Transportation of Carbon Dioxide in the European Union: Some Legal Issues

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I. INTRODUCTION

CARBON CAPTURE AND STORAGE (CCS) is a relatively new technology, aimed at combating climate change while continuing to use fossil fuels. As part of its climate policy, the European Union (EU) aims to reduce carbon dioxide (CO₂) emissions by 2020 by at least 20 per cent based on 1990 levels.¹ In this process, CCS is considered as a transitional instrument, as it limits the emission of CO₂ but not the use of fossil fuels. It may be used until other reliable means of clean energy can be applied on a larger scale.

A regulatory framework for CCS came into place in the EU following the entry into force of Council Directive 2009/31/EC (the CCS Directive) in June 2009.² The CCS Directive governs the geological storage of CO₂. As a result, each Member State may individually decide whether it wishes to regulate permanent storage of captured CO₂ in subsoil reservoirs. In practice, a Member State’s decision will depend on the availability of suitable sites like depleted oil and/or gas fields and aquifers. Since some Member States may not have sufficient suitable sites within their territory, the CCS Directive also provides for cross-border CCS, in which an emitter in one Member State should have the opportunity to inject and store CO₂ in another Member State. Obviously, the concept of cross-border CCS is in line with the general principles of free movement of goods, services and capital in EU law.

¹ This chapter is a slightly amended and updated version of the chapter ‘CO₂ Transportation in the European Union: Can the Regulation of CO₂ Pipelines Benefit from the Experiences of the Energy Sector?’ by Martha M Roggenkamp and Avelien Haan-Kamminga in the 1st edn of this volume.
² The EU Council agreed to these targets in a Council Meeting of 8–9 March 2007, Presidency Conclusions presented on 2 May 2007, 7224/1/07 REV 1.
Given that most emitters are located in industrial areas, and suitable storage locations are often situated in remote areas, both onshore and offshore, the process of CCS will require the transportation of the captured CO₂ to an underground storage facility. It will thus usually involve the following three stages: capture, transport and storage. In practice, several means of transportation can be applied. Although not explicitly stated, the focus of the CCS Directive seems to be transportation through subsoil pipelines. Sometimes it may be possible to use existing pipelines to transport CO₂, but it is equally likely that new pipelines will need to be constructed as part of a specific CCS project. In general, this mode of transportation is considered to be relatively safe and well suited to transporting large quantities of CO₂. However, due to the steadily increasing public opposition towards onshore storage of CO₂, there seems to be a general trend to consider CO₂ storage offshore, and subsequently attention is now also on the possibility to transport CO₂ by ship.³

This chapter will examine both means of transportation. When doing so, one should keep in mind that capturing and transporting CO₂ is not a new phenomenon. The soft drinks and agricultural sector, for example, already utilise CO₂, which is transported by lorry and subsoil pipelines.⁴ By contrast, so far the development of CCS in the EU has been rather slow, and therefore the analysis presented below is still theoretical in scope. After discussing CO₂ transport via pipelines, the focus will turn to CO₂ transport by ship and how the regime governing Trans-European Networks may promote the development of CO₂ transport infrastructure in the EU.

II. TRANSPORTING CO₂ VIA PIPELINES

A. Qualifying CO₂ Pipelines

The CCS Directive contains few provisions on the role of (piped) transportation. The relevant provisions in the Directive focus on the composition of the CO₂ stream, the pipeline access regime, and the application of Directive 85/337/EEC (as amended) (the EIA Directive)⁵ to transport and storage.⁶ Due to the lack of regulatory guidance at the EU level, Member States are free to govern (i) the construction and siting of pipelines, (ii) the safety of pipelines and (iii) the use of pipelines, and this may lead to a variety of different national solutions.

Given the fact that CO₂ is a gaseous substance and can be transported via pipelines, it seems obvious to compare piped transportation of CO₂ with that of natural...
Transportation of CO₂ in the EU

The CO₂ will then be pressured above 74 bar and transported at temperatures higher than 31°C. At that stage, it will become a substance somewhere between a gas and a liquid (supercritical phase). When stored, however, CO₂ will take the form of a high-pressured liquid (dense phase).

Each category of these pipelines may be subject to a different set of rules applying to their construction and/or use. These rules focus in particular on the need to create independent network operators (via unbundling procedures) and rules on third-party access to existing networks.

In the case of CCS, a CO₂ pipeline will connect a producer of CO₂ (an emitter) with a consumer/receiver of CO₂ (a subsoil storage facility). These storage facilities are often depleted oil and/or gas fields. In the case of storage in a depleted field, it is possible that abandoned pipelines are still present, and the existing infrastructure can be used.

However, if CO₂ is injected in a producing field, or if pipelines have been removed, it will be necessary to construct new pipelines. Considering that a pipeline is directly linked to the reservoir, it may be argued that CO₂ pipelines should be considered as some sort of ‘reversed’ upstream pipeline system. Instead of the reservoir being the starting point of the chain, ie the ‘producer’, it is now the terminus point of the chain, ie the ‘consumer’ or ‘receiver’.

Although the terminus point of the pipeline—the reservoir—is known, it is less clear where the pipeline begins. It may be that the pipeline is directly connected to the emitter. In that case, the pipeline can also be considered as some sort of direct or dedicated (pipe)line. It may also be that several emitters are connected to the same pipeline. Does the assumption that a CO₂ pipeline should be considered a ‘reversed’
upstream pipeline change if several ‘emitters’, or ‘consumers/fields’, are connected to the pipeline? Not necessarily. In the upstream petroleum sector, it is common practice that several producers/fields are connected to one (sometimes very long) upstream pipeline. Although the injection of CO₂ is the opposite of the extraction of gas, they share the characteristic of being only one activity, or one-way traffic. This might indicate, again, that CO₂ pipelines can be considered as reversed upstream pipelines.

It follows from the above that there are sufficient arguments and reasons to treat CO₂ pipelines within the framework of CCS as some sort of reversed upstream pipeline. Consequently, these CO₂ pipelines could be governed by national petroleum or mining law, which also may govern the underground storage of CO₂.¹¹ This has certain advantages. First and foremost, it would provide that the oil and gas upstream regulatory and safety regime also applies to CO₂ pipelines. This is a regime which has proven itself effective, and already has competent regulatory authorities in place. Apart from this, it would also mean that the regulatory regimes applying to the use of the upstream pipelines could be applied. These consequences will be discussed in section II.B.

B. Health, Safety and the Environment

i. Health and Safety Regulation

The public acceptance of CCS is closely linked to the safe and environmentally friendly operations for both the transportation and storage of CO₂. Unsafe transportation can result in damaged pipelines, leading to leakages that harm the environment, health and safety, and the climate in general. Member States intending to apply CCS thus need to take into account the need to guarantee, as far as possible, that the activities are carried out in a safe manner. As the CCS Directive does not provide any clear instructions, each Member State may choose the relevant health and safety measures. National legal choices may differ between the application of national safety laws and/or pipelines laws (if any) to the construction and use of CO₂ pipelines. It may also be that no specific law applies, and consideration must be given to a large number of different, more general laws and regulations. Consideration would be based on which permit may be required, such as a building/construction permit or a spatial planning/zoning permit. These permits may again contain a variety of safety requirements.

¹¹ In The Netherlands, the Mining Code of 2003 provides for a special subsoil storage regime, which also applies to CO₂ storage. See MM Roggenkamp, ‘Regulating Underground Storage of CO₂’ in MM Roggenkamp and E Woerdman, Legal Design of Carbon Capture and Storage—Developments in the Netherlands from an International and EU Perspective (Antwerp, Intersentia, 2009). Several other EU Member States (eg, France, Denmark and Italy) also have a licensing regime under the national Mining, Petroleum or Subsoil Law. See, for these storage regimes, MM Roggenkamp et al, Energy Law in Europe: National, EU and International Regulation, 2nd edn (Oxford, Oxford University Press, 2007).
When classifying CO\(_2\) pipelines as upstream pipelines, a comprehensive safety regime could be in place through the application of the existing upstream health and safety regimes, although it can be expected that certain amendments need to be made to facilitate CO\(_2\) transportation. Hence, the operators of these pipelines could be made subject to health and safety regulations under the national (onshore and/or offshore) petroleum or mining laws. The safety guidelines and procedures would include requirements regarding the design, maintenance and integrity of the pipeline, the construction and operation of the pipeline, arrangements for incidents and emergencies, prevention of damage to pipelines and many other considerations.\(^{12}\) Moreover, the construction and operation of CO\(_2\) pipelines would also be subject to supervision by the national health and safety authority.\(^{13}\) The same competent authority would then be charged with monitoring the subsoil storage reservoir and the subsoil pipeline.

In conclusion, when classifying CO\(_2\) pipelines as upstream pipelines, CO\(_2\) storage and transportation could be subject to a single health and safety regime and supervised by the same health and safety authority. The application of one health and safety regime will result in more transparency and, thus, fewer risks of unsafe operations.

\textit{ii. Protecting the Environment}

The CCS Directive provides slightly more guidance concerning the need to protect the environment, as it requires operators to apply for an environmental impact assessment (EIA) covering the construction and operation of CO\(_2\) pipelines.\(^{14}\) The EIA shall 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 cultural heritage; and the interaction between these factors. This requirement, based on the EIA Directive, will be implemented in national legislation and procedures. These national requirements may go beyond the provisions in the EIA Directive.\(^{15}\) Onshore pipeline development will usually entail a variety of licensing requirements, building permits, land use agreements, and, in general, provisions regarding ownership rights and pipeline registration.\(^{16}\)

It also means that the public will be involved in the process of granting permits for the construction of pipelines. The EIA Directive requires that members of the public affected by, or having an interest in, the construction and use of the pipelines are

\(^{12}\) See, eg, the UK Pipelines Safety Regulations 1996 (SI 1996/825) and the Dutch Mining Decree and Mining Regulations of 2003.
\(^{13}\) In the UK, the Health and Safety Executive is charged with the supervision of upstream health and safety. In The Netherlands, it is the State Supervision of Mines.
\(^{14}\) CCS Directive, n 3 above, recital 17, Art 31.
\(^{15}\) The EIA Directive, n 5 above.
\(^{16}\) National law may, eg, provide for the establishment of a pipeline register so as to avoid any construction activities taking place near the registered pipeline and so that the pipeline is protected from damage as a result of these activities. See also DA Lubach, "Pipelines Transporting CO\(_2\) from a Public and Private Law Perspective" in Roggenkamp and Woerdman, n 11 above, 198.
informed and able to participate in the decision-making process. This might mean that when the public are opposed to the construction of a pipeline, their means of having access to justice (ie appeal procedures) may slow down the permitting process, as illustrated by the Dutch ‘Barendrecht’ case, where a storage permit has not been awarded due to strong opposition from the public and local authorities. Although there is little experience with constructing and operating CO\textsubscript{2} pipelines, it is striking that the experience so far has not resulted in any dangerous situations or appeals. The conversion of an abandoned 85 km long oil pipeline owned by NPM to a CO\textsubscript{2} pipeline early in 2000 by a company called OCAP Trading BV (OCAP), and the additional construction of some 130 km of pipelines to supply greenhouse growers with pure CO\textsubscript{2}, have not led to any public debate or opposition. Given that this pipeline is located in the same area, the difference in response to both projects is noticeable.

The CCS Directive clearly recognises the need to protect the environment from damage resulting from CCS. It provides for an amendment of the Environmental Liability Directive (ELD)\textsuperscript{19} to ensure that adequate provisions are made regarding liability for damage to the environment (ie to protected species and natural habitats, water and land) resulting from any failure of permanent containment of CO\textsubscript{2}. Does this amendment to the ELD also affect the transportation of CO\textsubscript{2}? In principle, only the storage of CO\textsubscript{2} is covered by the ELD under the CCS Directive, thereby guaranteeing compensation by the operator for environmental damage on the basis of a regime of strict liability.\textsuperscript{20} However, this strict liability applies only to subsoil storage of CO\textsubscript{2}. Transport is not included in Annex III of the ELD.\textsuperscript{21} Hence, a fault-based system of liability applies to damage resulting from CO\textsubscript{2} transportation, as a result of which only damage to protected species and natural habitats will be compensated. Since the ELD restricts the types of damage to be compensated, (pipeline) operators are liable only if the damage was caused by fault on the side of the operator.

Apart from applicable EU law, account needs to be taken of national law governing civil law claims for harm to persons and property resulting from damage to CO\textsubscript{2} pipelines. The national compensation or remediation obligations that result

\textsuperscript{17} The ‘Barendrecht’ case concerns the storage of CO\textsubscript{2} captured at a Shell refinery in depleted gas-fields operated by Shell and located under (part of) the city of Barendrecht. The Government may limit the number of possible appeals by using the regulating of the coordination of large projects (Rijkscoördinatie- regeling) based on para 3.6.3 of the Spatial Planning Act. See also CFJ Feenstra et al, \textit{What happened in Barendrecht? Case study on the planned onshore carbon dioxide storage in Barendrecht, the Netherlands} (Energy Research Centre of the Netherlands and Global Carbon Capture Storage Institute, 2010) at www.globalccsinstitute.com/publications/what-happened-barendrecht.

\textsuperscript{18} OCAP is an abbreviation of Organic Carbon Dioxide for Assimilation of Plants. OCAP Trading BV is a joint venture between the gas supplier Linde Gas Benelux BV and the contractor Volker Wessels.


\textsuperscript{20} Art 34 of the CCS Directive amending Directive 2004/35. If there is a significant adverse effect in the environment, or if there are measurable adverse effects for humans, the Directive provides for the strict liability of the operator. Re environmental liability, see also JH Jans and HB Vedder, \textit{European Environmental Law} (Groningen, Europa Law Publishing, 2007) 341.

\textsuperscript{21} Only in the unlikely situation that the CO\textsubscript{2} stream is contaminated with substances that can be qualified as dangerous, toxic or waste, may transport fall under the strict liability regime.
from such claims may include costs such as reinstatement of habitats and species, compensation payments for victims of bodily injury or losses in property values, and business interruption claims where economic activity has been disrupted.

iii. Leakages and Impact on Climate Change

As the purpose of the CCS Directive is to avoid CO₂ emissions through permanent storage, any leakage of CO₂ should be avoided. This also applies to leakages from pipelines transporting the captured CO₂ to the storage sites. This is achieved first and foremost by safeguarding the external and internal safety of the pipeline. In addition to this, and due to the close link with the EU climate policy, any leakages need to be compensated by submitting sufficient emissions allowances. The CCS Directive therefore amends the EU Emissions Trading System Directive (EU ETS) to state that stored CO₂ is not considered to have been ‘emitted’, and also introduces a regime of corrective measures in case of leakages. In addition, the CCS Directive brings the transport of CO₂ under the EU ETS as of 2013. Under the amended EU ETS, operators of CO₂ pipelines need to apply for an emissions permit.

Article 4 of the EU ETS requires Member States to ensure that all installations listed in Annex I (including transport facilities) have a permit authorising them to emit greenhouse gases (GHGs). As a result, the same regime applies to pipeline operators, storage operators and the CO₂ emitters. Each of them needs an emission permit stating which activities are to be undertaken, the materials used, and a methodology for the monitoring and reporting of emissions. Member States are required to verify the annual emissions reports submitted by the facility, in accordance with the criteria contained in Annex V of the Directive. The emissions report is to be submitted to the national regulatory (emissions) authority by 31 March each year, and the holder of the permit then surrenders sufficient allowances to meet its verified emissions before 30 April.

Obviously, neither the pipeline operator nor the storage operator aims to emit large quantities of CO₂. Emissions during the transportation of CO₂ are either fugitive emissions—emissions from venting—or the result of potential leakages from the pipeline. Since fugitive emissions are usually low, and leakages can easily be detected and repaired, a system of input and output measurement seems sensible, although measurement along the length of the pipeline does create more accuracy.
The idea is that the amount of CO₂ is measured at the beginning and at the end of the pipeline. If these amounts are not equal, leakage has occurred, and the operator is obliged to buy emissions allowances which meet the level of CO₂ emissions.\(^{26}\)

C. The Use of CO₂ Pipelines

i. Pipeline Owners and Users

The CCS Directive does not refer to the ownership of CO₂ pipelines. It is for Member States to decide whether these pipelines will be constructed and operated by the state, a state-owned company, private parties or a public-private partnership. In practice, we may see a variety of solutions, which may depend on previous experiences in Member States. In other words, the extent to which the current energy infrastructure is owned and operated by the state may also be decisive for choosing an ownership structure for CO₂ pipelines. Lower levels of government may also own and operate the energy infrastructure, as is the case regarding the transmission and/or distribution systems in, for example, The Netherlands or Denmark; alternatively, private parties may also own/operate the infrastructure, as is the case in Germany, or public-private parties, as in most offshore (upstream) pipelines.

In practice, the choice will also depend on (i) whether use will/can be made of existing infrastructure, (ii) the wish of the original owners (if any) to keep their shares in the pipeline, (iii) the guarantee of any profits on the transportation, and (iv) the risks concerning any liability for damages. In the case of new infrastructure, the costs of constructing and operating a CO₂ pipeline will be crucial, if not decisive. It is therefore possible that the national government will be involved in one way or another, either as a financial participant/shareholder in a new or existing pipeline, or as the party (exclusively) entitled to construct and operate CO₂ pipelines. It may also be that the above scenarios exist next to each other, depending on the location of the pipeline.

The CCS Directive leaves all options open. However, the choices made by national legislators will influence the way in which the pipeline is used. The case in which several CO₂ emitters have a share in a storage facility and a CO₂ pipeline differs from the situation where the state or another party exploits the pipeline. In the first situation, the emitters/shareholders will aim to use their share in the pipeline for their own needs. In the latter situation, the pipeline will be organised as a public facility, to be used by anyone who requests access. Although the CCS Directive does not contain any explicit provision on ownership and pipeline exploitation, it does recognise that pipelines and storage facilities may hold a monopoly position, and therefore some sort of access regime should be applied.

ii. Third-party Access Regime

Article 21 of the CCS Directive obliges pipeline operators/owners to negotiate access with any interested party on the basis of rules governing transparent and non-discriminatory access. A refusal of access may be based on:

— the lack of available capacity;
— incompatibility of technical specifications;
— duly substantiated reasonable needs of the owner; or
— CO₂ reduction obligations to be met through CCS.

This provision shows a striking resemblance with the regime under the EU Gas Directive governing third-party access to upstream pipelines and the US Courts’ Essential Facility Doctrine as applied by the European Commission and the European Court of Justice in cases of arbitrary or discriminatory refusal of access to infrastructures. It entails that if a party depends on the use of a specific facility and a parallel infrastructure is not economically viable (as in the case of a natural monopoly), Member States shall take the necessary measures to ensure that said party can obtain access to the facility (ie, an upstream pipeline). The owner/operator of the facility/pipeline and the third party seeking access are thus required to negotiate access to the infrastructure, and a refusal of access is limited to:

— a lack of available capacity;
— incompatibility of technical specifications;
— the duly substantiated reasonable needs of the owner; and
— payment of adequate compensation to the owners/operator.

The objective of the regime is to identify whether the facility (infrastructure) is essential to the activities of the potential competitor, and whether a denial of such access constitutes an abuse of a dominant position. If so, general EU competition law applies.

Although the essential facility doctrine is of little relevance to the downstream transmission and distribution systems, as these systems are subject to a regime of regulated third-party access, the EU legislator apparently assumed it to be relevant in relation to access to upstream gas pipelines and CO₂ pipelines. It is nonetheless for Member States to decide whether they wish to follow the requirements of the CCS Directive (minimum harmonisation) or go beyond these provisions and include stricter access provisions, ie apply a regime of regulated Third Party Access (rTPA), and thus the appointment of an ex ante regulator (national regulatory authority) who is charged with setting or approving the conditions and tariffs so that any

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29 See also MM Roggenkamp, ‘The concept of third-party access applied to CCS’ in Roggenkamp and Woerdman, n 11 above, 273.
interested third party knows beforehand the financial and technical conditions under which the commodity can be transported through the grid.

A reason for opting for such a regime could be the wish to avoid long periods of negotiations on tariffs and conditions. In a situation of many interested parties seeking pipeline access, it could be beneficial to introduce a system of ex ante access regulation, as this would minimise transaction costs and provide certainty. However, in contrast to the natural gas sector, with CCS there is less need to speed up negotiations because there is no supply security involved. Moreover, there will be relatively few parties interested in negotiating access to CO₂ infrastructure—both pipelines and storage facilities—because the parties interested in CCS usually involve some major industries qualifying as point emitters. In The Netherlands, for example, there are some 30 point emitters. Introducing a system of regulated access would lead to high administrative costs, which is not in the interests of the few parties that may be interested in CCS and transporting CO₂. Furthermore, CCS is used as a temporary solution to reduce emissions until the dependency on, and use of, fossil fuels has decreased. Thus, creating a competitive market is not the main objective of regulating access to the CO₂ pipelines.

It can thus be concluded that there are no solid arguments to introduce a system of regulated access to CO₂ pipelines. There is limited need for such a regime, as there is no supply security at the end of the pipe as in the case of natural gas. In addition, any agreement on access will be part of a broader investment decision on CCS, which will nevertheless be time-consuming. Moreover, opting for a regime of negotiated access does not limit the possibility for Member States to further regulate the procedures and timing for such negotiations.

iii. National Developments

When considering the overall situation in the EU, the picture is diverse. Whereas some Member States have decided not to allow CO₂ storage on their territory, others have introduced restrictions such as restraints as regards the type of projects (demonstration projects only), the volumes to be stored or the location of the project (offshore only). Other Member States (Belgium and Germany) expect that CO₂ will be exported and stored elsewhere. The Netherlands, the UK and Norway

30 These 30 point emitters involve 12 industrial installations such as refineries (73% of all industrial CO₂) and 20 installations in the electricity-generating sector (81% of all emissions in this sector). See Advies van de Werkgroep Schoon Fossiel, ‘Platform Nieuw Gas (Platform New Gas)’ (Advies van de Werkgroep Schoon Fossiel, 2007) 19.
31 See, eg, the UK Infrastructure Code of Practice.
32 These include Austria, Brussels Capital Region of Belgium, Estonia, Finland Ireland, Latvia, Luxembourg and Slovenia.
33 The Czech Republic prohibits CCS activities until 2020. Germany sets the maximum volume of stored CO₂ per storage site at 1.3 million tonnes per year, and the total amount for Germany at 4 million tonnes of CO₂ per year. Poland only allows CCS in the framework of ‘demonstration projects’.
In Estonia such information has to be published on the operators’ websites, and in Belgium such information must be published in the Official Journal. Other states have different requirements (e.g., France and Denmark), although generally information must be updated regularly.

In Belgium interested parties must submit a request with all relevant data to the operator, via registered mail. Similarly, in Denmark the operator has to notify the applicant of the receipt of the request for access and about whether or not the request can be accommodated. Negotiations must be completed within four months, unless another time period is agreed upon between the parties.

The Ministry may alter the conditions that have been approved or determined, in order to ensure that CO₂ transport and storage is carried out with due consideration for the resources and that the owner of the facility will receive a reasonable profit, balancing investments and risk.

See n 18 above.

D. Other CO₂ Pipelines

In the preceding sections the focus has been on carbon transport’s being part of the CCS chain. In practice CO₂ can also be captured and used for different purposes and in different contexts, such as the soft drinks and horticulture industries. For example, in The Netherlands, the company OCAP has operated, since 2005, an...
extensive pipeline system through which it supplies approximately 160,000 kg of pure CO₂ per hour to 550 greenhouse growers in the area between Rotterdam and Amsterdam. 39 OCAP purchases the CO₂ from Shell PER+ at the refinery gate. 40 What kind of regulatory regime applies to this pipeline system, and how is it operated in comparison to those pipelines that are part of a CCS project?

A difference between the OCAP pipeline and pipelines needed for large-scale CCS is, inter alia, that the pressure used for transporting CO₂ to horticulturists is considerably lower than the pressure needed for CCS. However, this is only a matter of economics, i.e., the amount of energy it takes to compress the CO₂ in combination with the size of the pipeline needed for transport—the more compressed it is, the more energy is needed, but it results in a cheaper pipeline construction. More importantly, however, is that these pipelines have a different position in the energy chain, as there are consumers of CO₂ at the terminus point of the pipeline. When end consumers, like greenhouse growers, are connected to the terminus point of the pipeline, it is more problematic to qualify these pipelines as an upstream pipeline. These pipelines may therefore be considered as direct lines instead. This qualification may also apply to CO₂ pipelines like OCAP.

A complicating factor is that the EU ETS regime does not apply to other CO₂ pipelines, such as pipelines not used within the framework of CCS. Carbon dioxide transported for purposes other than permanent storage does not count as a prevented emission under the EU ETS. 41 Sometimes pipelines may transport CO₂ to end consumers as well as to subsoil storage facilities, as was envisaged in the Barendrecht case (see section II.B) and the potential Rotterdam Nucleus Project (see section V.B). What kind of regime applies to such a dual-purpose pipeline? The OCAP pipeline system could serve several CO₂ suppliers, as well as several storage sites and CO₂ consumers. But only part of the CO₂ stream in the OCAP pipeline system would be subject to the EU ETS, and in cases of permanent storage counts as ‘not emitted’. An emission permit will at least be required for the part of the pipeline connected to the subsoil storage facility. However, once the EU ETS applies to the transportation network, a complicated situation occurs when other CO₂ (non-EU ETS) is also transported through that pipeline, as it will be difficult to measure the input and output of CO₂ relevant for EU ETS separately. In case of such a dual-purpose pipeline, it may be difficult to provide the level of accuracy demanded by the EU ETS monitoring and reporting guidelines, while simultaneously meeting the business expectations of the other (non-EU ETS) users of the pipeline.

39 The pipeline system consists of two parts: (i) an existing 85 km long pipeline running from the Rotterdam industrial area to the port of Amsterdam and passing a number of major greenhouse horticultural areas; and (ii) a new distribution network of 130 km, which has been connected to this main transportation pipeline. In addition, 500 delivery/metering stations (i.e., horticulturists) are connected to this grid.

40 The CO₂ is released during the production of hydrogen at the Shell PER+ refinery in the Botlek area and supplied to horticulturists, who save about 95 million cubic metres of natural gas per year (and increase the horticulturists’ competitive position) and reduce some 170,000 tonnes of CO₂ emissions per year. The supply agreements are based on an all-in regime, i.e., no distinction between the supply and transportation of CO₂.

41 De Graaf and Jans, n 22 above, 163.
III. TRANSPORT OF CO\textsubscript{2} BY SHIP

A. Qualifying CO\textsubscript{2} Transport by Ship

The current focus on offshore carbon storage has also led to a gradual shift towards another type of transportation than pipelines. The transport of CO\textsubscript{2} to the storage facility (underground reservoir or aquifer) can also be done by ship, in particular as this means of transportation may be economically more attractive if CO\textsubscript{2} has to be moved over large distances. An example is the Green Hydrogen Project, which would involve CO\textsubscript{2} capture by Air Liquide and the transportation of the captured CO\textsubscript{2} from the Maasvlakte by ship to the Danish Continental Shelf for permanent storage in some mature oilfields operated by MaerskOil, in combination with EOR. So far, the project has not been able to attract sufficient funding.\textsuperscript{42}

In order to transport large volumes of CO\textsubscript{2} by ship the gas needs to be compressed, i.e. liquefied to 7 bar (–50\degree C). The entire process is similar to transporting LPG (liquefied petroleum gas) or LNG (liquefied natural gas) by ship. As in the case of shipping LPG and LNG, the pressure in the tank will rise during transport due to heat transfer from the environment through the wall of the cargo tank. Although it is not dangerous to discharge CO\textsubscript{2} boil-off gas together with the exhaust gas from the ship’s engines, it is of course not in line with the objectives of CCS. Zero CO\textsubscript{2} emissions can nevertheless be achieved by using a refrigeration unit to capture and liquefy boil-off and exhaust CO\textsubscript{2}; this will, however, entail additional construction costs. Given the similarities between the transport by ship of LPG, LNG and CO\textsubscript{2}, this section will briefly examine the rules applying to the transport of LNG and LPG, as these rules most likely will also apply to shipped transportation of CO\textsubscript{2}. The focus will be on the rules that are relevant for safety, cross-border transport and offshore liability.

B. Offshore Safety and the Environment

i. Safety Regulation

The safety of ships and their cargo can be endangered as a result of collision, wrecking, stranding and fire. Some of these failures can be avoided by careful navigation along prescribed routes, and by prescribing severe standards of construction and operation. Collision risks (ruptured tanks) can be minimised by making certain that the high standards of construction and operation applied to LPG and LNG are also applied to ships transporting CO\textsubscript{2}. The most important treaty governing the safety of merchant ships is the International Convention for the Safety of Life at Sea (SOLAS Convention). The current

version of the treaty dates from 1974, but it has been amended several times since.\textsuperscript{43} The SOLAS Convention requires signatories to ensure that ships sailing under their jurisdiction (flag-state jurisdiction) comply with minimum safety standards as regards their construction, equipment and operation, including the transport of dangerous goods. Consequently, contracting states are required to apply the International Maritime Dangerous Goods (IMDG) Code developed by the International Maritime Organisation (IMO).\textsuperscript{44} Moreover, the construction and equipment of ships carrying liquefied gases in bulk and gas carriers need to comply with the requirements of the International Gas Carrier Code (IGC Code), which was adopted in 1983 and most recently amended in 2016.\textsuperscript{45} The IGC Code applies to ships, regardless of their size, engaged in the carriage of liquefied gases having a vapor pressure exceeding 2.8 bar and a temperature of 37.8°C, as well as other products specified in the Code. In 2006 the Maritime Safety Committee added CO\textsubscript{2} to the list of specified products,\textsuperscript{46} and the construction and operation of ships transporting CO\textsubscript{2} will thus need to be subject to these rules.\textsuperscript{47}

The aim of the Code is to provide an international standard for the safe carriage by sea in bulk of liquefied gases by prescribing the design and construction standards of ships involved in such carriage, and the equipment they should carry so as to minimise the risk to the ship, to its crew and to the environment, having regard to the nature of the products involved. In order to demonstrate compliance with the requirements of the IGC Code, ships must have been awarded the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.\textsuperscript{48} For this purpose the ship will be regularly examined. Before being taken into service, gas tank ships will be subject to an extensive inspection process, including a full inspection of the construction, equipment, installations, facilities and materials of the ship, in so far as they are covered by the Code. To maintain the certificate, all gas tank ships are subject to a small annual inspection and to a more elaborate inspection every five years. If an inspector concludes that the ship or its equipment does not meet the requirements of the certificate, or that the ship is not seaworthy, the ship owner needs to take all necessary measures to meet the requirements set. If not, the certificate is revoked and the local authorities informed.\textsuperscript{49}

\textsuperscript{43} International Convention for the Safety of Life at Sea, 1974 (with annex and final act of the International Conference on Safety of Life at Sea, 1974) (concluded at London on 1 November 1974) 1184 UNTS 18961. The Solas Convention was adopted on 1 November 1974 and entered into force on 25 May 1980. In March 2016, SOLAS 1974 had 162 contracting states, which flag about 99% of merchant ships around the world in terms of gross tonnage.


\textsuperscript{46} The 2016 IGC Code will in principle also apply to floating storage regasification units. Less clear, however, is the status of floating production storage and offloading units.

\textsuperscript{47} IGC Code, Art 1.5.1.1–1.5.4.1.

\textsuperscript{48} See also HD Boekholt, ‘Scheepstransport van CO\textsubscript{2} voor permanente opslag offshore: Veiligheid van schepen en aansprakelijkheid voor schade door uitstroom van gevaarlijke stoffen’ (2013) 4 Nederlands Tijdschrift voor Energierecht 192.
ii. Leakages and Climate Protection Offshore

Carbon dioxide releases from the ship may be the result of discharge of CO₂ boil-off gas, or from collisions or other incidents offshore. It is assumed that such releases will not have long-term environmental impacts and would be different from LNG spills, because liquid CO₂ in a tanker is not as cold as LNG but much denser. Its interactions with the sea would be complex as hydrates and ice might form, and temperature differences could 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 CO₂ 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.

As already discussed, the CCS Directive aims at capturing and permanently storing CO₂, and consequently introduces a regime of corrective measures in the event of leakages. The CCS Directive therefore brings the transport of CO₂ via pipelines under the EU ETS. Given the specific reference to piped transportation, the obligation in the EU ETS for a permit does not apply to transport of CO₂ by ship. In the case of a leakage of CO₂ transported by ship during its passage to the permanent storage location, there is no legal obligation in place such that the emitted quantities need to be compensated via the purchase of an equal amount of emissions allowances. The transport of CO₂ by ship is thus treated differently from transport via pipelines and this is not in the spirit of the CCS Directive. Given the possibility that more CO₂ will be transported by ship, there is an apparent need to amend current legislation. The question, however, will be who will be the subject of such legislation, as ships do not necessarily sail under the flag of an EU jurisdiction. So far this has been one of the reasons why shipping in general is not included in the EU ETS.  

iii. Liability Offshore

As discussed in section II.B.ii, the CCS Directive provides for an amendment of the ELD in order to ensure that adequate provisions are made regarding liability for damage to the environment (ie, to protected species and natural habitats, water and land) resulting from any failure of permanent containment of CO₂. Apart from the fact that transport is not listed in Annex III of the latter Directive, the ELD applies neither to environmental damage nor to any imminent threat of such damage arising from an incident in respect of which liability or compensation falls within the scope of any of the international conventions listed in its Annex IV. This includes the International Convention on Liability and Compensation for Damage in Connection

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with the Carriage of Hazardous and Noxious Substances by Sea (HNS Convention) of 3 May 1996 and the 2010 HNS Protocol.\(^{52}\)

The HNS Convention aims at compensating for damage (loss of life or personal injury, loss of or damage to property outside the ship, loss or damage caused by contamination of the environment and costs of preventive measures) caused by spillage of hazardous and noxious substances during maritime transportation. Whether a substance is hazardous or noxious is determined by the IMO. Substances listed under International Maritime Dangerous Goods Code (and thus CO\(_2\)) are, for example, considered HNS. The HNS Convention establishes a two-tier system for compensation in the event of accidents at sea involving hazardous and noxious substances. Tier one will be covered by the ship owner’s compulsory insurance. Depending on the gross tonnage, the ship owner will be able to limit his financial liability.\(^{53}\) In cases where the insurance is insufficient, a second tier of compensation (with a maximum of 250 million SDR) will be paid from a special HNS fund. Companies that import hazardous and noxious substances in states party to the Convention will be required to contribute to this fund. Contributions are based on the amount of substances companies receive each year.

Until the HNS Convention enters into force, the owners of ships transporting CO\(_2\) will be able to limit liability under the Convention on limitation of liability for maritime claims (the LLMC Convention).\(^{54}\) This Convention is to a large extent similar to the HNS Convention as it (i) limits liability to a certain maximum amount per incident, depending on the tonnage of the ship (Article 3) and (ii) provides for a fund to be established through the deposit of a sum of money or a financial guarantee (Article 5). The compensation limits, however, are significantly lower than provided for by the HNS Convention.\(^{55}\) Moreover, although the LLMC Convention provides for the establishment of a fund, this fund is not intended as a safety net but is used for direct payment if liability has been established. Ship owners have, as in the case of the HNS Convention, no right to limit their liability if there is evidence that they have caused the damage themselves intentionally or as a result of recklessness.

At the EU level, Council Directive 2009/20/EC on insurance of ship owners for maritime claims applies. The objective of this Directive is to fill a legal vacuum, as there is no obligation to have insurance under international law, and to avoid substandard shipping in EU waters. Some level of harmonisation is achieved by ‘endorsing’ LLMC standards. The Directive applies to ships over 300gt, but excludes, for example, state-owned ships used for non-commercial purposes.\(^{56}\) The latter could potential apply to transport of CO\(_2\).

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52 In 2009 the Convention had still not entered into force since it had not been ratified by a sufficient number of countries. A protocol to the Convention was consequently adopted in 2010 (2010 HNS Protocol) to overcome the initial ratification problems.

53 The Convention applies the International Monetary Fund’s currency, ie special drawing rights or SDR. Liability is capped at 10 million and 100 million SDR for ships under 2,000 tonnes. If damage is caused by packaged HNS, the maximum liability for the ship owner is 115 million SDR.


55 Total liability limits for a ship with a gross tonnage of 50,000 tonnes under the LLMC Convention is 54.6 million SDR, while under the HNS Convention it will be 72 million SDR.

C. Transport

The ships transporting CO₂ will probably have to be specifically designed and constructed for this purpose, but can be owned and operated by a wide range of parties, including entities involved in a CO₂ emissions activity, a storage operator or an independent shipping company. Given the focus of the CCS Directive on transportation via pipelines, the transport of CO₂ by ship to an offshore storage location falls outside the scope of the CCS Directive and is thus governed by general principles of maritime law. In general, maritime transport is governed by two basic contracts: FOB or CIF. Whereas a FOB or ‘Free on Board’ contract entails that the seller delivers at the railing of the ship and the buyer takes all the risk, a CIF or ‘Cost, Insurance Freight’ contract means that the seller has responsibility for transport, insurance and freight charges to a destination chosen by the buyer. In the case of CCS, it can be assumed that the seller has to take all the risks until the CO₂ is injected in the geological formation, and use will be made of a CIF contract, the owner of the ship thus not taking any risk.

Given the special design and investments needed, there will probably be few ships available. This may result in a situation where the ship owners have a monopoly situation and may thus be in a position to favour certain cargoes above others. In that case the person affected by a refusal to transport certain quantities of CO₂ may have to rely on general competition law and the earlier-mentioned essential facility doctrine (see section II.C.ii).

IV. CROSS-BORDER TRANSPORTATION OF CO₂ OFFSHORE

Cross-border transportation of CO₂ is potentially hampered due to the need to safeguard the offshore environment. Two treaties are of special importance as regards the protection of the marine environment: the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) of 1972; and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) of 1998. Both Conventions have as their primary goal to ‘protect the maritime area against the adverse effects of human activities’. However, whereas the London Convention did not refer to CO₂ at all, the OSPAR Convention originally abolished any CCS activities. In 2007, the OSPAR Convention was amended in order to remove all legal barriers to CCS. Similarly, attempts have been made to enable CCS under the London Convention. In 2006 the London Protocol of 1996 entered into force, replacing the London Convention. 57 One of the amendments concerns Article 6 of the Protocol, which prohibits the export of waste for dumping, and thereby poses a legal hurdle to the transboundary transport of CO₂. 58 It provides that CO₂ may be exported as long as the states concerned have

58 C Armeni, ‘Legal Developments for Carbon Capture and Storage under International and Regional Marine Legislation’ in Havercroft et al (eds), n 3 above, 151.
agreed to do so. This amendment was adopted in 2009 but has not yet entered into force, as it has so far not reached the required number of ratifications. This means that states may permanently store CO\textsubscript{2} within their national boundaries, but storage outside their territory, and thus transboundary transport of CO\textsubscript{2}, is still prohibited. The same applies to cross-border transport for enhanced hydrocarbons recovery (see section III.A).

V. TRANS-EUROPEAN NETWORKS

The preceding sections have shown that the CCS Directive provides little guidance and support for developing CO\textsubscript{2} transport infrastructure. The need for such support is becoming more apparent, as transport distances seem to increase given the trend to develop carbon storage offshore. At the EU level the regime governing the development of Trans-European Networks (TENs) has applied since 2013 to CO\textsubscript{2} infrastructure as well.

A. EU Legal Framework

The concept of TENs was introduced in 1992 (Treaty of Maastricht) and is now included in Title XVI (Articles 170 to 172) of the Treaty on the Functioning of the European Union (TFEU). It provides that the EU shall contribute to the establishment and development of TENs in the areas of transport, telecommunications and energy infrastructures in order to help achieve the objectives of an internal market, to strengthen economic and social cohesion, and to enable those concerned to derive the full benefit from the setting-up of an area without internal frontiers. This policy can be achieved by the increased interconnection and interoperability of national networks, as well as access to such networks, whilst particularly taking into account the need to link islands, landlocked and peripheral regions with the central regions of the Union. These objectives can be achieved by removing two main obstacles, that is, lengthy permitting procedures and insufficient finances for developing TENs. The TENs policy thus aims at (i) streamlining administrative and permitting procedures in order to avoid delays when developing cross-border infrastructure projects and (ii) financially supporting TENs via, for example, feasibility studies, loan guarantees, interest rate subsidies or through the Cohesion Fund.

60 Art 21(3) of the London Protocol provides that an amendment cannot enter into force before two thirds of the Contracting Parties have deposited an instrument of acceptance of the amendment.
61 Treaty on the Functioning of the European Union (TFEU), Art 170. Art 171(3) TFEU explicitly provides that for the purpose of TENs, the EU may also cooperate with third countries to promote projects of mutual interest and to ensure the operability of networks.
62 Art 171(1) TFEU. If necessary the Union may also take specific measures in the field of technical standardisation.
These policy goals only apply to networks identified as projects of common interest (PCIs).\textsuperscript{63} For this purpose the EU needs to establish for each sector a set of guidelines, which provide rules and procedures for the identification, selection and treatment of PCIs. Since the first guidelines for the energy sector (TEN-E) from 1996, the rules governing the identification of PCIs have gradually been intensified, and currently PCIs need to be part of ‘priority corridors and areas of trans-European energy infrastructure’. The most recent guidelines are included in Regulation 347/2013 (the Regulation)\textsuperscript{64} and aim at identifying PCIs that are necessary to implement priority corridors and areas falling under the energy infrastructure categories such as electricity, gas and oil, as well as CO$_2$.\textsuperscript{65} This means that CO$_2$ networks are considered as an energy infrastructure category even if there is no direct link with the energy sector, as would be the case if CO$_2$ emissions from a cement producer were to be captured and injected into an aquifer. However, categorising all CO$_2$ networks under one TEN category is probably the most pragmatic solution to identifying and promoting the development of these networks.

B. Carbon Dioxide Networks

According to Regulation 347/2013, a project can be considered as a PCI if the infrastructure is part of a specific category.\textsuperscript{66} The first category refers to dedicated pipelines, other than an upstream pipeline network, used to transport CO$_2$ from more than one source (ie, industrial installations that produce CO$_2$ gas from combustion or other chemical reactions involving fossil or non-fossil carbon-containing compounds) for the purpose of permanent geological storage of CO$_2$ pursuant to the CCS Directive. This category of networks consists of pipelines specifically developed to transport CO$_2$ as part of the CCS chain. Moreover, these pipelines should be able to transport CO$_2$ from several sources, and would thus exclude a pipeline connecting one CO$_2$ source and one storage facility. Although ‘upstream pipeline networks’ are specifically excluded from this category, the Regulation does not provide for a definition of ‘upstream pipeline networks’, and it is thus not clear what kind of pipelines the Regulation is actually excluding. Is it referring to the concept of upstream pipeline networks used in the Gas Directive, ie ‘any pipeline or network of pipelines operated or constructed as part of an oil/gas production project, or used to convey natural gas from one or more such projects to as processing plant or terminal or final coastal landing terminal’? If so, it is not clear why this category is excluded, as a re-use of such pipelines could play a significant role in carbon storage. If the idea

\textsuperscript{63} Art 172 TFEU provides the legislative procedure for establishing such guidelines.
\textsuperscript{65} Regulation, Art 1.
\textsuperscript{66} Regulation, Annex II, s 4.
would be that existing pipelines should be excluded as these require fewer investments than a similar exemption should also apply to transport and distribution pipelines.67

The second category includes facilities for liquefaction and buffer storage of CO2 in view of its further transportation (excluding infrastructure within a geological formation used for the permanent geological storage of CO2 pursuant to the CCS Directive), and is thus of special relevance for transport by ship, but only as far as it concerns liquefaction and unloading facilities. A similar approach can again be found with regard to LNG infrastructure.

In order to qualify as a PCI, the project should be necessary for developing at least one energy infrastructure priority corridor or area, and involve at least two Member States either by directly crossing the border of two or more Member States (including a country from the European Economic Area) or by having a significant cross-border impact.68 Unlike the electricity and gas sectors, there is no EU master plan for developing CO2 networks. In the absence of such a plan, it seems that it would be sufficient that a plan is presented by at least two Member States, as long as it fulfils the requirements of the Regulation, ie that in addition to the project’s having to cross two borders or have a significant cross-border impact, it states that the potential benefits of the project should outweigh its costs. In order to assess the latter it will be necessary to develop a common methodology for a cost–benefit analysis (CBA). Similarly, it is not yet clear what is understood by ‘significant’ cross-border impact. For this purpose a capacity or throughput capacity threshold could be applied.69 Whichever threshold is being used, it must be carefully designed in order to avoid any unnecessary obstacles to developing CO2 networks.

In addition, the project has to meet some general criteria, as it has to contribute to (i) the avoidance of CO2 emissions whilst maintaining security of energy supply, (ii) increasing the resilience and security of CO2 transport, and (iii) the efficient use of resources, by enabling the connection of multiple CO2 sources and storage sites via common infrastructure and minimising the environmental burden and risks. The first criterion seems to be relevant to the energy sector only, and to focus more on the emissions/capture part of the CCS chain than the part involving the transport of CO2. The need included in the second criterion, to increase the resilience and security of CO2 transport, is relevant. As already discussed, so far no clear European legal framework applies, and given the potential different treatment of pipelines transporting CO2 for storage purposes and other pipelines, a project promoter will need to present some clear views on this matter. The Regulation also seems to favour larger networks to be used by several users. This brings with it a clear financial aspect, as it may require the need to develop some larger/oversized infrastructure

69 See Milieu Law and Policy Consulting, n 67 above.
and thus anticipatory investments. Such projects could benefit from EU funding if they are classified as a PCI.

Last but not least, the Regulation provides that the identification and selection of PCIs for inclusion in the list of supported projects is made by regional or thematic groups consisting of the Commission, relevant Member States and project promoters. The groups identifying and selecting CO\textsubscript{2} networks are established on an ad hoc basis. A thematic group for a cross-border CO\textsubscript{2} network in the North Sea has been created, and on the basis of the criteria for project selection included in the Regulation, a template will be issued so that project promoters can identify possible candidate projects for PCI status in the next call of early 2017. A possible project could be the Rotterdam Nucleus PCI, which involves Belgium (emitters near/at the port of Antwerp), The Netherlands (emitters near/at the port of Rotterdam, the existing OCAP project as well as an offshore storage site P15/P18 operated by Taqa) and the UK (offshore storage site/UK Fizzy field), as well as possible future extensions to Germany and France. The project would involve transportation by ship (from Antwerp to P18) and via pipelines (The Netherlands to P18). If awarded the status of a PCI, the project could apply for a subsidy under the Connecting Europe Facility for a feasibility study.\textsuperscript{70} From 22 May 2017 to 15 August 2017 the European Commission organised a consultation on the third list of PCIs, which included a list of four potential carbon dioxide pipelines in the North Sea area, including the one mentioned above. The objective of this consultation is to receive views on the need for cross-border carbon dioxide pipelines from an EU energy policy perspective.

VI. CONCLUSION

The process of carbon capture and permanent storage of CO\textsubscript{2} implies that the captured CO\textsubscript{2} has to be transported to a storage facility. The CCS Directive seems to focus on piped transportation, given the many similarities between the transport of natural gas and CO\textsubscript{2}, and has made use of schemes also applying to the (upstream) gas sector. Several Member States have, however, also decided not to select storage sites, or to limit storage to certain phases (pilots) or areas (offshore). The North Sea is thus becoming the main area for CO\textsubscript{2} storage, and as a result of this the focus is gradually shifting to transportation of CO\textsubscript{2} by ship instead of submarine pipelines. Shipped transportation is, however, subject to a completely different set of regulations. Irrespective of the means of transportation, the development of CO\textsubscript{2} transport and storage in the North Sea is restricted to the individual coastal states, as the London Convention is currently still hampering cross-border transport of CO\textsubscript{2}.

Despite a large number of CCS project plans, only one CCS project has been realised, the Lacq pilot project in France. Lack of funding at the EU level (for example

\textsuperscript{70} If such a feasibility study could take place in 2018 it would be possible to have a start-up in 2025. See also K Aursland, ‘One Step Closer to European CCS Deployment: GATEWAY Pilot Case Chosen’ (September 2016), at blog.sintefenergy.com/ccs/gateway-pilot-case-chosen/.
NER 300) and by national governments (for example co-funding) and low carbon prices are the main reasons for this slow development of CCS projects. As of 2013 an additional type of funding has been identified for CO$_2$ pipelines, and that involves some partial funding on the basis of the regime governing TENs. This regime may facilitate the development of cross-border CCS projects in the North Sea area, but it has had little impact so far.

Moreover, the CCS Directive is only focusing on pipelines connecting major point emitters and subsoil storage facilities, and does not take into account other transportation networks. As a result, pipelines transporting CO$_2$ for different purposes will be treated in different ways, especially within the framework of the EU ETS. This is surprising, as safety and environmental concerns are largely the same. It shows, once again, that the transportation of CO$_2$ needs to be considered from a broader perspective than CCS alone.

It follows from the above that, so far, little experience has been gained with CCS and thus with CO$_2$ transportation, but that in practice it will not be limited to piped transportation. The trend is towards developing several offshore hubs around the North Sea, and this would require a more integrated approach towards cross-border transport via pipelines as well as ships, and the integration of pipelines used for non-CCS transport (OCAP). When carbon prices increase and CCS becomes more attractive, it could be useful to apply a more holistic approach towards CO$_2$ transportation.