' under the SEA Protocol? Or a 'significant adverse transboundary impact' under the EIA Convention?

In the ***climate change context***, what is the relationship between '*sources*', '*sinks*' and '*reservoirs*' under the UNFCCC and Kyoto Protocol? Is captured CO_2 ever '*emitted*' '*into the atmosphere*'? Is it '*transferred*'? How does the definition of '*installation*' apply to industrial facilities that have a technical connection to injection sites under the Emissions Allowance Trading Directive? What is a '*technical connection*'? How are emission '*allowances*' treated where CO_2 is generated through an industrial process, but captured for storage rather than emitted? Does captured CO_2 represent an emission reduction?

For the operation of ***liability regimes***, is CO_2 handled in bulk a '*hazardous substance*' for purposes of the Industrial Accidents Convention and Watercourses and Industrial Accidents Protocol? Is CO_2 in bulk ever '*toxic*' or '*dangerous for the environment*'? Is the handling or storage of CO_2 a '*dangerous activity*' under the Lugano Convention? Is a geological storage site a site '*for the permanent disposal of waste*' under the Lugano Convention? Is CO_2 a '*waste*' under the Basel Liability Protocol? What kinds of '*environmental damage*' should be of concern from CCS activities under the EU Environmental Liability Directive, and who are potentially liable '*operators*'?

CCS activities pose legal and regulatory risks where there are not clear or agreed answers to the above questions.

B. Geographic Scope

The specific physical location in which CCS activities are to be undertaken will determine the range of potentially applicable legal regimes. For example, CCS activities may be undertaken on-shore or offshore, within territorial waters or outside territorial waters, within or outside the EU. CCS activities that take place within different geographic regions (e.g., the EU or the Middle East) may also be subject to different legal regimes. Certain activities may be prohibited in some regions, but permitted in others, depending on the conventions and laws in force in that jurisdiction. Thus the physical location of the CCS activity, its nature, and its potential transboundary impacts will indicate the universe of potentially applicable legal regimes.

Potentially applicable regimes may apply to internal waters, groundwater, surface waters, coastal waters, or territorial waters. They may extend to the 'maritime area', the marine water column, the continental shelf, the exclusive economic zone, the marine seabed, its subsoil or the sub-seabed. Obligations may apply only within the European territory of contracting Parties, or they may extend beyond the strict territorial limits of national jurisdiction for certain purposes.

The UN Convention on the Law of the Sea (UNCLOS) sets out a framework for the reach of State jurisdiction under international law for the protection and exploitation of the marine environment.[15] UNCLOS extends the sovereignty of a coastal State to 12 nautical miles, known as the territorial sea. It also recognizes an exclusive economic zone with a 200 mile limit from the same baselines used to measure the territorial sea for conservation and management duties. Other international conventions contain provisions setting out their geographic reach, consistent with convention objectives.

With respect to the geographic reach of EU environmental law, Article 299 of the EC Treaty provides merely that 'The Treaty shall apply to . . .' listed Member States. It has been said that '[a]ccording to general principles of international law this means that the Treaty binds the Parties with respect to the entire territory over which they are sovereign, unless the Treaty itself allows exceptions or applies special rules.'[16] The scope of the Treaty and Community law may extend beyond the territory under the full jurisdiction of Member States, to the extent international law allows Member States to exercise a limited functional jurisdiction.[17] It has been argued that '[i]n so far as Member States are competent under international law to protect the environment outside their own territories, the Community must also be regarded as being competent to take such measures, at least to the extent that the subject matter of the measure falls within the substantive scope of application of Article 174 EC'.[18] Therefore, while Community law can be applied outside the territory of Member States, not every piece of Community legislation has such a wid-

[15] See discussion of UNCLOS elsewhere in this paper.
[16] J.J. Jans, 'The Habitats Directive', Journal of Environmental Law, Vol 12 No 3, OUP 2000, p. 386.
[17] Id.
[18] Id.

ened territorial scope – and the geographic scope of an EU Directive or Regulation at issue must be interpreted in light of its language and objectives.[19]

C. Jurisdiction

Some conventions are global, some are regional; some conventions may be ratified only by States, while others may be ratified by territories or by regional economic integration units (such as the European Community). As not all States are bound by all conventions, it is important to determine which countries are bound by which regimes. Even where international agreements are in force, they do not bind private actors unless they have been transposed into national law. For this reason, it is also important to consider whether and how relevant treaty obligations been implemented at the EU and national levels.

While some activities may be regulated solely under national law, the potential for transboundary impacts may bring EU or international requirements into play, depending on the nature of the risks involved. At the same time, an activity that falls with the geographic reach of a convention or EU directive and within the regulatory jurisdiction of a State may nevertheless fall outside the scope of existing regulations if legal thresholds for coverage are not met or exceeded (e.g., a substance is not present in excess of an established minimum volume), or if exceptions within those frameworks exclude a specific activity from the regime's legal scope.

The applicability and scope of relevant conventions and directives, and the regulatory obligations that derive from these regimes, will have cost implications on States and on those undertaking CCS activities. These costs may affect decisions on the selection of geological storage sites, the routing of pipelines or the form of transportation selected.

D. Ownership and control of activities and facilities

Whether transport and geologic storage occurs on-shore, off-shore, on privately held land, or on publicly owned or controlled land, will all play a role in determining the applicability and application of regulatory regimes. It is also likely to affect the design of permitting procedures, the identity of the relevant permitting authority or authorities, responsibility for monitoring, and environmental impact assessment procedures.

Whether facilities for geologic storage are privately owned and operated, or state owned or operated, will also affect responsibility in the event of leakage for health hazards and environmental impacts, with ramifications for liability, remediation and damages. This in turn impacts who bears the financial ultimate cost of geologic storage (industrial generators of CO_2? operators of geological storage sites? taxpayers?), and offers some indication of to what extent governments endorse this approach to emission avoidance. This has implications for the polluter pays principle, as well as for the achievement of climate change objectives through incentives for CCS.

[19] Id.

The anticipated location of storage sites and their proximity to national boundaries may influence the applicability and/or design of liability systems, as well as accounting systems and monitoring systems tailored to CCS activities. This is particularly so where the risk of significant transboundary effects is present, or where many installations, or installations in many States, may be expected to contribute CO_2 to a particular storage site. Liability regimes may consider joint and several liabilities for multiple contributors, or multiple site owners (compare the EU Environmental Liability Directive).

E. Mode of transportation and form transported

Whether captured CO_2 is transported by road, rail, ship, pipeline or some combination will affect which regulatory systems apply to regulate its safe transport. Different modes of transport, and the risks each entail, are addressed by different legal regimes at the international, regional and EU levels (e.g., HNS Protocol, ADR, SOLAS). Different packaging, handling, labelling, and safety rules apply, depending upon the nature of the CO_2 shipped (liquid or gas) and the mode of transport used (truck, pipeline, ship).

The specific mode of transport and specific form in which CO_2 is transported will affect the risk of environmental damage and human health impacts from accidental releases. Different risks attach to different modes of transport (e.g., liquid in bulk, liquid in small containers, liquid in pipelines, gas in containers). The mode of transport employed will impact the identity of the party responsible for damages resulting from the accidental release of CO_2 during transport (e.g., rail carrier, ship-owner, pipeline owner or supervisor). Important questions include: under what circumstances does the transport of CO_2 pose risks to the public? To the environment? To the marine environment? To the aquatic environment? To groundwater? How are these risks required to be minimized? Which liability regimes might apply (e.g., CRTD Convention (road, rail, inland navigation vessel), HNS Convention (ship), Basel Protocol (exporter, importer), Watercourses and Industrial Accidents Protocol (on site transport, off-site by pipeline))? How have the international regimes that are in force been implemented? For EU Member States, does the Environmental Liability Directive address the range of relevant transport possibilities?

Risk assessments will need to be tailored to the form in which CO_2 is transported. The particular risks that a particular form of transport entails for human safety and for ecological impacts will be important for the establishment of appropriate permitting conditions, and for appropriate financial guarantees where liability regimes (international and EU) come into play.

F. Route and risks – responsibility, control, risk

The physical route selected for the transport of CO_2 for storage will affect risks to human health and the environment. The nature and size of this risk (significant? transboundary?) as well as the location of the source of CO_2 and its destination (is it transported on-

site? within national jurisdiction? within the EU? on-shore to off-shore?) will affect the applicability of different legal regimes.

If the siting of a pipeline for transport of CO_2 holds the potential to impact populations in other States in the event of an accidental release, or impact protected habitats or species, this may require broader notification and public participation under international law. Expanded environmental impact assessments and consultation with potentially affected governments and the public in other countries may be required. Proximity of CCS activities to population centres will also increase risk, and the nature of this risk may trigger a variety of additional risk assessment obligations.

The shifting identity of responsible parties may impose another regulatory risk on the CCS process where many parties are involved in transport and storage activities. Is CO_2 destined for storage the responsibility of the generator? The transporter? The party operating the disposal site? What happens if a pipeline crosses national boundaries? Costs of releases that are not borne by operators consistent with the Environmental Liability Directive or borne by other responsible entities under other international regimes, will have to be borne by governments, the public, and the environment.

G. Monitoring, reporting, verification, accounting

Some Conventions contain very broad commitments on monitoring, reporting and verification of predicted impacts of polluting activities (e.g., Antarctic Protocol) and assessments of environmental quality (OSPAR). These commitments raise issues of responsibility, competence and cost.

Who should be responsible for monitoring the impacts of CCS activities and leakage from storage sites? The generator of the CO_2? The geological storage site operator? A competent national authority? A new regional or international body? Who should be responsible for reporting on accidental releases, and for verifying that CO_2 has been and is being successfully stored? How does the polluter pays principle affect the allocation of these tasks, and payment for the costs of these tasks? How might the incorporation of CCS activities into the Emissions Allowance Trading Directive affect this allocation? How stringent must monitoring and verification be if the trading of units resulting from CCS activities is contemplated?

H. Licensing, permitting

Many international conventions and EU Directives require authorisations or permits for activities that are likely to implicated by CCS (e.g., emissions from industrial installations, waste disposal operations, transportation of wastes, landfilling of wastes). In order to obtain a license or permit, background studies, environmental impact assessments, and public participation and consultation may be required. Permit conditions may need to be developed specifically for CCS activities, particularly for activities undertaken near protected habitats or near population centres, or where the volume handled is such that acci-

dental releases may have significant impacts. The installation of new equipment or new technology, or a change in use of existing facilities, may also trigger new or additional obligations. The demonstration of permit compliance will require monitoring and reporting, and may require an assessment of the impacts of CCS activities. Each of these elements presents challenges in the context of CCS, and will impact the cost and feasibility of activity in or through a particular location.

I. Scientific research v. commercial purposes

Some conventions allow an activity to take place for scientific purposes only, but preclude the same activity when undertaken for commercial purposes (see, e.g., Antarctic Treaty and Protocol). In the context of marine pollution, for example, the dumping of waste may be prohibited, but the 'placement of matter for a purpose other than the mere disposal thereof' is not considered 'dumping' (UNCLOS, London Convention, London Protocol, OSPAR, Helsinki, Barcelona Dumping Protocol).

Where is the line between 'scientific and technical research' (OSPAR) and commercial activities? Where little may be known about the characteristics or behaviour of particular geological storage sites, the accuracy of baseline data, or the efficacy of different monitoring and accounting techniques, there is a need to test and approve these sites and systems prior to permitting for commercial use. The extent to which this is facilitated through legal frameworks will impact the cost and feasibility of CCS.

J. Emissions trading

At the international level, systems have been established to inventory greenhouse gas (GHG) emissions from Parties (UNFCCC, Kyoto Protocol), and to permit the trading of credits reflecting emission reductions or reflecting the sequestration of GHGs through the transfer of assigned amount units, and credits from Clean Development Mechanism and Joint Implementation projects. At the EU level, regulatory systems have been created to require the reporting of GHG emissions, and to permit the trading of allowances each representing a tonne of CO_2 equivalent among installations. Limits have been imposed on the number of allowances issued to encourage reductions in GHG emissions at the source.

To enable these trading systems to achieve least-cost solutions, GHG reporting and accounting systems have been established at the international level, EU level and installation level. Compliance systems have also been developed to regulate participation in trading, and to prevent the overselling of Kyoto credits and EU allowances. These systems raise significant issues for CO_2 capture and storage, in defining emission reductions, determining the value of a tonne of CO_2 emissions avoided through capture and storage and its relationship to existing tradable units, and determining means to account for stored CO_2 and potential leakage from geological storage sites.

K. Liability

In the context of CCS, it has been said that at least three kinds of liability require consideration[20]:

- operational liability, for immediate human health risks, environmental damage and remediation from accidental release in the process of carbon capture, transport and storage; and
- in situ liability, for the public health impacts and environmental and ecosystem damage as a result of CO_2 leaking from the reservoir back to the surface from geological sites, and
- climate liability, associated with leakage from geological storage sites, where credit may have been awarded under emissions trading schemes (e.g. Kyoto trading of assigned amount units).

For the first category of liability, a number of international liability regimes and regulatory systems are already in existence that may address activities related to the capture, transport and storage of CO_2. For example, the HNS Convention (not yet in force) addresses liability for damages from a pollution incident involving the transport by vessel of liquefied gases in bulk by ship. The Watercourses and Industrial Accidents Protocol on civil liability (not yet in force) addresses the transboundary effects of industrial accidents. The Basel Liability Protocol (not yet in force) addresses liability and compensation for damage resulting from the transboundary movement and disposal of hazardous wastes and other wastes and clarifies who will be responsible for compensation in the event of an accident.

The role of the operator, the mode of transport, and the location of geological storage sites employed will all be important in determining which of these and other international regimes applies if an accidental release occurs during operations. Existing international regimes may need to be extended or clarified to cover bulk capture and transport of CO_2, depending upon the scale contemplated for these activities and the risk they may pose as a result. Any new regime designed to address the unique risks arising from CCS activities will require design choices with political implications. Existing international liability regimes address certain issues, but leave the answers to others either unclear, unaddressed or unsatisfactorily addressed.

Important questions to ask include the following. Who is liable for accidents in the capture and transport of CO_2? Who is liable if leakage from a storage site occurs? Should responsibility lie with the generator of the CO_2? The operator of the geological storage site? Should responsibility lie with the State, if it has encouraged geological storage, and the cost of damage exceeds the resources of those directly responsible? Should joint and several liability exist for generators of CO_2, if CO_2 generated by a number of facilities is combined in a single disposal site? Should liability be limited or unlimited? For what kinds of damage should liability exist? Should liability extend to remediation and resto-

[20] Stenhouse, M.J., Wilson, M.; Herzog, H.; Cassidy, B.; Kozak, M.; Zhou, W.; Gale, J. "Regulatory Issues Associated With Deep (Geological) CO_2 Storage" GHGT7, Vancouver, 2004.

ration costs? How long should responsibility last? For EU Member States, the Environmental Liability Directive addresses many of these issues.[21] The answer will be less clear if CCS activities are undertaken elsewhere and relevant international frameworks have not yet entered into force.

For the third category of liability – liability for the release of CO_2 for which credit has already been awarded under emission trading schemes – a system is likely to be needed to be created specifically for CCS activities, to fit with existing accounting and liability systems under the climate change regime and its related EU directives and regulations.

L. Planning phase – environmental impact assessments and public participation

Many conventions and directives include reference to environmental impact assessments. Some references are quite general and aspirational (UNCLOS, UNFCCC, Convention on Biological Diversity); others are quite specific and mandatory (Antarctic Protocol, Espoo (EIA) Convention, EIA Directive, SEA Directive). Different activities and thresholds trigger the EIA process under different regimes, and impact who is to participate in this process and how. The timing of EIAs also varies, with some to take place prior to the initiation of an activity, project, plan or programme, and other assessments to take place after an activity is underway.

Important issues here include: when does the public have a right to know about plans for geological storage? How formal must these plans be? What information must be given to the public and when (Aarhus, Espoo)? How may the public contribute to these discussions? How is public defined? What is the threshold for triggering preparation of an EIA? If it is the likelihood or severity of the risk, how is that risk determined? Is it the nature of the particular activity? Is a 'project' involved? Is a 'plan', 'programme' or 'policy' involved? What is the timing of an EIA? Who is responsible for conducting it? What should its contents be, and who determines these contents? Is there reasonable grounds for believing that a planned activity may cause substantial pollution or significant changes to the environment? Is there a significant likelihood of harm? How should this likelihood be measured?

M. Siting of CCS activities

Where should large scale carbon capture, transport and geological storage activities be permitted to take place? Do facilities engaging in these activities have effective plans in place for the minimization of risk to nearby populations and to the environment (Industrial Accidents Convention, Seveso II Directive)? Might transboundary impacts be anticipated for which notice should be given to potentially affected members of the public in other States (EIA Convention)? Are the habitats of protected species likely to be impacted (Bern Convention, Habitats Directive, Birds Directive)?

[21] See discussion of the Environmental Liability Directive in Appendix 2.

3.5. Legal barriers to the implementation of carbon dioxide and geological storage

This section addresses barriers to the implementation of carbon dioxide capture and storage arising from the EU and international law frameworks reviewed, with emphasis on those frameworks most directly relevant.

A. Legal Definitions and Scope

Many international, regional and EU legal frameworks are relevant to CCS activities and many definitions and prohibitions within these frameworks are sufficiently broad to encompass CO_2 capture and geological storage activities. Nevertheless, few of the frameworks reviewed directly address CCS activities and either include them or exclude them from their scope.[22] Clear inclusion or exclusion will increase transparency, provide regulatory certainty, and facilitate CCS activities and methodologies that are agreed to be consistent with international, regional and EU frameworks.

Areas that have been identified as problematic for CO_2 capture and geologic storage include the following:

- ***The London Convention*** prohibits the dumping 'at sea' of 'industrial wastes.' 'Industrial waste' means 'waste materials generated by manufacturing or processing operations.' There is still no consensus within that Convention process on whether this definition includes or excludes CO_2. Intuitively, captured CO_2 resulting from industrial processes that is to be disposed of would seem to fall within the definition of 'industrial waste'. Exclusions from the prohibition against dumping of industrial wastes do exist (e.g., for certain inert geological material), but it is not clear that CO_2 resulting from industrial processes would fall within any of the listed exclusions. Hence a good argument exists that the London Convention prohibits the deliberate disposal of CO_2 directly into marine waters. The Convention does not expressly address the sub-seabed. The applicability or inapplicability of the London Convention to injection into the seabed may benefit from clarification.

- ***The London Protocol,*** which is not yet in force, is intended to replace the London Convention. The Protocol expressly prohibits the deliberate disposal (dumping) into the 'sea' of wastes from vessels or manmade platforms. 'Sea' is now defined broadly to include the 'seabed and subsoil thereof', but not to include 'sub-seabed repositories accessed only by land.' Thus geologic storage by injection from vessels or manmade platforms at sea, directly into sub-seabed repositories (accessible by water) would seem to be prohibited. However, the London Protocol does not bring within its scope (and therefore does not prohibit) geological storage of CO_2 by pipeline from a land-based source to a sub-seabed re-

[22] Exceptions include the UNFCCC, Kyoto Protocol and the EU's Monitoring and Reporting Guidelines.

pository. The rationale for this difference in treatment between storage in repositories accessed only by land, and those accessed by water, may warrant explanation.

- ***The OSPAR Convention*** regulates pollution in the marine environment of the North-East Atlantic Ocean using different approaches for different sources of pollution (pollution from land-based sources, pollution by dumping, and pollution from off-shore sources – oil and gas activities). As a result, the same wastes, matter, or substances, with the same effects on the marine environment, may be regulated differently under different OSPAR Annexes depending upon how those wastes, matter or substances reach the marine environment. In addition, OSPAR looks to the purpose for which wastes or other matter may be placed in the maritime area. Different purposes are regulated differently, though they may have the same environmental impact.

  For example, Annex I ***permits*** the deliberate disposal under the seabed of pollution from land-based sources, with land-based sources defined to include 'sources associated with any deliberate disposal under the sea-bed made accessible from land by tunnel, pipeline or other means and sources associated with man-made structures placed in the maritime area . . . other than for the purpose of offshore activities' (i.e., oil and gas activities). Under Annex II, the 'dumping' of CO_2 (wastes and other matter) in the seabed and its subsoil from vessels and man-made structures at sea is ***prohibited***, though exceptions exist for 'placement' for certain purposes. Annex III then ***prohibits*** the dumping of wastes or other matter from offshore installations (oil and gas), but ***allows*** 'discharges or emissions' from these installations, and ***allows*** for certain 'placements' but only in the context of offshore activities.

  These three Annexes create the potential for different treatment of CO_2 injection into geological storage sites reached by pipeline from land, by pipeline from vessels, by pipeline from manmade structures at sea that are not related to oil and gas extraction, and by pipeline from offshore installations that are related to oil and gas extraction. It also creates the potential for different treatment of CO_2 that arises from offshore activities (hydrocarbon extraction), and that does not arise from offshore activities. These Annexes should be reviewed toward a common approach for CO_2 that addresses similar risks, purposes and wastes similarly, either across the three Annexes or through a new Annex, in order to increase regulatory certainty.

- Under ***the OSPAR Convention***, where land-based sources are involved and deliberate disposal under the sea-bed is contemplated, Parties must: require use of best available technology (BAT) for point sources, including clean technology where appropriate; require best environmental practice (BEP) for point sources, including where appropriate clean technology; create a system for monitoring

and inspection for compliance with regulations or permits; and undertake other initiatives. These elements and systems may need to be established for pollution from land-based sources in the context of CCS activities.

- ***The EU Waste Framework Directive's*** broad definition of 'waste' excludes from its scope 'gaseous effluents emitted into the atmosphere.' However, CO_2 that is not 'emitted into the atmosphere' but instead captured prior to emission, and intended for disposal, would seem to fall within the Waste Framework Directive's regulatory scope. If captured CO_2 is regulated as 'waste', establishments or undertakings carrying out waste disposal or recovery operations related to CO_2 will require permits under Articles 9 and 10 with appropriate conditions. The regulation of CO_2 as 'waste' impacts the treatment of captured CO_2 under other Directives that rely on the definitions of waste under the Waste Framework, among them the Landfill Directive.

- ***The EU Landfill Directive*** bans the landfilling of 'liquid waste.' CO_2 is most likely to be injected into geological cavities in liquid form. At least one Court, evaluating the disposal of liquid waste by injection into a borehole 1000 meters or so below sea level has found this activity covered by the Landfill Directive, and the injection of liquid waste prohibited (see discussion of Landfill Directive in Annex). Hence the physical state in which CO_2 is 'accepted' at a landfill, and the physical state of CO_2 at injection are likely to impact its treatment under current legislative frameworks.

- ***The EU Water Framework Directive*** allows Member States to authorise the injection of 'water containing substances resulting from the operations for exploration and extraction of hydrocarbons . . . into geological formations from which hydrocarbons or other substances have been extracted or into geological formations that are unsuitable for other purposes.' (Art. 11(3)(j)). It also permits Member States to authorise injection of natural gas or liquefied petroleum gas into geological formations, which are permanently unsuitable for other purposes, or to inject natural gas or LPG for storage purposes in certain circumstances (Art. 11(3)(j)). The Water Framework Directive contains no explicit reference to CO_2. The relationship between the Landfill Directive and the Water Framework Directive warrants consideration in the context of CO_2 storage.

- ***The Climate Change Convention*** requires the compilation of a national inventory of 'emissions by sources' and 'removals by sinks' of all greenhouse gases, using comparable methodologies agreed by the Parties. Parties must also report on policies and measures and their impacts on emissions by sources and removals by sinks. It is not clear how CO_2 captured and stored in geological repositories would be reported under existing UNFCCC reporting requirements. Article 1.8 of the UNFCCC defines 'sink' as 'any process, activity or mechanism which removes a greenhouse gas, an aerosol or precursor of a greenhouse gas from the

atmosphere.' 'Source' is defined as any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.' The Convention also defines 'reservoir' as a component of the climate system where a greenhouse gas is or a precursor of a greenhouse gas is stored.' Reporting may be challenging where leakage rates from storage sites are unknown, where geological storage sites combine CO_2 from a variety of installations, or for a variety of purposes (e.g. disposal, storage, enhanced oil recovery), or where these sites extend beyond national borders. Clarification is needed on how captured and stored CO_2 relates to 'emissions by sources' and to 'removals by sinks. Emission factors for individual geological storage sites may need to be developed.

- ***The Kyoto Protocol*** permits emissions trading between Annex I Parties, where a Party has not exceeded its full assigned amount for a given commitment period. The relationship of CO_2 capture and storage to present and future Kyoto commitments and to emissions trading under the Kyoto Protocol requires substantial discussion and clarification.

- ***The EU Monitoring Guidelines*** define 'installation' as a stationary technical unit and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution, as defined in the Directive'. It is not clear under whether or under what circumstances the boundaries of an 'installation' for a particular activity could extend to related geological storage activities.

- ***The EU Environmental Liability Directive*** places strict liability on 'operators' for the prevention and remediation of environmental damage to protected species, natural habitats, water or land resulting from a range of listed 'occupational activities'; fault-based liability exists for damage to protected species and natural habitats resulting from non-listed occupational activities. Listed activities include the operation of installations with IPPC permits, waste management operations (including the collection, transport, recovery and disposal of waste, supervision of these operations, after-care of waste disposal sites subject to permit under the Waste Directive, and operation of landfill sites under the Landfill Directive). Listed 'occupational activities' also include the discharge of pollutants into groundwater under the Water Framework Directive. Clarification may be needed as to when and which CCS activities fall within these occupational activities (e.g., is CO_2 considered a 'waste'? is a geological storage site a 'landfill'?)

- ***The EU Environmental Liability Directive*** provides for certain exonerations from liability, including where an emission or event is authorized by permit. Appropriate permit conditions would need to be developed to address CCS activities and to minimise the risk of environmental damage. Appropriate financial security for CCS activities and for operators of geological storage sites would re-

quire consideration. Systems would be needed to monitor the sources of injected CO_2, as multiple operators might be potentially liable for environmental damage resulting from emissions, particularly where installations in various Member States contribute CO_2 to a single geological site.

B. Information on long-term impacts, site conditions and leakage rates

The lack of information on the long-term impacts of CO_2 storage on the environment, the absence of information on the storage effectiveness of particular sites, and absence of information on the potential human and environmental impacts of accidental releases from pipelines and individual storage sites, all present barriers to large-scale CCS activities. The precautionary principle requires that conservative measures be taken where scientific knowledge is not complete.

Many of the legal frameworks reviewed require information on site conditions and impacts in conjunction with the issuance of permits, or in conjunction with environmental assessments if there is a likelihood of significant environmental impacts. Substantial information is needed to issue a permit with appropriate permit conditions. Substantial information is also needed to determine that there is not a likelihood of significant environmental impacts. For example, under the Waste Directive, any establishment undertaking waste disposal operations into landfills, deep injection into wells, salt domes or naturally occurring repositories must have a permit. If the intended method of disposal is unacceptable from the point of view of environmental protection, permits may be refused. Information may need to be gathered on best available technology, or best environmental practices in order to develop appropriate permit conditions. Permits are also required for dumping of wastes at sea, and from land-based sources (London Protocol, OSPAR Convention, Barcelona Convention) and different considerations may apply under different regimes.

In addition to permit conditions, permitting also requires consideration of appropriate fees, decisions as to the timeframe for permitting, and the identity of the appropriate permit holder.

C. Criteria for monitoring and reporting

The lack of existing criteria for monitoring and reporting captured and stored CO_2 presents a barrier to large-scale CCS activities.

For example, the EU's Monitoring Guidelines for the reporting of GHG emissions under the Emissions Allowance Trading Directive allow Member States to submit interim guidelines for the monitoring and reporting of CO_2 capture and storage to the Commission for approval. Subject to approval, the capture and storage of CO_2 may be subtracted from the calculated level of emissions from installations covered under the Directive in accordance with those guidelines. However, it is not clear how any interim guidelines that are submitted by Member States are to be reviewed by the Commission.

Monitoring will need to be done for three major purposes: (1) to protect health and safety by confirming the integrity of the reservoir; (2) for public confidence; and (3) to provide data in support of accounting for GHG emissions, to verify credits for CO_2 emission reductions.[23]

Closely related to monitoring are issues of site ownership and responsibility. Is the reservoir and pore space privately or publicly owned?[24] Might transboundary migration occur? If the government has ownership of the reservoir and the pore space, and takes responsibility for reporting under the Kyoto Protocol, does it assume some of the liability for leakage? Should there be any retained liability on the part of the generator, shipper or site operator?[25]

What should the timeframe be for monitoring and recordkeeping? What are the cost implications of long-term monitoring? How is leakage to be accounted for, if different storage sites exhibit different storage effectiveness? Over what timeframe should baseline data be gathered to be reliable? Many of these questions will have to be answered before accounting systems will be credible.

D. Incentives for employment of technology

The lack of incentives for CO_2 capture and geological storage presents a barrier to large-scale implementation. The main incentives that exist at present are:

- achievement of Kyoto Protocol targets and overarching objective of the UNFCCC
- use in enhanced oil recovery operations and other extractive industries
- financial benefits from CO_2 emissions avoidance (where the per tonne cost of avoidance is competitive with the market price for allowances under the EU ETS, competitive with the cost of other technological approaches to emissions reduction, or competitive with the cost of fines for failure to hold sufficient allowances to cover installation emissions).

Additional incentives that might enable greater use of CO_2 capture and geologic storage technologies include:

- tradable emission reduction credits for captured and stored CO_2
- the imposition of carbon taxes on emitted CO_2
- tax relief for investments in CCS technologies
- funding for scientific research and demonstration projects

The creation of a clear regulatory framework for CCS will allow for the realistic pricing of the costs and benefits of its use, and regulatory certainty will facilitate use of the tech-

[23] Stenhouse, M.J., Wilson, M.; Herzog, H.; Cassidy, B.; Kozak, M.; Zhou, W.; Gale, J. "Regulatory Issues Associated With Deep (Geological) CO_2 Storage" GHGT7, Vancouver, 2004
[24] Id.
[25] Compare the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) established under U.S. law.

nology in cost effective situations. However, in view of the polluter pays principle, and the precautionary principle, the calculation of the cost of CCS should encompass related externalities. These include:

- any additional risks to human health and the environment from use of the technology
- costs of additional emissions resulting from the CCS process itself (including transport, the manufacture, transport and laying of pipelines, shipping, injection)
- life-cycle cost to the environment of the materials and technologies used (manufacture and installation of technologies and materials used)
- costs of monitoring and administering a regulatory system for CO_2 geological storage sites.

E. Policy Issues and concerns

A significant barrier to CO_2 capture and storage is the important political and practical issue of whether the avoidance of emissions to the atmosphere through long-term geological storage should be treated as equivalent to emissions reduction at the source. A sound policy justification would have to be made for this treatment.

A related issue is whether continuing process emissions of CO_2, and the increase in CO_2 process emissions that CO_2 capture and storage will enable, is actually consistent with the objectives of the UNFCCC and other conventions that contemplate the prevention and reduction of pollution at the source, and other conventions and directives that aim at the elimination of wastes and pollution (see, e.g., marine pollution conventions, EU Waste Directive).

Arguments can be made both for and against CCS, based on principles of sustainable development, intergenerational equity, and the precautionary principle. At the same time, it can be argued that these same principles weigh in favour of narrowly restricting the instances in which CCS may be used, in order to create incentives for mitigation of process emissions, and to drive the uptake of cleaner technology. The issue of best environmental practices and best available technologies, and how they may relate to CCS activities does not appear to have been addressed.

There is also a need for an open discussion on the hazards posed to humans and to the environment by CCS technology, activities and siting, and an open discussion on liability associated with these risks, where CCS technology is employed and large volumes of CO_2 are involved.

F. Liability

The absence of an appropriate liability regime for CCS presents a barrier to its large-scale implementation.

For example, the Lugano Convention addresses liability for the operation of a site for the permanent deposit of waste. If injected CO_2 is considered 'waste' (which is not defined under the Lugano Convention), then the Lugano Convention is potentially applicable. However, that Convention is not in force, and it has been suggested by some that it is not likely to come into force.[26] This may require consideration of other alternatives tailored to the circumstances of CCS activities.

Within the EU, the Environmental Liability Directive covers damage to protected species and natural habitats, water damage and land damage. But it does not address 'climate' liability for the air pollution occasioned by leakage of CO_2 from geological storage sites where a financial benefit from reduced emissions may have already been given under the Emissions Allowance Trading (EAT) Directive. 'Remedial measures' under the Environmental Liability Directive do not clearly address these issues. The Environmental Liability Directive also does not impose liability if more than 30 years have passed since the emission, event or incident resulting in the damage has occurred.

The operationalisation of the polluter pays principle in the context of CCS activities requires consideration of who, among a variety of potentially responsible parties, should bear the financial burden of:

- damage to human health and the environment from accidental releases of CO_2
- undertaking the costs of prevention of pollution from CCS
- the costs of control measures for CCS
- monitoring the integrity of geological storage sites
- reporting on the integrity of geological storage sites
- accounting for potential and actual emissions from storage sites
- the costs of reducing damage from CCS, should a leak occur
- the costs of remediating damage from CCS, should a leak occur
- administrative costs of managing databases including site information, release information and providing this information to the public.

Liability for damage caused to human health and the environment by CCS should be placed on the polluting party. Those undertaking CCS activities should also be exposed to liability in the event of leakage causing transboundary environmental damage. It has been said that there are three sources of liability associated with CCS.[27]

- Operational liability – associated with CO_2 capture, compression, transportation and injection.
- In situ liability – associated with potential public health impacts and environmental and ecosystem damage as a result of CO_2 leaking from the geological storage reservoir back to the surface.
- Climate liability – associated with leakage under a future regulatory regime controlling CO_2 emissions.

[26] Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 933.
[27] Stenhouse, M.J., Wilson, M.; Herzog, H.; Cassidy, B.; Kozak, M.; Zhou, W.; Gale, J. "Regulatory Issues Associated With Deep (Geological) CO_2 Storage" GHGT7, Vancouver, 2004

There are many examples of ways in which a new liability regime for CO_2 capture and storage could be structured. The choice of mechanism will affect the cost of CCS, and affect public perceptions of the safety of geologic storage.

Consideration will have to be given to the *types of damage* to which operational liability might attach. These may include public health impacts, environmental and ecosystem damage. Although CO_2 is safe and non-toxic at low concentrations, and does not directly affect human health, CO_2 is denser than air and may accumulate in low-lying confined or poorly ventilated spaces. At high enough concentrations, this can lead to fatal consequences from asphyxiation.[28] Significant leaks could also lead to environmental or ecosystem damage, including soil acidification or suppression of respiration in the root zone.[29] In this regard, damage to protected species and natural habitats, land damage and water damage will be addressed under the Environmental Liability Directive.

With respect to leakage from long-term storage, consideration will have to be given to whether a *strict liability* system should apply, a *negligence-based* system, or some *combination* to various types of damage. In an effort to impose costs on the entity most able to control risk, many existing international compensation and liability regimes use strict liability to hold an entity liable for the harm that its activity causes, regardless of whether reasonable care is used.[30] This application of the polluter-pays principle is seen often in regimes that impose strict liability on operators involved in hazardous activities or involved in the transportation or handling of dangerous or hazardous substances. The Lugano Convention, for example, channels liability to the operator of a permanent storage facility, and classifies this operation as a 'dangerous activity.'

The Environmental Liability Directive uses strict liability for environmental damage from listed occupational activities, and applies fault-based liability to damage from non-listed activities. For example, strict liability is imposed upon operators of waste disposal sites and landfills. Operators may be required to maintain insurance or other financial guarantees to satisfy claims for damages resulting from their activities up to an established limit of liability. Multiple party causation is permitted under the Directive through national regulation. Where CO_2 is collected from a number of generators, a system of joint and several liability may be appropriate. As explained in Section 3.6 and in Appendix 2, the Directive addresses certain forms of environmental damage (aspects of operational and in-situ liability), but has limitations in the context of long-term geological storage activities and does not address 'climate' liability.

Where strict liability is applied for environmental damage and other forms of injury, international regimes display a range of ways of establishing limitations on this liability. These systems reflect different ways of measuring potential risk from a dangerous activ-

[28] Id.
[29] Id.
[30] Id.

ity *ex-ante* (e.g., volume handled, toxicity, activity, characteristics of operators). They also reflect value judgments about appropriate burden sharing in each context, since primary limits of liability directly affect the amount of risk to be retained by victims and/or their governments as insurers of last resort.

Liability for certain CCS activities or certain forms of damage from these activities may need to be addressed at the international level, national level, industry level, and/or corporation level. It may also need to be shared over a number of levels, as is done with the oil spill conventions, the HNS Convention and the nuclear regime, which utilize layering to share the risk between beneficiaries of risky activities, corporations, states and the international community. Appropriate limitations on liability may warrant consideration in the context of geological storage. Joint and several liability may also warrant consideration where CO_2 is comingled from a variety of sources.

G. Recordkeeping

A system will need to be created to address ownership and responsibility issues, and for the purposes of public access to information. This may involve the mapping of geological storage sites, and their relationship one to another, to ensure that drilling does not impact other existing or potential storage sites. For public information purposes, and for the avoidance of accident hazards, mapping may need to include the proximity of carbon capture, transport and storage sites to protected areas and to areas of significant population.

The system may also involve the tracking of ownership issues related to the CO_2 stored within these sites. This will be important if generator liability is desirable, and joint and several liabilities for releases from storage sites is anticipated.

A timeframe will also need to be established for recordkeeping in conjunction with the CO_2 deposited at storage sites, and a central repository for this information. This raises further issues, including the identity of the administrative body that will maintain these records, and the level (national? regional? international?) at which these records will be maintained.

H. Choice of regulatory system

The development of a framework to address CCS issues could take two basic forms. It could be a new stand-alone framework that addresses the unique aspects of CCS. Alternatively, CCS issues could be integrated into existing regulatory frameworks though amendment of these frameworks, or through agreed interpretations, decisions or guidance documents.

The adaptation of existing EU frameworks that are relevant to CO_2 capture and storage may in some ways reflect a natural extension of these frameworks. However, for interna-

tional and regional conventions, the amendment process may be time consuming and challenging, and depend upon the political dynamics of each convention process.

A stand-alone framework may be easier to draft, amend and update as new information becomes available or as policy changes. It may also be more transparent. However, if a new framework is to be created, areas of overlap with existing structures will need to be identified so that CCS issues can be excluded from their coverage as appropriate, and suitable cross-references to existing frameworks made.

Table 11. Summary of significant legal barriers and gaps in existing international and EU frameworks related to CO_2 capture, transport and storage

Legal Regime	Barriers
London Convention	Prohibits the dumping 'at sea' of 'industrial wastes. 'Industrial waste' includes 'waste materials generated by manufacturing or processing operations.' Prohibits the deliberate disposal CO_2 directly into marine waters. Does not define 'at sea' or expressly mention the sub seabed.
London Protocol	Dumping of 'industrial wastes' is prohibited. The deliberate disposal ('dumping') into the 'sea' of wastes from vessels or man-made platforms is prohibited. 'Sea' includes 'seabed and subsoil thereof', but does not include 'sub-seabed repositories accessed only by land.' Thus geologic storage by injection from vessels or manmade platforms at sea, directly into sub-seabed repositories is prohibited; injection of CO_2 by pipeline from a land-based source to a sub-seabed repository is not prohibited. This distinction in treatment between storage in repositories accessed only by land, and those accessed by water, warrants a risk-based explanation.
OSPAR	Placements with different impacts on the environment may not be distinguished (e.g., placement in the water column and placement in underground strata - if they occur by pipeline under Annex I) Different methods of placement with same impact may be treated differently (e.g., placement from a specially-built structure at sea linked to land by a pipeline is permissible under Annex I; placement from a vessel equipped with special equipment is prohibited under Annex II). Makes a distinction between placement from offshore installations of arisings from offshore activities (oil and gas activities) (permissible under Annex III), and placement of non-offshore arisings from offshore installations (permissible only for enhancing hydrocarbon production under Annex III). Scope of the phrase 'placement of matter for a purpose other than the mere disposal thereof' warrants clarification in the context of CCS activities, where storage is to be of indefinite duration. Methods and purposes of 'placement' do not necessarily reflect risk. Requires a means to monitor and assess the quality of the marine environment in the context of CCS activities. BAT and BEP required, to emphasize non-waste technology and a graduated range

	of measures.
UN Framework Convention on Climate Change	Requires national inventory of emissions by sources and removals by sinks of GHGs. Captured and stored CO_2 is not clearly an 'emission by source' or 'a removal by sink.' The definition of reservoir is relevant, but unexplored. Means of monitoring, reporting and accounting for stored CO_2 is needed.
Kyoto Protocol	Permits emissions trading between Annex I Parties where a Party has not exceeded its full assigned amount. Clarification is needed on whether captured CO_2 represent an emission reduction or the temporary storage of emissions.
EU Waste Framework Directive	Excludes from coverage only 'gaseous effluents emitted into the atmosphere.' Where CO_2 is captured prior to emission into the atmosphere, and intended for disposal, CO_2 falls within the scope of the Directive as regulated waste.
EU Landfill Directive	Prohibits the landfilling of 'liquid waste'. CO_2 is likely to be injected into a liquid form.
EU Water Framework Directive	Permits injection of natural gas and liquid petroleum gas into geological formations. Contains no similar express reference to CO_2.
EU Monitoring Guidelines	Define 'installation' as a stationary technical unit...and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution, as defined in the Directive'. It is not clear whether the boundaries of an 'installation' for a particular activity could extend to related geological storage activities.
EU Environmental Liability Directive	Provides for strict liability on 'operators' for environmental damage resulting from listed 'occupational activities' as well as fault-based liability for non-listed activities. Clarity on the regulatory treatment of CCS activities ('waste management?) will facilitate application of the Directive. Does not adequately address environmental impact or economic damage where a release occurs, but credit has already been earned from reduced emissions. Consideration is needed for limits of liability, duration of liability, joint and several liability, and suitable financial guarantees.
GAPS PRESENTING ADDITIONAL BARRIERS	
Information on long term impacts is needed to establish appropriate permit conditions	
Information on site conditions and leakage rates is needed to establish appropriate permit conditions	
Criteria for monitoring and reporting is needed	
Incentives for employment of technology are needed	
Recordkeeping systems are needed	
A liability system tailored to CCS activities is needed	
Accounting system needed	

3.6. Recommendations on technical and legal approaches to address the risks of carbon dioxide capture and geological storage projects.

This section considers technical and legal approaches to address the risks of carbon dioxide capture and geological storage projects in three areas:

A. requirements for adequate accounting for the storage of carbon dioxide;
B. liability in the event of leakage; and
C. requirements to avoid environmental and safety risks.

A. Adequate Accounting for CO_2 Storage

If CO_2 capture and storage is to be used to meet Kyoto Protocol commitments, a system will need to be devised to account for emissions prevented, controlled or avoided through CCS activities, as these prevented, controlled or avoided emissions will not be equivalent to the elimination of process emissions at the source.

If credits from CCS projects are to be credited toward a Party's compliance with its Kyoto commitments, the nature of these credits must be determined. Are they tradable, and if so, at what value? Should they be treated as temporary reductions, or discounted to account for permanence issues? If CCS projects are to be eligible for the CDM and JI, how are permanence, additionality and sustainable development criteria to be evaluated?[31]

Any accounting system must take into consideration that:

- **The technology chosen for a CCS project may be different from the most efficient technology otherwise chosen**. If emissions avoided due to CCS are to qualify for emission allowance trading, a baseline methodology, and issues of additionality must be considered and resolved.[32]
- **Additional emissions result from the processes of carbon capture, transport and injection**. Processes for carbon capture from facilities generating the gas, followed by compression, transport, and final disposal, all require substantial energy and CO_2 penalties themselves, raising additionality issues.[33] Existing national GHG inventory systems may pick some of these emissions up; some may not.

[31] De Coninck, H.C. "Project – Based Kyoto Mechanisms and CO_2 Capture and Storage" Energy Research Centre of the Netherlands (ECN).
[32] Id.
[33] Id.; Johnston, P., Santillo; D., Stringer, R.; Parmentier, R.; Hare, B., Krueger, M., "Sequestration of Carbon Dioxide from Fossil Fuel Production and Use: An Overview of Rationale, Techniques and Implications, "Greenpeace Research Laboratories, Technical Note 01/99 (March 1999).

- **Storage permanence**. A factor is needed for storage effectiveness.[34] Physico-chemical impacts of the introduction of high pressure CO_2 on formation chemistry and physical integrity are not certain, and the dissolution of some rock types may be expected.[35]
- **Leakage may occur into different media.** Leakage might occur into the atmosphere, into the marine environment, or into other sites.[36] Certain forms of leakage present greater risks to the atmosphere, or to health and safety. Leakage that occurs laterally into other sites, as a result of drilling operations that connect otherwise isolated formations, creates further accounting problems.[37]

Responsibility for accounting must also be considered. Is accounting to be done by the operator of a reservoir site, or by the generator of the stored emissions? Who accounts, and where is this reported? If an installation is required to report on its emissions, and has no control over the site into which its CO_2 is deposited, how does that installation reflect these avoided emissions in its reporting? If there is an escape, how is it traced back to the relevant installation? Is this necessary to provide an incentive for the further reduction of emissions at the installation level? Or, should reservoirs themselves be considered installations, and regulated separately?

An accounting penalty may be needed, representing the loss of value from the loss of storage. This requires decisions on valuation. Should the cost of leakage be valued at the market price of carbon at the time of escape? Or at the per tonne cost of CCS, which is likely to be higher? Should a discount rate be applied representing for the time the CO_2 was held back from the atmosphere? How does the timeframe for this calculation relate to commitment periods under the climate regime?

B. Liability in the event of leakage

There are many examples of ways in which a liability regime for CO_2 capture and storage could be structured. The choice of mechanism will affect the cost of CCS, and affect public perceptions of the safety of geologic storage.

The design of any liability system involves value judgments not just about scale of risk, but about the identity of the liable party, and appropriate burden sharing: how much risk should be left with the operator and how should be borne by potential victims, taxpayers, beneficiaries of inherently risky activities, or by the international community as a whole? Where conventions use supplemental funds to backstop operator liability, decisions must

[34] De Coninck, H.C. "Project – Based Kyoto Mechanisms and CO_2 Capture and Storage" Energy Research Centre of the Netherlands (ECN).
[35] Johnston, P., et al., "Sequestration of Carbon Dioxide from Fossil Fuel Production and Use: An Overview of Rationale, Techniques and Implications,"Greenpeace Research Laboratories, Technical Note 01/99 (March 1999).
[36] Id.; Stenhouse, M.J., Wilson, M.; Herzog, H.; Cassidy, B.; Kozak, M.; Zhou, W.; Gale, J. "Regulatory Issues Associated With Deep (Geological) CO_2 Storage" GHGT7, Vancouver, 2004
[37] Johnston, P., et al., "Sequestration of Carbon Dioxide from Fossil Fuel Production and Use: An Overview of Rationale, Techniques and Implications," Greenpeace Research Laboratories, Technical Note 01/99 (March 1999).

also be made about how inclusive to make contributions, and whether to leave out small players and discount small risks.

Liability may be addressed at a number of levels – at the international level, national level, industry level, or corporation level. It can also be shared over a number of these levels (as is done with the oil spill conventions, the HNS Convention and the nuclear regime) through the tiering of liability layers, to share the risk between beneficiaries of risky activities, corporations, states and the international community.

International liability and compensation regimes each have various ways of measuring potential risk from a dangerous activity ex-ante, for purposes of establishing limits on strict liability for operators. Some regimes look to the characteristics of individual operators (HNS Convention, Basel Protocol, Watercourses and Industrial Accidents Protocol). Some establish minimum or maximum limits of liability and defer to member States to address further differentiation if they so choose (Basel). Some use layers of responsibility. Some relate limits of liability to the various types of damage that may be caused (CRTD).

The ***Basel Liability Protocol*** and ***HNS Convention*** use limits of liability linked to the ***amount*** of regulated substance shipped, as an indicator of the potential damage that might be caused by an accidental spill or release. The Basel Liability Protocol's limits of liability are determined by domestic law, but *minimum* limits of liability are established for any one incident, correlated to risk based on tonnes of waste shipped and the role of the responsible party (notifier, exporter, importer, disposer) as set out below.

Basel Liability Protocol – Limits of Liability

Tonnes of waste shipped	Minimum Limit of Liability for Notifier, Exporter, Importer for single incident (million SDR)	Minimum Limit of Liability for Disposer for single incident (million SDR)
up to 5	1	2
> 5 - 25	2	2
> 25 -50	4	2
> 50-1,000	6	2
>1,000-10,000	10	2
>10,000	Plus add'tl 1,000 SDR per tonne up to 30 million SDR max	2

The HNS Convention calculates limits of liability similarly. For ships not exceeding 2,000 gross tonnes, the limit is set at 10 million SDR. For ships above that tonnage, an additional 1,500 SDR is added for each tonne from 2001 to 50,000, and 360 SDR for each tonne in excess of 50,000. When an incident occurs where compensation is payable, compensation is first sought from the shipowner, up to the maximum limit of 100 million SDR. Once this limit is reached, compensation is paid from the second tier, the HNS Fund, up to a maximum of 250 million SDR, which includes compensation paid under the first tier. Contributions to HNS Fund are levied on persons in the Contracting States who receive a certain minimum quantity of HNS cargo during a calendar year. The HNS Fund, when in place, will consist of one general account and three separate ac-

counts for oil, liquefied natural gas (LNG) and liquefied petroleum gas (LPG). This separation of accounts is done to avoid cross-subsidization between different HNS substances.

HNS Convention – Limits of Liability		
Gross tonnage of vessel	Shipowner liability (million SDR)	Limit of compensation available from HNS Fund (million SDR)
up to 2,000 >2,000 – 50,000 >50,000	10 - Plus addt'l 1500 SDR for each unit of tonnage - Plus addt'l 360 SDR for each unit of tonnage up to 100 million	250 250 250

The Watercourses and Industrial Accidents Protocol limits liability by reference to the quantity of hazardous substances present at an industrial facility, and the type or toxicity of those substances. Limits of liability take into account both the risks posed by the hazardous activities as well as the nature, quantity and properties of the hazardous substances present. These limits are reviewed on a regular basis. The Protocol requires minimum levels of financial security.

In contrast to regimes that use volume of waste or cargo shipped as an indicator of potential harm, the ***CRTD Convention*** limits liability by type of injury potentially suffered. The liability of the *road or rail carrier* is limited for claims arising from any one incident to 18 million SDR with respect to claims for *loss of life or personal injury,* and 12 million SDR with respect to *any other claim*. The liability of the carrier by *inland navigation vessel* for claims arising from any one incident is limited to 8 million SDR with respect to claims for loss of life or personal injury, and 7 million SDR with respect to any other claim.

These systems may suggest approaches for the establishment of financial guarantees for accidental releases related to CCS activities.

C. Requirements to avoid environmental and safety risks

The risks associated with capture, compression and transport have many similarities with current practise in the (chemical) industry and are in many cases covered by present legislation. The associated risks are well established in the process industry, although typically much larger volumes are targeted in CCS operations. For the processing industry ISO and OHRAS standards provide assurance that environment, safety, health and quality management systems are in place (see also section 2.3).

The specific mode of transport (pipeline, ship, truck) and specific form in which CO_2 is transported will affect the risk of environmental damage and human health impacts from accidental releases. The route is also important because risks may vary on for instance route condition, and population density around the route. It is therefore important that

legislation addresses these different circumstances and that the responsibility of the many parties involved are clearly defined (see further section 2.3.2 ('regulation of CO_2 pipelines) and section 3.4 (subsections E and F)).

The subsurface portion is, in contrast to capture and transport, highly incomparable to existing activities and it is likely that existing legislation have to be adapted or new legislation have to be developed to reduce environmental and safety risks. Exceptions might be the application of carbon dioxide in enhanced oil recovery, which is current practise in some regions of the world.

Injection of carbon dioxide leads towards an increased pressure in the reservoir zone and consequently could affect the integrity of the overlying seal. Furthermore, carbon dioxide is a reactive substance when dissolved in formation water, which might lead to increase of permeability of the reservoir. Existing standards for underground gas storage (UGS) in Europe might also be applicable to storage of CO_2 if the specific physico-chemical properties are taken into account. See Table 6 on page 16 for a summary of risks and possible remediation actions.

During injection corrosion of injection equipment is one of the main reasons of leakage of CO_2. Formation of hydrates and ice may cause stresses and may block valves and the injection equipment. See Table 5 on page 15 for a summary of risks and possible remediation actions.

A useful tool for addressing environmental and safety risks resulting from CCS activities is the application of an Environmental Risk Assessment (ERA). The ERA is the examination of risks resulting from CCS technology that threaten ecosystems, animals and people. It includes human risks assessments, ecological or eco-toxicological risk assessments, and specific industrial applications of risk assessment that examine end-points in people, biota or ecosystems.

The risk assessment may include an evaluation of what the risks mean in practise to those affected. This will depend heavily on how the risk is perceived. Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable".

Risk assessment is one of the principal components of risk management in general. In performing a risk assessment, site-specific data are needed as well as a clear understanding of the storage concept and a description of the technical design.

The outcome of the risk assessment provides insight into critical risk factors that need to be monitored and for which a remedial action plan should be developed. In brief, risk management consists of the following phases:

1. site characterisation and technical design
2. risk assessment including the definition of the assessment basis
3. development of monitoring plan and design of monitoring system
4. development of suite of potential remedial actions

Table 10 on page 21 presents a list of areas in which legislation should address local risks from CO_2 releases from capture, transport and injection and global risks from CO_2 release from reservoirs. Important issues are safety procedures and monitoring requirements, material standards, reservoir requirements, operational requirements and future activities in the storage area.

3.7. Conclusions

1. Many international, regional and EU legal frameworks are relevant to Carbon dioxide Capture and Storage (CCS) activities and many definitions and prohibitions within these frameworks are sufficiently broad to encompass and regulate various CO_2 capture and geological storage activities.
2. Only a few of the frameworks reviewed (notably the UNFCCC, Kyoto Protocol and the EU's Monitoring and Reporting Guidelines) explicitly address CCS activities and either include them or exclude them from their scope. Clear inclusion or exclusion will increase transparency, provide regulatory certainty, and facilitate CCS activities and methodologies that are agreed to be consistent with international, regional and EU frameworks
3. International legal frameworks are particularly relevant in the context of potential transboundary impacts, and transboundary transport and offshore storage activities.
4. The creation of a clear regulatory framework for CCS will allow for the realistic pricing of the costs and benefits of its use, and regulatory certainty will facilitate use of the technology in cost-effective situations. However, in view of the polluter pays principle, and the precautionary principle, the calculation of the cost of CCS should encompass related externalities.
5. The lack of information on the long-term impacts of CO_2 storage on the environment, the absence of information on the storage effectiveness of particular sites, and absence of information on the potential human and environmental impacts of accidental releases from pipelines and individual storage sites, all present barriers to large-scale CCS activities. The precautionary principle requires that conservative measures be taken where scientific knowledge is not complete.
6. Substantial information is needed to issue a permit with appropriate permit conditions. Substantial information is also needed to determine that there is not a likelihood of significant environmental impacts from CCS activities undertaken in particular locations.
7. Monitoring will need to be done for three major purposes: (1) to protect health and safety by confirming the integrity of the reservoir; (2) for public confidence; and (3) to provide data in support of accounting for GHG emissions, to verify credits for CO_2 emission reductions. The lack of existing criteria for monitoring and reporting captured and stored CO_2 presents a barrier to large-scale CCS activities.
8. A significant barrier to CO_2 capture and storage is the important political and practical issue of whether the avoidance of emissions to the atmosphere through long-term geological storage should be treated as equivalent to emissions reduction at the source. A sound policy justification would have to be made for this treatment.
9. The absence of an appropriate liability regime for CCS presents a barrier to its large-scale implementation.
10. A system will need to be created to address ownership and responsibility issues, and for the purposes of public access to information. The system may also involve the tracking of ownership issues related to the CO_2 stored within these sites.
11. The development of a framework to address CCS issues could take two basic forms. It could be a new stand-alone framework that addresses the unique aspects

of CCS. Such a framework could be created either outside or within an existing legal framework. Alternatively, CCS issues could be integrated into existing regulatory frameworks though amendment of these frameworks, or through agreed interpretations, decisions or guidance documents. A stand-alone framework may be easier to draft, amend and update as new information becomes available or as policy changes. It may also be more transparent.

12. To facilitate rapid implementation of CCS activities, a distinction needs to be made between CCS used for demonstration or scientific purposes, and CCS undertaken as a commercial activity.

4. References

AER (2004) 'Geosequestration - some regulatory and legal issues', Australian Environment Review, vol. 19, no. 9, p. 5 - 9, October 2004

AETF (2004) 'Australasian Emissions Trading Forum (AETF), Review "Australia vs the Kyoto Protocol", Oct/Nov 2004

Arts (2004) 'Recent time-lapse seismic data show no indication of leakage at the Sleipner CO_2 injection site', R. Arts, A. Chadwick, O. Eiken, Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies, Vancouver, Canada, September 2004

Bradshaw (2004) 'Storage retention time of CO_2 in sedimentary basins; examples from petroleum systems', J. Bradshaw, C. Boreham, F. la Pedalina, Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies, Vancouver, Canada, September 2004

Chiodini (1999) 'Quantification of deep CO_2 fluxes from central Italy: examples of carbon balance for regional aquifers and of soil diffuse degassing', G. Chiodini, F. Frondini, D.M. Kerrick, J. Rogie, F. Parello, L. Peruzzi, A.R. Zanzari, Chemical Geology, Vol. 159, 205 - 22, 1999

CMLR (1994) R V Secretary of State for Trade & Industry ex parte Greenpeace [2000] 2 CMLR", 1994

Daniel (2003) 'Civil Liability Regimes as a complement to Multilateral Environmental Agreements: Sound International Policy or False Comfort?', A. Daniel, RECIEL 12(3) (2003)

De Coninck (2004) 'Project – Based Kyoto Mechanisms and CO_2 Capture and Storage", H. de Coninck, Energy Research Centre of the Netherlands (ECN), Greenhouse Gas Technology Conference GHGT7, Vancouver, 2004

DNV (2003) 'Risk analysis of the geological sequestration of carbon dioxide', M. Vendrig, J. Spouge, A. Bird, J. Daycock, O. Johnsen, DTI report no. R246, 2003

DTI (2003) 'Review of the Feasibility of Carbon Dioxide Capture and Storage in the UK', DTI, Cleaner Fossil Fuels Programme (2003)

DTI (2003) 'Report of DTI International Technology Service Mission to the USA and Canada from 27th October to 7th November 2002', DTI, Advanced Power Generation Technology Forum, February 2003

Edenhof (2004) 'A Regulatory Framework for Carbon Capturing and Sequestration within the Post-Kyoto Process', Edenhofer, O., Held, H., Bauer, N., PIK – Potsdam Institute for Climate Impact Research, 2004

EGPIG (1995) European Gas Pipeline Incident Group, Pipes and Pipelines, July - August 1995

Espie (2004) 'Understanding risk for the long term storage of CO_2 in geological formations'. T. Espie, Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies, Vancouver, Canada, September 2004

FNI (2001) 'Legal Aspects of Underground CO_2 Storage: Summary of Developments under the London Convention and North Sea Conference', Fridtjof Nansen Institute, 2001

Gale (2002) 'Transmission of CO_2 - safety and economic considerations', J. Gale, J. Davison, Proceedings of the 6th International Conference on Greenhouse Gas Control Technologies, Kyoto, Japan, October 2002

Gallo (2004) 'Assessing the risks of geological storage of CO_2 in mature oil fields', Y. Le Gallo, J.M. Ketzer, B. Carpentier, Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies, Vancouver, Canada, September 2004

Guruswamy (1997) 'International Environmental Law in a Nutshell', Guruswamy, L.D. and Hendricks, B.R., West Publishing Co., 1997

Hendriks (2003) 'EC - Case Carbon Dioxide Sequestration," Hendriks, C., Wildenborg, T., Feron, P., Graus, W., Bransma, R., ECOFYS, December 2003

Hovey (1999) D.J. Hovey, E.J. Farmer, Oil and Gas Journal, 213, 1, 41-44, 1999

IEA (2004) 'Legal Aspects of Storing Carbon Dioxide – draft discussion', International Energy Agency, 2004

IMO (2004) 'Report of the Twenty Sixth Consultative Meeting of the contracting parties to the convention on the prevention of marine pollution by dumping of wastes and other matter 1972", International Maritime Organisation ,LC 26/15 at 21, 2004

Jans (2000) 'The Habitats Directive', Jans, J., Journal of Environmental Law, Vol 12 No 3, OUP 2000, p. 386

Johnston (1999) 'Sequestration of Carbon Dioxide from Fossil Fuel Production and Use: An Overview of Rationale, Techniques and Implications', Johnston, P., Santillo; D., Stringer, R.; Parmentier, R.; Hare, B., Krueger, M., Greenpeace Research Laboratories, Technical Note 01/99, March 1999

Kruse (1996) "Calculating the Consequences of a CO_2-Pipeline Rupture", Kruse, H. and Tekiela, M., Energy Conversion Management, 37, Nos. 6-8, pp.1013–1018

Lee (2004) 'Policies and Incentives Developments in CO_2 Capture and Storage Technology: a Focused Survey by the CO_2 Capture Project', Lee, A.; Christensen, D.; Cappelen, F.; Hartog, J.; Thompson, A.; Johns, G; Senior, B.; Akhurst, M., 2004

Lindeberg (2002) 'The long-term fate of CO_2 injected into an acquifer', E. Lindeberg, P. Bergmo, Proceedings of the 6th International Conference on Greenhouse Gas Control Technologies, Kyoto, Japan, October 2002

Purdy (2004) 'Geological carbon sequestration: critical legal issues', Purdy, R.; Macrory, R., Tyndall Centre Working Paper No. 45 (January 2004)

Sands (2003) *Principles of international environmental law*, P. Sands (2nd ed. 2003)

Saripalli (2002) 'Risk and hazard assessment for projects involving the geological sequestration of CO_2', K. Saripalli, N. Mahasenan, E. Cook, Proceedings of the 6th International Conference on Greenhouse Gas Control Technologies, Kyoto, Japan, October 2002

Savage (2003) 'The assessment of the long-term fate of carbon dioxide in geological systems', D. Savage, P. Maul, S. Benbow, M. Stenhouse, Conference "Coping with Climate Change" – The Geological Society, London, March 2003

Sax (1984) 'Dangerous properties of industrial materials', N.I. Sax, 6th edition, an Nostrand Reinhold Company, New York, p. 641, 1984

Spackman (2003) 'Offshore Drilling Pollution Standards Evolving', Spackman, A., *Drilling Contractor*, 2003

Stenhouse (2004) Regulatory Issues Associated With Deep (Geological) CO_2 Storage", Stenhouse, M.J., Wilson, M.; Herzog, H.; Cassidy, B.; Kozak, M.; Zhou, W.; Gale, J., Greenhouse Gas Technology Conference GHGT7, Vancouver, 2004

Streit (2004) 'Estimating rates of potential CO_2 loss from geological storage sites for risk and uncertainty analysis', J.E. Streit, M.N. Watson, Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies, Vancouver, Canada, September 2004

Taberner (2004) 'Geosequestration – Some Regulatory and Legal Issues', Taberner, J.; Dwyer, M.; Back, M., Environment Review 19(9), 2004

Wall (2004) 'International and European Legal Aspects of Underground Geological Storage of CO_2', Wall, C.; Bernstone, C.; Olvastam, M. L., Greenhouse Gas Technology Conference GHGT7, Vancouver, 2004

Walton (2004) 'Geological storage of CO_2: a statistical approach to assessing performance and risk', F. Walton, J. Tait, D. LeNeveu, M. Sheppard, Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies, Vancouver, Canada, September 2004

Wouters (2003/4) 'Analysing the ECE Water Convention: What Lessons for the Regional Management of Transboundary Water Resources?', Wouters, P.; Vinogradov, S., (2003/4)

Yamamoto (2004) 'A risk analysis scheme of the CO_2 leakage from geologic sequestration; simple estimation methodology of leakage from geologic storage of CO_2', K. Yamamoto, O. Kitamura, K. Itaoka, M. Akai, Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies, Vancouver, Canada, September 2004

Appendices

Appendix 1: List of International, Regional and EU Regimes Reviewed

I. INTERNATIONAL AND REGIONAL AGREEMENTS

A. WASTE MANAGEMENT AND TRANSPORT

International Conventions

1. 1989 Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, in force 1992 (Basel Convention)

2. 1999 Protocol on Liability and Compensation for Damage resulting from Transboundary Movements of Hazardous Wastes and their Disposal, not in force. (Basel Liability Protocol)

Regional Conventions

3. 1991 Convention on the Ban of Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, in force 1998 (Bamako Convention)

B. MARINE POLLUTION

International Conventions

4. 1982 United Nations Convention on the Law of the Sea, in force 1994 (UNCLOS)

5. 1973 International Convention for the Prevention of Pollution by Ships, as modified by the 1978 Protocol relating thereto (MARPOL 73/78)

6. 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, in force 1975 (London Convention)

7. 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, not in force (London Protocol)

8. 1959 Antarctic Treaty, in force 1961, and 1991 Protocol on Environmental Protection, in force 1998

Regional Conventions

9. 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)

10. 1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area, in force 2000 (Helsinki Convention)

11. Convention for the Protection of the Mediterranean Sea against Pollution, in force 1978, as amended the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, in force 2004 (Barcelona Convention)

12. 1983 Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, in force 1986 (Cartagena Convention)

13. 1985 Convention for the Protection, Management and Development of the Marine and Coastal Environment of the East African Region, in force 1996 (Nairobi Convention)

14. 1983 Agreement for Co-operation in Dealing with Pollution of the North Sea by Oil and other Harmful Substances, in force 1989

C. CLIMATE CHANGE

15. 1992 United Nations Framework Convention on Climate Change, in force 1994 (UNFCCC)

16. 1997 Protocol to the United Nations Framework Convention on Climate Change, in force 2005 (Kyoto Protocol)

D. TRANSPORT AND LIABILITY

International Conventions

17. SOLAS - 1974 International Convention for the Safety of Life at Sea, in force 1980 and amendment in 2002

18. COTIF - 1980 Convention Concerning International Carriage by Rail, in force 1985

19. CRTD Convention -- 1989 Convention on Civil Liability for Damage caused during Carriage of Dangerous Goods by Road, Rail and Inland Navigation Vessels, not in force

20. HNS Convention - 1996 International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, not in force

21. HNS Protocol -- 2000 Protocol to the OPRC Convention on Preparedness, Response and Cooperation to Pollution Incidents by Hazardous and Noxious Substances, not in force

Regional Conventions

22. ADR Convention - 1957 UNECE Agreement concerning the International Carriage of Goods by Road, in force 1968

23. ADN Convention - 2000 UNECE Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways, not in force

E. ACCESS TO INFORMATION, PUBLIC PARTICIPATION, ACCESS TO JUSTICE

International Conventions

24. Aarhus Convention - 1998 Convention on Access to Information, Public Participation and Decision Making and Access to Justice in Environmental Matters, in force 2001

Regional Conventions

25. Espoo (EIA) Convention - 1991 Convention on Environmental Impact Assessment in a Transboundary Context, in force 1997

26. SEA Protocol - 2003 Protocol on Strategic Environmental Assessment, not in force

F. WATER

27. 1992 UN/ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, in force 1996 (Water Convention)

G. LIABILITY FOR TRANSBOUNDARY IMPACTS

28. 1992 UNECE Convention on the Transboundary Effects of Industrial Accidents, in force 2000 (Industrial Accidents Convention)

29. 1993 UN/ECE Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment, not in force (Lugano Convention)

30. 2003 Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters (Watercourses and Industrial Accidents Protocol)

H. NATURE CONSERVATION

31. 1992 Convention on Biological Diversity

32. 1979 Convention on the Conservation of European Wildlife and Natural Habitats, in force 1982 (Berne Convention)

II. EUROPEAN COMMUNITY LAW

A. WASTE

33. Council Directive 75/442/EEC of 15 July 1975 on waste, as amended by Directive 91/962/EEC of 23 December 1991 (Waste Framework Directive)

34. Council Directive 91/689/EEC of 12 December 1991 on hazardous waste (Hazardous Waste Directive).

35. Council Regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the EC

36. Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC Directive)

37. Council Directive 99/31/EC of 26 April 1999 on the landfill of waste (Landfill Directive)

B. CLIMATE CHANGE AND EMISSIONS TRADING

38. Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants

39. Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC

40. Decision No. 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol, superseding Council Decision 93/389/EEC as amended by Decision 99/296/EC

41. Monitoring Guidelines - Commission Decision of 29 January 2004 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (2004/156/EC) (Monitoring Guidelines)

C. LIABILITY

42. Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage (Environmental Liability Directive)

D. ENVIRONMENTAL IMPACTS ASSESSMENTS, ACCESS TO INFORMATION, PUBLIC PARTICIPATION, ACCESS TO JUSTICE

43. EIA Directive - Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment

44. Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003 providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC

45. SEA Directive - 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment

E. WATER

46. Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community

47. Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances

48. Water Framework Directive - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy

F. MARINE POLLUTION

49. Decision No 2850/2000/EC of the European Parliament and of the Council of 20 December 2000 setting up a Community framework for cooperation in the field of accidental or deliberate marine pollution

50. Regulation (EC) No 2099/2002 of the European Parliament and of the Council of 5 November 2002 establishing a Committee on Safe Seas and the Prevention of Pollution from Ships (COSS) and amending the Regulations on maritime safety and the prevention of pollution from ships

G. TRANSPORT

51. Council Directive 94/55/EC on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road.

52. Council Directive 95/50/EC of 6 October 1995 on uniform procedures for checks on the transport of dangerous goods by road.

53. Council Directive 96/49/EC on the approximation of the laws of the Member States with regard to the transport of dangerous goods by rail.

H. NATURE CONSERVATION

54. Habitats Directive - Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

55. Birds Directive - Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds

I. SITING - ACCIDENT HAZARDS INVOLVING DANGEROUS SUBSTANCES

56. Seveso II Directive – Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances.

Appendix 2: Overview of International and Regional Conventionsand EU Directives Relevant to Carbon Capture and Geological Storage

Table of Contents Appendix 2

I. Overview of international and regional conventions, and EU Directives relevant to carbon capture and geological storage

The following sections provide an overview and analysis of a number of the key international legal frameworks and EU directives relevant to the issues raised by carbon capture, transport and geological storage – in particular, the issues of environmental and human risk and associated liability.

Part II addresses international and regional legal frameworks, grouping these frameworks by thematic area (waste management and transport; marine pollution; climate change; transport and liability; access to information, public participation and access to justice; water; liability for transboundary impacts; nature conservation).

Part III addresses European Community law, again proceeding by thematic area (waste; climate change and emissions trading; liability; environmental impact assessments, access to information, public participation and access to justice; water; marine pollution; transport; nature conservation; siting with respect to accident hazards).

II. INTERNATIONAL LAW

A. WASTE MANAGEMENT AND TRANSPORT

International Conventions

1. Basel Convention, in force 1992

The Basel Convention[38] establishes a global regime for the control of international trade in hazardous wastes and other wastes. The Convention aims to protect human health and minimize the production of hazardous waste through an "integrated life-cycle approach" which involves controls from the generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. The Convention imposes requirements on the documentation and transport of hazardous waste between countries.

The term '*hazardous wastes'* is defined to include: (1) substances listed in Annex I to the Convention that are subjected to transboundary movement, unless they fail to possess any of the hazardous characteristics set out in Annex III; and (2) substances that are defined as hazardous waste under domestic legislation of the country of export, import or transit (Art. 1.1). Parties must inform the Secretariat of wastes they consider hazardous under national law. This provides room for Parties to decide at the national level what constitutes 'hazardous waste'.

'*Other wastes*' include any wastes that belong to any category contained in Annex II (household waste and residues from the incineration of household waste) that are subject to transboundary movement. '*Wastes'* are defined as substances or objects, which are disposed of, intended to be disposed of or required to be disposed of under national law (Art. 2.1).

Based on these definitions, CO_2 may fall within the definition of 'wastes' if regulated under national law. CO_2 falls outside the definition of 'other wastes'. CO_2 also does not appear to be an Annex I 'hazardous waste'. Annex I lists different processes by which waste can be created. None of the listed processes would address CO_2 handled as part of CCS activities (the closest category is "Y18 - Residues arising from industrial waste disposal operations"). Annex I additionally lists chemical compounds that are considered

[38] 1989 Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

hazardous waste. Certain trace substances within liquefied CO_2 may bring it within the ambit of the treaty, but only if hazardous characteristics are present set out in Annex III.[39]

CO_2 could nevertheless fall within the Convention's scope if it were considered as a 'hazardous waste' under national law and notified to the Secretariat. It is unlikely that CO_2 will fall under the Basel Convention's definition of 'hazardous waste' (the EU does not recognize it as such)[40], though it is conceivable that at some point a Party to the Convention may wish to recognize that CO_2, when captured and transported in bulk for long-term storage, poses certain risks, and regulate it as a 'hazardous waste' under national law.

If CO_2 were listed as a '*hazardous waste'*, its disposal and its transboundary movement would be regulated under the Basel Convention. '*Disposal'* is defined as any operation specified in Annex IV. Annex IV includes many provisions applicable to CCS, including deep injection and sea-bed insertion. '*Transboundary movement*' is defined as any movement of hazardous wastes or other wastes from an area under the national jurisdiction of one State to or through an area under the national jurisdiction of another State or to or through an area not under the national jurisdiction of any State, provided at least two States are involved in the movement. '*Management*' means the collection, transport and disposal of hazardous wastes or '*other wastes*', including after-care of disposal sites.

Where hazardous wastes are involved, certain obligations arise before transboundary shipment is permitted. Prior written notification must be given to the relevant authorities of the importing State; each shipment must be accompanied by a movement document from the point of production to the point of disposal; and shipments to some countries are banned outright. See Arts. 4.5, 4.2 (e), 4.9 and 6.

2. Basel Liability Protocol, not in force

The Basel Liability Protocol[41] sets out rules and procedures on liability and compensation for damage resulting from the transboundary movement and disposal of hazardous wastes and other wastes, including illegal traffic. The Protocol clarifies who will be responsible for compensation in the event of an accident. The Protocol channels liability to notifiers, importers, exporters, re-importers and disposers of hazardous and illegal waste, at each phase of transboundary transport. The Protocol would apply (if it were in force) from the moment that wastes are loaded on the means of transport in an area under the jurisdiction of the State of export until their disposal.

[39] One relevant hazardous characteristic in Annex III is "H12 - Ecotoxic - Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems".
[40] See Commission Decision 2000/532/EC of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste and amendments.
[41] 1999 Protocol on Liability and Compensation for Damage resulting from Transboundary Movements of Hazardous Wastes and their Disposal.

Under the Protocol, potentially liable persons are required to establish insurance, bonds, or other financial guarantees during their period of potential liability. *Minimum* limits of liability are established, with these limits based on tonnes of waste shipped. This ranges from 1 million SDR for a shipment of up to 5 tonnes of waste, to 30 million SDR for a single incident involving a shipment of 30,000 or more tonnes. Limitations also vary based on the role of the responsible party as notifier, exporter, importer or disposer. *Maximum* limits of liability are to be set at the national level.

If damage occurs, claims must be brought within 5 years from when the claimant knew or ought reasonably to have known of the damage, but in any case no more than 10 years from the date of the incident. The Protocol contains provisions on the relevant national remedies, provisions on conflict of laws, competent courts and enforcement of court decisions.

There is exoneration from liability where damage is caused by armed conflict, hostilities, civil war or insurrection, *a natural phenomenon of exceptional, inevitable, unforeseeable and irresistible character*, or as a result of compliance with a compulsory measure of a public authority of the State where the damage occurred, or of the wrongful intentional conduct of a third party. Where many persons are liable, they are jointly and severally liable.

Fault-based liability also exists for any person who caused damage or contributed to damage through a lack of compliance with the Convention or by intentional wrongful, reckless or negligent acts or omissions (Daniel:230). If the financial guarantees established do not provide sufficient coverage, or where exonerations apply, unlike some other international conventions, the Basel Protocol does not provide for an international compensation fund to address damage (Daniel:230).

Regional Conventions

3. Bamako Convention, in force 1998

The Bamako Convention[42] is similar to the Basel Convention in that it regulates the transport of hazardous waste, within the African continent. The definitions of hazardous waste are identical to those under Basel, and therefore it is unlikely that this treaty will impact CO_2 transport/storage. The Convention is limited to member States of the African Union.

Article 2 defines "hazardous waste" to include:

- substances listed in Annex I (which combines Annexes I and II to the Basel Convention)
- substances defined as hazardous waste under domestic legislation
- substances which possesses any of the characteristics contained in Annex II, and

[42] 1991 Convention on the Ban of Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa.

- hazardous wastes that have been banned, cancelled or refused registration by government regulatory action or voluntarily withdrawn.[43]

Annex I lists the same processes and chemical compounds listed in the Basel Convention. Annex II lists hazardous characteristics. The only possible impact on CO_2 transport and storage is provision 9 which includes ecotoxic chemicals defined as "substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems". Finally, "wastes" are substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law (Art. 2.1). "Disposal" is defined any operation specified in Annex III, which includes many provisions applicable to CCS. Therefore, CO_2 would likely be classified as mere 'waste' under the Convention, in which case national law would govern, rather than the Bamako Convention.

If the Bamako Convention as "hazardous waste" covered CO_2 transport and storage in bulk, then its import and disposal would be banned from non-parties to the Convention, as under the Basel Convention. Transboundary shipments of hazardous waste generated in Africa can only take place when there is the prior written notification to the relevant authorities of the importing state (Art. 6). Each shipment must be accompanied by a movement document from the point of production to the point of disposal, according to the provisions of Annex IV.

B. MARINE POLLUTION

International law addressing marine environment protection falls into two broad categories: global rules, and regional rules. Global Conventions include: (1) UNCLOS; (2) the London Convention; and (3) MARPOL. Regional rules include UNEP Regional Seas Programme conventions and protocols and other regional and sub-regional arrangements.[44]

There are four broad categories of pollution regulated by international conventions on marine pollution:

- pollution from ships or vessels
- pollution from land-based sources
- pollution from dumping
- pollution from seabed activities.

Each category of marine pollution may be implicated by carbon capture, transport and geological storage activities, depending on whether CO_2 destined for geological cavities is transported by ship and injected from floating or fixed platforms or ships, transported

[43] Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 680.

[44] Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 395.

and injected from land-based pipelines running across or beneath the seabed, or injected from facilities used for offshore activities (oil and gas exploration and exploitation) .

UNCLOS addresses each of the above four categories of marine pollution. MARPOL primarily addresses operational or accidental marine pollution from ships or vessels. The London Convention (sometimes referred to as the London Dumping Convention) primarily addresses marine pollution from dumping. There are also three particularly relevant regional Conventions that implement aspects of UNCLOS, MARPOL and the London Convention at the regional level. These are: (1) the 1992 OSPAR Convention, which addresses marine pollution in the North-East Atlantic; (2) the 1992 Helsinki Convention, which addresses marine pollution in the Baltic Region; and (3) the 1976 Barcelona Convention and its 6 Protocols, which address marine pollution in the Mediterranean region. The European Community is a Party to each of these three regional Conventions.

The Barcelona Convention is one of a number of regional agreements that are similar in objective and scope. These are the products of the UNEP Regional Seas Programme. These include:

(1) 1976 Barcelona Convention (Mediterranean);
(2) 1978 Kuwait Convention (Arabian Gulf);
(3) 1981 Abijdjan Convention (Gulf of Guinea);
(4) 1981 Lima Convention (South-East Pacific);
(5) 1982 Jeddah Convention (Red Sea and Gulf of Aden);
(6) 1983 Cartagena Convention (Caribbean);
(7) 1985 Nairobi Convention (Indian Ocean and East Africa);
(8) 1986 Noumea Convention (South Pacific);
(9) 1992 Black Sea Convention[45]; and
(10) 2002 North-East Pacific Convention.

Each of these regional agreements[46] defines 'pollutant' in a manner similar to UNCLOS Article 1(4). Each also includes general obligations to take, individually or jointly, appropriate measures to prevent, abate and combat pollution to protect and enhance the marine environment. Each also contains obligations to conserve biological diversity, to combat pollution from different sources, including dumping from ships and aircraft, from vessels, pollution from exploration and exploitation of the territorial sea and/or continental shelf and /or seabed, pollution from land-based sources, pollution from transboundary movement of hazardous wastes and their disposal, and from the atmosphere, and obligations to cooperate in dealing with pollution emergencies.[47] Each framework agreement contains procedural obligations that include monitoring, scientific and technical cooperation, technical assistance, exchange of information, public access to information and participation, environmental impact assessment; and reporting requirements. These are sup-

[45] The *Black Sea* Region includes the marine and coastal waters of Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine (see http://www.gpa.unep.org/seas/workshop/BLACKSEA.htm).
[46] Except the 1983 Cartagena Convention (Caribbean region) which has no definition.
[47] Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 406.

ported by more specific obligations in their supporting Protocols.[48] Again, the EC is a Party to the Barcelona Convention (Mediterranean). It has signed but not ratified the Cartagena Convention (Caribbean) and the Nairobi Convention (East Africa).

International Conventions

4. UNCLOS [49], in force 1994

The United Nations Convention on Law of the Sea (UNCLOS) provides a comprehensive framework for use of the world's oceans. It aims to establish 'a legal order for the seas and oceans' that will, among other things, 'promote the peaceful uses of the seas and oceans, the equitable and efficient utilisation of their resources, the conservation of their living resources, and the study, protection and preservation of the marine environment' (Preamble). UNCLOS creates a structure for the governance and protection of all marine areas, including the airspace above and the seabed and subsoil below.[50] It reflects consensus on the extent of jurisdiction that States may exercise off their coasts, and allocates rights and duties among States.[51]

UNCLOS provides for a territorial sea of a maximum breadth of 12 nautical miles, and provides for coastal State sovereign rights over fisheries and other natural resources in an Exclusive Economic Zone (EEZ) that may extend to 200 nautical miles from the coast.[52] The Convention also provides for coastal State sovereign rights over the exploration and development of non-living resources, including oil and gas, found in the seabed and subsoil of the continental shelf, which is defined to extend to 200 nautical miles from the coast or, where the continental margin extends beyond that limit, to the outer edge of the geological continental margin.[53]

UNCLOS is a lengthy document with a broad reach. Its 320 articles and nine annexes addresses all aspects of ocean space, including delimitation, environmental control, marine scientific research, economic and commercial activities, transfer of technology and the settlement of disputes relating to ocean matters.[54] UNCLOS has about 140 Parties. The EC has been a Party since 1998.

The Convention requires States to pursue two main environmental objectives: (1) to prevent, reduce and control marine pollution; and (2) to conserve and manage marine living resources.[55] Toward both goals, it establishes rules on information, scientific research, monitoring, environmental assessment, enforcement and liability.[56]

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[48] Id at 407.
[49] 1982 United Nations Convention on the Law of the Sea.
[50] Law of the Sea Convention, Letters of Transmittal and Submittal and Commentary (US Government, 1994), at 3.
[51] Id.
[52] Id.
[53] Id.
[54] www.londonconvention.org/UNCLOS.htm
[55] Sands, P., *Principles of international environmental law*, (2nd ed. 2003), p. 396.
[56] Id at 398-99.

Under Article 194(1), States are under a duty to take all the measures consistent with UNCLOS, which are necessary, to *prevent, reduce and control* pollution of the marine environment from any source, using the best practicable means at their disposal and in accordance with their capabilities. '***Pollution***' is defined as:

> *'the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate use of the sea, impairment of quality for uses of sea water and reduction of amenities.'*

This same definition forms the basis for definitions of 'pollution' under a number of regional Conventions. Under Article 194(2), states are required not to cause damage by pollution, and to 'take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other states and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights.' Significantly, States must not 'transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another'(Art. 195) and ' take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control (Art. 196).

The Convention sets forth a comprehensive legal framework and basic obligations for protecting the marine environment from all sources of pollution, including

- pollution from land-based activities
- pollution from sea bed activities
- pollution from dumping
- pollution from vessels
- pollution through the atmosphere.

See Arts. 207-216.[57] These categories of activities are addressed in more detail under the distinct Protocols to the various conventions that implement UNCLOS at the regional level. As with the definition of 'pollution', UNCLOS provides a definition for 'dumping' that is repeated in many regional conventions. Under Article 5 of UNCLOS, '***dumping***' is defined as:

(i) any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea;

[57] Law of the Sea Convention, Letters of Transmittal and Submittal and Commentary (US Government, 1994), at 3.

(ii) any deliberate disposal of vessels, aircraft, platforms or other man-made structures at sea.

'*Dumping*' does not include:

(i) the disposal of wastes or other matter incidental to, or derived from the normal operations of vessels, aircraft, platforms or other man-made structures at sea and their equipment, other than wastes or other matter transported by or to vessels, aircraft, platforms or other man-made structures at sea, operating for the purpose of disposal of such matter or derived from the treatment of such wastes or other matter on such vessels, aircraft, platforms or structures;

(ii) ***placement of matter for a purpose other than the mere disposal thereof***, provided that such placement is not contrary to the aims of this Convention.

There has been a good deal of discussion under regional marine pollution conventions as to exactly what activities might be considered 'placement' for a purpose other than disposal. This discussion has occurred prominently under the London and OSPAR Conventions.[58]

UNCLOS contains provisions on monitoring and on the environmental assessment of activities that may damage the marine environment. Article 205 requires States to 'endeavour, as far as practicable, directly or through the competent international organizations, to observe, measure, evaluate and analyse' the risks or effects of pollution of the marine environment. States are to 'keep under surveillance' the effects of activities, which they permit to determine whether these activities are likely to pollute the marine environment. Under Article 206, "when states have *reasonable grounds* for believing that *planned* activities under their jurisdiction or control *may cause substantial pollution* of or significant and harmful changes to the marine environment, they shall, *as far as practicable*, assess the potential effects of such activities on the marine environment…" (emphasis added). While this obligation is quite general, it may place an affirmative obligation on States to consider the potential impacts of CCS activities, for example, where plans are under consideration for extensive pipelines through the marine environment for this purpose. The right to lay pipelines on the continental shelf is protected by UNCLOS Article 79.[59]

Under UNCLOS, coastal States exercise their jurisdiction and sovereignty within their established borders as well as over the territorial sea[60], which extends up to 12 nautical miles from the baseline[61]. In addition, under UNCLOS coastal States have jurisdiction[62] over their exclusive economic zone (EEZ), which extends up to 200 nautical miles[63], with regard to the 'protection and preservation of the marine environment'[64]. Within their

[58] See discussion of these conventions herein.
[59] Law of the Sea Convention, Letters of Transmittal and Submittal and Commentary (US Government, 1994), at 32.
[60] UNCLOS Article 2(1).
[61] Id, Article 3.
[62] Coastal States must 'have due regard to the rights and duties of other States and shall act in a manner compatible with the provisions of this Convention' when they exercise their rights in the EEZ in accordance with UNCLOS. (Article 56(2), UNCLOS).
[63] Id, Article 57.
[64] Id, Article 56(1)(b)(iii).

EEZ, States can claim rights, but also have obligations.[65] Not all EU Member States have declared an EEZ.[66]

Article 235 of UNCLOS provides that States are responsible for fulfilment of their international obligations concerning the protection and preservation of the marine environment and shall be liable in accordance with international law.[67] States must ensure recourse in their legal systems for relief from damage caused by pollution of the marine environment. Finally, States are obligated to cooperate in the implementation of existing international law and the further development of international law relating to responsibility and liability.

It seems that the EU's Habitats Directive and its species protection measures extend beyond the narrow band of Member States' territorial waters to all areas under Member States' jurisdiction, including the continental shelf[68] and/or the EEZ[69]. The position of the European Commission supports this interpretation, as expressed by Environment Commissioner in response to a written question on the Habitats Directive and the marine environment.[70] In addition, the 1999 Commission Communication on 'Fisheries Management and Nature Conservation in the Marine Environment'[71] states that the provisions of the Habitats Directive automatically apply to the marine habitats and species in territorial waters, and that 'if a Member State exerts its sovereignty rights in an EEZ of 200 nautical miles, it thereby considers itself competent to enforce national laws in that area, and consequently the Commission considers in this case that the Habitats Directive also applies'[72].

5. MARPOL 73/78, in force 1983

MARPOL 73/78[73] is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively[74] and updated by amend-

[65] Id, Article 58.
[66] A list of UNCLOS Parties and the status of their claims to maritime jurisdiction as of 31 March 2004 may be found at http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/claims_2004.pdf
[67] Id at 25.
[68] 'The continental shelf of a coastal State comprises the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance' (Article 76(1), UNCLOS).
[69] Jans, J.H. 'European Environmental Law', second revised edition, Europa Law Publishing, 2000, p. 418.
[70] Answer given by the Environment Commissioner on 17 January 1997 to question E-3529/96 by MEP Mr D.Eisma. OJ C 138, of 5 May 1997 ("As far as Member States have competence, it [the Habitats Directive] applies to the exclusive economic zone. However, the marine species and habitats concerned generally have their main range inside territorial waters').
[71] COM(1999)363 final, of 14 July 1999.
[72] Id. at section 5.2.2.
[73] International Convention for the Prevention of Pollution by Ships, as modified by the 1978 Protocol relating thereto.
[74] 1973 International Convention for the Prevention of Pollution by Ships, and 1978 Protocol Relating to the 1973 International Convention for the Prevention of Pollution from Ships, in force 1983.

ments through the years. MARPOL provides specific regulations to eliminate intentional marine pollution by oil and other 'harmful substances', and to minimize accidental discharges. '***Harmful substances***' are defined at Article 2.2 to include

> *'any substance which, if introduced into the sea, is likely to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea'* (Art. 2.2)

Article 2(4) of MARPOL defines 'ship' as a vessel of any type whatsoever operating in the marine environment.' This definition is broad enough to encompass fixed and floating platforms, and mobile offshore drilling rigs that might be used to inject CO_2 into the seafloor.[75]

The Convention includes regulations of emissions from routine operations as well as accidental pollution. The types of pollution regulated include: oil (Annex I), noxious liquid substances (Annex II), harmful substances (Annex III), sewage (Annex IV), garbage (Annex V), and air pollution (Annex VI).

Annex II contains Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk. These regulations have to do with residues resulting from in tank cleaning and deballasting operations and are not relevant to CO_2 transported in bulk for injection.

Annex III contains Regulations for the Prevention of Pollution by Harmful Substances in Packaged Form. Annex III is implemented through the International Maritime Dangerous Goods Code (IMDG). CO_2 gas cylinders and containers for the shipment of liquid CO_2 are regulated under the IMDG Code. Ships transporting liquefied CO_2 would be subject to the general requirements under Annex III, which list detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifications for preventing pollution by harmful substances. The IMDG and IBC codes contain lists of 'Harmful Substances.'

Annex VI contains Regulations for the Prevention of Air Pollution from Ships. Annex VI sets limits on sulphur oxide (SOx) and nitrogen oxide (NOx) emissions from ship exhaust operations, and prohibits the deliberate emissions of ozone depleting gases. Annex VI will enter into force on May 19, 2005. Although CO_2 is not currently listed as a regulated emission, with concerns about climate change this Annex VI could be amended to include CO_2. Efforts are already underway within the IMO's Marine Environment Protection Committee to address GHGs from ships, and CO_2 in particular. Thus this Annex might ultimately be relevant to CCS, but only insofar as emissions from ship exhaust might warrant consideration as an offset factor (or life-cycle factor), if the purpose of maritime shipping of liquefied CO_2 is to ultimately store or dispose of greenhouse gases.

75 See Spackman, A. 'Offshore Drilling Pollution Standards Evolving', Drilling Contractor. 2003.

6. London Convention, in force 1975

The London Convention's[76] objective is to prevent the pollution of the sea by the dumping of waste, with 'sea' defined to include 'all marine waters other than the internal waters of States'. (Art. III.3).[77] The London Convention preceded UNCLOS, and UNCLOS picks up many of its definitions (dumping, for example).

'*Waste*' is broadly defined under the London Convention to include "material and substance of any kind, form or description'. '*Dumping*' is defined as the '*deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms, or other man-made structures at sea*.' (Art. III.1).

Parties 'pledge themselves especially to take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.' (Art. I).

The London Convention would apply to prohibit the deliberate disposal of CO_2 into marine waters, to the extent CO_2 is understood to be an '***industrial waste***' – a waste generated by manufacturing or processing operations. The London Convention is more directly applicable to marine disposal than to geological storage, as geological storage does not involve deliberate disposal into marine waters, even if CO_2 stored in geological sites may escape from storage into marine waters. The Parties to the London Convention agreed in 1996 to update the Convention. This has been done through the 1996 London Protocol, which is not yet in force (see next section). The London Protocol will replace the London Convention in its entirety, and expand and extend its protections to the seabed and subsoil. This will then directly implicate geological storage.

The London Convention contains the same definition of dumping contained in UNCLOS. It excludes from the definition of 'dumping' under Article III.1(b)

- 'the disposal at sea of wastes or other matter incidental to, or derived from normal operations of vessels, aircraft, platforms or other man-made structures at sea and their equipment, other than wastes or other matter transported by or to vessels, aircraft, platforms or other man-made structures at sea, operating for the purpose of disposal of such matter or derived from the treatment of such wastes or other matter on such vessels, aircraft, platforms or structures'; and
- 'placement of matter for a purpose *other than the mere disposal thereof*, provided that such placement is not contrary to the aims of this Convention' (emphasis added).

Neither of these exclusions would clearly address CO_2 intended for injection into geological storage sites. CO_2 disposed in bulk would not represent disposal 'incidental to' or 'derived from' the normal operations a vessel or platform or man-made structure at sea.

76 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter

77 The London Convention covers marine waters. The 1996 Protocol to the London Convention, which is not yet in force, extends the scope of the London Convention to include the seabed and its subsoil. See discussion below.

Nor would CO_2 injected into a geological storage site from a vessel or platform be 'placed' for a purpose other than disposal.

Under the London Convention, Annex I substances are directly prohibited from dumping, Annex II substances may be dumped but require 'special' permits, and all other non-listed substances may be dumped but require a prior 'general' permit (Annex III). See Article IV. 'Special' and 'general' permits are granted by national authorities for matters intended for dumping loaded in their territory. Annex III lists criteria that must be taken into account before a permit may be granted (nature of the waste, dumping site, method of deposit, potentional impacts of marine environment, alternatives to dumping). National authorities must keep records of authorizations, must monitor the impacts of dumping, and must make reports to the IMO.

Significantly, Annex I prohibits the dumping of '*industrial wastes'* as of January 1996. '*Industrial waste'* means *'waste materials generated by manufacturing or processing operations'* and does not apply to:

- dredged material
- sewage sludge
- fish waste, or organic materials resulting from industrial fish processing operations
- vessels and platforms or other man-made structures at sea, provided that material capable of creating floating debris or otherwise contributing to pollution of the marine environment has been removed to the maximum extent
- uncontaminated inert geological materials the chemical constituents of which are unlikely to be released into the marine environment
- uncontaminated organic materials of natural origin.

Annex I(11). The London Convention's broad definition of 'industrial waste' could include captured CO_2, in which case CO_2 falls under Annex I and its dumping 'at sea' is completely prohibited. While Annex I(11) does exclude from the prohibited category of 'industrial waste' 'uncontaminated inert geological materials' and 'uncontaminated organic materials of natural origin', CO_2 does not clearly fall into either of these exceptions.

Annex II also contains a catch-all provision which states that 'materials which, though of a non-toxic nature, may become harmful due to the quantities in which they are dumped, or which are liable to seriously reduce amenities' are subject to special permitting requirements. (Annex II(D)). Therefore, even if deliberate disposal of CO_2 at sea were not prohibited as *'industrial waste'* under Annex I, a special permit could be required under Annex II.

The Contracting Parties to the London Convention have discussed whether CO_2 falls within the category of 'industrial waste' prohibited for dumping at sea. In 1997, the GESAMP conducted a study that noted that the dumping from vessels and platforms of

both liquid and solid CO_2 is prohibited by the London Convention and the 1996 London Protocol.[78] In 1999, the Scientific Group to the London Convention concluded at its 22nd meeting that fossil fuel derived CO_2 was an industrial waste. The Parties to the Convention, at their 21st meeting concluded that the Scientific Group should continue to follow the relevant research, and that the Parties would consider the legal, political and institutional aspects of a proposal to amend the London Convention or 1996 Protocol at a later stage.[79]

At the 26th Consultative Meeting of the Parties to the London Convention, which took place in November 2004, the Contracting Parties addressed again the interpretation of 'industrial waste', noting that no consensus had yet been reached on guidance for this definition.[80] The Parties recalled that the sea disposal of industrial waste had been prohibited since 1996 under Annex I, paragraph 11. They also recalled that the issue of policy interpretations of the definition of "industrial waste", and conditions under which materials exempted from that definition as listed in Annex I, paragraphs 11(a) to (f) of the Convention, would be eligible for disposal at sea had been discussed at their previous five sessions. The 24th Consultative Meeting had requested the Scientific Group to review: (1) the criteria for exemptions to the definition of industrial waste and for allocation of wastes on the reverse list; and (2) the adequacy of the Specific Guidelines for Assessment of Inert, Inorganic Geological Material (LC 24/17, paragraph 8.12). The 25th Consultative Meeting had endorsed the Group's intention to develop pre-screening criteria to assess both inert, inorganic geological material and organic material of natural origin.

The Parties noted that the Scientific Group was making progress on pre-screening criteria for 'inert, inorganic geological material', and that it would continue this review during the 28th session of the Group in May 2005, and report its recommendations on this issue to the 27th Consultative Meeting of the Parties.[81] The members endorsed the Scientific Group's recommendation that 'pre-screening criteria' would not be needed for Specific Guidelines for Assessment of Organic Material of Natural Origin.'[82]

The above discussions are primarily relevant to the sea disposal of CO_2. Nevertheless, if a decision were taken to permit the sea disposal of liquid or solid CO_2 under the London Convention, there would likely be fewer objections to the seabed or subsoil disposal of CO_2 by injection for geological storage, as the likelihood of pollution damage would be further attenuated.

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[78] Purdy, R.; Macrory, R., "Geological carbon sequestration: critical legal issues" Tyndall Centre Working Paper No. 45 (January 2004), pp. 25-26.
[79] Id at 25.
80 See Report of the Twenty Sixth Consultative Meeting, LC 26/15 at 21 (www.londonconvention.org/documents/meetings/consultative/26th/15.pdf)
81 LC 26/15 at 21.
82 Id.

The clear language of the Convention now prohibits the dumping of industrial waste; interpretative guidance on this definition that may appear to undermine, rather than implement that prohibition, would be risky from a political perspective.

Under the Convention, each coastal State has a duty to enforce the Convention within its jurisdiction. Responsibility for enforcement on the high seas lies primarily with the dumping vessel's flag State.[83] Under Article X of the Convention, the Parties 'undertake to develop procedures for the assessment of liability and the settlement of disputes regarding dumping' in accordance with 'the principles of international law regarding State responsibility for damage to the environment of other States or to any other area of the environment, caused by dumping of wastes and other matter of all kinds'.

7. London Protocol, not in force

The London Protocol[84] was drafted to modernize and replace the London Convention. The Protocol supersedes the Convention for Parties to the Protocol who are also signatories of the Convention (Art. 23). The London Protocol is directly relevant to the geologic storage of CO_2, though it has not yet entered into force. The Protocol does not appear to bring within its scope the geologic storage of CO_2 by pipeline from a land-based source to a sub-seabed repository. It appears to prohibit geologic storage by injection from vessels or manmade platforms at sea, directly into sub-seabed repositories.

The objective of the London Protocol is 'to protect the *marine environment* from all sources of *pollution*, and to *eliminate*, as far as practicable, pollution caused by dumping' (emphasis added). 'Pollution' is defined
to mean

> '*the introduction,* ***directly or indirectly****, by human activity, of wastes or other matter into the sea which* ***results or is likely to result*** *in such deleterious effects as harm to living resources and marine ecosystems, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities.*' (emphasis added)

The definition of '*sea'* is expanded under the Protocol to mean 'all marine waters, other than the internal waters of States, ***as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land'*** (Art. 1.7). Thus 'sea' does not include sub-seabed repositories accessed from land.

The definition of 'dumping' has also been expanded from that contained in the Convention to include 'any deliberate disposal into the sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea' and '***any storage of wastes***

83 www.londonconvention.org
84 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

or other matter in the seabed and the subsoil thereof from vessels, aircraft, platforms or other man-made structures at sea' (Art. I.(4.1)) . The term 'waste or other matter' is broad enough to encompass CO_2.

The Protocol contains the same two exclusions from the definition of 'dumping' contained in the Convention – for dumping 'incidental to, or derived from the normal operations of vessels, aircraft, platforms or other man-made structures', and for 'placement of matter for a purpose other than the mere disposal thereof.' (Art. 1(4.2))

Under the Protocol, the regulatory approach of the London Convention is reversed. Instead of directly prohibiting certain substances from dumping and regulating others, Parties are required to prohibit the dumping of all wastes except those listed in Annex I. Annex I provides that the following wastes or other matter "are those that may be considered for dumping":

- dredged material;
- sewage sludge;
- fish waste, or material resulting from industrial fish processing operations;
- vessels and platforms or other man-made structures at sea;
- inert, inorganic geological material;
- organic material of natural origin; and
- bulky items primarily comprising iron, steel, concrete and similarly unharmful materials for which the concern is physical impact

CO_2 is not explicitly listed as a waste that may be considered for dumping. However, 'dumping' is described as disposal 'into the sea' at Protocol Article I.4.1, rather than 'at sea' as in the London Convention Article III.1. Dumping is "any deliberate disposal ***into the sea*** of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea" and '*any* ***storage*** *of wastes or other matter in the seabed and the subsoil thereof from vessels, aircraft, platforms or other man-made structures at sea'* (Art. I.(4.1)). Again, the definition of '*sea'* means 'all marine waters, other than the internal waters of States, *as well as the seabed and the subsoil thereof; it* ***does not include sub-seabed repositories accessed only from land'*** (Art. 1.7).

This raises the question of whether 'sea' includes sub-seabed repositories accessible by sea -- in which case dumping at sea, for purposes of storage in sub-seabed repositories accessed by sea, is regulated, and prohibited. This would create a situation in which CO_2 can be injected into 'sub-seabed repositories accessed only from land' but not into sub-seabed repositories accessed only by sea. The Protocol's prohibition is limited to dumping from vessels, aircraft and off-shore platforms, and does not preclude disposal via land-based pipeline.

Annex I, 1.6 permits the dumping of 'organic material of natural origin', but it is unlikely that captured CO_2 in liquefied gas form would fit this exception. Both the UK government and the OSPAR Secretariat have opined that there is doubt that CO_2 could be in-

cluded in any of the seven enumerated categories permitted for dumping under the Protocol. (Purdy and McCrory: 22).

In considering a possible amendment to the Protocol to permit geological storage by injection from ships or floating platforms, the Protocol's precautionary principle is relevant. Article 3 of the Protocol provides that Contracting Parties "shall apply a precautionary approach to environmental protection from dumping of wastes or other matter whereby appropriate preventive measures are taken ***when there is reason to believe that waste or other matters introduced to the marine environment are likely cause harm even when there is no conclusive evidence to prove a causal relation between inputs and their effects***." (Art. 3.1)

Article 3 further provides that "each Contracting Party shall endeavour to promote practices whereby those it has authorized to engage in dumping or incineration at sea bear the cost of meeting the pollution prevention and control requirements for the authorized activities, having due regard to the public interest" (Art. 3.2). Those authorized to engage in dumping would be expected to bear the cost of monitoring and control requirements.

Significantly, in implementing the provisions of the Protocol, the Contracting Parties "shall act so as not to transfer, directly or indirectly, damage or likelihood of damage from one part of the environment to another or transform one type of pollution into another." (Art. 3.3)

It appears that for geological storage by injection from vessels or floating platforms to be clearly permissible under the Protocol, the Protocol would need to be amended. This might be done by inclusion of CO_2 on the reverse list of acceptable wastes in Annex I, with further amendments made to address issues raised by CCS.

This inclusion would not remove the obligation under Annex II to consider alternatives to dumping, including waste reduction at source. Each of the elements contained within Annex II would need to be addressed, including a waste reduction audit, consideration of waste management options, a characterisation of the waste for its impacts, development of an action list to screen CO_2 wastes and their constituents on the basis of their potential effects on human health and the marine environment, specifying an upper level and may also specify a lower level, with the upper level should be set so as to avoid acute or chronic effects on human health or on sensitive marine organisms representative of the marine ecosystem. Other elements for scrutiny under Annex I include a variety of factors associated with dump-site selection, assessment of potential effects, environmental monitoring, and appropriate permit conditions.

8. Antarctic Treaty, in force 1961, and Protocol on Environmental Protection, in force 1998

The 1959 Antarctic Treaty[85] stipulates that Antarctica should be used exclusively for peaceful purposes. It prohibits military activities, guarantees continued freedom to conduct scientific investigation, and addresses cooperation in sharing of information from scientific research. Among other things, it prohibits the disposal of radioactive waste, and establishes a number of rules for the disposal of waste generated by Parties in the Antarctic area.

In 1991, a *Protocol on Environmental Protection to the Antarctic Treaty* was agreed, which came into force in 1998. The Parties to the Protocol commit themselves to the comprehensive protection of the Antarctic environment and dependent and associated ecosystems and designate Antarctica as a natural reserve, devoted to peace and science.

Under Article 3 of the Protocol, which sets out environmental principles, activities in the Antarctic Treaty area must be planned and conducted so as to limit adverse impacts on the Antarctic environment and dependent and associated ecosystems. Prior assessments must be made as to the possible impacts of activities on the Antarctic environment and dependent and associated ecosystems and on the value of Antarctic for the conduct of scientific research.

While the Antarctic Treaty will not be relevant to CCS activities, the system it creates for assessing possible impacts is interesting. Annex I sets out procedures for the evaluation of proposed activities according to whether they may have: (a) less than a minor or transitory impact; (b) a minor or transitory impact; or c) more than a minor or transitory impact.

If an activity is determined as having less than a minor or transitory impact, under national procedures, it may proceed. If it is determined that the activity will not have less than a minor or transitory impact, an *Initial Environmental Evaluation* must be prepared to assess whether the proposed activity may have more than a minor or transitory impact. If an Initial Environmental Evaluation indicates that a proposed activity is likely to have no more than a minor or transitory impact, the activity may proceed, provided that appropriate procedures, which may include monitoring, are put in place to assess and verify the impact of the activity. If the proposed activity may have more than a minor or transitory impact, a *Comprehensive Environmental Evaluation* must be prepared and circulated to the public and to the Parties for comment.

These prior assessment procedures must be applied in the planning processes leading to decisions about any activities undertaken in the Antarctic Treaty area pursuant to scientific research programmes, tourism and all other governmental and non-governmental activities in the Treaty area.

[85] 1959 Antarctic Treaty, in force 1961, and 1991 Protocol on Environmental Protection, in force 1998

Regional Conventions

9. OSPAR Convention, in force 1998

The OSPAR Convention[86] regulates the deliberate dumping of pollutants into the North-East Atlantic Ocean maritime area.[87] Under OSPAR, Parties are under a general obligation to

> '*take all possible steps to prevent and eliminate pollution and shall take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.*' (Art. 2.1(a))

To this end, the Parties are to adopt programmes and measures and to harmonise their policies and strategies (Art. 2.1(b)). The Convention has 16 Contracting Parties, including the European Union.

OSPAR is relevant to CO_2 injection into the sea-bed from land-based pipelines. It is also relevant to injection into geological repositories from floating and fixed platforms and vessels, injection from offshore activities for oil and gas exploration and exploitation, and dumping of CO_2 into waters in the 'maritime area'. The '*maritime area*' defined for control measures under OSPAR includes the internal waters and territorial seas of the Parties, the sea beyond and adjacent to the territorial sea under the jurisdiction of the coastal state to the extent recognised by international law, and the high seas, '***including the bed of all those waters and its sub-soil***' (Art. 1(a)). Thus the Convention covers the water column of the sea within the Convention area, up to the freshwater limit, the sea-bed, and all the underground strata below the seabed in that area. [88]

OSPAR replaces two earlier Conventions: the *1972 Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft* and the *1974 Paris Convention on the Prevention of Marine Pollution from Land-Based Sources*. The Oslo Convention was the first regional agreement to regulate and prohibit dumping at sea, and preceded the London Convention.[89] It applied to the North-East Atlantic Ocean, including the North Sea, but not the Baltic and Mediterranean seas. In 1989, the Oslo Convention's

[86] 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic.
[87] OSPAR does not apply to the Baltic and Mediterranean Seas which are separately controlled by the Helsinki and Barcelona Conventions respectively, described in further detail below. A map displaying the full reach of the OSPAR area may be found at www.ospar.org in the document 2003 Strategy for a Joint Assessment and Monitoring Programme (JAMP) (as revised by OSPAR 2004)(Reference 2004-17-E).
[88] Report from the Group of Jurists and Linguists on Placement of Carbon Dioxide in the OSPAR Maritime Area, OSPAR Commission, Summary Record OSPAR 2004, OSPAR 04/23/1-E, annex 12 at 2 and n. 7.
[89] Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 423.

administrative body, the OSCOM, ***agreed to cease dumping of industrial wastes in the North Sea by December 31, 1989 and in other Convention waters by 31 December 1995***, except for inert materials of natural origin and industrial wastes for which there were 'no practical alternatives on land' and where 'the materials cause no harm in the marine environment.'[90] This same cessation of dumping of industrial wastes has carried over under 1992 OSPAR Convention, which came into force in 1998.[91]

The OSPAR Convention was designed to take a more comprehensive approach than the Oslo and Paris Conventions by regulating all types of marine pollution from all sources. It also adopted an ecosystem approach to the control and prevention of pollution, with pollution to be 'prevented' and 'eliminated' rather than prevented, reduced and controlled (Art. 2(1)(a)). "***Pollution***" is defined as '*the introduction by man, directly or indirectly, of substances or energy into the maritime area which results, or is likely to result, in hazards to human health, harm to living resources and marine ecosystems, damage to amenities or interference with other legitimate uses of the sea*' (Art. 1(d)). This definition is similar to that used by UNCLOS.[92]

OSPAR Parties must apply the ***precautionary principle*** which requires that '*preventive measures [be] taken when there are reasonable grounds for concern that substance or energy introduced, directly or indirectly, into the marine environment may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship between the inputs and the effects. . .*' (Art. 2.2(a)). 'May bring about hazards' presents a low threshold. It is also unclear what might constitute 'reasonable grounds for concern', or what 'preventative measures' might include in the context of CCS – particularly given the long time frames potentially involved in geologic storage.

OSPAR also requires its Parties to apply the '***polluter pays principle***' 'by virtue of which the costs of pollution prevention, control and reduction measures are to be borne by the polluter' (Art. 2.2(b)). This requires consideration of appropriate mechanisms for implementing this principle, given the unique issues arising from geologic storage, the absence of an international regulatory regime specifically tailored to CCS, and the costs of establishing such a regime.

Parties agree to adopt programmes and measures which 'take full account of the use of the latest technological developments and practices designed to prevent and eliminate

[90] Id, p. 425.
[91] Under Article 31(2) of the OSPAR Convention, decisions, recommendations and all other agreements adopted under the 1972 Oslo Convention or the 1974 Paris Convention continue to be applicable to the extent that they are compatible with, or not explicitly terminated by, the OSPAR Convention, or decisions and recommendations adopted under the OSPAR Convention. See www.ospar.org. By Decision 98/1, the OSPAR Commission revoked all previous decisions, recommendation and other agreements which were not compatible with the OSPAR Convention or which had become moot.
[92] OSPAR's definition speaks to the maritime area, rather than UNCLOS's marine environment, and refers to 'marine ecosystems' rather than UNCLOS's marine life.

pollution fully' (Art. 3(a)). With respect to these programmes and measures, Parties must define and apply 'best available techniques' (BAT) and 'best environmental practice' (BEP), including the use of clean technology (Art. 3(b)). Appendix I of OSPAR provides criteria for the definition of BAT and BEP.

Under OSPAR, the Parties undertake and publish regular joint assessments of the quality of the marine environment, including the effectiveness of measures taken and planned on the basis of monitoring, modelling, remote sensing and progressive risk assessment strategies.[93]

The main substantive framework of regulations under the OSPAR Convention is contained in a series of Annexes which deal with the following specific areas:

- Annex I: Prevention and elimination of pollution from land-based sources;
- Annex II: Prevention and elimination of pollution by dumping or incineration;
- Annex III: Prevention and elimination of pollution from offshore sources; and
- Annex IV: Assessment of the quality of the marine environment.
- Annex V: The protection and conservation of the ecosystems and biodiversity of the maritime area

'*Dumping*' is defined in Article 1(g) as any deliberate disposal ***in the maritime area*** of ***wastes or other matter***, either ***from vessels or*** aircraft or ***from offshore installations*** (as well as any deliberate disposal in the maritime area of vessels or aircraft, or offshore installations and offshore pipelines). Again, '***maritime area***' is defined to include the seabed of all those waters and its sub-soil. Some pollutants are strictly prohibited from dumping. Others may be dumped according to permitting procedures laid out in the Annexes.

'***Wastes or other matter***' under the OSPAR Convention include everything but: human remains; offshore installations; offshore pipelines; and unprocessed fish and fish offal discarded from fishing vessels (Art. 1(o)). '***Vessels***' means waterborne craft of any type whatsoever, their parts and other fittings, and include air-cushion craft, floating craft whether self-propelled or not, and other man-made structures in the maritime area and their equipment, but excludes offshore installations and offshore pipelines. '***Offshore installation***' means any man-made structure, plant or vessel or parts thereof, whether floating or fixed to the seabed, placed within the maritime area for the purpose of offshore activities (Art. 1(l)). The term '***Offshore activities'*** is limited to activities carried out in the maritime area for the purposes of the exploration, appraisal or exploitation of liquid and gaseous hydrocarbons. '***Offshore sources***' means offshore installations and offshore pipelines from which substances or energy reach the maritime area. '***Offshore pipeline'*** means 'any pipeline placed within the maritime area for the purpose of offshore activities' (i.e., oil and gas exploration).

[93] Sands, P., Principles of international environmental law, (2nd ed. 2003), p. 411.

Based on these definitions, and the broad definition of 'dumping' under OSPAR, it appears that the deliberate disposal of liquid CO_2 by injection into the seabed from ***vessels or floating platforms*** would constitute dumping. Similarly, the deliberate disposal of liquid CO_2 by injection from ***offshore installations*** (used for gas exploration, appraisal or exploitation) would be considered dumping.

However 'dumping' does not include, for purposes of OSPAR:

(i) disposal in accordance with [73/78 MARPOL], or other applicable international law, of wastes or other matter incidental to, or derived from, the normal operations of vessels or aircraft or offshore installations other than wastes or other matter transported by or to vessels or aircraft or offshore installations for the purpose of disposal of such wastes or other matter, or derived from the treatment of such wastes or other matter on such vessels or aircraft or offshore installations;

(ii) *placement of matter for a purpose other than the mere disposal thereof, provided that, if the placement is for a purpose other than that for which the matter was originally designed or constructed, it is in accordance with the relevant provisions of the Convention;* and

(iii) for purposes of Annex III, the leaving wholly or partly in place of a disused offshore installation or disused offshore pipeline, provided that any such operation takes place in accordance with any relevant provision of the Convention and with other relevant international law (Art. 1(g)).

In the context of CO_2 capture and storage, much attention has focused on exclusions from the definition of dumping, and in particular the scope of the exception pertaining to 'placement of matter for a purpose other than the mere disposal thereof.'

In 2002, OSPAR commissioned its Jurists and Linguists group (JL Group) to determine whether CO_2 storage was prohibited under OSPAR. After a preliminary paper from the JL Group was considered by OSPAR 2003, the Group was asked to revise this paper and agree on a report on its initial views. This occurred in May 2004, and the agreed report was considered at OSPAR 2004 in June/July 2004. The JL Group focused on the implications of various purposes for the 'placement of matter.' It considered the following possible purposes of placement:

(a) placement for the purposes of scientific experiment[94]

(b) placement for the purposes of facilitating or improving the production of oil or gas

(c) placement for the purposes of "mitigating the effects on climate change"

(d) placement for the purposes of mere disposal, other than placement covered by sub-paragraph (c).

[94] Article 8 of OSPAR provides that '[t]o further the aims of the Convention, the Contracting Parties shall establish complementary or joint programmes of scientific or technical research . . .'

That report contained the following conclusions, which the report emphasized, were to be taken in the context of the report as a whole:

> 32. Since the OSPAR Convention contains, in effect, three separate régimes [Annex 1 - land based sources; Annex II - dumping; Annex III - offshore sources], the results it produces are complex. Since the applicable régime is determined by the method and purpose of placement, and not by the effect of placement on the marine environment, the results of the application of the Convention régimes may well be that:
>
> a. placements with different impacts on the environment (for example, placement in the water column and placement in underground strata) may not be distinguished, while
>
> b. different methods of placement having the same impact (for example, from a specially built structure at sea linked to land by a pipeline and from a vessel equipped with special equipment) may be treated differently (with the former permissible and the latter not).
>
> 33. This suggests that further consideration is needed of the interrelations between the current legal position, the possible physical impacts of the placement of CO_2 on the marine environment, and the appropriate regulatory approach."[95]

The report concluded that CO_2 placed in the maritime area by pipeline for ***experimental purposes*** was not prohibited under Annexes I, II or III, but is either subject to authorisation or regulation (Annex I), or must be in accordance with relevant provisions of the Convention (Annexes II and III).[96] Placement of CO_2 by ***pipeline*** for purposes of mitigation of climate change or for purposes of mere disposal is not prohibited under Annex I, but subject to authorisation or regulation.[97] Placement of CO_2 when ***shipped by vessel for placement by a vessel***, for purposes of mitigation of climate change or for purposes of mere disposal, is prohibited under Annex II.[98] Placement of CO_2 from a ***structure in the maritime area that is neither part of a pipeline system nor an offshore installation*** for purposes of climate change mitigation or mere disposal is also prohibited under Annex II.[99] Placement ***from an offshore installation*** (oil and gas) of CO_2 ***arising from 'offshore activities'*** -- oil and gas activities -- is not prohibited under Annex III for purposes of improving hydrocarbon production, mitigating climate change, or for mere disposal – but subject to authorisation or regulation.[100] ***Placement from an offshore installation (oil and gas) of CO_2 that does not arise from 'offshore activities'*** is not prohibited by

[95] OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic, Meeting of the OSPAR Commission (OSPAR), Reykjavik: 28 June – 1 July, Report from the Group of Jurists and Linguists on Placement of Carbon Dioxide in the OSPAR Maritime Area, Summary Record OSPAR 2004, OSPAR 04/23/1-E (Annex 12 (Ref. §11.7a) (available at www.ospar.com, Meetings and Documents).
[96] Summary Record OSPAR 2004, OSPAR 04/23/1-E, Annex 12, Appendix.
[97] Id.
[98] Id.
[99] Id.
[100] Id.

Annex III for the purpose of improving hydrocarbon production, but is subject to authorisation or regulation.[101] However, the same placement of CO_2 from an offshore installation, arising from non-offshore activities, is prohibited under Annex III if done for purposes of mitigating climate change or for mere disposal.[102]

The net result of this analysis is that CO_2 that ***arises*** from oil and gas activities ('offshore activities'), and is placed from an offshore installation, may be injected for scientific purposes, for improving hydrocarbon production, for mitigating climate change, or for mere disposal. CO_2 that is ***generated in other ways*** (e.g., captured from other industrial installations), may only be placed from an offshore installation for enhancing hydrocarbon production. However, it may be placed in the maritime area even for disposal directly by pipeline or by pipeline through a structure in the maritime area that is not an offshore installation (subject to authorisation or regulation) under Annex I (addressing pollution from land-based sources). Despite this possibility under Annex I, under Annex II (addressing pollution from dumping), CO_2 cannot be placed in the maritime area from a structure in the maritime area that is not part of a pipeline system, or that is not an 'offshore installation' – not a structure used for oil and gas activities.

Article 10 of OSPAR establishes a Commission (OSCOM), made up of representatives of the Parties. Observers are allowed to participate in the activities of the Commission, including non-governmental organisations (Art. 11). OSPAR additionally establishes rights of access to information about the maritime area covered by the Convention (Art. 9). The Commission is responsible for, among other things:

- supervising implementation of the Convention;
- reviewing the condition of the maritime area and the priorities and need for additional measures;
- drawing up programmes and measures for the prevention and elimination of pollution, and for the control of activities which may directly or indirectly affect the maritime area, including economic instruments; and
- considering and, where appropriate, adopting proposals for the amendment of the Convention.

The Commission has the authority to issue legally-binding decisions, and non-binding recommendations. Decisions concerning any Annex or Appendix are only to be taken by the Contracting Parties bound the concerned Annex or Appendix (Art. 13). Decisions and recommendations are adopted by unanimous vote of the Parties. However, if unanimity is not attainable, the Commission may adopt decisions or recommendations by a ¾ majority. Article 7 of the Convention provides that the Contracting Parties

> *'shall cooperate with a view to adopting Annexes, prescribing measures, procedures and standards to protect the maritime area against pollution from other sources, to the extent that such pollution is not al-*

[101] Id.
[102] Id.

ready the subject of effective measures agreed by other international organisations or prescribed by other international conventions.'

(Art. 7). These provisions provide substantial scope for the adoption of decisions, recommendations and the adoption of Annexes that clarify the regulatory position of geological storage.

The individual Annexes to OSPAR are discussed separately below.

Annex I – Prevention and Elimination of Pollution from Land-based Sources

Annex I of OSPAR addresses the prevention and elimination of pollution from land-based sources. '*Land-based sources'* is defined to include '*point and diffuse sources on land from which substances or energy reach the maritime area by water, through the air, or directly from the coast*' (Art. 1(e)). Land-based sources also include ***'sources associated with any deliberate disposal under the sea-bed made accessible from land by tunnel, pipeline or other means and sources associated with man-made structures placed, in the maritime area under the jurisdiction of a Contracting Party, other than for the purpose of offshore activities***' (other than for oil and gas exploration, appraisal or exploitation) (Art. 1(e)). Hence land-based sources would include sources on land that emit CO_2 into the air, sources on land that utilize pipelines for disposal of CO_2 under the sea-bed, and sources from which CO_2 reaches the maritime area associated with structures placed in the maritime area that are not for the purpose of oil and gas exploration, appraisal or exploitation.

In adopting programmes and measures toward the prevention and elimination of pollution from these sources, Parties must

- Require the use of best available techniques (BAT) for point sources, including where appropriate clean technology, emphasizing the use of non-waste technology (with criteria for BAT set out in Appendix I)[103]
- Require the use of best environmental practice (BEP) for point and diffuse sources, including where appropriate clean technology, applying the most appropriate combination of environmental control measures and strategies (with criteria for BEP set out in Appendix I)[104]
- Apply criteria in Appendix 2 in setting priorities for the prevention of pollution from land-based sources
- Take preventative measures to minimise the risk of pollution caused by accidents
- Provide for a system of regular monitoring and inspection by their competent authorities to assess compliance with regulations or permits.

Appendix 2 contains criteria such as persistency, toxicity, tendency to bioaccumulate, radioactivity, transboundary significance, risk of undesirable changes in the marine ecosys-

[103] Article 2, Article 3, Annex I and Appendix I, para. 1.
[104] Id.

tem and irreversibility or durability of effects, and distribution pattern (i.e., quantities involved, use pattern and liability to reach the marine environment). These criteria do not have to be given equal weight. A number of substances are presumptively required to be subject to programmes and measures based on Appendix 2 criteria – CO_2 is not listed among them (App. 2(3)).

Hence under Annex I, substances or energy (which would include CO_2) from land-based sources that may result in pollution of the maritime area is regulated, rather than prohibited. Point source discharges to the maritime area, and releases into water or air which reach and may affect the maritime area, are subject to permit and regulation (Annex I, Art. 2), and a system of monitoring and inspection is required to assess compliance with permit and relevant regulations (Annex I, Art. 2). The Commission is required to draw up plans for reducing and phasing out substances that are toxic, persistent and liable to bioaccumulate from land-based sources.

Annex II prohibits the dumping of all wastes and other matter, except for

- dredged material
- inert materials of natural origin, that is solid, chemically unprocessed geological material the chemical constituents of which are unlikely to be released into the marine environment
- sewage sludge
- fish waste
- vessels or aircraft until at the latest December 2004
- the dumping of low and intermediate level radioactive substances, including wastes

'*Dumping*' is defined in Article 1(g) as any deliberate disposal ***in the maritime area*** of ***wastes or other matter***, either ***from vessels or*** aircraft or ***from offshore installations*** (as well as any deliberate disposal in the maritime area of vessels or aircraft, or offshore installations and offshore pipelines). However 'dumping' specifically does not include, under Article 1(g):

(i) disposal in accordance with [73/78 MARPOL], or other applicable international law, of wastes or other matter incidental to, or derived from, the normal operations of vessels or aircraft or offshore installations other than wastes or other matter transported by or to vessels or aircraft or offshore installations for the purpose of disposal of such wastes or other matter, or derived from the treatment of such wastes or other matter on such vessels or aircraft or offshore installations;

(ii) *placement of matter for a purpose other than the mere disposal thereof, provided that, if the placement is for a purpose other than that for which the matter was originally designed or constructed, it is in accordance with the relevant provisions of the Convention.*

Under Article 1(g)(ii) some placement may subject to permitting. Annex II, Article 5, provides that '[n]o placement of matter in the maritime area for a purpose other than that for which it was originally designed or constructed shall take place without authorisation or regulation by the competent authority of the relevant Contracting Party' (Annex II, Art.5). This language does not seem applicable to CO_2, which could not be 'designed or constructed'. Moreover, the overarching purpose of CO_2 injection into a geological storage site would appear to be disposal.[105]

Hence Annex II's dumping prohibition would prohibit the injection of CO_2 in the seabed and subsoil [106] from vessels or offshore installations, as CO_2 does not fall within one of the exceptions provided in Annex II, Articles 2 and 3, and CO_2 injection does not fall within the exception to the definition of 'dumping' contained in OSPAR Article 1(g)(i).[107]

Annex III – Prevention and elimination of pollution from offshore sources

Annex III of OSPAR prohibits 'any dumping of wastes or other matter from offshore installations' (Art. 3.1). However, 'discharges or emissions from offshore sources' of substances 'which may reach and affect the maritime area' are not prohibited (Art. 3.2), provided that they are strictly authorized and regulated by competent authorities through a permitting process that implements applicable decisions, recommendations and other agreements adopted under OSPAR (Art. 4). Competent authorities must provide for a system of monitoring and inspection to assess compliance with permit conditions.

'***Offshore installations***' are defined as 'any man-made structure, plant or vessel or parts thereof, whether floating or fixed to the seabed, ***placed within the maritime areas for the purpose of offshore activities***' (emphasis added). '***Offshore activities***' are further defined as 'activities carried out in the maritime area for the purposes of the exploration, appraisal or exploitation of liquid and gaseous hydrocarbons.'

Under Annex III, 'dumping' is prohibited from installations placed in maritime areas for purposes of exploitation of liquid and gaseous hydrocarbons. However, 'discharges or

[105] The Jurists and Linguists Group, referenced above, considered 'placement for mitigating climate change' as one possible purpose for placement under Annex II of OSPAR. This may be strained reading of Article 1(g) of the Convention (and other conventions that exempt certain placements from the definition of 'dumping'). An EU source, regulated under the IPPC Directive and EAT Directive, more logically would intend to dispose of CO_2 for the primary purpose of avoiding CO_2 emissions to the atmosphere, with consequent regulatory costs. Hence the purpose of CO_2 injection would be permanent disposal, or, for a subset of generators of CO_2, enhanced oil and gas recovery. OSPAR's term 'placement' seems also to suggest the intention or possibility of recovery or retrieval at some point in the future. The injection of CO_2 (unless for enhanced hydrocarbon recovery) – without an intention to retrieve at some future point in time -- seems more in the nature of disposal. In contrast, the designation of a geological site by competent authority, to be used for purposes of mitigating the impacts of CO_2 emissions on the environment for a particular duration of time, would seem more arguably consistent with the purpose 'mitigating climate change.'

[106] As 'dumping' is defined to include disposal in the 'maritime area', and 'maritime area' includes the seabed and subsoil.

[107] Deliberate disposal in the maritime area of wastes or other matter from offshore installations (for enhanced hydrocarbon recovery) is addressed in Annex III.

emissions' from offshore sources are not prohibited (Art. 3). The terms 'discharge' and 'emissions' are not defined. 'Offshore sources' include 'offshore installations and offshore pipelines from which substances or energy reach the maritime area' with 'offshore pipelines' limited to pipelines that have been 'placed in the maritime area for the purpose of offshore activities' (oil and gas activities) (OSPAR Art. 1(m)).

Hence 'emissions' and 'discharges' of CO_2 from pipelines related to oil and gas activities are not prohibited and can be permitted and regulated. Dumping of CO_2 from these installations, in contrast, is prohibited. However, under OSPAR Article 1(g)(ii), 'placement' of CO_2 in the context of offshore activities, for purposes other than 'its mere disposal' is not be prohibited, 'if undertaken in accordance with relevant provisions of the Convention.' Article 1(g)(ii)'s mention of 'design' and 'construction' may however raise concerns about the appropriateness of this interpretation with respect to CO_2.

Annex IV – Assessment of the Quality of the Marine Environment

The OSPAR Convention contains a general obligation on Parties to collaborate in regular monitoring and assessment of the state of the marine environment in the maritime area (Art. 6). Annex IV to the Convention provides for cooperation in monitoring programmes, joint quality assurance arrangements, the development of scientific assessment tools, such as modelling, remote sensing and risk assessment strategies, and the preparation of assessments.[108] In 2000, a Quality Assessment Report was produced on the quality of the marine environment for the North-East Atlantic, supported by five sub-regional reports. A 2003 Strategy for a Joint Assessment and Monitoring Programme (JAMP) (as amended by OSPAR 2004) has been adopted with timeframes, themes and outputs.[109]

Annex V- Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime area

Annex V was adopted in 1998, and references the Convention on Biological Diversity. Programmes or measures under Annex V are to avoid duplicating action, which is already prescribed by other international conventions, and the subject of appropriate measures agreed by other international organizations. Before a programme or measure is adopted, consideration is to be given to whether action could be taken more appropriately under some other international convention or arrangement.

10. Helsinki Convention, in force 2000

The Helsinki Convention[110] aims to reduce pollution in the Baltic Sea area. The Convention replaces the earlier 1974 Baltic Sea Convention and enlarges the protected area un-

[108] www.ospar.org
[109] 2003 Strategy for a Joint Assessment and Monitoring Programme (JAMP) (as revised by OSPAR 2004)
(Reference 2004-17-E)
[110] 1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area.

der that earlier Convention to include internal waters. The Convention area now includes the Baltic Sea, entrances to the Baltic Sea, and internal waters (Art. 1).[111]

The Helsinki Convention is similar to OSPAR in that it utilizes a holistic approach to protect the Baltic marine environment. The objective of the Convention is to 'prevent and abate pollution from land-based sources, ships, dumping and exploration and exploitation of the seabed and its subsoil' (Arts. 6-10). It addresses discharges through rivers, estuaries, outfalls and pipelines, dumping and normal operations of vessels as well as through airborne pollutants.[112]

The Convention uses a definition for 'pollution' that is similar to that used by UNCLOS, and definitions for 'land-based sources', 'ship' and 'dumping' that are similar to those used in the OSPAR Convention. '*Pollution'* means "introduction by man, directly or indirectly, of substances or energy into the sea, including estuaries, which are ***liable to create hazards to human health, to harm living resources and marine ecosystems***, to cause hindrance to legitimate uses of the sea including fishing, to impair the quality for use of sea water, and to lead to a reduction of amenities."

"*Pollution from land-based sources*" means pollution of the sea "by point or diffuse inputs from all sources on land *reaching the sea* waterborne, airborne or directly from the coast. ***It includes pollution from any deliberate disposal under the seabed with access from land by tunnel, pipeline or other means.*** This clearly is relevant to CCS.

"Ship" means a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or ***floating platforms***.

The Convention prohibits ***dumping*** from all sources in the Baltic Sea (Art. 11.1). "Dumping" is defined as "deliberate disposal at sea ***or into the seabed*** of wastes or other matter from ships, other man-made structures at sea or aircraft" or any deliberate disposal at sea of ships, other man-made structures at sea or aircraft, but does not include:

- the disposal at sea of wastes or other matter incidental to, or derived from the normal operations of ships, other man-made structures at sea or aircraft and their equipment, other than wastes or other matter transported by or to ships, other man-made structures at sea or aircraft, operating for the purpose of disposal of such matter or derived from the treatment of such wastes or other matter on such ships, structures or aircraft;
- placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of the present Convention;

[111] Parties include all States bordering the Baltic (Denmark, Germany, Sweden, Estonia, Finland, Latvia, Lithuania, Poland and Russia). http://europa.eu.int/scadplus/leg/en/lvb/l28089.htm
[112] http://europa.eu.int/scadplus/leg/en/lvb/l28089.htm

Art.2.4. Each Party is required to ensure compliance of the ships and aircrafts registered or loading in its territory (Art. 11.3). The only dumping permitted is dumping of dredge material by special permit (Annex V), and dumping in emergency situations.

The Parties are required to *prevent* and *eliminate* pollution of the Baltic Sea from ***land-based sources*** (Art.6). The definition of 'pollution' includes ***pollution from any deliberate disposal under the seabed with access from land by tunnel, pipeline or other means***. This is relevant to CO_2 storage by injection from land-based sources to storage sites under the seabed by pipeline. Thus the *deliberate disposal* of CO_2 under the seabed that is *liable to create hazards to human health, to harm living resources and marine ecosystems* is to be prevented and eliminated. Point sources are required to employ best environmental practices and best applicable technologies, and must implement the measures and procedures laid out in Annex III.

The Helsinki Convention further regulates pollution from ships and hazardous substances, which are less relevant to CCS. The sections relating to prevention of pollution from ships mainly apply to emissions incidental to the operation of a ship and Parties are guided to apply the provisions of the MARPOL treaty in preventing and eliminating these sources of pollution. For example, under Annex IV (***pollution from ships***), "discharge" in relation to harmful substances or effluents containing such substances, means any release howsoever caused from a ship and includes any escape, disposal, spilling, leaking, pumping, emitting or emptying". Excluded from coverage is

- dumping within the meaning of the 1972 London Dumping Convention; or
- release of harmful substances directly arising from the exploration, exploitation and associated off-shore processing of sea-bed mineral resources; or
- release of harmful substances for purposes of legitimate scientific research into pollution abatement or control.

Harmful substances requiring additional attention are listed in Annex I. CO_2 is not included in Annex I, and therefore these provisions would not apply to CCS activities (Art. 5) .

Under Article 12, each Contracting Party shall take all measures in order to prevent pollution of the marine environment of the Baltic Sea Area resulting from ***exploration or exploitation of its part of the seabed and the subsoil thereof*** or from any associated activities thereon as well as to ensure that adequate preparedness is maintained for immediate response actions against pollution incidents caused by such activities.

Like OSPAR, the Helsinki Convention includes the precautionary principle, polluter pays principle, and a requirement to use best available technology and best environmental practice. Annex VI addresses pollution from offshore activities, but is limited to exploration and exploitation of oil and gas.

11. Barcelona Convention, in force 1978, as amended, in force 2004

The Barcelona Convention[113] is a framework agreement for the protection of the Mediterranean Sea area and the Mediterranean coastal region. Under the Convention, Parties agree to 'take all appropriate measures to prevent, abate and to the fullest possible extent eliminate pollution of the Mediterranean Sea Area caused by:

- dumping from ships and aircraft or incineration at sea;
- pollution from ships;
- pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil; and
- pollution from land-based sources
- pollution resulting from the transboundary movement of hazardous wastes and their disposal, and to reduce to a minimum, and if possible eliminate, such transboundary movements.

They further agree to cooperate in dealing with pollution emergencies. They also commit to take appropriate measures to protect and preserve biological diversity, rare or fragile ecosystems, as well as species of wild fauna and flora which are rare, depleted, threatened or endangered and their habitats, in the Convention area.

The Parties agree to endeavour to establish, in cooperation with international entities or other parties, programmes for pollution monitoring and a pollution monitoring system for the Mediterranean Sea area. They are to designate the competent authorities responsible for pollution monitoring within areas under their national jurisdiction and participate in international arrangements for pollution monitoring in areas beyond national jurisdiction.

For Convention purposes, the 'Mediterranean Sea area' is defined as '***the maritime waters of the Mediterranean Sea proper, including its gulfs and seas***'(Art. 1). The Convention may be extended to coastal areas as defined by each Party within its own territory.[114] Any Protocol to the Convention may extend the geographical coverage of the subject matter to which that particular Protocol applies (Art. 1.3).

The Barcelona Convention has 6 Protocols:[115]

- *Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft* (in force); [116]
- *Protocol concerning cooperation in preventing pollution from ships and, in cases of emergency, combating pollution of the Mediterranean Sea* (Prevention and Emergency Protocol) (in force 2004), replacing the 1976 Protocol Concerning

[113] Convention for the Protection of the Mediterranean Sea against Pollution, in force 1978, as amended the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, in force 2004.
[114] Parties include Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Morocco, Slovenia, Spain, Syria, Tunisia, Turkey and the European Community). See www. http://www.unepmap.org/home.asp
[115] www.unepmap.org/home.asp
[116] Revised in 1995 as the 'Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea' (amendment not in force).

co-operation in combating pollution of the Mediterranean Sea by oil and other harmful substances in cases of emergency;

- *Protocol for the Protection of the Mediterranean Sea against pollution from Land-Based Sources* (LS Protocol) (in force); [117]
- *Protocol concerning Specially Protected Areas and Biodiversity in the Mediterranean*, and replacing the Protocol Concerning Mediterranean Specially Protected Areas (in force);
- *Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil* (Offshore Protocol) (not in force); and
- *Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal* (Hazardous Wastes Protocol) (not in force). [118]

The EU is a party to the Dumping Protocol, Prevention and Emergency Protocol, LBS Protocol, and the SPA and Biodiversity Protocol. The Dumping Protocol and the LBS Protocol were revised in 1995. These amendments are not yet in force, but have been accepted by the EU.

The Barcelona Convention uses a definition of 'pollution' that is virtually identical to that used by UNCLOS:

> '*the introduction by man, directly or indirectly, of substances or energy into the marine environment resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea water and reduction of amenities.*'

Art. 2(a). The indirect introduction of CO_2 into the marine environment by an accidental release from CO_2 transport or geological storage activities can be considered pollution under the Barcelona Convention if it results in harm to living resources, hazards to human health.

Under the Convention, the Parties agree to take all appropriate measures to *prevent, abate, combat and to the fullest possible extent eliminate pollution* of the Mediterranean Sea Area and to protect and enhance the marine environment so as to contribute towards its sustainable development (Art. 4.1). They further pledge to pursue the protection of the marine environment and the natural resources of the Mediterranean Sea Area as an integral part of the development process, "meeting the needs of present and future generations in an equitable manner" (Art. 4.2). Under Article 3, the Parties commit themselves to:

[117] Revised in 1995 as the 'Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources and Activities' (amendment not in force).
[118] http://www.unepmap.org/home.asp

(a) *apply the precautionary principle*, by virtue of which where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation;
(b) *apply the polluter pays principle*, by virtue of which the costs of pollution prevention, control and reduction measures are to be borne by the polluter, with due regard to the public interest;
(c) ***undertake environmental impact assessment*** for ***proposed activities*** that are ***likely to cause a significant adverse impact on the marine environment*** and are subject to an authorization by competent national authorities;
(d) promote cooperation between and among States in *environmental impact assessment procedures* related to activities under their jurisdiction or control ***which are likely to have a significant adverse effect on the marine environment of other States*** or areas beyond the limits of national jurisdiction, on the basis of notification, exchange of information and consultation;

The Parties undertake to exchange data and other scientific information for Convention purposes, and cooperate in the formulation, establishment and implementation of clean production processes (Art. 13). They also agree to use the ***best available techniques*** and the best environmental practices and ***promote the application of, access to and transfer of environmentally sound technology, including clean production technologies***, taking into account social, economic and technological conditions (Art. 4).

With respect to liability, the Parties "undertake to cooperate in the formulation and adoption of appropriate rules and procedures for the determination of liability and compensation for damage resulting from pollution of the marine environment in the Mediterranean Sea Area" (Art. 16).

With respect to public information, the Parties "shall ensure that their competent authorities shall give to the public appropriate access to information on the environmental state in the field of application of the Convention and the Protocols, ***on activities or measures adversely affecting or likely to affect [the public]*** and on activities carried out or measures taken in accordance with the Convention and the Protocols" (Art. 15.1). The Parties are also required to ensure that public is given the opportunity to participate in decision-making processes relevant to the field of application of the Convention and the Protocols, "as appropriate" (Art. 15.2).

A. Dumping Protocol, in force 1978

The Dumping Protocol[119] builds upon Barcelona Convention commitments with respect to the prevention and abatement of pollution of the Mediterranean Sea area caused by

[119] 1976 Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft.

dumping from ships and aircraft. It also builds upon the 1972 London Convention's objectives.

The Protocol prohibits the deliberate disposal "at sea" of wastes or other matter from ships or aircraft that are listed in Annex I to the Protocol. CO_2 is not an Annex I listed waste. Wastes and other matter listed in the Protocol's Annex II may be dumped under a special permit. The dumping of CO_2 may require a special permit, as a "substance[ ] which, though of a non-toxic nature may become harmful owing to the quantities in which they are dumped…" (Annex II, para. 4). The dumping of all other wastes requires a general permit.

The Protocol would be relevant to the disposal of CO_2 into the sea itself, but does not appear to cover injection into the sub-seabed. Annex III factors that bear on the issuance of permits all address the direct impacts of disposal into the sea itself.

In 1995, the Dumping Protocol was amended and recorded as the *Protocol for the Prevention and Elimination of Pollution in the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea*, and adopted in June 1995. The entry into force of the amended Protocol is still pending.[120] The EU has accepted these amendments. The amended Protocol's preamble makes specific reference to the London Convention's prohibition of the dumping and incineration of industrial wastes at sea, and takes "*into account Resolutions LC 49(16) and LC 50(16), approved by the 16th Consultative Meeting of the 1972 London Convention, which prohibit the dumping and incineration of industrial wastes at sea*." The amended Dumping Protocol aims for a phase out of dumping of wastes into the sea. Under the 1995 amendments, the dumping of all "wastes or other matter" is prohibited within the Mediterranean Sea area (as it is defined in the Barcelona Convention). The only exceptions are:

- dredged material
- fish waste or organic materials resulting from the processing of fish and other marine organisms
- vessels, until 31 December 2000
- platforms and other man-made structures at sea
- inert uncontaminated geological materials the chemical constituents of which are unlikely to be released into the marine environment

(Art. 4). The dumping of these wastes requires a special permit. When granting permits, the effects of the dumped materials on marine life and uses of the sea are to be considered. A list of factors is set out in the Protocol's Annex. Additional exceptions are available in emergency situations, or where "in a critical situation of an exceptional nature" a Party considers that wastes cannot be disposed of on land "without unacceptable danger or damage" (Arts. 6 and 9).

[120] http://www.unepmap.org/home.asp

Under the 1995 amended Protocol, the dumping prohibition extends to any 'deliberate disposal at sea of wastes or other matter from ships or aircraft' or any '***deliberate disposal or storage and burial of wastes or other matter on the seabed or in the marine subsoil from ships or aircraft'*** (Art. 3). Assuming that there is a distinction between marine subsoil, and sub-seabed cavities to be used for geological storage, this language would appear not to regulate (or prohibit) deliberate storage in geological storage sites beneath the seabed.

B. Land Based Sources Protocol (LBS Protocol)121

The objective of the Barcelona Convention's LBS Protocol is to 'prevent, abate, combat and control pollution of the Mediterranean Sea area by discharges from rivers, coastal establishments or outfalls, or emanating from any other land-based sources' (Art. 1). The LBS Protocol uses the same definitions as the London Convention. The Protocol area includes the Mediterranean Sea area, as defined in the Barcelona Convention, plus waters on the landward side of the baselines from which the breadth of the territorial sea is measured, extending in the case of watercourses up to the freshwater limit, and saltwater marshes communicating with the sea (Art. 3).

Like the London Convention, the LBS Protocol provides for 3 categories of substances:

- ***Annex I substances***, whose dumping is *prohibited* based on their high level of toxicity, persistence and bioaccumulation;
- ***Annex II substances***, which can only be dumped after a ***special permit*** is issued by national authorities, taking account of the characteristics set out in Annex III (composition of waste, discharge site, receiving marine environment, availability of waste technologies, and potential impairment of marine ecosystems and seawater uses); and
- ***all other wastes, whose dumping*** requires a prior ***general permit***. Art. 6(3), Annex III.

Special and general permits are issued for wastes loaded in the territory of the Party, or by a ship or aircraft registered in its territory or flying its flag when loading occurs in the territory of a non-Party.

Parties are required to implement necessary programmes and measures in order to eliminate pollution of the Protocol area from land-based sources by substances listed in Annex I of the Protocol, and limit pollution from land-based sources by substances or sources listed in Annex II (Art. 5 and 6). Parties are also required to formulate and adopt guidelines and, as appropriate, standards or criteria for emission limits and criteria for the siting of pipelines for outfalls (length, depth, position), local ecological and geographical characteristics, the absorptive capacity of the local marine environment, and other elements (Art. 7). They are to co-operate as far as possible in scientific and technological fields related to pollution from land-based sources, particularly on research on inputs,

[121] 1980 Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources

pathways and effects of pollutants and on the development of new methods for their treatment, reduction or elimination (Art. 9).

These provisions would apply to CO_2 injected by pipeline from a land-based source directly into the marine environment; however, they do not appear to address CO_2 injected by pipeline into a cavity underneath the marine environment. The Protocol applies to polluting discharges 'reaching' the Protocol area from land-based sources, 'in particular' directly from outfalls discharging into the sea, or indirectly through rivers, canals or other watercourses, including underground watercourses (Art. 4.1(a)). It also applies to polluting discharges from fixed man-made off-shore platforms (other than those used for the exploration and exploitation of mineral resources) (Art. 4.2).

The intent of these provisions seems to be to address direct or indirect pollution from land-based sources into marine waters themselves. Pollution resulting from incidental discharges from geological storage sites beneath the Protocol area would need to be minimized, but does not seem to be directly regulated by this regime. Incidental discharges into the Protocol area in the course of injection into geological storage sites from man-made offshore platforms or from land-based sources are more directly covered.

C. *Offshore Protocol* 122

The Offshore Protocol to the Barcelona Convention regulates exploration and exploitation activities on or in the continental shelf, the seabed and its subsoil, and establishes rules to grant permits to carry out regulated activities. "Activities concerning exploration and/or exploitation of the resources in the Protocol Area" are defined to include the following:

- Activities of scientific research concerning the resources of the seabed and its subsoil
- Exploration activities
    - Seismological activities; surveys of the seabed and its subsoil; sample taking
    - Exploration drilling
- Exploitation activities
    - Establishment of an installation for the purpose of recovering resources, and activities connected therewith;
    - Development drilling;
    - Recovery, treatment and storage;
    - Transportation to shore by pipeline and loading of ships;
    - Maintenance, repair and other ancillary operations.

Art. 1(d). These activities focus on the extraction and recovery of substances or resources, rather than on their introduction, or injection. The only activities addressed by

[122] The Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil.

the Protocol that are arguably relevant to CCS for CO_2 generated from land-based operations are scientific research concerning the resources of the subsoil (if resource is understood to include storage capability), and exploration activities.

12. Cartagena Convention, in force 1986

The Cartagena Convention[123] addresses the marine environment of the Gulf of Mexico, the Caribbean Sea and the areas of the Atlantic Ocean but does not cover the internal waters of the Contracting Parties. The European Economic Community is a signatory to the Convention, but not a Party.

Under the Convention the Parties are to "take all appropriate measures to prevent, reduce and combat pollution," caused by discharges from ships (Art. 5), dumping of wastes and other matter (Art.6), and from land-based sources, including coastal disposal, discharges emanating from rivers, estuaries, coastal establishments, outfall structures or any other sources within their territory. (Art. 7) The Convention also regulates pollution caused from "sea-bed activities," which is pollution "resulting directly or indirectly from exploration and exploitation of the sea-bed and its subsoil" (Art. 8).

Whether the UNEP Framework Sea Conventions, including the Cartagena Convention, cover CCS depends how the terms 'waste' and 'dumping' are defined. It is likely this treaty will cover disposal via both shipping and pipeline, as the Convention regulates dumping, discharges from ships, and land-based sources which includes 'outfall structures or any other sources.' (Art. 7) Further this treaty is not limited to the water column and could additionally regulate activities in the sea-bed. CO_2 storage could be considered 'exploration or exploitation of the sea bed and its subsoil' and be regulated subject to Article 8.

Additional provisions which could impact CCS, include:

- Environmental Impact Assessments - which are required for major development projects which might reasonably be expected to cause substantial pollution or harmful changes to the marine environment (Art. 13)
- Specially Protected Areas - Parties are allowed to create Specially Protected Areas to protect 'rare or fragile ecosystems as well as rare, depleted, threatened or endangered species of wild fauna and flora and their habitats.' In these protected areas, Parties can 'prohibit an activity likely to have adverse effects on the species, ecosystems or biological processes'. (Art. 10)

13. Nairobi Convention, in force 1996

The Nairobi Convention[124] is another UNEP Regional Seas Convention. The Nairobi Convention mirrors the Cartagena Convention, discussed above, addressing the Indian

[123] 1983 Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region.
[124] 1985 Convention for the Protection, Management and Development of the Marine and Coastal Environment of the East African Region

Ocean within the region of Eastern Africa. The European Economic Community is a signatory to the Convention, but not a Party.

As with the other Regional Seas agreements, the Nairobi Convention is designed to protect the marine environment by directing parties to take all measures to 'prevent, reduce and combat pollution' from a series of sources, including: discharges from ships (Art. 5); dumping of waste and other matter (Art. 6); from land-based sources (Art. 7) ; and from 'sea-bed activities' (Art. 8). Application of this Convention to CCS again depends on the definition of waste and dumping, as discussed above. Additional provisions that may impact CCS include the provisions requiring EIA, and allowing Parties to create specially protected areas.

14. Bonn Agreement, in force

The Bonn Agreement[125] (1983) is relevant to the shipping, transport and escape of oil and harmful substances. Parties agree to cooperate whenever the presence (or the prospective presence) of oil or other '***harmful substances***' polluting or threatening to pollute the sea within the North Sea area presents a ***grave and imminent danger*** to the coast or related interests of one or more Contracting Parties.[126] Neither 'pollution' nor 'harmful substances' is defined.

Parties agree to jointly develop and establish guidelines for joint action to address pollution, including the practical, operational and technical aspects of joint action. To accommodate this, the North Sea has been divided in zones. The Parties under joint responsibility for a zone are to enter into a special technical agreement to manage the zone.

Parties agree to communicate with each other about their national capacities for avoiding or dealing with pollution by oil and other harmful substances, which might be made available for international assistance if an event should occur. Whenever a Party is aware of a casualty, or aware of the presence of oil or other harmful substances in the North Sea area that is likely to constitute a serious threat to the coast or related interests of any other Party, it is required to inform that Party without delay through its competent authority.

The Bonn Agreement contains no liability provisions. However, Parties may enter into financial arrangements governing actions to deal with pollution on a bilateral or multilateral basis, or in the event joint operation are undertaken to combat pollution. In the absence of such an agreement, if one Party at the request of another takes action, the Party requesting assistance is responsible for reimbursing the costs of its action. If a Party on its own initiative took the action, that Party bears the costs of its action.

[125] 1983 Agreement for Co-operation in Dealing with Pollution of the North Sea by Oil and other Harmful Substances, in force 1989.
[126] Parties include Belgium, Denmark, France, Germany, Netherlands, Norway, Sweden, United Kingdom and the European Economic Community.

C. CLIMATE CHANGE

15. UN Climate Change Convention, in force 1994

The objective of the Climate Change Convention[127] is to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system (Art. 2). CO_2 is one of the six greenhouse gases regulated under the Convention.

Under Article 4, Parties commit to formulate and implement national and regional programmes containing measures to mitigate climate change by addressing emissions by sources and removals by sinks of greenhouse gases (not controlled by the Montreal Protocol). They are also to promote and cooperate in the development, application and diffusion of technologies, practices and processes that *control*, *reduce* or *prevent* anthropogenic emissions of GHGs in relevant sectors, including the energy, industry and waste management sectors (Art. 4.1(c)). Under Article 4.2, each Party agrees to 'adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. Parties aim to return individually or jointly to their 1990 levels of anthropogenic GHG emissions (Art. 4.2(b)).

Article 1.8 of the UNFCCC defines '*emissions*' as 'the release of greenhouse gases and/or their precursors *into the atmosphere over a specified area and period of time*.' '*Sink*' is defined as 'any process, activity or mechanism, which removes a greenhouse gas, an aerosol or precursor of a greenhouse gas from the atmosphere.' '*Source*' is defined as any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.'

Article 1.8 also contains a definition for '*reservoir*' – 'a component of the climate system where a greenhouse gas is or a precursor of a greenhouse gas *is stored*' (emphasis added). '*Climate system*' is in turn defined as 'the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions.' Hence the Convention draws a distinction between sources and sinks, which relate to the release or removal of greenhouse gases from the atmosphere, and reservoirs, which may relate to storage in other parts of the climate system. Under Article 1(d), all Parties are to cooperate in the conservation and *enhancement of sinks and reservoirs of all greenhouse gases* . . . including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems'. Under Article 2(a), developed country Parties are to 'adopt national policies and take corresponding measures on the mitigation of climate change, by limiting anthropogenic emissions of greenhouse gases and protecting and *enhancing its greenhouse gas sinks and reservoirs*.'

Under the UNFCCC, Parties must report annually on their inventories of CO_2, using a common reporting format, and also report on their progress toward the stabilization of

[127] 1992 United Nations Framework Convention on Climate Change.

GHGs in the atmosphere at a level that prevents dangerous climate change. It is not clear how emissions prevented or avoided would be reported.
Under Article 4.1(a), Parties agree to periodically report on 'inventories of anthropogenic emissions by sources and removals by sinks . . . using comparable methodologies. National inventory reporting under the Convention may be challenging in the absence of clarification on how captured and stored CO_2 relates to 'emissions by sources' and to 'removals by sinks' – particularly if CCS is to be brought into emissions trading systems under the Kyoto Protocol or related domestic or regional trading systems. Reporting will also be challenging if geological sites are to combine CO_2 from a variety of industrial installations, or for a variety of purposes (e.g. disposal, storage, enhanced oil recovery), or where these sites extend beyond national borders. Conceivably, geological storage sites might themselves be treated as sources of emissions, with reporting on emission leakage rates required.

However, the overarching goal of the Convention is to stabilize greenhouse gas concentrations in the atmosphere, at a level that would prevent dangerous anthropogenic interference with the climate system as a whole (with climate system including the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions). The Convention contains a number of principles that may support CCS in the short run, given the harmful potential of unrestrained GHG emissions (including the precautionary principle and the principle of intergenerational equity). At the same time, the very same principles of precaution and equity counsel in favour of the Convention's principal approach to the problem of increasing GHG emissions – which is to prevent, limit, and control the generation of these gases. For this reason, a CCS system that encourages or enables the generation of increasing levels of CO_2 -- by offering means to dispose of this waste[128] in geological cavities – may be viewed as inconsistent with the Convention's fundamental goals. Here the distinction between storage and disposal may be important.

16. Kyoto Protocol, in force 2005

Under the Kyoto Protocol[129] to the Climate Change Convention, Parties agree to ensure that their aggregate anthropogenic carbon-dioxide equivalent emissions do not exceed certain assigned amounts in a first commitment period that runs from 2008 to 2012 (Art. 3). Assigned amounts are calculated from Parties' quantified emission limitation or reduction commitments, made as a percentage of base year emissions. The EU and its Member States have committed to reducing their aggregate emissions by 8% below 1990 levels. See Article 3 and Annex B. If a Party does not use its full assigned amount during the first commitment period, the remainder may be traded to another Party (Art. 17), or carried over to a subsequent commitment period (Art. 3.13). The Conference of the Parties to the UNFCCC defines the relevant principles, modalities, rules and guidelines for verification, reporting and accountability for emissions trading (Art. 17).

[128] See discussion of Waste Framework Directive herein.
[129] 1997 Protocol to the United Nations Framework Convention on Climate Change.

To meet its commitments, any Party included in Annex I may transfer to, or acquire from, any other Annex I Party 'emission reduction units' (ERUs) resulting from 'projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy', provided that that project provides 'a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur' (Art. 6). Annex I Parties may also utilize 'certified emission reductions' (CERs) generated by clean development mechanism (CDM) projects in developing country Parties, to assist them in achieving compliance with their quantified emission limitation and reduction commitments under Article 3 (Art. 12). CDM projects must be approved by developing country host governments; contribute to real, measurable and long-term benefits related to the mitigation of climate change; and generate 'reductions in emissions that are additional to any that would occur in the absence of the certified project activity' (Art. 12(5)).

A key intention of the KP was to achieve emission reductions through reductions at the source (Johnston et al.). Nevertheless, it is conceivable that an argument might be made that CO_2 capture projects, if they reduce emissions to the atmosphere by sources in addition to any reduction that would otherwise occur, could generate ERUs or CERs. 'Emissions' for purposes of the Kyoto Protocol are defined in the same manner as in the Convention – 'the release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time' (Art. 1)

Under Article 2 of the Kyoto Protocol, in achieving its emission target, each Annex I Party is to 'implement and/or further elaborate policies and measures in accordance with national circumstances' such as:

- Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation (Art. 2.1(a)(ii))
- 'Research on and promotion, development and increased use of new and renewable forms of energy, of carbon dioxide sequestration technologies, and of advanced and innovative environmentally sound technologies' (Art. 2.1(a)(iv)).

'Carbon dioxide sequestration technologies' are not defined. 'Innovative environmentally sound technologies' are also not defined. 'Sinks' and 'reservoirs' are as defined in the UNFCCC.

Parties are to put in place a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases. This may be challenging in the absence of clarification on how captured and stored CO_2 is to be reported, and how it relates to 'emissions by sources' and to 'removals by sinks' – particularly if CCS is to be brought into emissions trading systems under the Kyoto Protocol or related domestic or regional trading systems.

D. TRANSPORT AND LIABILITY

International Conventions

17. SOLAS, in force 1980

SOLAS[130] regulates the carriage of goods by merchant ship. The provisions apply to all ships carrying the flag of the Parties, which are subject to inspection and certification by their home ports, and can be inspected by the port authorities of other Parties, when there are clear grounds for believing that the ship and its equipment do not substantially comply with the Convention's safety requirements.

The Convention regulates safety measures required of ships travelling in international waters, and its provisions would be generally applicable to any cargo ship, regardless of its cargo. Additional measures are imposed on ships carrying special cargo such as liquefied gases (IGC Code), hazardous materials (IMDG Code) and bulk goods (IBC Code). Vessels carrying special cargo are required to meet provisions for the classification, packing, marking, labelling and placarding, documentation and stowage of those dangerous goods.

Regulation 13 requires carriers of liquefied gases to take additional safety measures pursuant to the IGC Code. The IGC applies to all ships engaged in the carriage of liquefied gases having a vapour pressure greater than 2.7 bar absolute at a temperature of 37.8 ˚C and other products listed in Chapter 19. (Chapter 1.1.1) CO_2 is not specifically listed under Chapter 19. Therefore only the general provisions of the IGC Code would apply to ships carrying CO_2, no special provisions under Chapter 19 would be required. The general requirements of the IGC include provisions regarding the construction of ships (Ch. 2 & 3.6), cargo containment (Ch. 4, 5 & 8), environmental controls (Ch. 9) and operating requirements (Ch. 18).

18. COTIF, in force 1985

COTIF[131] regulates the carriage of passengers, luggage and goods in international through traffic by rail between Member States and does not seem to apply to CCS. Section 3 is the only provision that could be construed to regulate CCS. Section 3 relieves the railway of liability when loss or damage arises from the 'special risks inherent in the nature of certain goods which renders them inherently liable to total or partial loss or damage, especially through breakage, rust, interior and spontaneous decay, desiccation or wastage'. (App.B, Title IV, Art. 36). Other regional treaties, such as the ADR, are more applicable to CO_2 transport by rail and would likely govern.

[130] 1974 International Convention for the Safety of Life at Sea, in force 1980, and amended in 2002
[131] 1980 Convention Concerning International Carriage by Rail.

19. CRTD Convention, not in force

The CRTD Convention[132] establishes non-contractual liability of the carrier for damage caused by any dangerous goods during their carriage by road, rail or inland navigation vessel. Under the Convention, carriers of dangerous goods are held strictly liable for damage occurring during transport, and must obtain insurance or financial security to provide cover for losses.

The CRTD Convention limits liability by type of carrier (road, rail, vessel) and type of injury potentially suffered (loss of life, personal injury, other). The liability of the road or rail carrier is limited for claims arising from any one incident to 30 million SDR: 18 million for loss of life or personal injury; and 12 million SDR with respect to any other claim. The liability of the carrier by inland navigation vessel is limited to 15 million SDR: 8 million for loss of life or personal injury; and 7 million with respect to any other claim. The CRTD Convention is not yet in force.

The Convention covers pecuniary and non-pecuniary damage, impairment to the environment, the costs of reinstatement measures actually undertaken or to be undertaken, as well as the cost of preventive measures and further loss or damage caused by such measures.

The carrier at the time of the incident is liable. If an incident consists of a series of occurrences, liability attaches to the carrier at the time of the first of such occurrences. The Convention provides for joint and several liabilities if more than one carrier is involved. Claims must be brought within three years of the date at which the person suffering the damage knew or ought reasonably to have known of the damage and of the identity of the carrier -- in any case no longer than ten years from the date of the incident, which caused the damage. The Convention contains provisions on competent courts, conflict of laws and enforcement of judicial decisions.

20. HNS Convention, not in force

The HNS Convention[133] is an International Maritime Convention that aims to ensure that adequate, prompt, and effective compensation is available to persons who suffer damage caused by incidents in connection with the carriage by sea of hazardous and noxious substances (HNS). The Convention is open to all States. It is not open to regional economic integration organizations. The Convention's geographic scope extends to damage caused on the territory, including the territorial sea, and in exclusive economic zones of State Parties.

'***Hazardous and noxious substances***' (HNS) are defined by reference to lists of substances included in various IMO Conventions and Codes. These include: oils; other liq-

[132] 1989 Convention on Civil Liability for Damage caused during Carriage of Dangerous Goods by Road, Rail and Inland Navigation Vessels.
[133] 1996 International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea.

uid substances defined as noxious or dangerous; ***liquefied gases***; liquid substances with a flashpoint not exceeding 60°C; dangerous, hazardous and harmful materials and substances carried in packaged form; and solid bulk materials defined as possessing chemical hazards. The Convention also covers residues left by the previous carriage of HNS, other than those carried in packaged form.

The HNS Convention is based on the two-tier system: (1) ***strict liability for the ship owner***, with this liability limited, and (2) ***a supplementary fund*** constituted from contributions from the receivers of HNS cargo or governments on their behalf. The HNS Convention is based on the two-tier system established under the 1969 International Convention on Civil Liability for Oil Pollution Damage and 1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (OPCR Convention and Fund Convention). However, it goes further than these conventions, in that it covers not only pollution damage but also the risks of fire and explosion, including loss of life or personal injury as well as loss of or damage to property.

The Convention defines damage to include loss of life or personal injury, loss of or damage to property outside the ship, loss or damage by contamination of the environment, and the costs of preventative measures and further loss or damage caused by these measures.

While the Convention introduces strict liability for the shipowner and a system of compulsory insurance, it also includes limits for liability. These liability limits are linked to vessel tonnage. When an incident occurs for which compensation is payable under the HNS Convention, compensation is first sought from the shipowner, up to the maximum limit of 100 million SDRs. Once this limit is reached, compensation is paid from the second tier (***the HNS Fund***) up to a maximum of 250 million SDRs, which sum includes compensation paid under the first tier. Contributions to the HNS Fund are levied on persons or entities in the Contracting States who ***receive*** a certain minimum quantity of HNS cargo during a calendar year.

The HNS Fund, when in force, will consist of one general account and three separate accounts for oil, liquefied natural gas (LNG) and liquefied petroleum gas (LPG). This separation of accounts is designed to avoid cross-subsidization between different HNS substances, when compensation is required from the transport of these substances. Conceivably, an account could be established for liquefied CO_2, however, risks involved in the accidental release of CO_2 will be far different in nature from an accidental spill of oil, LNG or LPG.

The HNS Convention is not in force yet, but may address (or might be extended to address) aspects of shipowner liability for the accidental release of liquid CO_2 transported in bulk by vessel for injection into a geologic storage site. Site operators receiving liquid CO_2 in bulk might be expected to contribute toward the HNS Fund. This will depend upon the threshold amounts of bulk HNS cargo received by these operators, whether they

act as principals for another entity, and how the term 'received' is understood under the HNS Convention for purpose of calculating 'contributing cargo' (cargo carried to a port or 'terminal' within a State).

21. HNS Protocol, not in force

The HNS Protocol[134] aims to provide a global framework for international cooperation in combating major incidents or threats of marine pollution from 'hazardous and noxious substances' (HNS), where these substances are broadly defined as 'any substance other than oil which, if introduced into the marine environment is likely to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea' (Art. 2.2). HNS for purposes of the HNS Protocol are defined as they are for purposes of the HNS Convention, by reference to lists of substances included in various IMO Conventions and Codes, and would include ***liquefied gases***.

Parties to the HNS Protocol are required to establish measures for dealing with pollution incidents, either nationally or in cooperation with other countries. 'Pollution incident' means 'any occurrence or series of occurrences having the same origin, including fire or explosion, which results or may result in a discharge, release or emission of hazardous and noxious substances and which poses or may pose a threat to the marine environment, or to the coastline or related interests of one or more States, and which requires emergency action or immediate response'.

Ships will be required to carry a shipboard pollution emergency plan to deal specifically with incidents involving HNS. An Annex to the Protocol addresses the reimbursement of costs of assistance provided by one State to another State, where actions are taken unilaterally, and at the request of a requesting State.

Regional Conventions

22. ADR Convention, in force 1968

The ADR[135] is a EU regional treaty governing the carriage of dangerous goods by rail. The ADR does not assign liability or consider the transboundary effects of leaks, it merely regulates how certain chemicals can be transported. While some chemicals are prohibited from international transport, less dangerous chemicals, such as CO_2, must merely meet packaging and labelling requirements.

[134] 2000 Protocol to the OPRC Convention on Preparedness, Response and Cooperation to Pollution Incidents by Hazardous and Noxious Substances
[135] 1957 UNECE Agreement concerning the International Carriage of Goods by Road.

23. ADN Convention, not in force

The 2000 ADN[136] regulates the transport of dangerous goods in inland waterways of the EU. Like the ADR, the ADN requires vessels transporting certain dangerous goods comply with shipping, vessel construction, labelling and permitting requirements. CO_2 as a Class 2 gas is not prohibited from shipment, but is subject to certain special provisions concerning carriage. See Annex B.1, Part II, 21 000 - 30 999; Annex B.2, Part II, 221 000 - 230 999

E. ACCESS TO INFORMATION, PUBLIC PARTICIPATION, ACCESS TO JUSTICE

International Conventions

24. Aarhus Convention, in force 2001

The objective of the Aarhus Convention[137] is to contribute to the protection of the right of every person of to live in an environment adequate to his or her health and well-being. Each Party to the Convention is to guarantee the rights of access to information, public participation in decision-making, and access to justice in environmental matters.

The Aarhus Convention provides for: (i) access to environmental information by the public; (ii) public participation in environmental decision-making; and (iii) access to justice in environmental matters (i.e. the right to challenge in a court of law public decisions adopted in violation of environmental laws and in violation of the rights of access to information and participation in decision-making).

The Aarhus Convention requires 'public authorities' to make 'environmental information' accessible to the public, and involve the public in decision-making on whether to permit certain proposed activities (Art. 6). Public participation can be triggered in two ways: (1) if the proposed activity is listed in Annex I; or(2) if the activity is not listed but 'may have a significant effect on the environment' (Art.6).

Annex I to the Convention provides a list of activities for which Article 6 procedures are mandatory. Certain of these activities may be relevant to CCS:

- Energy sector – 'Installations for gasification and liquefaction' (1)
- Chemical industry – 'chemical installations for the production of basic inorganic compounds, including gases, such as … carbon oxides' (4b)
- 'Pipelines for the transport of gas, oil or chemicals with a diameter of more than 800mm and a length of more than 40 km' (14)

[136] 2000 UNECE Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways.
[137] 1998 Convention on Access to Information, Public Participation and Decision Making and Access to Justice in Environmental Matters, in force 2001

- Any activity not covered . . . above where public participation is provided for under an environmental impact assessment procedure in accordance with national legislation' (20)

Parties are to require their competent public authorities to give the public access, upon request, to all information relevant to the decision-making process that is available at the time of the public participation procedure. Under Article 6, this includes:

(a) A description of the site and the physical and technical characteristics of the proposed activity, including an estimate of the expected residues and emissions;
(b) A description of the significant effects of the proposed activity on the environment;
(c) A description of the measures envisaged to prevent and/or reduce the effects, including emissions;
(d) A non-technical summary of the above;
(e) An outline of the main alternatives studied by the applicant; and
(f) In accordance with national legislation, the main reports and advice issued to the public authority.

Where proposed activities are not listed, Parties have discretion in determining whether they are subject to Article 6 requirements. The public is to be informed of proposed activities 'in an adequate, timely and effective manner', and public participation in the decision-making process must ensure that the public gets involved when all options are open. Due account must be taken of the outcome of public consultations, and the public is to be promptly informed of the decision taken and the basis and considerations underlying the decision.

Article 7 of the Convention addresses '***plans, programmes and policies***' relating to the environment. Each Party is required to provide opportunity for the public to participate during the preparation of 'plans and programmes' relating to the environment, within a transparent and fair framework, with the necessary information provided. Parties are also to endeavour to provide opportunities for public participation in the preparation of 'policies relating to the environment' 'to the extent appropriate.'

Hence if a particular CO_2 storage plan, programme or policy is under consideration, the Convention will require that adequate provision be made for public participation and access to information. Member states should have proper legislative mechanisms available at the national level for public consultation, as well as legal procedures in place for those seeking a review of decisions taken regarding projects, programmes or plans related to environment (Art. 9).

Under the Convention, Parties are to take steps to establish a nationwide system of pollution inventories or registers on a computerised publicly accessible database, compiled through standardised reporting (Art. 5(9)). This system may include releases and transfers of a range of substances and products, including water, energy and resource use,

from a specified range of activities, to the environment and to on-site and offsite treatment and disposal sites (Art. 5(9)).

Regional Conventions

25. Espoo (EIA) Convention, in force 1997

The Espoo (EIA) Convention[138] requires Parties to assess the environmental impact of certain activities at an early stage of planning. States have the general obligation to notify and consult each other on all major '***proposed activities***' under consideration that are likely to have a significant adverse environmental impact across borders. The Espoo (EIA) Convention is based on earlier EU Directives (Sands: 814), which are discussed below.

'*Proposed activity*' is 'any activity or any major change to an activity subject to a decision of a competent authority in accordance with an applicable national procedure' (Art. 2(3)). '*Impact'* is defined as '*any effect caused by a proposed activity on the environment including human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures or the interaction among these factors. . .*' '*Environmental impact assessment'* is defined as 'a national procedure for evaluating the likely impact of a proposed activity on the environment.

Parties agree to 'take all appropriate and effective measures to prevent, reduce and control significant adverse transboundary environmental impact from proposed activities' (Art. 2.1). They agree to take the necessary legal, administrative or other measures to implement the Convention – which include the establishment of a national procedure for public notice and participation, and the preparation of environmental impact assessment documentation for proposed activities listed in Appendix I that are ***likely to cause significant adverse transboundary impact***. EIA document requirements are described in Appendix II. The 'activities' listed in Appendix I include, among other things:

- Crude oil refineries over a certain size
- Thermal power stations over 300MW
- Large-diameter pipelines for the transport of oil, gas or chemicals
- Major storage facilities for petroleum, petrochemical or chemical products
- Waste-disposal installations for the incineration, chemical treatment or landfill of toxic and dangerous wastes

It is not likely that CO_2 would either be transported through large-diameter pipes in gas form, or that a CO_2 geological storage site could be considered a waste disposal installation for the landfill of a 'dangerous waste', or a major storage facility for a 'chemical product.' Even if it were arguably included in Annex I, for the Convention's EIA requirements to apply, there would have to be a likelihood of a significant adverse transboundary impact. Even if new large scale CCS activities might be deemed a 'major

[138] 1991 Convention on Environmental Impact Assessment in a Transboundary Context.

change to an activity subject to a decision of a competent authority in accordance with an applicable national procedure' in relation to a thermal power station, under Article 2(3)'s definition of proposed activity, the criterion of 'likely to cause significant adverse transboundary impact' would still need to be satisfied for EIA requirements to apply.

Nevertheless, even where a proposed activity is not listed in Annex I, concerned Parties 'shall, at the initiative of any such Party' enter into discussions on whether that activity is likely to cause a significant adverse transboundary impact and should nevertheless be treated as if it were listed in Appendix I. If the Parties agree, the activity will be treated as an Appendix I activity (Art. 2.5). General guidance for identifying ***criteria to determine significant adverse impact*** is set forth in Appendix III. These criteria include:

(a) Size: proposed activities, which are large for the type of the activity;

(b) Location: proposed activities which are located in or close to an area of special environmental sensitivity or importance (such as wetlands designated under the Ramsar Convention, national parks, nature reserves, sites of special scientific interest, . . .); also, proposed activities in locations where the characteristics of proposed development would be likely to have significant effects on the population;

(c) Effects: proposed activities with particularly complex and potentially adverse effects, including those giving rise to serious effects on humans or on valued species or organisms, those which threaten the existing or potential use of an affected area and those causing additional loading which cannot be sustained by the carrying capacity of the environment.

In considering these criteria, the 'concerned Parties' are also to consider proposed activities, which are located close to a border, 'as well as more remote proposed activities which could give rise to significant transboundary effects far removed from the site of development,' (Annex III, para. 2). These criteria suggest that the impacts of large-scale CO_2 geologic storage in sites that are either cross-boundary, or close to national boundaries, should be the subject of discussion among concerned Parties, and discussed for possible treatment in keeping with the treatment given to Appendix I proposed activities.

Where proposed activities are covered under the Convention, Parties within whose jurisdiction the proposed activity is to occur must afford the public, in areas likely to be affected, with an opportunity to participate in relevant EIA procedures. These procedures are to be equivalent to those provided to the public of the 'Party of origin.'

EIAs are to be undertaken at least at the project level. To the extent appropriate, Parties are also 'to endeavour to apply' EIA principles to policies, plans and programmes.

26. SEA Protocol, not in force

The 2003 SEA Protocol[139] to the Convention on Environmental Impact Assessment in a Transboundary Context aims to provide for a high level of environmental protection, including health, and to do so by:

- ensuring that environmental, including health, considerations are thoroughly taken into account in the development of plans and programmes;
- contributing to the consideration of environmental, including health concerns in the preparation of policies and legislation;
- establishing clear, transparent and effective procedures for SEA, and for public participation in SEA
- integrating by these means environmental, including health, concerns into measures and instruments designed to further sustainable development.

Under the SEA Directive, each Party is to ensure that an SEA is carried out for ***plans and programmes*** '***which are likely to have significant environmental, including health, effects***.' The Protocol applies to the relevant provisions of the UNECE Conventions on Environmental Impact in a Transboundary Context and on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Art. 15).

The phrase 'e*nvironmental, including health, effect*' is defined as 'any effect on the environment, including human health, flora, fauna, biodiversity, soil, ***climate, air***, water, landscape, ***natural sites***, material assets, cultural heritage *and the interaction among these factors*.' CCS would likely be considered to have such an effect, as it impacts climate, air, and the interaction among many of the listed factors.

'*plans and programmes*' means plans and programmes and any modifications to them that are (a) required by legislative, regulatory or administrative provisions; and (b) subject to preparation and/or adoption by an authority or prepared by an authority for adoption, through a formal procedure, by a parliament or a government' (Art. 1). A plan or programme for CCS might be fall within this scope if, for example, it creates a regulatory framework for CCS activities, or creates regulatory incentives for CCS, or addresses accounting frameworks for CCS.

The SEA itself is 'an 'evaluation of the likely environmental, including health, effects, which comprises the determination of the scope of an environmental report and its preparation, the carrying out of public participation and consultations, and the taking into account of the environmental report and the results of the public participation and consultations in a plan or programme' (Art. 1).

SEAs are required for plans and programmes prepared for agriculture, forestry, fisheries, *energy*, *industry* including mining, transport, regional development, *waste management*,

[139] 2003 Protocol on Strategic Environmental Assessment.

water management, telecommunications, tourism, town and country planning or land use, and 'that set the framework for future development consent for projects listed in Protocol Annex I' (Art. 4.2). SEAs are also required for any project listed in Protocol Annex II that requires an EIA under national legislation (Art. 4.2).

For plans and programmes subject to SEAs, an Environmental Report must be prepared that identifies, describes and evaluates the likely significant environmental, including health, effects of implementing the plan or programme and its reasonable alternatives.

Annex I contains 17 categories of projects. These are similar to those in the Espoo Appendix I (see above). A number of these are relevant to CCS. ***Annex II*** contains 90 categories of projects, a number of which may impact CCS. These include:

- industrial installations for the production of electricity, steam and hot water
- industrial installations for carrying gas, steam and hot water.
- deep drillings (in particular geothermal drilling, drilling for the storage of nuclear waste material, drilling for water supplies, with the exception of drillings for investigating the stability of the soil).
- pipelines for transport of gas or oil, as far as not included in annex I.
- pipelines for the transport of chemicals with a diameter of more than 800 mm and a length of more than 40 km.
- waste disposal installations (including landfill), as far as not included in annex I.

The SEA Protocol contains provisions on screening, scoping (Art. 6), public participation (Art. 8), report contents (Art. 7 and Annex IV), consultation with environmental and health authorities (Art. 9), and transboundary consultations (Art. 10). Each Party must monitor the 'significant environmental, including health, effects of the implementation of plans and programs adopted, in order to identify unforeseen adverse effects at an early stage and to be able to undertake appropriate remedial action.'

F. WATER

Regional Conventions

27. Water Convention, in force 1996

The ECE Water Convention[140] is a framework instrument that addresses international co-operation with respect to transboundary water resources in the wider European region. The Convention strengthens national measures for the protection and ecologically sound management of transboundary surface waters and groundwater. It addresses water-related issues at different levels (e.g. regional, watercourse-specific and bilateral) and obliges Parties to prevent, control and reduce water pollution from point and non-point sources (including adverse impact on the marine environment). It includes provisions for monitoring, research and development, consultations, warning and alarm systems, mutual assistance, institutional arrangements, and the exchange and protection of information, as well as public access to information. It provides an institutional infrastructure for increased region-wide co-operation, technical assistance at the country and river-basin levels, and concrete measures aimed at improving water-resource management (Wouters and Vinogradov, 2003).

Under Article 2, the Parties shall take all appropriate measures to prevent, control and reduce any transboundary impact, and ensure conservation and, where necessary, restoration of ecosystems. The Convention provides that 'measures for the prevention, control and reduction of water pollution shall be taken, where possible, at source'(Art. 2(3)), and measures shall not directly or indirectly result in a transfer of pollution to other parts of the environment (Art. 2(4)).

The Convention directs the Parties to be guided by the precautionary principle, the polluter pays principle and the principle of intergenerational equity.

The objectives of the Convention are to be achieved through a two-tiered approach. The first set of duties in Part I are more general and apply to all Parties to the Convention. The second, contained in Part II, are more concrete and must be implemented through the conclusion of specific agreements by the Riparian Parties -- Parties to the Convention that border 'the same transboundary waters'. The ECE Water Convention also contains a provision on public information [Article 16].

"*Transboundary waters*" means any surface or ground waters which mark, cross or are located on boundaries between two or more States; wherever transboundary waters flow directly into the sea, these transboundary waters end at a straight line across their respective mouths between points on the low-water line of their banks. "*Transboundary impact*" means ***any significant adverse effect on the environment*** resulting from a change in the conditions of transboundary waters caused by a human activity, the physical origin

[140] 1992 UN/ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

of which is situated wholly or in part within an area under the jurisdiction of a Party, within an area under the jurisdiction of another Party. Such effects on the environment include effects on human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures or the interaction among these factors; they also include effects on the cultural heritage or socio-economic conditions resulting from alterations to those factors.

Given the definition of transboundary waters, this Convention is likely to have limited impacts on geological storage. The definition of transboundary impact may include impacts on the environment caused by geological storage in an area under the jurisdiction of one Party, if stored CO_2 should escape and impacts the environment of another.

G. LIABILITY FOR TRANSBOUNDARY IMPACTS

28. Industrial Accidents Convention, in force 2000

This Convention[141] aims to prevent, prepare for, and respond to industrial accidents, including those caused by natural disasters. The Convention applies to industrial accidents capable of causing transboundary effects from activities involving hazardous substances. It covers events occurring in an installation, during manufacture, use, storage, handling or disposal, or during transportation.

What constitutes an 'installation' is undefined. 'Hazardous substances,' for the purposes of defining hazardous activities, are set out in Annex I to the Convention. Specific hazardous substances are set out in Annex I, Part II (CO_2 is not a named substance). In addition, certain categories of substances may also be covered, depending upon their threshold quantities. These include flammable gases (including LPG), highly flammable liquids, very toxic, toxic, oxidizing, explosive, and flammable liquids (handled under specific conditions of pressure and temperature). Also included is the catch-all category of 'dangerous to the environment', with a threshold of 200 tonnes. These categories are set out in Annex I, Part I.

The Convention does not cover land-based transport accidents, with the exception of emergency response to accidents and transportation on the site of the hazardous activity. It also does not apply to accidents caused by activities in the marine environment, including seabed exploration or exploitation, or spills of oil or other substances at sea. (Art. 2).

The Parties agree to take appropriate measures to protect humans and the environment against industrial accidents by preventing such accidents as far as possible, reducing their frequency and severity and mitigating their effects. To this end, the Parties are required to develop and implement policies and strategies for reducing the risks of industrial accidents and improving preventive, preparedness and response measures, including restora-

[141] 1992 UNECE Convention on the Transboundary Effects of Industrial Accidents.

tion measures, taking into account efforts already made at national and international levels (Art. 3).

Parties must develop policies on the siting of activities to minimise risk to the population and environment of all affected Parties, and establish emergency preparedness plans (Art. 7). In areas that are capable of being affected by an industrial accident, the public must be given information and an opportunity to participate in the development of prevention and preparedness measures. The Convention provides for a system of notification in the event of an accident or of an immediate threat of an accident. Parties must ensure that adequate response measures are taken to contain and minimise effects, and they must consult in assessing these effects with other potentially affected Parties where transboundary effects are possible (Art. 11). Parties agree to 'support appropriate international efforts to elaborate rules, criteria and procedures in the field of responsibility and liability' (Art. 16).

29. Lugano Convention, not in force

The 1993 Lugano Convention[142] aims to ensure adequate compensation for damage resulting from activities dangerous to the environment and provide for means of prevention and reinstatement. The Convention takes a comprehensive approach to civil liability for environmentally harmful activities.

'***Dangerous activity***' is defined to include, among other things,

- the production, handling, storage, use or discharge of dangerous substances or any operation dealing with such substances; and
- the operation of an installation or site for the incineration, treatment, handling or recycling of waste, such as those installations or sites specified in Annex II, provided that the quantities involved pose a significant risk for man, the environment or property;
- ***the operation of a site for the permanent deposit of waste***.

'*Waste*' is not defined. '*Dangerous substances*' are defined according to certain criteria following EC legislation or belong to the list of Annex I of Directive 67/548. Annex II is titled 'Installations or sites for the incineration, treatment, handling or recycling of waste' and includes

- Installations or sites for repacking prior to submission to the operation of a site for permanent deposit (§ 1).
- Installations or sites for high temperature degradation or thermal degasification of solid, gaseous or liquid wastes.
- Installations or sites for chemical, physical or biological treatment of wastes for recycling or disposal.
- Installations or sites for storage of materials intended for submission to any operation in this annex or to the operation of a site for the permanent deposit of

[142] 1993 UN/ECE Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment.

waste, temporary storage excluded, pending collection, on the site where it is produced (§ 9).

List of dangerous substances
The substances referred to in Article 2(2)(b) are those listed in Annex I of the Council Directive of the European Communities 67/548/EEC of 27 June 1967 (OJEC No. L196/1), on the approximation of the laws regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances as adapted to technical progress, for the sixteenth time, by Commission Directive of the European Communities 92/37/EEC of 30 April 1992 (OJEC No. L154/30).

The Convention channels liability to the operator for incidents causing damage from a dangerous activity. It does not allow Parties to limit their liability. Operators are not required to be covered by mandatory insurance, but each Party must ensure that operators are covered by a financial security scheme up to a certain limit where appropriate and taking due account of the risks of the activity. (Art. 12). Where many operators are involved, liability may be joint and several. Financial security is mandatory.

Article 7 addresses liability for damage from the ***permanent disposal of wastes***. It provides that the operator of a site for the permanent deposit of waste at the time when damage caused by waste deposited at that site becomes known, is liable for that damage. If damage caused by waste deposited before the closure of such a site becomes known after closure, the last operator shall be liable (Art. 10). Article 8 provides that the operator will not be liable for damage that he proves 'was caused by pollution at tolerable levels under local relevant circumstances.'

The Convention provides compensation for damage resulting from activities dangerous to the environment and also provides for means of prevention and reinstatement. Damage includes loss of life or personal injury, property damage, and the costs of preventive measures and any loss or damage caused by preventive measures and reinstatement measures, limited to the costs of measures actually taken or to be undertaken. It also includes ***environmental damage***, which is defined to include loss or damage by impairment of the environment and the costs of reasonable reinstatement actually undertaken or to be undertaken.

The Convention covers 'incidents' which include any 'sudden occurrence or continuous occurrence or any series of occurrences having the same origin, which causes damage or creates a grave and imminent threat of causing damage.' Joint and several liability attaches for damage caused by continuous occurrences, or a series of occurrences having the same origin. If an operator can prove that the occurrence during the time he had control of the dangerous activity only caused part of the damages, his is liable for only that part of the damage.

The Convention applies to ***carriage by pipeline***, as well as to carriage performed entirely in an installation or on a site inaccessible to the public where it is 'accessory to other activities and is an integral part thereof.'

Exonerations exist for damage caused by an act of war, hostilities, civil war, insurrection or a natural phenomenon of an exceptional, inevitable and irresistible character or done with the intent to cause damage by a third party or as a result of compliance with a specific order or compulsory measure of a public authority or caused by pollution at tolerable levels under local relevant circumstances; or by a dangerous activity taken lawfully in the interests of the person who suffered the damage.

Actions must be brought within three years from the date on which the claimant knew or ought reasonably to have known of the damage and the identity of the operator, and in any case no later than ***thirty years*** from the date of the incident which caused the damage. The Convention contains provisions on relevant national remedies, conflict of laws, competent courts and enforcement of court decisions.

The Convention contains provisions on ***access to information*** held by the government and the operator relating to the incident causing damage. It also elaborates rules governing ***access to national courts*** to allow enforcement of environmental obligations in the public interest (Sands: 177). It has been suggested that the Lugano Convention is not likely to come into force (Sands: 933).

30. Watercourses and Industrial Accidents Protocol, not in force

The Watercourses and Industrial Accidents Protocol[143], adopted in 2003, but not yet in force, provides for civil liability and compensation under two distinct international conventions: (1) the 1992 Industrial Accidents Convention, and (2) the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

The objective of the Protocol is to 'provide for a comprehensive regime for civil liability and for adequate and prompt compensation for damage caused by the transboundary effects of industrial accidents on transboundary waters. 'Industrial accident' is defined as an event resulting from an 'uncontrolled development in the course of a hazardous activity' and includes accidents: (1) in an installation, including during manufacture, use, storage, handling or disposal; (2) during transportation on the site of a hazardous activity; or (3) during off-site transportation via pipelines (Art. 2)

The Protocol applies only to damage caused by the transboundary effects of an industrial accident on transboundary waters, and only to damage suffered in a Party other than the Party where the industrial accident occurred.

[143] 2003 Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters.

Under the Protocol, operators of industrial installations are held strictly liable for damage caused by the impacts of their activities on international watercourses up to limits of liability established in Annex II to the Protocol. They must establish financial security, such as insurance or other guarantees, to provide cover for these losses.

The Protocol limits liability by reference to the quantity of hazardous substances present at an industrial facility, by the type or toxicity of those substances. Limits of liability range from 10 million SDRs up to 40 million SDRs. In a variation on the standard arrangement, in which the financial security required is equal to liability limits, minimum levels of financial security range from 2.5 to 10 million SDRs -- only a portion of the limits of liability imposed by the Protocol.

Claims may be brought directly against the operator, or directly against the insurer or financial security. The regime does not provide for a supplementary tier of compensation if the damage caused exceeds the operator's limited liability, in effect leaving the risk in excess of these limits with victims and their governments. The Protocol provides that limits of liability will be kept under review.

Where more than one operator is involved, they are both jointly and severally liable (Art. 4). The operator is also liable for damage caused or contributed to by his or her wrongful intentional, reckless or negligent acts or omissions (Art. 5). In these instances, there is no limit on liability (Art. 9).

Claims for compensation under the Protocol are not admissible unless they are brought within three years from the date that the claimant knew or ought reasonably to have known of the damage and of the person liable, but no later than 15 years from the date of the industrial accident. If the industrial accident consists of a series of occurrences having the same origin, time limits run from the date of the last occurrence. Where the industrial accident consists of a continuous occurrence, time limits on claims run from the end of that continuous occurrence.

The Protocol covers both monetary and non-monetary damage, including the costs of response (prevention, minimization or mitigation of possible loss or damage or arrangements for environmental clean-up) and reinstatement measures of the impaired environment, limited to the costs of measures actually taken or to be undertaken.

"***Hazardous activity***" means any activity in which one or more 'hazardous substances' are present or may be present in quantities at or in excess of the threshold quantities listed in Annex I and which is capable of causing transboundary effects on transboundary waters and their water uses in the event of an industrial accident. Annex I defines the ***hazardous substances*** in two ways:
(1) three categories of substances and preparations if they exceed threshold quantities in tons:

- 'very toxic' (200 tons)
- 'toxic' (200 tons) or
- 'dangerous for the environment' (200 tons);

(2) or fall within three listed categories of petroleum products (25,000 tons)

- gasolines and naphtha
- kerosenes
- gas oils.

The Protocol contains provisions on the relevant national remedies, provisions on conflict of laws, competent courts and enforcement of court decisions.

H. NATURE CONSERVATION

International Conventions

31. UN Convention on Biological Diversity, in force 1993

The objectives of the CBD are the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The Convention is global in geographic scope.

Under Article 14 of the CBD, each Party is to introduce procedures requiring ***environmental impact assessments*** of its proposed projects that are '*likely to have significant adverse effects on biological diversity*', with a view to avoiding or minimizing these effects, and allow for public participation in these procedures. Parties are also required to introduce arrangements to ensure that the environmental consequences of its ***programmes and policies*** that are likely to have significant adverse effects on biological diversity are also duly taken into account (Art. 14(1)).

Where activities under one State's control are likely to significantly affect adversely the biological diversity of other States or areas beyond the limits of national jurisdiction, Parties are required to exchange information and consult. Through decisions of the CBD Conference of the Parties, Parties have been encourage to assess not only the impacts of individual projects, but also their cumulative and global effects through strategic environmental assessment, incorporating biodiversity considerations at the decision-making and or environmental planning level (decision V/18, para. 2(a)).

Article 14(2) of the Convention requires the Parties to examine the issue of liability and redress, including restoration and compensation for damage to biological diversity.

The CBD's objectives are challenging to relate to the issue of CCS. Carbon capture and storage activities may benefit some species, if these activities are successful in avoiding CO_2 emissions to the atmosphere and decreasing the impacts of unabated emissions on the global climate. Locally, CCS activities may impact biodiversity depending on the siting of these activities, and the potential of geological storage sites for leakage.

Regional Conventions

32. Bern Convention, in force 1982

The aim of the Bern Convention[144] is to conserve wild flora and fauna species, especially those species and habitats whose conservation requires cooperation between several States. The Convention gives particular emphasis to endangered and vulnerable species, including migratory species, and to habitat protection. The Convention was originally to apply to developed country parties, but membership was subsequently extended to Africa and Central and Eastern Europe.

The main thrust of the Convention is to regulate the deliberate capture and killing of wild species. However, the Convention also requires Parties to consider whether species will be harmed incidental to other programmes or policies when making ***permitting and planning decisions***. This Convention is not particularly relevant to CCS. However, some provisions requiring Parties to promote national conservation policies and have regard to conservation in their regional planning policies and pollution abatement may impact CCS. If CCS is to take place in an area which is habitat to any of the listed species, Parties would be required to take this into account before authorizing any activities which could impact those protected species.

In Appendices to the Bern Convention, species and habitats are listed which require Parties to 'take appropriate and necessary legislative and administrative measures' to ensure their special protection. Annex I lists strictly protected flora species; Annex II lists strictly protected fauna species; Annex III lists protected fauna species; and Annex IV lists prohibited means and methods of killing, capture and other forms of exploitation of listed species.

[144] 1979 Convention on the Conservation of European Wildlife and Natural Habitats

III. EUROPEAN COMMUNITY LAW

The EC Treaty contains no plain guidance on the geographic scope of EU environmental law. Article 299 of the EC Treaty merely lists the names of the 15 Member States where the Treaty applies. Faced with a lack of further reference to the territory of Member States, it has been argued that the EC Treaty should not be regarded as limiting its territorial scope 'to that territory which falls under the sovereignty, or full jurisdiction, of the Member States' but should extend beyond this band.[145] As far as Member States are competent under international law to protect the environment outside their own territories, the EC must also be regarded as competent to take such measures at least on areas covered by Article 174 of the EC Treaty (Community environmental policy)[146]. See discussion of UNCLOS above, and the Habitats Directive, below for more on the issue of geographic scope.

I. WASTE

33. Waste Framework Directive

The Waste Framework Directive [147] requires Member States to take appropriate measures to (1) encourage the prevention or reduction of waste production and its harmfulness, and (2) encourage the recovery of waste by recycling, re-use, reclamation or any other process with a view to extracting secondary raw materials, or the use of waste as a source of energy. The prevention and reduction of waste are to be achieved by the development of clean technologies more sparing in their use of natural resources, the development of products designed to make the smallest possible contribution to increasing the amount or harmfulness of waste and pollution hazards, and techniques for the final disposal of dangerous substances (Art. 3).

'Waste' is defined as 'any substance or object in the categories set out in Annex I which the holder discards or intends or is required to discard.' Annex I categories include 'production or consumption residues' (Q1), 'residues from industrial processes' (Q8), and a catch-all category of 'any materials substances or products which are not contained in the above categories' (Q16). The scope of the term 'waste' is extremely broad, and therefore depends on the meaning of the word 'discard.'

[145] Jans, J. H. '*The Habitats Directive'*, Journal of Environmental Law, Vol 12 No 3, OUP 2000 at p.386.
[146] Id.
[147] Council Directive 75/442/EEC of 15 July 1975 on waste, as amended by Directive 91/962/EEC of 23 December 1991.

The Waste Directive expressly excludes from its scope '***gaseous effluents emitted into the atmosphere***' (Art. 2.1(a)). Thus gaseous effluents that are ***not*** emitted into the atmosphere fall ***within*** the Directive's scope as 'waste', provided that other criteria of the waste definition are satisfied. For this reason, CO_2 that is not emitted into the atmosphere, but is instead captured for discarding into geological storage sites, would likely be regulated as 'waste.'

Once captured CO_2 is regulated as 'waste', its physical state becomes important. For example, the Landfill Directive imposes a ban on the landfilling of liquid waste [148], and applies the definition of waste contained in the Waste Framework Directive. The manner in which injection is done in practice also then becomes important.

Under Article 1(a) of the Waste Framework Directive, the Commission is to draw up a list of wastes belonging to the categories in Annex I, which is to be periodically reviewed and if necessary revised. This has been done, and is contained in Commission Decision 2000/532/EC which provides a list of wastes with six-digit codes. [149] The first two digits define the source generating the waste, and the remaining digits identify the type of waste generated. Chapter 10, for example, applies to 'Inorganic Wastes from Thermal Processes'. Wastes from power stations and other combustion plants are given code 10 01. While none of the subsidiary categories includes gases (understandably, given Article 2.1's inapplicability to effluent gases), category 10 01 99 applies to 'wastes not otherwise specified.' Hence CO_2 not emitted could be reported as a waste from this industry 'not otherwise specified,' if it is considered inorganic. Alternatively, if no industry codes apply, Chapter 16 must be applied. Gases in containers are given heading 16 05 and CO_2 may fit under one of these codes.[150]

Member States are required under the Directive to take 'the necessary measures to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment' and in particular '*without risk to water, air, soil and plants and animals*.' Art. 4.

Member States are to take appropriate measures to establish an integrated and adequate network of waste disposal installations, taking account of the *best available technology* not involving excessive costs. The network must enable waste to be disposed of 'in one of the nearest appropriate installations, by means of the most appropriate methods and technologies in order to ensure a high level of protection for the environment and public

[148] Council Directive 99/31/EC of 26 April 1999 on the landfill of waste, discussed in greater detail elsewhere in this document.
[149] 2000/532/EC: Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste. http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_226/l_22620000906en00030024.pdf
[150] See 'Industrial gases in high pressure cylinders, LPG containers and industrial aerosol containers (including halons' (16 05 01); 'Other waste containing inorganic chemicals, e.g. lab chemicals not otherwise specified, fire extinguishing powders (16 05 02)'; 'Other waste containing organic chemicals, e.g. lab chemicals not otherwise specified' (16 05 03).

health' (Art. 5). In addition to the principle of proximity, the Directive includes the principle of self-sufficiency, whereby Member States are to address their own waste. Member States are also to encourage the technical development of products designed to make no contribution, or to make the smallest possible contribution, by nature of their manufacture or disposal to increasing the amount or harmfulness of waste and pollution hazards (Art. 3).

Competent authorities must draw up waste management plans that related to the type, quantity and origin of waste to be disposed of, general technical requirements, special arrangements for particular wastes, and suitable disposal sites or installations.

Permits must be obtained by any establishment or undertaking which carries out listed waste 'Disposal Operations' or 'Recovery Operations' (Arts. 9, 10). Annex IIA to the Waste Framework contains a list of 'Disposal Operations.' Permits for these operations must cover the types and quantities of waste, technical requirements, security precautions, the disposal site and treatment method. The only exception to the permitting requirement is for waste disposed of at the place of production, but only where (1) competent authorities have adopted general rules for each type of activity laying down the types and quantities of waste and the conditions under which the activity may be exempted from permitting requirements, and (2) the disposal is such that it poses no risk to human health or the environment under Article 4. Among Annex IIA's list of Disposal Operations are:

- Deposit into or onto land (e.g., landfill)
- Deep injection (e.g., injection of pumpable discards into wells, salt domes or naturally occurring repositories) (D 3)
- Release into seas/oceans including sea-bed insertion (D 7)
- Permanent storage (D 12)
- Repackaging prior to submission to listed operations (D 13)
- Storage pending any of the listed operation, excluding temporary storage, pending collection, on the site where it is produced.

Annex IIB provides a list of 'Recovery Operations' which do not appear relevant to CCS. In accordance with the polluter pays principle, the cost of disposing of waste must be borne by the holder who has waste handled by a waste collector or by an undertaking permitted under Article 9 (disposal operations), and/or the previous holders or the producer of the product from which the waste came. (Art. 15).

Assuming captured CO_2 is regulated as 'waste', where environmental damage to protected species and habitats, water, or land occurs or is threatened from CCS activities, the Environmental Liability Directive applies.[151] The Directive applies to installations with IPPC permits.[152] It also applies to waste management operations, which include the col-

[151] Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, Article 3 and Annex III.
[152] Id. para.1.

lection, transport, recovery and disposal of waste, the supervision of these operations, the after-care of disposal sites, and to the operation of landfill sites under the Landfill Directive.[153] The Directive imposes strict liability on operators for the costs of preventative or remedial action, subject to certain exceptions.[154] Many actors in the CCS chain could be potentially responsible for these costs, as the term 'operator' is defined to include any person who operates or controls the activity, or who has economic power over the technical functioning of an activity, including the permit holder.

34. Hazardous Waste Directive

The Hazardous Waste Directive[155] builds upon Article 2(2) of the Waste Directive (75/442/EEC), which provides that individual Directives may lay down specific rules for particular instances or supplementing the Waste Directive on particular categories of waste. See Article 1(a).

The Hazardous Waste Directive defines 'hazardous wastes' as wastes on a list drawn up in accordance with the Waste Directive, based on Annexes I and II to the Hazardous Waste Directive, or any other waste which is considered by a Member State to display properties included in Annex III. Annex I lists generic types of hazardous waste, which may be in liquid, solid or sludge in form.[156] Annex II lists constituents of Annex I.B wastes that render them hazardous when they have properties contained in Annex III. Relevant Annex III properties include 'harmful' (substances which if inhaled may involve limited health risks), 'toxic' (substances which, if inhaled may involve serious, acute or chronic health risks and even death), and 'ecotoxic' (substances which present or may present immediate or delayed risks for one or more sectors of the environment).

Commission Decision 2000/532/EC establishes a harmonised list of hazardous wastes for purposes of the Hazardous Wastes Directive.[157] CO_2 is not included within that list. Chemicals and gases in containers are not listed as hazardous.

35. Shipments of waste within, into and out of the EC

Council Regulation No. 259/93[158] implements the Basel Convention, and aims to comprehensively regulate waste shipments within, into and outside of the EC. 'Waste' is defined as in Article 1(a) of Directive 75/442/EEC. The regulation regulates four catego-

[153] Id.
[154] For example, under Article 8 of the Environmental Liability Directive, a defense exists where an emission or event is authorized by permit. Fault-based liability or liability based on negligence is also available for damage to protected species and habitats caused by activities other than those listed in Annex III of the Directive. See Article 3.1(b).
[155] Council Directive 91/689/EEC of 12 December 1991 on hazardous waste.
[156] The only relevant category is 'residue' from pollution control operations, included in Annex I.B. This is not likely to be understood to include captured CO_2. Even this category is only covered if it is has an Annex III property.
[157] 2000/532/EC: Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste.
[158] Council Regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the EC.

ries of activities: (1) shipments of waste between member states; (2) shipment of waste within member states; (3) export of waste; and (4) imports of waste. Additional rules apply to transit. The Regulation distinguishes between waste for disposal and waste for recovery in these categories.

- Between Member States, waste may be shipped for disposal subject to rules governing prior notification and authorisation by competent national authorities. States may raise objections on grounds of proximity, priority for recovery, and self-sufficiency in accordance with Council Directive 75/442/EEC. (Title II).
- Within Member States, an 'appropriate' system for supervision and control must be established (Title III).
- All exports of waste are prohibited, except to EFTA countries, which are Parties to the Basel Convention, subject to notification and authorisation provisions. However, exports may be banned where the EFTA country prohibits imports, has not given its written consent to a particular import, or has concerns regarding whether the waste will be managed in accordance with environmentally sound methods. Exports to ACP States are specifically prohibited, unless the waste at issue has been imported from that ACP State for processing (Title IV).
- Imports of waste for disposal into the EC are prohibited, except from EFTA countries that are Parties to the Basel Convention, other countries that are parties to Basel, and or that have concluded bilateral agreements with the EC or its member states. Prior notification and authorisation is required (Title V).

The Regulation was amended in 1997 to ban exports of hazardous waste destined for final disposal to non-OECD countries.

The shipment of wastes within, into or out of the EU, that is either authorised or prohibited by Regulation 259/93 (as amended), is an activity listed under Annex III to the Environmental Liability Directive.[159] Thus operators of pipelines that carry CO_2, or those who manage the transport of CO_2 by other means may be potentially responsible for environmental damage that occurs or that is threatened from these activities.

36. IPPC Directive

The purpose of the IPPC Directive[160] is to achieve integrated prevention and control of pollution arising from a wide range of industrial and agricultural activities. These include energy industries, production and processing of metals, mineral industries, chemical industries, waste management sector, pulp and paper industry and other activities listed in Annex I to the Directive.

The IPPC Directive lays down measures designed to prevent, or reduce emissions in the air, water and land from these activities, in order to achieve a high level of protection of the environment taken as a whole. This takes place in the context of a permit system for

[159] Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, Article 3 and Annex III.
[160] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control.

installations, which aims to ensure that operators of installations take preventative measures against pollution, in particular through the application of the best available techniques; that no significant pollution is caused; that waste that cannot be avoided is recovered or safely disposed of; that energy is used efficiently; that accidents are prevented and their consequences limited; and that the site of operation is returned to a satisfactory condition when the installation closes.[161]

The Directive takes a holistic approach, and is intended to require operators and regulators to take and integrated look at each installation and its environmental impacts before making decisions on any-cost effective measures that are necessary to achieve a high level of environmental protection. Among the environmental issues addressed by the Directive are issues of oxygen depletion in water, global warming, and releases of toxic pollutants to water or land.[162]

However, Article 26 of the Emission Allowance Trading Directive (2003/87/EC) amends the IPPC Directive to provide that where installations that are covered by the IPPC Directive are also regulated by the Emission Allowance Trading (EAT) Directive, no emission limits shall be set for the "direct emissions of that gas unless it is necessary to ensure that no significant local pollution is caused." Thus no emissions limits may be set in IPPC permits for direct CO_2 emissions for installations covered by the EAT Directive.

Article 8 of the EAT Directive requires Member States to ensure that for installations covered under the IPPC Directive, the conditions for and procedure for the issue of a greenhouse gas emissions permit under the EAT Directive are coordinated with those for the IPPC Directive. These procedures may be integrated into the permitting procedures under the IPPC Directive.

Some challenges in transposing the IPPC Directive into national law that have been noted by the Commission, include the absence of a definition of 'best available techniques' and no requirement that the authority take account of the technical characteristics of the installation concerned, its geographical location and the local environment conditions when it determines the conditions of the permit decision.[163] Other challenges include the drawing of the boundaries of an "installation", given that the definition includes all directly associated activities with a technical link. Also, what changes should be considered to be "substantial" such that an update of the permit is required.[164]

All industrial activities listed in Annex I of the IPPC Directive that are subject to permit are included among the activities to which the EU's Environmental Liability Directive applies, with the exception of installations or parts of installations used for research, de-

[161] See COM(2003) 354 final on Progress in implementing Council Directive 96/61/EC concerning integrated pollution prevention and control.
[162] Id.
[163] Id.
[164] Id at 9.

velopment and testing of new products and processes.[165] Thus operators of these facilities that capture CO_2 may be potentially responsible for environmental damage that occurs or that is threatened from such activities, subject to the relevant provisions of the Environmental Liability Directive. The operation of installations subject to permit under the IPPC Directive is an activity listed under Annex III to the Environmental Liability Directive.

37. Landfill Directive

The Landfill Directive[166] is problematic for the geological storage of liquid CO_2. The Directive, which applies to 'any landfill', imposes a total ban on the deposit of liquid waste into land.[167]

In the United Kingdom, a Court of Appeals has found that the disposal of liquid waste by injection into a borehole into sandstone and limestone strata 1000 meters or so below sea level constituted 'deposit into land' within the meaning of the Landfill Directive.[168] The Court considered the purpose and working of the Directive and its relationship to the Water Framework Directive and Waste Directive, and affirmed the lower Court's ruling that injection was prohibited. The Court found that the locality of the landfill can be anywhere on or beneath the surface of the land. It also saw no significant difference between 'injection' and 'deposit.'

The Landfill Directive's objective is to 'prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste, during the whole life cycle of a landfill.'

'***Landfill***' is defined as a 'waste disposal site for the deposit of waste onto or into land (i.e., underground)' including producers' internal waste disposal sites, and permanent storage sites (i.e., more than one year) used for the temporary storage of wastes. The Directive defines '***waste***' as in Directive 75/442/EEC. Thus whether CO_2 injection is covered by the Landfill Directive depends upon whether CO_2 is considered a 'waste' for purposes of the Waste Framework Directive, which defines 'waste' broadly to include 'any substance or object in the categories set out in Annex I which the holder discards or intends to discard.' Annex I itself includes a catch-all category (category Q 16) for any materials, substances or products which are not contained in other categories.

[165] Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, Article 3 and Annex III (specifically referencing the IPPC Directive).
[166] Council Directive 99/31/EC of 26 April 1999 on the landfill of waste
[167] Article 5 provides that Member States shall take measures to ensure that liquid waste is not accepted in a landfill.
[168] Blackland Park Exploration Ltd v. Environment Agency, CCA (Civ. Div) [2004].

The Landfill Directive contains definitions for '***underground storage***,' '***liquid waste***' and '***inert waste***' each of which is relevant to CO_2 storage. '***Underground storage***' is defined as a *permanent waste storage facility in a deep geological cavity such as a salt or potassium mine*. '***Liquid waste***' is defined as 'any waste in liquid form including waste waters but excluding sludge.' '***Inert waste***' is defined in Article 2 as

> *waste that does not undergo any significant physical, chemical, or biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give risk to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater.*

This definition is interesting, since the London Convention exempts 'inert geological materials' from its definition of 'industrial waste' prohibited from dumping at sea.

Under the Landfill Directive, each landfill must be classified in one of the following classes: (1) landfill for hazardous waste; (2) landfill for non-hazardous waste; or (3) landfill for inert waste. Liquid waste 'cannot be accepted at' a landfill under Article 5.3 of the Directive.

Annex I to the Landfill Directive sets out requirements for all landfills, which include location (including distance from the boundary of the site to residential and recreation areas, waterways, waterbodies; existence of groundwater, coastal water or nature protection zones in the area; and geological and hydrogeological conditions), water control and leachate management, and protection of soil and water. Operators of landfills are required to provide a financial guarantee to cover the costs of site operation. Relevant authorities must be notified of any adverse environmental effects caused by a landfill.

Without prejudice to the Waste Framework Directive, EU Member States may, at their own option, declare that 'underground storage' as defined in Article 2(f) can be exempted from certain requirements under the Landfill Directive (see Art. 3.5). Article 2(f) addresses permanent waste storage facilities 'in a deep geological cavity such as a salt or potassium mine.' The requirements from which these facilities may be exempted include:

- *Certain post-closure and after-care procedures* under Article 13(d) (monitoring and analysing landfill gas and leachate from the site and the groundwater regime in the vicinity of the site where competent authority considers that a landfill is likely to cause a hazard to the environment)

- *Measures to control precipitation from entering the landfill (*Annex I point 2 except first indent) *protection of soil and water, gas control, and nuisances and hazards* (Annex I points 3-5).
- *Meterorological data, emission data - water, leachate and gas control*, and topography of the site (Annex III points 2, 3 and 5)

J. CLIMATE CHANGE AND EMISSIONS TRADING

38. Emissions of certain pollutants into the air from large combustion plants

Directive 2001/80/EC [169] addresses emissions of sulphur dioxide and nitrogen oxides from combustion plants designed for the production of energy. The Directive requires Member States to progressively reduce total emissions from existing plants, and requires Member States to issue licenses for the construction or operation of new plants that contain conditions relating to compliance with emission limit values for sulphur dioxide and nitrogen oxides and dust. The Directive contains elements on monitoring and reporting of emissions. CO_2 emissions are not addressed.

39. Emissions Allowance Trading Directive

This Directive[170] creates an EU emission allowance trading scheme to assist the EU and its Member States in fulfilling commitments under the UN Framework Convention on Climate Change and its Kyoto Protocol. It creates a European market in greenhouse gas emission allowances, intended to promote the reduction of greenhouse gas emissions in a cost-effective and economically efficient manner. The scheme applies to emissions from activities listed in Annex I to the Directive, and to greenhouse gases listed in Annex II to the Directive, which include CO_2. The monitoring mechanism established through Council Decision 93/389/EEC assists Member States in determining the total quantity of allowances to allocate to covered installations.

For purposes of the Directive, an 'allowance' is an allowance to emit one tonne of carbon dioxide equivalent during a specified period 'which is only valid for the purposes of meeting the requirements of the Directive, and shall be transferable consistent with the provisions of the Directive'.
'***Emissions'*** are defined as '***the release of greenhouse gases into the atmosphere*** from sources in an installation'. '***Installation***' is defined as 'a stationary technical unit where one or more activities listed in Annex I are carried out *and any other directly associated activities* which have a ***technical connection*** with the activities carried out on that site and which could have an effect on emissions and pollution.' '***Source***' is defined as a

[169] Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants.
[170] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.

'separately identifiable point or process in an installation from which greenhouse gases are *emitted*'.

Operators of facilities that intend to utilize CCS technologies may be required to give notice under Article 7 of the EAT Directive. Under Article 7, operators are required to give notice of any changes planned in the nature, functioning or an extension of the installation, which may require updating of the GHG emissions permit. It may be argued that the definition of 'installation' is sufficiently broad to include pipelines and storage sites for CO_2 that is generated at a covered installation. Where appropriate, the permit will be updated.

The utilization of CCS technology will lessen the number of allowances needed by regulated installations to cover process emissions. Any excess allowances previously allocated may be used to expand emissions or be traded. Overtime, the implementation of CCS will have impacts on the allocation of allowances, and the timeframe for this allocation.

Under Article 24, from 2008 onwards, Member States are permitted to extend emissions allowance trading to activities, installations and GHGs that are not listed in Annex I to the Directive, provided the inclusion is approved by the Commission, and taking into account 'all relevant criteria, in particular effects on the internal market, potential distortions of competition, the environmental integrity of the scheme and reliability of the planned monitoring and reporting system.' Conceivably, CCS might be regulated as a newly-listed activity, with storage sites regulated as a new category of installations.

40. Monitoring of Community GHG emissions

This Decision establishes a mechanism for monitoring anthropogenic CO_2 emissions (and other GHG emissions) by sources and removals by sinks, evaluating progress toward meeting commitments with respect to these emissions, implementing the UNFCCC and Kyoto Protocol, and ensuring the timeliness, completeness, accuracy, consistency, comparability and transparency of reporting by the Community and its Member States to the UNFCCC Secretariat.

Member States must determine and report to the European Commission by 15 January each year their anthropogenic emissions of greenhouse gases listed in Annex A to the Kyoto Protocol: CO_2, CH4, N2O, HFCs, PFCs and SF6, during the year before the last. They are also to report elements of the national inventory report necessary for the Community's greenhouse gas inventory report, such as information on the Member State's quality assurance/quality control plan, and a general uncertainty evaluation.

Member States are also to report to the Commission by 15 March 2005, and every two years thereafter, information on national policies and measures which limit and/or reduce CO_2 emissions (and other greenhouse gas emissions) by sources or enhance removals by sinks, presented on a sectoral basis for each greenhouse gas (Art. 3(2.a)) and national

projections of CO_2 (and other GHG) emissions by sources and their removal by sinks for the years 2005, 2010, 2015 and 2020, separated by gas and by sector, including the assumptions underlying these projections. This would require the reporting of national policies and measures that support carbon capture and storage activities, which serve to limit CO_2 emissions.

41. Monitoring Guidelines

In January 2004, the Commission issued guidelines setting out criteria for the monitoring and reporting of GHG emission resulting from activities listed in Annex I to Directive 2003/87/EC , based on the principles for monitoring and reporting set out in the Directive.[171]

Like the EAT Directive, the Guidelines define '*emissions'* as 'the release of greenhouse gases *into the atmosphere* from sources in an installation, as defined in the Directive'. '*Installation'* means 'stationary technical unit where one or more activities listed in Annex I to the Directive are carried out *and any other directly associated activities* which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution, as defined in the Directive.' '*Source'* means a 'separately identifiable point or process in an installation from which greenhouse gases are *emitted*'.

Annex I, section 4, addresses monitoring, including boundaries for monitoring and reporting, and the determination of GHG emissions. The boundaries for monitoring and reporting for an installation include all emissions from all sources belonging to activities listed in Annex I to the Directive, carried out at the installation, of greenhouse gases specified in relation to those activities.

Annex I, at section 4.2.2.1.2, contains a definition of ***'transferred CO_2'***. 'Transferred CO_2' can be subtracted from the calculated level of emissions, and is limited to pure CO_2 transferred out of an installation for use for the carbonation of beverages and as dry ice for cooling purposes.

Annex I, at section 4.2.2.1.3 specifically references ***CO_2 capture and storage***. Annex I notes that the Commission is stimulating research into CCS, which will be important for the development and adaptation of guidelines on the monitoring and reporting of CO_2 capture and storage, where covered under the Directive, in accordance with the procedure under Article 23(2) of the Directive. Before such guidelines are adopted, Member States may submit interim guidelines to the Commission for the monitoring and reporting of CO_2, where covered under the Directive. 'Subject to the approval of the Commission, in accordance with the procedures referred to in Article 23(2) of the Directive, the ***capture***

[171] Commission Decision of 29 January 2004 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (2004/156/EC).

and storage of CO_2 may be subtracted from the calculated level of emissions from installations covered under the Directive in accordance with those interim guidelines'.

This language permits EU Member States to submit guidelines to the Commission for review. Upon approval by the Commission, CO_2 that is captured and stored may be subtracted from emissions. This will affect the number of allowances that are required to cover emissions from individual installations, and will thus have impacts for emissions trading under Directive 2003/87.

In order to approve interim guidelines, it can be expected that the Commission will develop its own methodology for reviewing the monitoring and reporting elements contained in submitted interim guidelines, as they will impact on the EU ETS, and trade within the EU on emission allowances. A difference in a methodology between EU Member States in their interim guidelines for monitoring and reporting of CO_2 capture and storage may impact the cost of CO_2 capture and storage in different Member States. To the extent that leakage may be anticipated from long-term storage, or additional emissions generated through the process of CO_2 capture and storage itself that would not be accounted for elsewhere these will have to be taken into consideration.

K. LIABILITY

42. Environmental Liability Directive

The objective of the Environmental Liability Directive[172] (2004/35/EC) is to establish a framework of environmental liability based on the '***polluter-pays***' principle, to prevent and remedy environmental damage. The Environmental Liability Directive entered into force on 30 April 2004. EU Member States have three years to transpose the Directive into national law.

The Directive does not cover situations in which certain international regimes already apply. These regimes include the oil spill regimes, nuclear regimes, the HNS Convention (hazardous and noxious substances transported by ship), and the CRTD Convention (carriage by road, rail or inland navigation vessel (see Art. 4 and Annexes IV and V), if those Conventions are already in force in the concerned EU Member State.

'***Environmental damage***' is defined to include:

(1) ***damage to protected species and natural habitats***, which is any damage that has 'significant adverse effects on reaching or maintaining the favourable conservation status of habitats or species

(2) ***water damage***, which is any damage that 'significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, of waters; and

[172] Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage.

(3) ***land damage***, which is any land contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction, in, on or under land, of substances, preparations, organisms or micro-organisms.

The Directive applies to damage caused by emissions from point sources, such as IPPC installations, to the imminent threat of damage, and to pollution of a diffuse character where it is possible to establish a causal link between the damage and the activities of individual operators.

The Directive establishes strict operator liability for a list of 'occupational activities' set out in Annex III, and fault-based operator liability for 'any other occupational activities' whenever the operator has been at fault or negligent. A number of the listed 'occupational activities' are relevant to CCS activities, including:

- the ***operation of installations subject to permit under the IPPC Directive*** (96/61/EC), except for installations or parts of installations used for research, development and testing of new products and processes
- ***waste management operations***, including the collection, transport, recovery and disposal of waste, and hazardous waste, including the supervision of such operations and after-care of disposal sites, subject to permit or registration under the ***Waste Directive*** and ***Hazardous Waste Directive***, and the operation of landfill sites under the ***Landfill Directive***
- manufacture, use, storage, processing, filling, release into the environment and onsite transport of ***dangerous substances*** as defined under Directive 67/548/EEC (relating to classification, packaging and labelling of dangerous substances).
- ***transboundary shipment of waste*** within, into or out of the EU under Council Regulation (EEC) No. 259/93.

While there is no specifically-listed 'occupational activity' for the operation of geological storage facilities for CO_2, or a clear permitting system specifically for these activities, the Directive is sufficiently broadly worded to impose strict liability on operators who undertake CCS activities within the categories of activities listed in Annex III to the Directive. For example, if CO_2 is regulated as 'waste' under the Waste Directive, then the operator of waste management operations related to CO_2 is potentially liable under the Environmental Liability Directive for costs of prevention and remediation related to environmental damage.

However, while the Environmental Liability Directive covers damage to protected species and natural habitats, water and land, it may not satisfactorily address damage to the atmosphere resulting from leakage of CO_2 from geological storage sites.[173] It also does not address liability for releases that may impact upon commitments under the Emissions Allowance Trading Directive.

[173] Article 4(5) of the Environmental Liability Directive states that the Directive 'shall only apply to environmental damage or to an imminent threat of such damage caused by pollution of a diffuse character, where it is possible to establish a causal link between the damage and the activities of individual operators.'

When environmental damage has occurred, operators are to inform the appropriate authorities, control, contain and manage contaminants to limit further damage, and take remedial measures. The State itself may intervene to take action and recover costs from operators (Art. 5). Member States may allow operators a defense to liability for the cost of remedial action where operators can demonstrate that they were not at fault or negligent, and they were in compliance with permit conditions, or where the state of scientific knowledge was such that environmental damage was not considered likely when the emission was released or the activity took place (Art. 8(4)).

States may recover the costs of any relevant operations within 5 years from the date on which those measures have been completed or the liable operator (or third party) has been identified, whichever is later (Art. 10). While financial security is not compulsory, Member States are to encourage the development of financial security instruments and markets by the appropriate economic and financial operators, including financial mechanisms to address insolvency, to enable operators to use financial guarantees to cover their responsibilities under the Directive (Art. 14).

L. ENVIRONMENTAL IMPACTS ASSESSMENTS, ACCESS TO INFORMATION, PUBLIC PARTICIPATION, ACCESS TO JUSTICE

43. EIA Directive

The objective of the EIA Directive[174] is to contribute to the integration of environmental considerations into the preparation and adoption of ***public and private projects***. The Directive requires that an environmental assessment be carried out in advance of those public and private projects '***which are likely to have significant effects on the environment***' (Art. 1). This is to enable competent authorities to take a decision on a specific project in full knowledge of the project's likely significant impact on the environment.

Member States must adopt measures to ensure that before consent is given, ***projects likely to have significant effects on the environment by virtue of their nature, size or location*** are made subject to a requirement for development consent and an environmental assessment (Art. 2). The environmental impact assessment required may be integrated with the procedures for fulfilling requirements under the IPPC Directive (96/61/EC). It must identify, describe and assess the direct and indirect effects of a project on:

- human beings, fauna and flora,
- soil, water, air, climate and the landscape
- material assets and the cultural heritage,

[174] Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment.

- and the interaction among the above.

Prior environmental assessments are required for projects listed in Annex I (21 categories) under Article 4(1) of 85/337/EEC, as amended. These include a variety of industrial facilities, including

- crude oil refineries,
- thermal power stations
- nuclear power stations
- integrated steel works
- integrated chemical installations
- incinerators for the disposal of hazardous wastes
- pipelines for the transport of gas with a diameter of more than 800 mm and a length of more than 40 km.

Projects listed in Annex II are evaluated by the Member States, who must decide whether a prior environmental assessment is required, either on a case-by-case basis or based on thresholds or criteria that the Member States themselves set establish (or both). These projects include categories similar to those in the SEA Directive, and include, among other things, certain drillings by the Extractive Industry, industrial installations for carrying gas, and surface storage of natural gas for the Energy Industry, oil and gas pipeline installations not included in Annex I, and a category of 'Other' projects. The category of 'other' includes '***installations for the disposal of waste***' which could encompass CO_2 injection facilities or storage facilities. Annex II also includes '***any change or extension of projects*** listed in Annex I or Annex II, already authorized or in the process of being executed, which may have a significant adverse effect on the environment.'

The Directive sets out selection criteria for the determination under Article 4(2). These include:

- ***characteristics of the projects*** (including size of project, production of waste, risk of accidents);
- ***location of projects*** (environmental sensitivity of geographical areas likely to be affected, absorption capacity of the natural environment, densely populated areas, special protection areas) and
- ***characteristics of the potential impact*** (including the extent of impact, transfrontier nature of the impact, magnitude and complexity of the project, probability of impact, and the duration, frequency and reversibility of the impact).

The applicability of the EIA Directive will depend upon whether EU Member States decide that a CCS project is considered 'likely to have significant effects on the environment by virtue of its nature, size or location. (Art. 2). In applying Annex II, different Member States may decide to employ different criteria in evaluating whether an environmental assessment is needed for geological storage. Facilities associated with geological storage are likely to be considered under Annex II, as either a '*change or exten-*

sion' of an existing project listed in Annex I, or as *an installation for the disposal of waste*, not included in Annex I. [175]

44. Public participation in the drawing up of plans and programmes relating to the environment, and access to justice under Directive 85/337/EEC and the IPPC Directive

Directive 2003/35/EC [176] implements the Aarhus Convention within the EC, by providing for public participation in the drawing up of certain plans and programmes relating to the environment, and by improving public participation provisions and provisions on access to justice within Council Directives 85/337/EEC (public and private projects) and under 96/61/EC (IPPC Directive). Member States have until June 25, 2005 to establish the necessary national laws, regulations and provisions to implement the Directive.

Member States are to ensure that the public is informed about proposals for plans or programmes relating to the environment, and that relevant information about proposals is made available to the public -- including information about the right to participate in decision-making. The public is entitled to express comments and opinions, and due account is to be taken of this input in making decisions. Once decisions are taken, the public is to be informed of these decision, and the reasons and considerations upon which they were based.

If a Member State is aware that a project on its territory is *likely to have significant effects* on the environment in another Member State (or where a Member State likely to be affected requests), that State must provide a description of the project, any available information on its possible transboundary impact, and information on the nature of the decision which may be taken. It must also give the other Member State an opportunity to participate in the environmental decision-making process. Member States must also ensure that members of the public that have a sufficient interest, including NGOs, have access to a review procedure before a court or impartial body to challenge the substantive or procedural legality of the decisions subject to the public participation process.

The Directive does not apply to plans and programmes for which a public procedure mechanism exists under Directive 2001/42/EC (SEA Directive) or under Directive 2000/60/EC (Water Framework Directive).

These provisions are clearly relevant where plans or programmes are in the process of being established to permit geological storage, or where projects are underway. They are also relevant where leaks may occur in one geological storage site that may impact another Member State, though the 'likely to have significant effects' threshold will be difficult to satisfy.

[175] Annex II (13) and Annex II (11(b)).
[176] Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003 providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC.

45. SEA Directive

The SEA Directive[177] requires Member States to ensure that 'an environmental assessment is carried out for certain ***plans and programmes which are likely to have significant effects on the environment***.' 'Plans and programmes' include those 'which are subject to preparation and/or adoption by an authority at national, regional or local level or which are prepared by an authority for adoption, through a legislative procedure by Parliament or Government, and which are required by legislative, regulatory or administrative provisions' (Art. 2(a)).

An environmental assessment is required for:

- Plans and programmes which are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use and which set the framework for future development consent of projects listed in Annexes I and II to Directive 85/337/EC (EIA Directive), or
- Plans and programmes which, in view of the likely effect on sites, have been determined to require an assessment pursuant to Article 6 or 7 of Directive 92/43/EEC (Habitats Directive). (Art. 3(2)).

Plans and programmes in the areas of energy, industry, transport, waste management, or that may affect Habitats Directive sites, may be relevant to CCS activities. Member States must also determine whether plans and programmes, other than those listed above, are *likely to have significant environmental effects*, either through case-by-case examination or by specifying types of plans and programmes or by combining both approaches (Arts. 3(4) and (5)).

Plans and programmes requiring an SEA include *modifications* that will have a likely significant effect on the environment (Art. 3(3)). Plans and programmes to create a regulatory framework for CCS activities would seem to require an SEA, but only if these p*lans and programmes are likely to have significant effects on the environment.* As 'significant environmental effect' is not defined, conceivable positive environmental effects may warrant an environmental assessment.

The assessment is to be carried out ***during preparation*** *of the plan or programme and its adoption or submission to a legislative procedure*. A report must be prepared that identified, describes and evaluates the likely significant effects. It must include information listed in Annex I, including information on reasonable alternatives (Art. 5(1)).

Where a Member State considers that the implementation of a ***plan or programme*** being prepared in relation to its territory ***is likely to have significant effects*** on the environment in another Member State, or where a Member State likely to be significantly affected re-

[177] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

quests, that Member State must forward a copy of the draft plan or programme and the relevant environmental report to the other Member State before its adoption or submission to the legislative procedure. The affected Member State may then seek consultations prior to adoption of the plan or programme (Art. 7). The Directive also requires that the Member State *monitor* the significant environmental effects of the implementation of the plan or programme '*to identify at an early stage unforeseen adverse effects, and to be able to undertake appropriate remedial action*.'

Article 12 of the SEA Directive requires the Commission to report on the application and effectiveness of the Directive before 21 July 2006. In this report the Commission is to consider the possibility of extending the scope of the Directive to other areas/sectors and other types of plans and programmes.

M. WATER

46. Dangerous substances discharged into the aquatic environment

Under Directive 76/464/EEC[178], Member States are required to take appropriate steps to eliminate water pollution in inland surface water, territorial waters, internal coastal waters, and ground water. Member States are required to eliminate pollution by certain dangerous substances contained in List I, and to reduce pollution by dangerous substances in List II. List I contains substances selected for their toxicity, persistence and bioaccumulation. List II contains substances for which limit values have not been determined. List II also includes, among other things, substances 'which have an adverse effect on the oxygen balance, particularly ammonia, nitrites' (Annex, List II, para. 8).

Article 4 of the Directive specifically excluded from the Directive's coverage 'Discharges injected into deep, saline and unusable strata.' 'Discharge' was defined to exclude operational discharges from ships and dumping from ships in territorial waters. Groundwater was excluded from regulation once a separate Directive on groundwater had been implemented.

In 1980 the protection of groundwater was taken out of 76/464/EEC and regulated under Council *Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances*. Directive 76/464/EEC has been incorporated into the Water Framework Directive (2000/60/EC).[179]

[178] Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.
[179] See http://europa.eu.int/comm/environment/water/water-dangersub/76_464.htm

47. Groundwater Directive

The Groundwater Directive[180] aims to prevent the pollution of groundwater by families and groups of substances contained in two lists. For substances in List I, direct discharges are prohibited with some exceptions. For substances in List II, discharge is limited and regulated. The Directive draws a distinction between direct discharges (without percolation through the ground or subsoil) and indirect discharges (after percolation through the ground or subsoil). It excludes domestic effluents, de minimise quantities of listed substances, and discharges of matter containing radioactive substances.

CO_2 is not found in the list of dangerous substances either List I or List II, and thus this Directive is not directly relevant, unless the geologically stored carbon dioxide contains other constituents that are listed.

This Directive is nevertheless interesting because it contains a provision allowing Member States, 'after prior investigation' to authorize discharges due to re-injection into the same aquifer of water used for geothermal purposes, water pumped out of mines and quarries or water pumped out for civil engineering works. The elements contained in Articles 7, 8, 9, and 10, addressing the contents of these prior investigations, and elements to be specified in authorisations for discharges, disposal and tipping (place where disposal is to be done, methods of disposal or discharge used, essential precautions paying particular attention to the nature and concentration of the substances present in the effluents, the characteristics of the receiving environment, arrangements for monitoring effluents and groundwater quality, etc.) are all useful elements to be included in CCS permitting authorisations.

48. Water Framework Directive

The Water Framework Directive[181] establishes a framework for the protection of inland surface water, transitional waters, coastal waters and groundwater. Among other things, it aims to protect and enhance aquatic ecosystems, promote sustainable water use, improve the aquatic environment, and reduce pollution of groundwater.

The Directive addresses all waters in the European Community, including surface water (inland waters, transitional waters, coastal waters, and territorial waters), groundwater (all water below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil), and protected areas. The Directive is thus relevant to CCS activities that potentially impact these waters and designated protected areas.

One goal of the Directive is to enhance the protection and improvement of the aquatic environment through specific measures for the progressive reduction of *discharges, emissions* and losses of priority substances (Art. 1). Another is to ensure the progressive re-

[180] Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances.
[181] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy.

duction of pollution of groundwater and prevent its further pollution (Art. 1). The Directive's definition of '***pollution***' is similar to that used in international marine pollution conventions (Helsinki Convention, OSPAR and Barcelona) (Art. 2). The Directive is also to contribute to the implementation of Community obligations under international conventions on water protection and management, including the UN Convention on the protection and use of transboundary watercourses and international lakes.[182]

Under Article 3 of the Directive, EU Member States are required to identify individual river basins lying within their territory and assign them to individual river basin districts. Where river basins cross borders, they are to be assigned to an international river basin district. A competent authority must be designated for each river basin district. Member States make an analysis of the characteristics of each river basin district, a review of the impact of human activity on the water and an economic analysis of water use (Art. 5). They must also establish a register of areas requiring special protection (Art. 6). For each river basin district, or for the part of an international river basin district within its territory, Member States must establish a programme of measures to achieve the environmental objectives set out in Article 4. Article 4 addresses surface waters, groundwater and protected areas.

Monitoring of surface water status, groundwater status and protected areas is required within river basin districts (Art. 8 and Annex V) to cover:

- for surface waters – the monitoring of volume and level or rate of flow to the extent relevant for ecological and chemical status, and ecological potential; the ecological and chemical status and ecological potential
- for groundwaters – monitoring of chemical and quantitative status
- for protected areas – supplementary monitoring for specifications contained in Community law under which the protected areas are established.

The Directive addresses emission sources through emission limits, and addresses the effects of emissions through water quality standards. Under Article 16 (strategies against pollution of water), a list of priority substances is to be established for action at the EU level, prioritised on the basis of risk, taking particular account of:

- evidence regarding the intrinsic hazard of the substance concerned, and its aquatic ecotoxicity and human toxicity via aquatic exposure routes
- evidence from monitoring of widespread environmental contamination, and
- other proven factors which may indicate the possibility of widespread environmental contamination, such as production, use volume and use pattern.

Article 16(2). Decision No 2455/2001/EC notes that in prioritising substances, international agreements of relevance include, among others, the OSPAR Convention, the Helsinki Convention, the Barcelona Convention, and the Conventions adopted within the IMO. Further, the identification of the priority hazardous substances on the list of prior-

[182] See discussion elsewhere in this document on the UN/ECE Water Convention (in the section on international regional conventions) and the Watercourses and Industrial Accidents Protocol.

ity substances should be made with regard to hazardous substances agreed for phase-out or for cessation of discharges, emissions and losses in international agreements, such as hazardous substances which are agreed for phase-out in international fora including IMO, UNEP or UN-ECE; hazardous substances which are agreed for cessation of discharges, emissions and losses as a priority in the OSPAR Convention ... " Here it should be recalled that in 1989, the OSPAR Convention's administrative body, the OSCOM, *agreed to cease dumping of industrial wastes in the North Sea by December 31, 1989 and in other Convention waters by 31 December 1995.*

In 2001 the list of priority substances was established by Decision No 2455/2001/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC. Further lists are contemplated. CO_2 is not included within the list of priority substances. However, under Article 16(9) of the Water Framework Directive, the Commission may prepare strategies against pollution of water by any other pollutants or groups of pollutants, including any pollution which occurs as a result of accidents.

Under Article 11 of the Directive, each Member States must establish a programme of measures which includes 'basic' and where necessary 'supplementary measures' (Art. 11). Point source discharges that are liable to cause pollution must receive prior regulation, with emission controls for the pollutants concerned (Art. 11). Among the 'basic' measures that are to be applied is a prohibition on the direct discharge of pollutants into groundwater, subject to certain provisions (Art. 11(3)(j). However, Member States may authorize, among other things:

- the ***reinjection*** into the same aquifer of water used for geothermal purposes
- ***injection of water*** containing substances resulting from operations for exploration and extraction of hydrocarbons or mining activities, and injection of water for technical reasons, into geological formations from which hydrocarbons or other substances have been extracted or into geological formations which for natural reasons are permanently unsuitable for other purposes (where injections do not contains substances other than those resulting from the above operations)
- ***injection of natural gas or liquefied petroleum gas (LPG) into geological formations*** *which for natural reasons are permanently unsuitable for other purposes.*
- ***injection of natural gas or LPG into geological formations*** *for storage purposes where there is an overriding need for security of gas supply, and where the injection is to prevent any present or future danger of deterioration in the quality of the receiving groundwater* (Art. 11(3)(j)).

Each of these discharges must not 'compromise the achievement of environmental objectives established for that body of groundwater' (Art. 11(3)(j). **The injection or reinjection of CO_2 from particular operations, such as the exploration and extraction of hydrocarbons, is not expressly addressed; conceivably it could be in this section**.

One purpose of the Water Framework Directive is to prevent any significant and sustained upward trend in the concentration of any pollutant in groundwater. If the storage or disposal of CO_2 by injection results in chemical processes that allow for the dissolution of other pollutants into the aquatic environment, the Water Framework Directive may be triggered (Lee et al.).

Where damage occurs, the *Environmental Liability Directive* may apply. *'Water damage'* is specifically defined in that Directive (2004/35/EC) as 'any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, as defined in Directive 2000/60/EC, of the waters concerned, with the exception of adverse effects where Article 4(7) of the Water Framework Directive applies (art. 2(1)(b) of Directive 2004/35/EC)'. Article 4(7) provides conditions (e.g., mitigation, disclosure, overriding public interest, no alternative means) whereby a Member State may derogate from the water quality standards set out in the Directive.

N. MARINE POLLUTION

49. Framework for cooperation in the field of accidental or deliberate marine pollution

Decision 2850/2000/EC[183] creates a framework for cooperation between Member States with respect to accidental or deliberate marine pollution. The Framework runs from January 2000 through December 2006, and is intended to support States' efforts to protect the marine environment, coastlines and human health against the risk of accidental or deliberate pollution at sea; improve the capabilities of States to respond to incidents involving spills or imminent spills of oil or other harmful substances at sea; strengthen efficient mutual assistance; and promote cooperation to provide for compensation for damage in accordance with the polluter pays principle. The financial framework to support implementation of the decision is set at € 7 million.

The decision recognises that several regional agreements on accidental marine pollution, such as the Bonn Cooperation Agreement, already facilitate mutual assistance and cooperation between Member States on accidental marine pollution. It also notes that "regard should be had" to the international agreements applicable to the European seas and maritime areas, including the OSPAR Convention, Barcelona Convention and Helsinki Convention.

For purposes of the decision, "*harmful substances*" means "any hazardous or noxious substance liable to raise concern if spilled into the marine environment." "*Accidental or deliberate pollution at sea*" includes "pollution from offshore installations and illicit operational spills from vessels." Accidental marine pollution risks include releases of harmful substances into the marine environment whatever their origin, both from ships

[183] Decision No 2850/2000/EC of the European Parliament and of the Council of 20 December 2000 setting up a Community framework for cooperation in the field of accidental or deliberate marine pollution.

and from the shoreline, including those linked to the presence of dumped materials. Excluded from the framework agreement for cooperation are "authorised discharges and continuous streams of pollution originating from land-based sources". See Article 1.

Based on these definitions, accidental releases of CO_2 from authorised land-based pipelines that run through the marine environment for geological storage, would not be covered by the framework agreement. Pollution resulting from CO_2 that has been permitted for direct injection into a geological storage site from ships or offshore platforms would also not fall within the framework.

50. Establishment of Committee on Safe Seas and the Prevention of Pollution from Ships (COSS)

Regulation (EC) No 20099/2002[184] is intended to improve the implementation of Community maritime legislation on maritime safety, the prevention of pollution from ships, and marine pollution and shipboard conditions in two ways: (1) by centralising the tasks of committees set up under separate legislation in a single Committee on Safe Seas and the Prevention of Pollution from Ships (known as COSS); and (2) accelerating the update of amendments to Community maritime legislation in light of developments in international instruments. 'International instruments' includes the conventions and protocols adopted by the International Maritime Organisation (including MARPOL, the London Convention) and the ILO.

The COSS will assist and advise the Commission on all matters of maritime safety and prevention or reduction of pollution of the environment by shipping activity. Among other things, it will assist in determining whether any amendment to an international instrument will lower the standard of maritime safety or of prevention of pollution from ships established by Community maritime legislation, or be incompatible with Community maritime legislation.

This provision is not directly applicable to CCS activities, though amendments to international instruments covered by the regulation, that impact the prevention of pollution from ships, will be reviewed by the COSS for compatibility with Community legislation.

O. TRANSPORT

51. Transport of dangerous goods by road

Council Directive 94/55/EC[185] transposes the requirements of the International Carriage of Dangerous Goods by Road (ADR) into Community law. The Directive applies to the transport of dangerous goods by road within or between Member States. 'Dangerous

[184] Regulation (EC) No 2099/2002 of the European Parliament and of the Council of 5 November 2002 establishing a Committee on Safe Seas and the Prevention of Pollution from Ships (COSS) and amending the Regulations on maritime safety and the prevention of pollution from ships.
[185] Council Directive 94/55/EC on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road.

goods' are defined as those 'substances and articles the transport of which is prohibited or authorized only in the circumstances by Annexes A and B to this Directive.' Annex A incorporates by reference provisions of Annex A to the ADR, and Annex B incorporates the provisions of Annex B of the ADR, with it being understood that 'Member States' replaces 'Contracting Party' in those provisions.

52. Uniform procedures for checks on the transport of dangerous goods by road

This Directive[186] references Directive 94/55/EC, and seeks to harmonize the procedures for checks carried out by Member States and the definitions relating to the transport of dangerous goods by road, for compliance with the safety standards set out in that Directive. Under Article 3, Member States are to ensure that a representative proportion of consignments of dangerous goods transported by road is subject to the checks set out in the Directive, to ensure compliance with the laws on the transport of dangerous goods by road. Annex I provides a checklist to be used by Member States.

53. Transport of dangerous goods by rail

This Directive[187] incorporates the provisions of COTIF (the Convention Concerning the International Carriage of Dangerous Good by Rail), into EU law. Article 3 provides that the transport of dangerous goods prohibited by the Directive's Annex may not be transported by rail. The Annex then incorporates by reference the regulations that appear in Annex I to Appendix B to the COTIF Convention. The transport of dangerous goods is authorized, subject to compliance with the rules laid out in the Annex (again, rules under COTIF). Each Member State may authorize the transport by rail of dangerous goods that are classified, packed and labelled in accordance with international requirements for maritime or air transport, whenever the transport involves a sea or air voyage.

P. NATURE CONSERVATION

54. Habitats Directive

Council Directive 92/43 of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) is the central piece of EU legislation on the conservation of biodiversity. Under the Habitats Directive, EU Member States must take measures to maintain or restore key habitats and species of wild flora and fauna that are considered 'of Community interest' (Art. 2(2)).

Annex I of the Directive provides a list of 9 natural habitat types 'of Community interest' whose conservation requires the designation of special areas of conservation. Annex II lists hundreds of animal and plant species of Community interest requiring the designation of special areas. Annex III lists criteria for selecting sites of Community importance.

[186] Council Directive 95/50/EC of 6 October 1995 on uniform procedures for checks on the transport of dangerous goods by road.
[187] Council Directive 96/49/EC on the approximation of the laws of the Member States with regard to the transport of dangerous goods by rail.

Annex IV lists those animal and plant species of Community interest that are 'in need of strict protection'. Annex V lists animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measures. Finally, Annex VI lists prohibited methods and means of transport.

The Directive has two objectives: the conservation of natural habitats and habitats of species, and the protection of species. Work has concentrated on the setting up of the Natura 2000 network of protected areas – intended to be a coherent European ecological network of special areas of conservation, including special protection areas classified under the Birds Directive.

EC Member States are required to notify the Commission of their habitat sites and species covered by Annexes I and II. The Commission then adopts its list of sites of Community importance. Once a site is designated as of Community importance, Member States must designate special areas of conservation (SACs). In these SACs, Member States must take appropriate steps to avoid the deterioration of natural habitats and the habitats of species, and avoid the disturbance of species (Art. 6.2).

Where any '***plan or project***' that is not directly connected with or necessary to the site's management, but that is '***likely to have significant effects***' on the site' is under consideration, Member States must conduct an 'appropriate assessment' of the implications for the site, in view of the site's conservation objectives (Art. 6(3)). National authorities may only agree to the plan or project after they have found that it will not adversely affect the site's integrity, and after the opinion of the general public has been obtained, if appropriate (Art. 6(3)). The provisions of Article 6(3) are not limited to plans and projects that exclusively occur in or cover a protected site; they also target developments situated outside the site that are likely to have a significant effect on the site.[188] If it is determined that there will be a negative impact, and there are no alternative solutions, the plan or project may only go ahead if it is shown that there are 'imperative reasons of overriding public interest, including those of a social or economic nature' (Art. 6.4). Then, the Member State must take all compensatory measures to show that the overall coherence of Natura 2000 is protected.

If the site hosts a priority natural habitat type and/or a priority species, the plan or project may only go ahead if there are considerations relating to human health or public safety, or there are beneficial consequences of primary importance for the environment, or there are other imperative reasons of overriding public interest (Art. 6(4)). 'Priority natural habitat type' means natural habitat types in danger of disappearance, which are present on the territory of the Member States (Art. 1(d)).

In September 2004 the ECJ issued a judgment in which it interpreted the provision of Art. 6(3) regarding the notion of 'plan' or 'project' as not only one particular event but

[188] 'Managing Natura 2000 Sites, the provisions of Article 6 of the 'Habitats Directive' 92/43/EEC', European Commission, April 2000 at 27.

also as ongoing activities happening periodically (cockle fishing was at issue, but activities such as maintenance works fall in the same category).[189] Therefore an evaluation may be needed each time these activities are carried out.

Article 2(1) of the Habitats Directive establishes the scope of its provisions as applying 'in the *European territory* of the Member States to which the Treaty applies'. This reference automatically excludes overseas territories and dependencies of EU Member States from application of the Directive. With respect to the territorial scope of Community law, Article 299 of the EC Treaty only lists the names of the Member States where the Treaty applies. In the absence of greater elaboration on the territory of Member States, it has been argued that the EC Treaty should not be regarded as limiting its territorial scope 'to that territory which falls under the sovereignty, or full jurisdiction, of the Member States.[190] As far as Member States are competent under international law to protect the environment outside their own territories, the EC must also be regarded as competent to take such measures at least on areas covered by Article 174 of the EC Treaty (Community environmental policy).[191] As explained above in the section on UNCLOS, coastal States exercise their sovereignty within their established borders, as well as over the territorial sea.[192] In addition, coastal States have jurisdiction over their exclusive economic zone (EEZ) which extends up to 200 nautical miles, with regard to the 'protection and preservation of the marine environment'.[193] Legal developments since adoption of the Habitats Directive support the argument that the geographic scope of the Directive and its species protection measures extend beyond the EU Member States' territorial waters to protect species and habitats in the continental shelf and/or the EEZ. It has been argued that the Habitats Directive is applicable on all areas under Member States' jurisdiction, including the continental shelf and /or the EEZ[194] The position of the European Commission supports this interpretation, as expressed by Environment Commissioner Mrs Bjerregaard in response to a written question on the Habitats Directive and the marine environment.[195] The 1999 Commission Communication on 'Fisheries Management and Nature Conservation in the Marine Environment'[196] states that the provisions of the Habitats Directive automatically apply to the marine habitats and species in territorial waters.[197] In addition, the Communication establishes that 'if a Member State exerts its sovereignty rights in an EEZ of 200 nautical miles, it thereby considers itself competent to enforce national laws in that area, and consequently the Commission considers in this case

[189] Case C-127/02, for a preliminary ruling (7 September 2004).
[190] Jans, J.H. 'The Habitats Directive', Journal of Environmental Law', Vol 12 No 3, OUP 2000 at p. 386.
[191] Id.
[192] UNCLOS Art. 2(1).
[193] UNCLOS Art. 56(1)(b)(iii).
[194] Jans, J.H. 'European Environmental Law', second revised edition, Europa Law Publishing, 2000, p. 418.
[195] Answer given by the Environment Commissioner on 17 January 1997 to question E-3529/96 by MEP Mr D.Eisma. OJ C 138, of 5 May 1997 ("As far as Member States have competence, it [the Habitats Directive] applies to the exclusive economic zone. However, the marine species and habitats concerned generally have their main range inside territorial waters').
[196] COM(1999)363 final, of 14 July 1999.
[197] Id. at section 5.2.2.

that the Habitats Directive also applies'.[198] UK courts have found that the UK government must apply the Habitats Directive to waters up to 200 nautical miles from the coast and to adjacent designated areas of continental shelf. See R v Secretary of State for Trade & Industry ex parte Greenpeace [2000] 2 CMLR 94.

CO_2 storage may impact on ecosystems as a result of the laying of pipelines and installation of other infrastructure (both on land and sea) used during operations. The possibility of CO_2 escaping and its effects on biodiversity will also require consideration. The most foreseeable impact on habitats and species is the impact resulting from the location of storage sites as well as the structures used for injection (e.g. platforms) and the routes used for transportation (e.g. pipelines). The expansion or amendment of the lists of natural habitat types of community interest (Annex I) and animal and plant species of community interest whose conservation requires the designation of special areas of conservation (Annex II) could affect the location in which CO_2 transport or storage activities might take place.

Liability for environmental damage that may result from a range of activities is provided for in the EC's Environmental Liability Directive (2004/35/EC). These activities include, among others, a number of activities potentially related to CCS -- such as the operation of installations subject to IPPC permits, the operation of waste management operations, the operation of landfills, and the transboundary shipment of waste.[199]

'Environmental damage' under the Environmental Liability Directive includes 'damage to protected species and natural habitats, which is any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species.' The significance of these effects is to be 'assessed with reference to the baseline condition, account of the criteria set out in Annex I' to the Directive.

55. Birds Directive

The Birds Directive[200] aims to conserve all species of naturally occurring birds in the wild state in the European territory of the Member States. This includes birds, their eggs, nests and habitats. The Directive covers the protection, management and control of covered species and lays down rules for their exploitation. It covers both land and sea areas.

For species listed in Annex I, Member States must classify the most suitable territories as special protection areas for the conservation of these species, and take similar measures for regularly occurring migratory species not listed in Annex I (Article 4). Member States must take "appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be signifi-

[198] Id.
[199] See discussion herein of the Environmental Liability Directive and Waste Directive.
[200] Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds.

cant in relation to the objectives of this Directive."[201] Outside protected areas, Member States must strive to avoid pollution or deterioration of habitats. The Directive includes both land-and sea-based birds and their habitats, and in particular wetlands. Liability for damage to birds' habitats is provided for in the EC Environmental Liability Directive (2004/35/EC).

'Any ***plan or project*** not directly connected with or necessary to the management of the site ***but likely to have a significant effect thereon***, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.'

The Directive does not provide absolute protection against interference in areas of special conservation. If licensing for CO_2 capture, transport or storage activities is likely to have an effect on protected species and/or habitats, in the absence of alternative solutions, Member States may permit interference for 'imperative reasons of overriding public interest' which include social and economic interests (Art. 7).

Q. SITING - ACCIDENT HAZARDS INVOLVING DANGEROUS SUBSTANCES

56. Seveso II Directive

The Seveso II Directive[202] is aimed at the prevention of major accidents involving dangerous substances and the limitation of their consequences for man and the environment. It applies to establishments where dangerous substances are present in quantities exceeding certain thresholds. The intention of the Directive is to address accidents such as those at Bhopal in India, where many people were injured as a result of the close siting of a chemical plant and dwellings.

The Directive solely is directed to the *presence of dangerous substances in establishments*. It covers both, *industrial "activities"* as well as the *storage* of dangerous chemicals. The Directive provides for a range of controls, proportionate to the quantity of a dangerous substance held by an establishment.

The Directive includes provisions on safety management systems, emergency planning, land-use planning, public access to information, and inspections. Member States are

[201] Obligations under the first sentence of Article 4(4) of the Birds Directive are replaced by obligations under Articles 6(2), 6(3) and 6(4) of the Habitats Directive, 92/43/EEC, for special protection areas, per Article 7 of the Habitats Directive.
[202]Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances.

obliged to pursue the aim of the Directive through controls on the *siting* of new establishments, *modifications* to existing establishments and new developments such as *transport links*, *locations frequented by the public* and *residential areas* in the vicinity of existing establishments.[203] In the long term, land-use planning policies are to ensure that *appropriate distances* between hazardous establishments and residential areas are maintained.

The Directive excludes nuclear safety, *the transport of dangerous substances and intermediate temporary storage by road, rail, internal waterways, or sea or air,* outside establishments covered by the Directive. It also excludes *the transport of dangerous substances by pipelines,* and excludes *waste landfill sites*. (Art. 4).

Paragraph 13 of the Directive's preamble notes that the *transmission of dangerous substances through pipelines* also has the potential to produce major accidents, and that the Commission should, after collecting and evaluating information about mechanisms for regulating these activities, and the occurrence of relevant incidences, prepare a communication setting out the case, and most appropriate instrument for action in this area if necessary.

Dangerous substances are defined as a substance, mixture or preparation listed in Annex 1, Part 1, or fulfilling the criteria laid down in Annex 1, Part 2, and present as a raw material, product, by-product, residue or intermediate. "Major accident" is defined to include "a major emission" resulting from uncontrolled developments and leading to serious danger to human health and/or the environment, immediate or delayed, *inside or outside* the establishment. (Art. 3)

Carbon dioxide is not a named substance in Annex I, Part 1, with a corresponding qualifying quantity in tonnes for the application of the Directive. However, other common gases are listed, such as hydrogen and oxygen, present in quantities equal to or in excess of 5 and 200 tonnes respectively. If CO_2 is handled, managed or stored on site in quantities that may pose a substantial accident hazard, it might be considered for inclusion in Part 1.

Annex I, Part 2 lists categories of substances and preparations. Among the categories included are 'very toxic' and 'toxic' with maximums of 5 and 50 tonnes respectively. Dangerous for the environment, due to toxicity for aquatic organisms is also included. Substances and preparations are classified by reference to other Directives, including the Council Directive 67/548/EEC relating to the classification, packaging and labelling of dangerous substances, and Directive 1999/45/EC relating to the classification, packaging and labelling of dangerous preparations.

[203] http://europa.eu.int/comm/environment/seveso/#2