From CO_2 Sources to Sinks:

Regulatory Challenges for Trans-Boundary Trade, Shipment and Storage

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Highlights

- CCS and Shipping
- Insurance Liability for CCS
- CCS in WTO

Keywords

CCS, Shipping, CCS insurance, Trade in Environmental Goods and Services

List of abbreviations:

APEC: Asia Pacific Economic Cooperation
CCC: Climate Change Committee
CCS: Carbon Capture and Storage
CO2: Carbon Dioxide
COP: Conference of the Parties
CBD: Convention on Biological Diversity 1993
CPC: Central Product Classification
EGS: Environmental Goods and Services
EPP: Environmentally Preferable Products
GATS: General Agreement on Trade in Services
GEM: Goods for environmental management
HNS Convention: International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 2010
IMO: International Maritime Organization
LC: Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention)
LNG: Liquefied Natural Gas
LP: London Protocol 1996
OECD: Organization of Economic Co-operation and Development
OSPAR: Oslo-Paris Convention for the Protection of the Marine Environment of the North – East Atlantic 1992
UNCLOS: United Nations Convention on the Law of the Sea
UNFCCC: United Nations Framework Convention on Climate Change 1992
WTO: World Trade Organisation

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Abstract:

Carbon Capture and Storage (CCS) technologies have been hailed as a solution to climate change with capacity not only to reduce atmospheric carbon di-oxide (CO_2) but also to achieve net-zero emission by the mid-21st century. CO_2 captured (either directly from the atmosphere or from large point sources), is compressed and transported to storage sites, either via pipelines or through shipping. Often, the CCS projects are deployed nationally where capture, transport and storage take place within the jurisdiction of one State. However, wide scale deployment of CCS projects is imperative for global matching of CO_2 sources to sinks. To that end, the outreach of CCS technology needs to go beyond the developed world. Studies have indicated that developing countries have vast storage resource potential. Internationalization of CCS projects where CO_2 is captured in one State and is then transported to another State for storage raises a number of challenges particularly in terms of trans-boundary transport and storage. This paper explores some of these challenges particularly in terms of international trade law, liability framework for shipping and storage and potential of insurance to act as a stop-gap arrangement until a regulatory regime is in place. It examines questions such as: whether CO_2 and CCS technologies are environmental goods and services under the trade law; is there any regulatory frameworks in place to ensure liability against long-term health and safety as well environmental risks, and; what role can insurance industry play in promoting global deployment of CCS projects?

1. Introduction

Carbon dioxide (CO_2) Capture and Storage (CCS) stands for a suite of technologies projected as a crucial technological solution to the biggest environmental challenge facing the globe, i.e., Climate Change. As a carbon mitigation technology, CCS separates CO_2 from industrial and energy related sources and transports it to a storage location ensuring long-term isolation from the atmosphere unless the CCS plants are located directly above the geographical storage site (IPCC, 2005). The captured CO_2 can further be used in various CO_2 derived products and services such as: fuels, chemicals, building materials from minerals, building materials from waste, and CO_2 use to enhance the yields of biological processes (IEA, 2019). The CCS facilities around the world are capturing more than 35 Million tonnes (Mt) of CO_2 of approximately 33.5 Giga tonnes of global CO_2 emission (IEA, 2019).[3] The CCS could eventually result in net removal of CO_2 from the atmosphere by capturing and storing the atmospheric CO_2 into a suitable storage location, thereby playing a substantial role in the transition to a net-zero global energy system (IEA, 2020). As a climate mitigation technology,

[3] The global emission of CO_2 reached a historical high of 33.513 Giga tonnes of CO_2 in 2018. Although the Covid 19 crisis in 2020 triggered the largest annual drop in global energy-related emissions, it is likely to increase in 2021 following the global economic recovery and lack of any major policy change. For more, see https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020

CCS can potentially play a vital role in achieving the Paris Agreement's[4] overarching target of keeping global temperature rise this century to well below 2 degrees Celsius above pre-industrial levels. Resultantly, the United Nations Framework Convention on Climate Change (UNFCCC) in December 2011 meeting decided to adopt modalities of CCS as Clean Development Mechanism (CDM) project activities under the Kyoto Protocol (Dixon et. al. 2013).

The global progress on utilisation of CCS technology so far has been rather limited. Often, CCS projects are deployed nationally, meaning that capture, transport and storage take place within the jurisdiction of one State. However, wide scale deployment of CCS projects is imperative for global matching of CO_2 sources to sinks, i.e., reservoirs. To that end, the outreach of CCS technology needs to go beyond the developed world. Although there was 33% growth in the CCS industry during 2020, there are only 122 CCS projects around the globe at present. Of these, only 26 are fully operational, 37 are at various stages of development (from early to advanced) and the rest vary from pilot phase to feasibility study to under construction (IOGP, 2020). Most of the CCS facilities (and almost all of the operational facilities) are located in the developed world, i.e., 36 in North America (14 operational) 51 in Europe (7 operational), and 8 in Australia (1 operational). China is the only developing country with any CCS projects, having 14, of which 1 is operational and 2 are expected to be operational in near future (IOGP, 2020).

Studies have indicated that developing countries have vast storage resource potential (see e.g., Kearns et. al. 2017). Such storage may be required where a State that does not have sufficient suitable geological storage capacity still wishes to use CCS to reduce emissions (Dixon et. al., 2014). However, the very nature of technological knowhow and advances required in the application of CCS technology for carbon mitigation, large-scale investment, resources for risk assessment and management, as well as the lack of legal framework for regulating CCS facilities has led to reluctance for participation by developing countries. Furthermore, internationalization of CCS projects where CO_2 is captured in one State and is then

[4] The Paris Agreement under the United Nations Framework Convention on Climate Change 2015

transported to another State for storage raises a number of regulatory challenges particularly in terms of transboundary transport and storage. While there are many factors to be considered in assessing the role of CCS in mitigating climate change, this paper focuses on challenges implicit in transboundary trade, transport and storage of CO_2. It begins with examining whether international trade law framework under the auspices of World Trade Organisation (WTO) mechanisms can be employed to promote global deployment of CCS. It then explores the regulatory challenges for the liability regime for trans-boundary shipping and storage. It argues that while a coordinated international effort is required for large-scale deployment of CCS projects, insurance can act as the stop-gap arrangement and lead the way while the regulatory regime catches up.

2. Challenges for International Trade in CCS

The first and foremost question one may ask when exploring the utilisation of WTO mechanisms to promote global CCS deployment is, whether international trade in CO_2 is permissible? The answer is, yes. At present, there are no impediments as such to the international trade of CO_2 for industrial purposes. In fact, CO_2 is traded internationally with average import duty ranging from 0 to 26 percent.[5] However, the relevant questions for facilitation of CCS technology under the WTO regime are, whether the large-scale CO_2 captured for sequestration can be acknowledged as an environmental good (EG) and whether the CCS technologies would qualify as environmental goods and services (EGS)? These are important questions since recognition of CO_2 as EG and CCS as climate mitigation technologies would facilitate trade by reduction or elimination of tariff and non-tariff barriers to trade as mandated under the 2001 Doha Ministerial Declaration (WTO, 2001).[6] To that end, one first needs to examine how EGS are defined in the WTO.

2.1 Is CO_2 an Environmental Good?

At present there is no accepted definition of environmental goods or services as the Doha mandate failed to reach a consensus thereon (ICTSD, 2012). During the Doha

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[5] WTO, Integrated Database (IDB) Notifications.

[6] Para 31(iii)

negotiations, three different approaches were forwarded to define EGS and identify the scope of goods and services to be liberalised as EGS.

i) The 'end use' or 'project' approach proposed by India and Argentina suggested a phased approach to EGS, where firstly the environmental activities are identified and listed, followed by developing a country list of public and private entities that carry out these activities. The list was then to be notified to the WTO for negotiating preferential tariff treatment. Argentina went further in recommending preferential treatment for goods, only if such goods are used in projects under the Kyoto Protocol's Clean Development Mechanism (Cosbey et. al., 2010). The goods on the agreed list were then to be subject to either total or phased tariff elimination.

ii) The 'request-offer' approach proposed by Brazil followed traditional WTO mechanics, where countries would request tariff reductions on product of interest from each other and then extend the bilaterally agreed tariff cuts to all WTO members based on the non-discriminatory Most Favoured Nation clause[7] (Balineau G and De Melo, 2013).

iii) The 'list' approach based on the existing Organization of Economic Co-operation and Development (OECD) and Asia Pacific Economic Cooperation (APEC) list of EGS was introduced by mostly developed countries having a high stake in export of listed goods. The initial list, compiled by the WTO secretariat, consisted of 480 products – classified primarily according to Harmonised Systems (HS)[8] code under the World Customs Organisation – was later trimmed down to 153 environmental goods (Cosbey et. al., 2010).

The EGs of interest were classified in five categories: Air pollution control; Renewable energy; Waste management/water-treatment/remediation; Environmental technologies; and Others (WTO, 2010). However, negotiations stalled

[7] The Most Favoured Nation principle requires the WTO Member States not to discriminate between their trading partners.

[8] HS is a standardized numerical method of classification used by customs authorities around the world to classify and identify traded products for taxation.

in the absence of an agreed definition of EGs or EGS, even though a number of bodies have proposed definitions. For instance, the OECD defines the environmental industry as consisting of: 'activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil as well as problems related to waste, noise and eco systems. Clean technologies, processes, products and services which reduce environmental risks and minimise pollution and material use are also considered part of the environmental industry' (OECD, 1999). Whereas this definition is used as a 'reference point' by some members, a consensus could not be reached in identifying what an EG is as there are two contemporary conceptions of EGs (Balineau G and De Melo, 2013).

1. Goods for environmental management (GEM), i.e., 'products [and services] that reduce the environmental risks and minimize pollution and resource use' (WTO, 2010). This category includes both pollution management and resource management products and services;
2. Environmentally preferable products (EPP), i.e., 'products that cause significantly less 'environmental harm' at some stage of their 'life-cycle', than alternative products serving the same purpose' (UNCTAD, 1995).

In the absence of an agreed definition, this paper will apply both these concepts in examining whether CO_2 captured from the environment for storage in geological sinks can be recognised as an EG. Looking at both conceptions of EGs, captured CO_2 itself does not seem to fit within the definition of "Goods for environmental management" (GEM), i.e., a product that reduces the environmental risk and minimises pollution. This is because CO_2 is considered to be a pollutant itself as it is the principal greenhouse gas that the UNFCCC aims at reducing emission of. Similarly CO_2 does not fit within the definition of EPP, for even if its storage may reduce environmental harm, CO_2 in itself is not a product that causes less environmental harm. This is the reason that the list of environmental goods proposed by Saudi Arabia that otherwise contained multiple organic chemicals and gases including liquefied natural gas, petroleum gases and gaseous hydrocarbons did not contain CO_2 (WTO, 2009). Thus it is unlikely that CO2 will in the future be considered an environmental good within the definitions proposed at WTO.

However, does it mean that CO_2 is a waste product? CO_2 as such is not listed as waste under the Basel Convention[9] that regulates the transboundary movements of hazardous wastes and their disposal. It is not listed either as hazardous waste under Annex VIII or non-hazardous waste under Annex IX (although spent carbon may be considered as hazardous or non-hazardous depending on its characteristics). Therefore transboundary movement and disposal of CO_2 is not prohibited or controlled therein. The only international legal framework that specifically regulates carbon capture and sequestration is the London Protocol[10] aimed at preventing marine pollution resulting from dumping of wastes and other matters in the seas. Its scope includes transportation of CO_2 from an onshore source to an offshore platform for injecting into a sub-seabed geological formation (Dixon et. al., 2009). Until recently, Art. 6 of the London Protocol forbade all contracting parties to export CO_2 for offshore storage. Specifically, it stated that the contracting parties shall not allow the export of wastes or other matter to other countries for dumping or incineration at sea (Heffron et. al., 2018). However, in 2019, parties agreed to provisional application of the amended Art.6 which allowed export and import of CO_2 for offshore geological storage (Dixon, 2020).[11] As a result, transboundary export and CO_2 storage in sub-seabed geological formations is now permitted under the London Protocol for the parties that have made a declaration to that intent.

Another issue worth examining for trade liberalisation, (i.e., reducing or eliminating tariff on CO_2), is whether the importing country would benefit from the emission reduction and storage of CO_2. Potential storage methods for captured CO_2 include injecting it in underground geological formations or Deep Ocean and industrial fixation in inorganic carbonates. Industrial use of CO_2 (varying from chemical and biological processes to various technological applications) can, in principle, store the carbon in the 'chemical carbon pool'. However, the total industrial

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[9] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1989

[10] 1996 Protocol to The Convention On The Prevention Of Marine Pollution By Dumping Of Wastes And Other Matter, 1972

[11] Resolution LP.5(14) on the Provisional Application of the 2009 Amendment to Article 6 of the London Protocol adopted 11 October 2019, by the 14th Meeting of the Contracting Parties to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matters.

use of CO_2 is far less than the emission from anthropogenic sources and the storage time is shorter, only days to months before it is used in industrial processes and again emitted to the atmosphere (IPCC, 2005). In terms of sub-seabed geological sequestration, there are associated risks, such as abrupt or gradual leakage, which raises environmental and associated liability concerns as discussed later in this paper.

CO_2, particularly in large quantities for sequestration purposes, is more likely to be considered as non-hazardous or other waste that is allowed to be dumped. Nonetheless, it is still a waste product and not an EG within the definitions proposed in WTO. Moreover, the risks associated with resulting impact of elevated CO_2 concentrations in the shallow subsurface such as lethal effects on plants and subsoil animals and the contamination of groundwater, further makes it unprofitable for a country to liberalise importing of captured CO_2 by reducing or eliminating tariff thereon. Therefore, it is not likely that the WTO mechanism can be engaged for facilitating global deployment of CCS at least in terms of importing/exporting large-scale CO_2 for sequestration.

2.2 Are CCS Technologies Environmental Goods and Services?

Now let us move to whether international trade in CCS technologies can be facilitated under the WTO. CCS technologies minimise pollution and correct environmental damage to air and thus are a part of the environmental industry. Accordingly, CCS technologies featured as environmental technologies in the list proposed by Saudi Arabia during the WTO negotiations (WTO, 2009). Separation of CO_2 from industrial and energy related sources and sub-seabed geological storage requires a number of specific products and specialist services. As CCS is considered a pollution management technology, the question arises whether CCS products and services can be categorised as GEM as they reduce the environmental risks and minimize pollution.

The main issue with GEM is that these products often have multiple end-uses. For example, the goods enlisted by Saudi Arabia such as tubes, pipes, reservoirs, tanks etc. under the environmental technologies are multiple end-use products. The WTO list of 153 goods (compiling submissions from 13 mostly developed countries which account for nearly six/seventh of all trade in such goods), enlisted goods where developed countries generally have a comparative advantage and excluded the goods in which they had high tariffs (Balineau G and De Melo, 2013). Also, most of the commodities that appeared on the WTO list were multiple end-use that developing countries had raised objection to (Mathur and Guin, 2006). Most developing countries wish to liberalise single specific end-use products (Balineau G and De Melo, 2013). Since most of the goods listed were not of export interest to developing countries, they objected to the WTO list as by reducing tariffs on these goods not only do they risk losing the tariff revenue but they also jeopardise their domestic economics and development of new green industry through increased competition from cheaper imports (ICTSD, 2012). This mercantilistic response to trade negotiations in environmental goods and services, thus kept many developing countries (including most least developed countries) out, simply because they did not have interests at stake (Wu, 2014). Given the minimal gains for exports, no obvious benefits (either in environmental or in trade terms), and development priorities, for most developing countries, the costs appear to exceed the benefit (ICTSD, 2007). However, lack of EG status does not mean that trade in components of CCS technology cannot be liberalised. A WTO member can unilaterally reduce or eliminate tariffs on CCS related goods if it wishes to deploy the CCS technology to reduce carbon from its atmosphere.

As with most environmental technologies, CCS technologies also entwine both goods and services. However, the case is different with liberalisation of international trade in environmental services. The General Agreement on Trade in Services (GATS) is a flexible legal instrument that allows the Members to liberalise their service sectors, across four different modes of supply according to their needs. Instead of defining services, GATS identifies four modes through which international trade in services takes place:[12]

1) Mode 1 (cross-border): services are supplied from the territory of Member A into the territory of Member B;

2) Mode 2 (consumption abroad): service consumers from Member B travel to Member A to consume the services;

[12] GATS, Article I:2

3) Mode 3 (commercial presence): a service supplier from Member A provides services in territory of Member B, through a locally-established affiliate or subsidiary etc. and;

4) Mode 4 (cross-border movement of Members' citizens): where nationals of Member A provide services within the territory of Member B as an independent supplier or employee of a foreign service firm.

Members can choose to open their internal markets fully/partially/not at all as well as treat the foreign service providers with or without any discrimination. Services sector classification is largely based on UN Provisional Central Product Classification (CPC). The environmental services sector enlisted in GATS schedule includes: (A) Sewage services, (B) Refuse disposal services, (C) Sanitation and similar services, and (D) Other environmental services (WTO, 1998). The other category (i.e., section 6.D of the GATS schedule) includes 'cleaning of exhaust gases' where CCS technologies seem to fit.

For the purpose of deployment of CCS technologies, services trade is most likely to take place through commercial presence accompanying movement of natural persons. In other words, the CCS industry in the developed world would operate in the importing state through its subsidiary (mode 3) and employ experts with the technical knowhow who will also move to the sites in the importing country to provide services (mode 4). Barriers to trade in environmental services in these modes vary, from limitation on foreign investment, requirement to form a joint venture with local suppliers, nationality requirement for staff, residency requirement for managers and directors, performance and local content requirements, taxation and subsidisation, immigration policy and visa restrictions etc. which will have impact on the sector (WTO, 1998). Global deployment of CCS technologies will remain hindered until these barriers are removed and trade in environmental services is liberalised.

Rapid internationalisation, increasing environmental awareness and adoption of world-wide environmental standards have resulted in growth of the environmental services market and increased international trade opportunities (WTO, 1998). Nonetheless, at present only 52 out of 164 WTO Members have formally committed themselves to open their markets for other environmental services. Of these, only 44

Members have made specific commitments in 'cleaning services of exhaust gases (CPC 9404).' There are two main reasons for fewer commitments in environmental services: a) historically major environmental services such as sewage and refuse disposal are deemed public goods and thus were provided by the governments (WTO, 1998); and b) the integral nature of environmental goods and services, as there are many environmental activities where delivery of services is amalgamated with the use of goods (WTO, 2005). Another reason for fewer commitments is that trade liberalisation in environmental services is intertwined with the definition of EGs. Some Members criticised the list approach for treating EGSs in a mutually exclusive manner, whereas some recommended parallel negotiations for liberalisation of trade in environmental services (WTO, 2005). Application of CCS technologies does not entail environmental services that are of public goods nature. Therefore, the private sector can play a crucial role in mitigating carbon emission. Since there is no consensus on EGs, parallel negotiations for defining environmental services and identifying barriers to trade liberalisation may produce better result. Once again, EGS categorisation is not a prerequisite for trade liberalisation as there is nothing in GATS that prevents Members from unilaterally liberalising the services component of CCS. GATS doesn't require Members to commit themselves to liberalisation by scheduling the services sectors they wish to liberalise. Thus WTO Members willing to deploy CCS technologies can unilaterally liberalise CCS related services without embedding them within the GATS legal framework. Moreover, unilateral liberalisation of trade in environmental services gives a Member regulatory and policy space to devise the mechanism as is suitable to its needs and reverse the policies if the outcome is unsuitable to its needs.

Once captured and transported, CO_2 can be stored in geological sites (such as oil and gas fields, unmineable coal beds and deep saline formations), in oceans, and industrially through fixation of CO_2 into inorganic carbonates (IPCC, 2005). Storage of CO_2 can be undertaken locally, an arrangement which would be more efficient in terms of energy and environmental footprint. As noted earlier, States can transport the captured CO_2 to another country for sub-seabed sequestration in the absence of a suitable geological site within their geographical boundaries. Trans-boundary transportation of captured CO_2 through shipping as well as its storage raises altogether new regulatory challenges as explored in the next section.

3. Challenges for Trans-border Shipping and Storage of CO_2

Offshore carriage of the captured CO2 from the source to the storage reservoir can be performed by ships or by pipelines. Each mode of transport raises differing environmental challenges requiring specific liability arrangements (Svensson et. al., 2004). Whereas compressed CO_2 can be transported via pipelines for short distances, transportation via ships is more viable for larger distances overseas (IPCC, 2005). As pipelines are useful in short-distance transporting of large quantities of CO_2 (Kjärstad et al., 2013), ships are a better, more feasible and relatively low-cost alternative for transportation to geological sites not served by such pipelines (Weber and Tsimplis, 2017). Transport of large-scale carriage of CO_2 by ship could be done in the same way as the transport of liquefied natural gas (LNG) (Scott et. al., 2013). Ships specially designed for carrying large quantities of CO_2 may prove more financially efficient because otherwise the return voyage will most likely be in ballast. However, the development of such specially designed ships is challenging, not only technologically but also with respect to the required regulatory changes.

Shipping is a globally standardised, yet slowly evolving sector characterised by reluctant to adopt innovative solutions because of the high regulatory costs in addition to financial inconvenience. Any regulatory change is not easy to implement in the global shipping regime as harmonisation of the national regulatory regimes of flag states requires the agreement of globally applicable safety and environmental standards through negotiations at the International Maritime Organization (IMO) (Balkin, 2001). Moreover, the development of regulatory and liability arrangements does not automatically guarantee the adoption of new technology. Given the risks and safety hazards inherent in transportation of large-scale CO_2, global deployment of CCS requires a new legal and regulatory regime for transboundary movement of large-scale CO_2 with specific clarity on the liability of CO_2 transporters.

3.1 Liability regime for Large-Scale CO_2 Shipping

Whichever transport mechanism (e.g., pipeline, vessel) is utilised for transportation of CO_2 from the capture site to the ultimate storage location, it will require regulatory frameworks to minimise environmental risks. Although both methods of transport (be it shipping or pipelines) expose the carrier of the CO_2 to environmental liability and liability towards third parties, there is a key difference in the regulation of the two. In the case of transportation via pipelines, liability is by and large defined by national rules as pipelines are often used within the boundary of a State. On the other hand, due to the trans-boundary nature of transportation by shipping, liability will be regulated by the international legal framework (Weber and Tsimplis, 2017). Accordingly, shipping transportation of CO_2 would require a robust liability framework. The International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 2010 (HNS Convention) covers pollution damage, loss of life, personal injury, and property damage caused by hazardous and noxious substances. Following the 'polluter pays' principle, the HNS Convention ensures that the shipping and HNS industry provide compensation as well as provide for the 2010 HNS Fund.[13] However, it is not yet in force. This means that the HNS Convention must enter into force before large-scale CO_2 shipping is deployed, so as to secure a robust liability regime to ensure compliance by ship-owners holding them responsible for any damages. Developing financial instruments and incentives, based probably on established carbon trading systems,[14] would be crucial to attracting investors, if shipping is to be part of the solution to CCS. The Climate Change Committee (CCC) Report identifies the paradox that although there is rapid development of CCS technology and infrastructure, nevertheless, the actual pace of vast deployment of CCS technology in shipping is slow and has been delayed so far. The CCC Report has been critical of existing national policy measures, which have not progressed sufficiently even for existing emission reductions targets (Tainsh, 2019).

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[13] Agreeing that the shipowner liability alone may not sufficiently cover the damage caused in connection with the carriage of HNS cargo, the 2010 HNS Protocol provides the second tier of liability through the HNS Fund financed by cargo interests. For more, see https://www.imo.org/en/About/Conventions/Pages/International-Convention-on-Liability-and-Compensation-for-Damage-in-Connection-with-the-Carriage-of-Hazardous-and-Noxious-.aspx

[14] EU Directive 2003/87/EC (OJ L 275, 25.10.2003); EU Directive (2009/29/EC OJ L 140, 5.6.2009).

3.2 Liability regime for Long-Term CO_2 Storage

Long-term liability for stored CO_2 is equally essential in achieving a robust regulation of CCS. In relation to a storage site in a CCS context, liability covers tortious or civil law liabilities for damage to the environment as well as responsibility for leakage of CO_2 to the atmosphere. To date, there is no clear consensus on whether liability should be transferred at some point after cessation of the operations from operators to State, in order to spread the liability. Although most domestic regulations on CCS are silent, there are some that potentially provide for liability transfer. The extent of the liability transfer also differs in various jurisdictions, where some allow transferring responsibility for certain types of liability and other allow the transfer of a capped liability (Garret, 2011). For example, the state of Victoria in Australia has implemented State and Commonwealth legal and regulatory models to support CCS technology. These include the State of Victoria's Greenhouse Geological Sequestration Act 2008, the Offshore Petroleum and Greenhouse Gas Storage Act 2010 and other secondary Regulations, such as the Greenhouse Gas Geological Sequestration Regulations 2009, which vest ownership of potential storage formations in the Crown which then may grant a right to explore or inject and store CO_2. Similarly, in Alberta, Canada, the Carbon Capture and Storage Statutes Amendment Act 2010, amended several provincial energy statutes, such as the Mines and Minerals Act 2000, which establishes the Crown's ownership of the pore space and enables the Minister to enter agreements and allows for the post-closure transfer of liability for stored CO_2 to the Province.[15] However, even these regulatory frameworks require evidence of absence of significant risk of stored CO_2 leakage impacting the atmosphere or subsurface resources. The liability transfer only applies to future liabilities for remediation of the pollution damage though operators are not to be altogether free of all civil liability claims relating to the operation of a site. Another requirement is that a set period of time has elapsed, from the cessation of the injection of CO_2, so as to make sure that the operation is complete (Havencroft and Macrory, 2014). Therefore, a long-term

[15] The Mines and Minerals Act was recently revised on July 23, 2020 but has not changed the crown's ownership of the captured CO_2 reservoirs under S. 121.

domestic liability framework is essential to the successful large-scale deployment as well as public acceptance of the CCS technologies.

Even if some States have taken long-term responsibility in situations that are comparable to CO_2 storage (e.g. underground mining), liability issues arising from the long-term effects of leakage of CO_2 to the atmosphere and local environmental impacts remain unresolved at international level. States in general have a responsibility to ensure that activities within their jurisdiction do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[16] For sub-seabed storage of CO_2, the applicable international legal framework is the United Nations Convention on the Law of the Sea (UNCLOS) which establishes a legal framework for all marine and maritime activities. Although deliberate disposal of wastes or other matter at sea is considered 'dumping,' this has not been interpreted to include any storage mechanism for CO_2 transported via pipelines from land directly to the sub-seabed point of injection. Therefore it is argued that even if CO_2 storage using a vessel, platform, or man-made structure at sea would be defined as "dumping" under UNCLOS, it is not necessarily prohibited (Shahbazi and Nasab, 2016). Similar arguments have been made earlier in terms of The Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention'), the legal instrument aimed at international cooperation to protect the marine environment of the North-East Atlantic. It was recommended that CO_2 injection into the geological sub-seabed and the ocean in instances where the CO_2 is transported via a pipeline from land could be compatible with the treaty (IPCC, 2005). Similar arguments were made by some legal commentators in terms of the London Protocol, i.e., CO_2 captured from an oil or natural gas extraction operation and stored offshore in a geological formation would not be considered "dumping" under the London Convention and therefore not prohibited therein (see e.g., Purdy and Macrory, 2004; Wall et al. 2005) . These recommendations led to 2007 amendment in OSPAR that now allows CO_2 placement in the North East Atlantic and in its seabed and subsoil through a pipeline from land only if no further activities through a vessel

[16] See e.g., UNCLOS Art 194(2), CBD Art. 3

or an offshore installation (oil and gas platform) are included.[17] The London Protocol, as noted earlier, has also allowed CO_2 sequestration in sub-seabed geological formations.

Although it looks like acceptance of CCS technologies and sub-seabed storage of CO_2 is getting traction in the international legal arena, this acceptance is limited and subject to strict conditions. For example, OSPAR only allows sub-seabed geological formations in a manner that avoids significant adverse consequences for the marine environment, human health and other legitimate users of the maritime area (OSPAR Commission, 2007). Similarly, the London Protocol does not allow the CO_2 disposal into the seabed but only in sub-seabed storage that too subject to certain conditions, i.e., a) the CO_2 disposal is into a sub-seabed geological formation, b) such disposal consists overwhelmingly of CO_2, and c) no wastes or other matter are added for the purpose of disposing of those wastes or other matter.[18] Finally, owing to the uncertainties and potential adverse implications of climate related geo-engineering (which includes carbon sequestration from the atmosphere on a large-scale) for biodiversity, the Conference of Parties (COP) to the Convention on Biological Diversity (CBD) placed a moratorium on these activities in 2010. Following the precautionary principle, the COP agreed that climate related geoengineering must remain halted until there is adequate scientific basis and appropriate risk assessment for the environment and, biodiversity as well as the socio-economic and cultural impact of these activities that justifies these geo-engineering activities. However, small scale scientific research activities conducted strictly under the controlled setting in accordance with Art 3 of the CBD were given conditional access (CBD, 2010). Noting the need for more transdisciplinary research and knowledge sharing to better understand the impact of climate-related geoengineering on biodiversity and ecosystem as well as the regulatory options, the COP in 2016 decided to extend the moratorium (CBD, 2016).

[17] OSPAR Convention, Annex II, Art. 3

[18] London Protocol, Annex I, Art. 4

Despite the increasing acceptance of CCS as climate mitigation technologies in the international legal arena, there is no international legal framework so far to identify and regulate liability concerns arising from long-term CO2 storage at large-scale. Even the UNCLOS is a framework agreement which neither allows detailed interventions nor defines long-term liability coverage from CO2 storage. The OSPAR and London Protocol may be seen as moving forward by allowing CO2 storage, albeit under certain conditions. Nonetheless, there is no clearly defined long-term liability legal framework contained in either of them.

Given the piecemeal legislation in international law and fragmented national and international approaches towards liability, a robust international liability regime for an adequate coverage of long-term liability that creates a stable, transparent and accountable harmonious regulatory framework applicable beyond national level is a prerequisite for vast deployment of CCS technologies and large-scale CO_2 storage. In the absence of a uniform domestic or international legal liability and regulatory framework, can insurance be a stop-gap arrangement, until the States get their act together and take the initiative to adopt a robust regulatory mechanism for CCS technologies? This issue will be addressed in the next section.

4. Can Insurance Mitigate These Challenges?

Given the uncertainty regarding the exact nature and risks entailed in CCS activities and its likely harm, insurance is a desirable mechanism to be used to mitigate the extent and probability of the harm (Kirchsteiger, 2008). Insurance can act as an environmental mitigation mechanism, able to help transfer the risk to multiple parties or help spread such risk via 'insurance risk spreading pools' (Abraham, 1988). Since CCS is a new technology and a new form of climate change mitigation, any new insurance products will need to develop alongside the insurance market (Flory & Podkanski, 2005).

There are two forms of liabilities that the insurance market will need to underwrite:

a) Short-term liability arising during transit of CO_2. Marine insurance covers losses and damages caused by perils of the sea. There are two main types of marine cargo insurance coverage options available in the market, i.e., 'all risk' or 'named peril'. All risk cargo insurance allows for broad coverage for all physical loss or damage due to a fortuity, whereas named peril insurance is a narrower coverage that will only cover the loss if it is caused by specific, named perils ranging from earthquake, volcanic eruption, and damage due to rainwater, seawater, river water, etc., and loss to package overboard or during loading and unloading to loss or damage due to the bursting of boilers; the breakage of shafts; any latent defect in the machinery, hull or appurtenances etc. The marine insurance products currently available in the market can cover the short-term liabilities in shipping of CO_2. However, the large quantities of CO_2 to be shipped CO_2 and unknown risk attached therewith, may result in the insurers either restricting the coverage, adding more exclusions or asking for higher premium, hence, making insurance practically unavailable.

b) Long-term liability for environmental pollution, either during shipping or storage of CO_2. The need to address long-term liability concerns includes resorting to options such as improved and expanded insurance. This need is exacerbated, due to the fact that there are several types of risks in CCS projects which may result in liability for damages, such as environmental pollution damages, clean-up costs, pollution restoration costs, crisis management costs etc. (Wendy, Jacobs & Craig, 2019). Hence, in order for prospective CCS projects to progress, it is important to address such potential liability. Environmental incidents entail a gradual occurrence of pollution over long periods of time that makes the traditional operation and insurance coverage of ordinary liability policies inapplicable. Existing liability policies for CCS projects do not extend coverage to long-term liability risks, because this would entail long-tail policies for risks that extend to hundreds of years in the future, which the insurance industry at present is reluctant to underwrite. Yet, the paradox lies exactly herein, i.e., these long-term risks arising from CCS operations are what require adequate coverage, even more as there is no single legal or regulatory framework to define the actual liability extent. In effect, this is hindering insurance carriers in the design of policies that fit the needs of CCS projects, since it is usually the regulation that drives the evolution of insurance requirements, and also because the insurance market's capacity, terms, and conditions depend on the regulatory framework (Wendy, Jacobs & Craig, 2019).

There are a number of major issues such as the large risk premiums, the existence of an insufficient pool to spread the risk, and the reluctance to underwrite projects with unknown future liabilities that are yet to be addressed by the insurance industry. Given the gradual occurrence of pollution, environmental insurance claims cover past actions as well as the site-specific ones together with claims following the occurrence of the event. As a result, even if the insurance industry is not reluctant to offer insurance coverage, such coverage will entail high premiums (Katzman, 1988). Challenges of underwriting the risk include regulatory and credit risks, directors' and officers' liability, and many more that will emerge as the technology is deployed in usage. Insurance exclusions and conditions will also need to be determined, as most excess liability policies either restrict or exclude pollution coverage altogether (Maguire, 2009). Given the environmental risks, casualty, i.e., incident coverage and crisis management risks are also to be added covering clean-up and third-party liability. Capping the potential liabilities is of particular importance, if insurance is to be promoted as guarantee for CCS projects. Therefore, it is essential for the insurance market to fix a new liability limit for environmental pollution liability insurance (Noussia, 2020). Since CCS has not been widely deployed, there are few commercial insurance options available for CCS during and after operations. Consequently, the insurance industry has not adequately addressed long-term liability issues arising therefrom.

One solution to the current lack of insurance products to adequately address long-term liability issues, is for existing insurers to expand their products as well as for more insurers to enter the market. Until more guidance is available from the regulators to guide and direct the insurance industry to procure more insurance products, CCS initiatives will require a custom-designed, risk-specific pollution legal liability policy to fit the needs of the specific project involved. Taking the lead in this direction, Zurich has developed a few specific products designed to capture the risks associated with CCS operations, e.g., the 'Carbon Capture and Sequestration Liability

Insurance Policy', specifically addressed to CCS project operators. These insurance products offer pollution event liability, business interruption coverage, well control coverage, transmission liability and even geo-mechanical liability, with coverage extending to 30-50 years (Wendy, Jacobs & Craig, 2019). In addition, Zurich has established a task force, in order to design an insurance product to cover the physical and legal risks associated with CCS (Streidl, 2020). State intervention, for coverage of such risks beyond a cap covered by the insurance market, would also prompt more insurers to enter the market (Moss, 2004). New insurance products for CCS will permit offering better insurance coverage, whilst allowing the market to enlarge its pool of product offerings. General liability insurers have (through the practice established over years) indicated the availability of 'bolt-on' solutions, via endorsements to excess liability insurance policies. Entering more commercial insurers will not only offer new insurance products for CCS projects, but also result in faster broadening of coverage, premium price reduction and greater market capacity. Advances in CCS insurance will prompt the adoption of legal and regulatory framework for the CCS industry, which, in turn, will lead to lowering the price of CCS liability insurance, as the underwriting efforts and legal costs related to coordinating different legal regimes could be avoided (Maguire, 2019).

The way forward entails the existence of multiple and adequate CCS operation insurance coverages to be available. Such multiplicity of insurance products and coverage will prompt regulatory initiatives and enactment, which in turn will prompt more insurance products and coverage to be available in the insurance market. These products will be 'bespoke' (i.e., created specifically to respond to long-term liability), deter the imposition of large premiums, and establish a new liability limit as per their capacity to meet such a new cap. Post this agreed new cap, it is also necessary to have state support for these insurance products to develop and be widely available. Hence, state-aid schemes for coverage of such risks beyond the cap covered by the insurance market need to be put in practice. It is only then that developing states will be able to embrace the risks of storage operations of CCS; for, only then, given such insurance coverage availability, will the wide deployment and use of CCS be feasible.

5. Conclusion

CCS, a suite of technologies that capture CO_2 from large source points or directly from the atmosphere, use the captured CO_2 in a range of applications or inject it into deep geological formations for permanent storage, can play a big role in potentially achieving the net-zero emission target by mid-century. However, wide scale deployment of CCS projects is imperative for global matching of CO_2 sources to sinks. To that end, the outreach of CCS technology needs to go beyond the developed world.

The present paper set out to examine whether and to what extent WTO mechanisms can be employed to facilitate international trade in CCS. Studies have indicated vast storage resource potential globally including in developing countries (Consoli & Wildgust, 2017). Lowering tariffs on established environmental technologies will make a substantial difference by not only bringing the cost of economic activities in the environmental sector down but also allow developing countries to secure compliance with stricter environmental regulations (Howse & van Bork, 2006). As the discussion revealed, there is no prohibition on international trade of CO_2. However, the large-scale CO_2 for sequestration purposes will be considered as waste and as such, the trade is not likely to benefit from reduction/omission of tariffs. The position is not clear on the status of other components used in CCS technologies as there is no agreed definition of EGs or EGS in place in the WTO. Despite the global consensus that climate change is a priority environmental issue and lower trade barriers will potentially result in positive outcomes particularly for developing countries with increased technology transfer, most developing countries (including the major emitters of CO_2) stayed out of the negotiation on goods to be identified as EGs for reduction or elimination of tariffs (Balineau G and De Melo, 2013). An impasse on trade negotiations on EGS at WTO does not mean that these goods and services cannot be liberalised at all (Wu, 2014). Members can choose to liberalise trade in CCS technologies by reducing or removing import duties on CCS components. The access to EGs can be made less expensive, at any time, through unilateral reduction of tariff rates (ICTSD, 2012). Turning environmental need into demand for environmental goods and services is a gradual process that largely depends on availability of capital and capacity for regulation and enforcement (Vikhlyaev, 2004). Unilateral liberalisation of CCS industrial components as EGs and technologies as environmental services, based on continuously evolving evidence-based assessment of the functioning of CCS will further assist WTO Members in evaluating the kind and extent of liberalisation they would wish to commit themselves to.

CCS is a promising component in our battle against climate change. Nonetheless, a long-term liability framework for trans-boundary shipping and storage of captured CO_2 is crucial for global deployment, as well as public acceptance of CCS technology. As the discussion in this paper revealed, despite the increasing acceptance of CCS as climate mitigation technologies in the international legal arena, concerns regarding the long-term risks and impact on biological diversity, the environment (including marine life and ecosystem), human health, society and culture still remain, requiring further scientific research and knowledge sharing. In fact, a lack of Parties' response regarding measures undertaken as well as the knowledge gap in science based global, transparent and effective control and regulatory mechanisms in relation to climate-related geoengineering activities led the COP to extend the moratorium on these activities in 2016. To fill that knowledge gap in both scientific research and policy making, the CCS industry needs to work with the states and find mutually beneficial innovative solutions based on public private partnerships. As noted earlier, insurance can be one such mechanism that can support proliferation of the CCS industry.

Having discussed the trade, shipping and storage challenges, this paper recommends that a globally coordinated effort to have a transparent and uniform approach towards acknowledgement of CCS technologies as EGSs, a robust long-term liability framework for trans-boundary shipping and storage of captured CO_2, backed by an insurance industry that can provide a 'tailor-made' insurance product for specific project (until such regulatory mechanism is in place), is the need of the hour for large-scale global deployment of CCS projects.

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