ERCST

Roundtable on
Climate Change and
Sustainable Transition

2021

Scaling up and trading CO2 storage units (CSUs) under Article 6 of the Paris Agreement

POTENTIAL CHALLENGES, ENABLERS, GOVERNANCE AND MECHANISMS

Table of Contents

1. Introduction ***- 2 -***

1.1. About the project **- 2 -**

1.2. About the team **- 2 -**

1.3. Our approach **- 3 -**

2. Background ***- 4 -***

2.1. Carbon Capture Utilization and Storage **- 4 -**

2.2. Evolution of CCS in CDM **- 7 -**

2.3. Article 6 of the Paris Agreement **- 10 -**

3. Concepts ***- 11 -***

3.1. CSU and CSO **- 13 -**

3.2. Article 6 & CSU **- 16 -**

4. Operationalization ***- 17 -***

4.1. Pathways for implementation of CSU based policies **- 18 -**

4.1.1. Voluntary actions based on CSUs - 18 -

4.1.2. Regulatory approaches based on CSUs - 19 -

4.2. Universal conditions for implementation **- 21 -**

5. Assessing the needs and potential of CSU-based policies ***- 22 -***

5.1. Technical factors **- 22 -**

5.2. Regulatory factors **- 25 -**

5.3. Political factors **- 27 -**

5.4. Commercial factors **- 28 -**

6. Features of Potential Governance Frameworks ***- 30 -***

6.1. Potential frameworks **- 30 -**

6.2. Why the carbon club model for a Regulatory Framework? **- 32 -**

6.3. Outline of a potential Regulatory Framework **- 35 -**

7. Conclusions and Recommendations ***- 39 -***

References ***- 42 -***

1. Introduction

1.1. About the project

While there have been efforts to develop CCUS projects across the globe, it is becoming clear that current trends cannot possibly meet the needs to achieve carbon neutrality. For instance, the IEA's Net-Zero Roadmap indicates 7.6 Gt of CO2 will need to be stored in 2050, even with significant curtailment of fossil fuel production and use.

This project explores ways in which geo-storage of CO_2 (CCUS) can be incentivized in the context of Article 6 of the Paris Agreement. The concept under analysis builds upon the use of a Carbon Storage Unit (CSU) and explores ways to provide a CSU with value and recognition under Article 6 of the Paris Agreement.

As such the project will:

- Define CSU concepts to establish a common understanding
- Consider technical, political, regulatory and governance challenges/barriers to incorporating CCUS methodologies
- Consider perceptions from a wide group of stakeholders
- Explore a CSU Club under Article 6 of the Paris Agreement

The project takes a stakeholder driven approach to collect the required data and conduct in-depth analysis of how to achieve the overall objective of the project in testing the feasibility of CSUs under Article 6 of the Paris Agreement. Therefore, in addition to a literature review and the existing knowledge of the team, stakeholders were consulted through a survey, interviews, and webinars.

1.2. About the team

The project team is composed of highly experienced experts, as well as seasoned technical & support staff. ERCST is the lead partner, and the consortium is completed with HFW and Carbon Counts.

Andrei Marcu (ERCST) has extensive experience in UNFCCC negotiations, more specifically on Article 6 of the Paris Agreement. He has been a negotiator for several countries and has an active role in facilitating the discussions through ERCST's informal dialogue on Article 6. He has published numerous papers on Article 6, has presented at well-known international forums and has a history of developing projects and trading at Mercuria Energy Trading. Lastly, he has led a significant number of Article 6 related projects for national governments, international institutions and the private sector including the ADB, World Bank, GGGI and different Turkish Ministries.

Peter Zaman (HFW) is a well-known lawyer and partner at HFW in Singapore. He has advised a sovereign wealth fund on the global regulatory framework for carbon offsetting, as part of their plans to implement their Sustainability Net Zero carbon reduction commitments. He worked with the World Bank to draft a proposed framework for Article 6.2 of the Paris Agreement, drafted a template form put and call option agreements for sale and purchase of CORSIA eligible offsets and Art 6.4 credits and in the context of the PMR program, gave advise on legal and regulatory requirements to support a carbon registry infrastructure. He worked with several other international organisations and governments including the ICTSD, the Government of Lithuania and the Green Climate Fund.

Paul Zakkour (Carbon Counts) is a leading expert on carbon removals and carbon sequestration. He has worked on the topic of CCUS for around 20 years, during which time he, inter alia, led development of the first MRV guidelines for CCS in Europe, worked with experts to develop the 2006 IPCC Guidelines chapters on CCS, supported the European Commission in developing its CCS Directive, helped the UNFCCC Secretariat to develop the modalities and procedures for CCS (where he remains a ; Member of CCS Working Group, CDM EB) and has authored several studies on the topic of carbon capture and utilisation (CCU). He has spoken and written extensively on these and other topics over the past decade. Over recent years he led the development of seminal papers describing the potential for CSUs, including the 2019 KAPSARC/2021 Climate Policy CSUs papers.

Among other areas of experience, he has also worked extensively on geothermal power in East Africa, worked with several countries to develop NDCs and LT-LEDS (Chile, Zimbabwe, Rwanda, Malawi, Mozambique), worked on carbon pricing programmes for several developing countries (Chile, The Philippines, Indonesia) and is also presently working with the European Commission to develop options for its carbon removals certification policy.

1.3. Our approach

The objective of this paper is to assess the feasibility of the basic Carbon Storage Unit concepts and incentives/mechanisms. To achieve this, the paper outlines pros and cons of standard emission-based mechanisms, as well as hurdles and barriers to implementation.

The paper will also provide an overview of the strategic benefits (e.g. enhanced support for Paris-aligned mitigation pathways with fossil fuels; enhanced clarity of net-zero claims for fossil fuel producers) and the strategic challenges (acceptability, governance, accounting).

Lastly, the paper will identify areas for potential trade-offs and describes the impacts of different options, as well as a way forward.

2. Background

2.1. Carbon Capture Utilization and Storage

Entry into force of the 2015 Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) represents a landmark for global climate action, allowing for seamless continuation of efforts to mitigate global climate change and adaptation to its consequences following the end of the Kyoto Protocol in 2020.

In terms of mitigation, all signatory Parties acknowledge the two key climate change mitigation goals set out the Agreement:

- Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
- To achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases (GHGs) in the second half of this century – also widely referred to as 'net zero'.

Nearly all scenarios modelling pathways for meeting the Agreement's ambitious mitigation goals foresee a significant role for the geological sequestration of carbon dioxide (CO_2). Envisaged uses of carbon capture and storage (CCS) technologies encompasses both the avoidance of fossil CO_2 emissions to the atmosphere from large point sources (conventional "CCS"), and the removal of CO_2 from the atmosphere through either the capture and storage of biogenic CO_2 from facilities using biomass as an energy feedstock (also referred to as bioenergy with carbon capture and storage, or "BECCS") and the storage of CO_2 captured directly from the air (DAC or "DACCS").

Establishment of a gigatonne (Gt) CO_2 geologic storage industry is critical to the functioning of all three technologies. Recent estimates from the International Energy Agency (IEA) suggest that even with a significant curtailment of fossil fuel production and use, around 7.2 $GtCO_2$ – derived from a variety of sources – will need to be stored in 2050 to achieve global net zero (IEA 2021; Figure 2-1).

Similar needs can also be seen in the assessments by the Intergovernmental Panel in Climate Change (IPCC). For example, in the 2018 IPCC Special Report on Warming of 1.5°C (IPCC 2018; SR1.5), three of the four 1.5°C aligned mitigation scenarios analysed in various integrated assessment models (IAMs; scenarios P2, P3, P4) suggest geological storage needs in the range 350-1200 $GtCO_2$ by 2100 (p. 14). Achieving such levels equates to, on average, storing between 5 and 15 $GtCO_2$ each year between now and the end of the 21st century. A significant portion of the captured CO_2 in all three IPCC scenarios derives from biogenic origins (ranging 43% to 97% over the period), highlighting the strong reliance on atmospheric removals to meet ambitious climate stabilisation targets. Recent analysis by the International Emissions Trading Association and the University of Maryland on the role of Article 6 in meeting global net zero supports a similar narrative, with geosequestration needs in the order of 15 $GtCO_2$ stored in 2050 (IETA 2021).

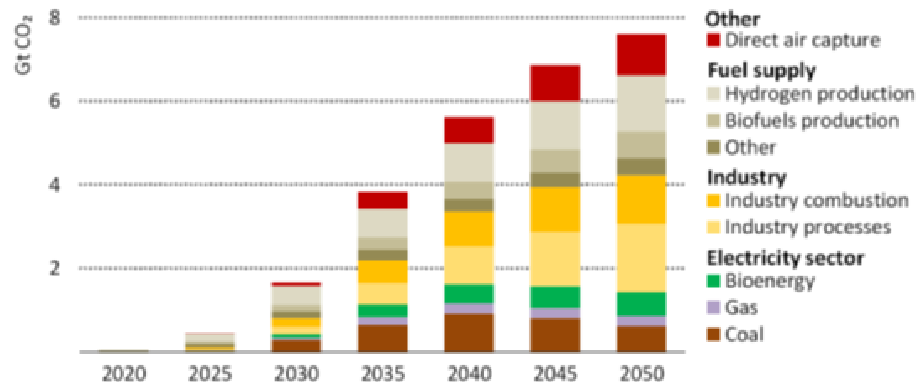

Figure 2-1 Global CO2 capture by source in 2050 under the IEA's net zero scenario, Source: IEA (2021), p.80

As well as the contribution of different industrial sectors, CCS of all varieties will be needed across all parts of the world. The IEA's Net Zero scenario did not show an expected regional distribution of CCS deployment. However, previous assessments under its Sustainable Development Scenario (SDS; IEA 2020) suggest that China alone will require 25% of global CCS deployment in 2070, closely followed by India and the rest of the world (meanly South-East Asia).

In all three cases, CCS primarily acts to reduce emissions from the significant coal-fired power generation fleets (IEA 2020). In the Middle East, CCS linked to CO_2 enhanced oil recovery (EOR) primarily capturing CO_2 from the petrochemicals sector is a feature. In North America and Europe, a more balanced portfolio of sources is foreseen (IEA 2020; Figure 2-2).

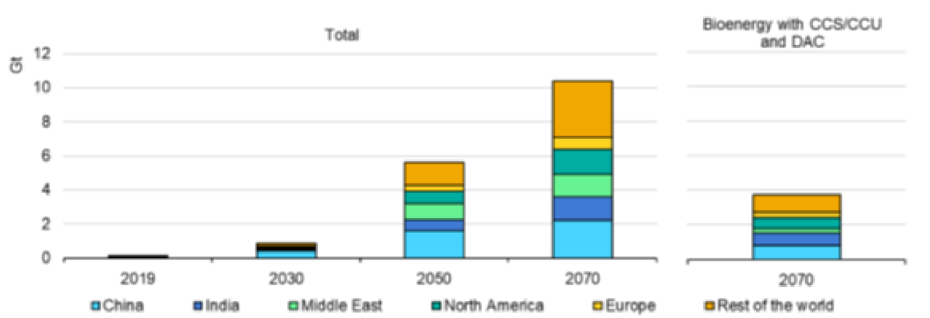

Figure 2-2 CO2 captured by country/region in the IEA Sustainable Development Scenario, Source: IEA (2020), p.127

Ambitious outlooks for CCS deployment are not a recent development for global climate policy (Zakkour and Heidug 2019; Martin-Roberts et al. 2021). More than a decade ago, the IEA forecasted the need for more than 300 CCS projects worldwide capturing and storing 100 $MtCO_2$ by 2020 (IEA, 2009). In parallel, the EU and G8 leaders made ambitious pledges to support the technology over the same period (see Zakkour & Heidug 2019).

To date, climate policy has largely focussed on the use of carbon pricing instruments to promote CCS, supplemented by direct governmental support in various forms. Under these programmes, the capture of CO_2 at regulated point sources – such as thermal-electric generating plants, iron and steel blast furnaces and cement kilns – for subsequent transport and storage allows the operator to avoid the cost of paying the carbon price.

Over the past 15 years or so, significant efforts have been expended in building the necessary regulatory systems that can support these policies, in particular in the handling of the permanence of the emissions reduction achieved, and the allocation of liability in the event of carbon reversal (e.g. due to leaks of CO_2 from geological storage sites).

In these contexts, 15 years ago the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006; 2006 IPCC Guidelines) for the first time introduced specific guidance for countries wishing to record national CCS activities in their GHG inventory accounts. Guidance therein covers approaches for the monitoring and reporting of CO_2 capture at various sources (power plants, bioenergy facilities, industrial facilities) and for the estimation of emissions from transport and geological storage (in Volume 2, Chapter 5).

These guidelines set an important precedent for countries wishing to count CCS action within their contributions to the Paris Agreement goals. The guidance also provides prescriptive requirements for the regulation of geological storage sites within countries "to help build confidence that there will be minimum leakage" (IPCC, 2006, p 5.14; as summarised below in Figure 2-3).

Countries not following the guidance in the 2006 IPCC Guidelines may deduct CO_2 from the relevant source category in their national GHG inventories, but would need to add the amounts back into the *Geological Storage* source category because of insufficient assurances over the long-term security of geological storage (i.e. CCS will not be recognised as an emission reduction activity and the captured CO_2 will instead be recorded as an emission in the national GHG inventory).

Since publication of the 2006 IPCC Guidelines, efforts were made in Europe, the U.S., Canada and Australia establish regulatory standards by which to assure the safe, environmentally sound, and permanent storage of CO_2 in geological reservoirs (e.g. in Europe, the 2009 CCS Directive, in the U.S., the 2010 Class VI rules on underground injection control within the ambit of the Safe Drinking Water Act). In Europe and the U.S., GHG emissions reporting standards for CCS have also been established in, respectively, the monitoring and reporting rules under the EU Emissions Trading System (EU ETS; since 2010), and within the EPA's Greenhouse Gas Reporting Program, subpart RR (since 2010).

In the case of Europe, incorporation of monitoring and reporting rules under the EU ETS has allowed any qualifying installation within the system to be absolved of the obligation to surrender EU Allowances for the amounts of CO_2 captured and transferred offsite for the purpose of geological storage.

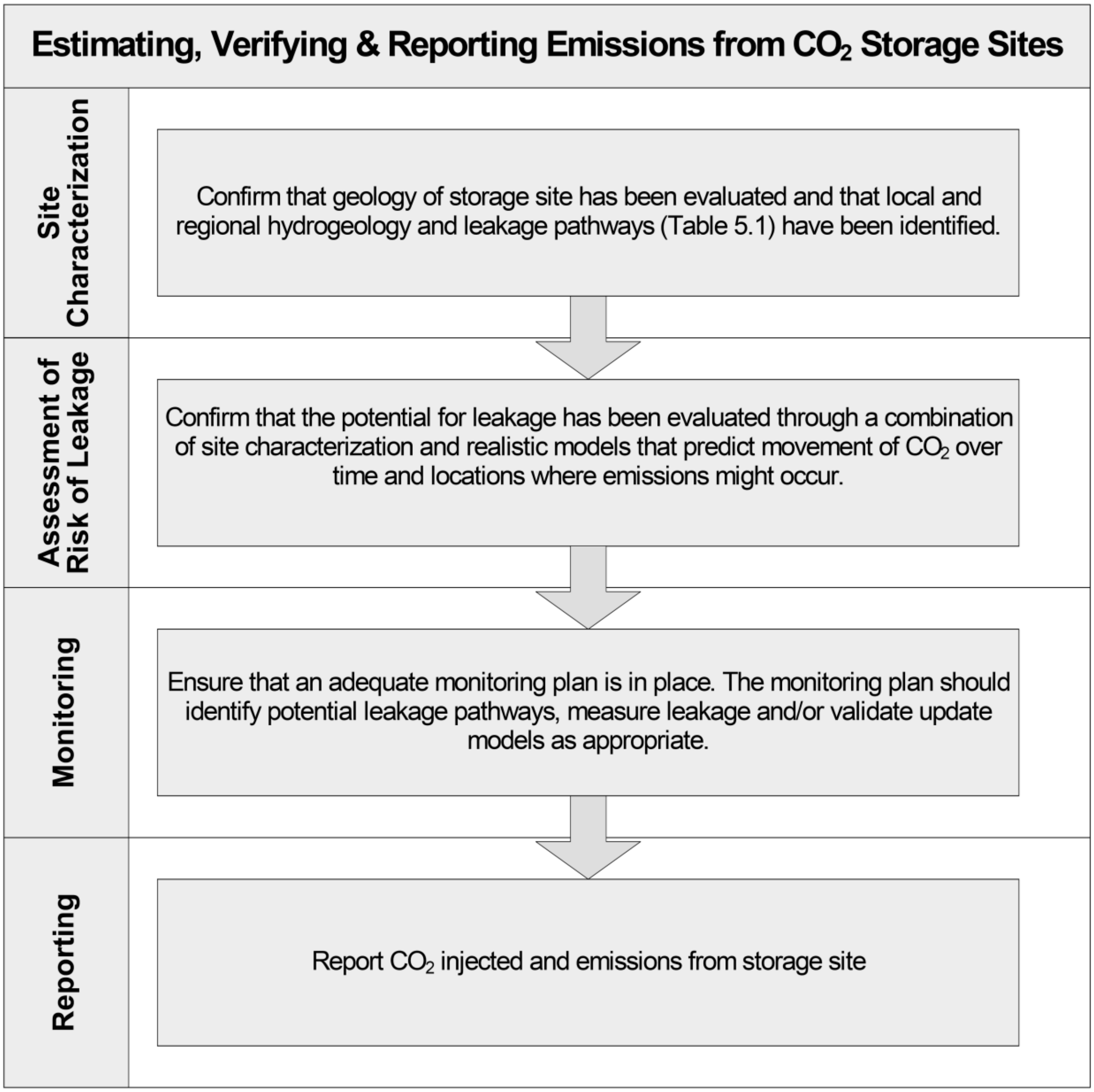

Figure 2-3 IPCC 2006 Guidelines: Procedures for estimating emissions from CO2 storage sites, Source: IPCC (2006), volume 2 chapter 5

2.2. Evolution of CCS in CDM

The evolution in regulation and reporting for CCS around the world also contributed to the inclusion of CCS as an eligible technology under the Kyoto Protocol's Clean Development Mechanism (CDM) in 2011. Inclusion of CCS in the CDM meant that projects in developing countries could generate certified emissions reductions (CERs) that could be used as compliance units by countries with quantified emission limitation and reduction obligations under the Kyoto Protocol.

The process for CDM inclusion began in 2005, when two proposed methodologies were submitted to the CDM Executive Board for approval as CDM project activities (Figure 2-4). The CDM Executive Board and its supporting methodologies panel reviewed the submissions and subsequently referred the topic back to governments, seeking guidance on, among other aspects, boundaries, leakage and permanence. Thereafter ensued six years of detailed and sometimes fractious discussions by Parties to the Kyoto Protocol under the auspices of the UNFCCC negotiations (Figure 2-4).

The resulting standard – known as the *Modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities* (UNFCCC, 2011) – was the culmination of multiple workshops, many written submissions by governments and observer experts, and drew heavily from the standard setting processes that many had been through in their domestic settings.

An overview of developments is set out in Figure 2-4.

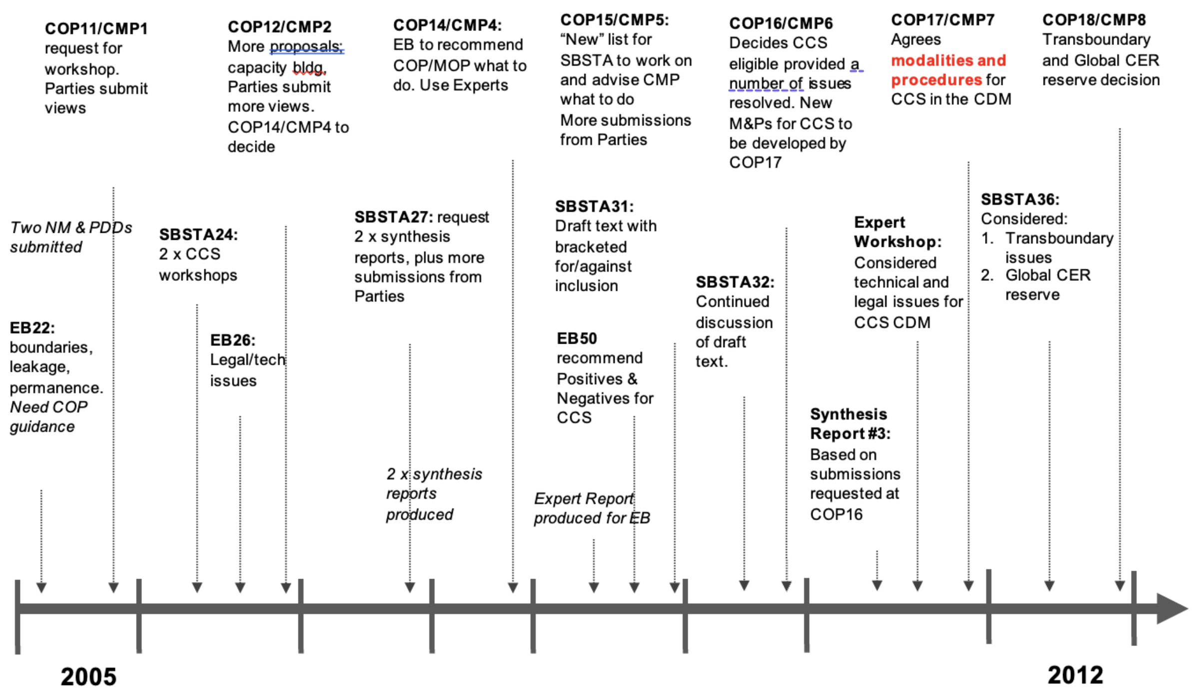

Figure 2-4 Evolution of CCS under the CDM, Source: adapted from Zakkour et al (2011)

The CCS CDM modalities and procedures are significant. They provide an internationally agreed methodological standard for establishing activity boundaries, handling leakage, undertaking monitoring, and managing permanence and carbon reversals in the event of a CO_2 leak from a storage site in any jurisdiction. As such, a substantive basis exists for the establishing the trading of mitigation outcomes from CCS under Article 6 of the Paris Agreement. Alignment with the 2006 IPCC Guidelines also means that both domestic CCS activities and traded CCS mitigation outcomes face similar requirements in terms of measurement, reporting and verification (MRV).

However, notwithstanding the plethora of ambitious deployment scenarios and the rich tapestry of supporting policies, regulations and standards established over the past 15 years designed to support these goals, CCS has yet to live up to its anticipated role in climate change mitigation (Zakkour and Heidug 2019; Martin-Roberts et al. 2021). To date, only 21 large scale CCS projects capturing and storing around 40 million tCO_2 are in existence around the world. In some cases, projects established over this period are no longer operating due to a lack of sufficient incentive, while others were built more than 20 years ago to supply the EOR industry in the U.S. and Canada. Projections of current deployment rates see only around 700 $MtCO_2$ geosequestered in 2050 (Martin-Roberts et al. 2021).

In most cases, projects have developed under niche circumstances, including localised policies (such as Norway's Offshore CO_2 Tax; Barrow Island Act supporting the Gorgon project) or economic circumstances (such as the price paid to purchase CO_2 by large-scale CO_2-EOR operators in the U.S. or the multiple funding streams applied to Quest in Alberta, Canada).

By way of contrast, neither the EU ETS nor the CDM – both of which are based on carbon pricing – have supported the deployment of any CCS projects to date.

There are several reasons for this failure, which broadly fall into two categories:

- **Lack of sufficient, or sufficiently stable, carbon price signals to support deployment**. CCS is an expensive technology, requiring substantial capital investment and the imposition of significant ongoing operating costs. These characteristics mean that long-term, stable, price support is needed to incentivise deployment. However, the price volatility and oversupply of EU Allowances seen in the EU ETS over the period 2005-2020 – which also drove down prices in the CDM up to 2012 – led to the cancellation of many planned CCS projects. The placement of the incentive only at the point of capture is also problematic for establishing the chain of activities downstream of the point of capture.
- **Cross-chain risks**. Each component in the chain of CCS operations is reliant on each other. If one part fails, the chain fails (e.g. if storage does not materialise, or malfunctions, or capture cannot occur or the operator elects to switch off the plant for economic reasons, and vice versa). Further, under carbon pricing regimes, the business case for the entire CCS chain is reliant solely on the value of emission reductions (or removals) placed at the point of emissions. Thus, all other components in the chain rely on the emissions price, which, due to instability, may lead to the operator switching off the capture plant. Such arrangements pose significant stranded asset risks. CCS projects established to date have mainly developed under single-ownership arrangements (e.g. Sliepner, Gorgon, Quest CCS projects) or built around a business case reliant on the revenues for CO_2-EOR that create an incentive at the point of storage (e.g. Boundary Dam, Petra Nova CCS projects).

Large-scale government grant funding introduced to address these risks has largely stalled (Lipponen et al., 2017), with funds either failing (e.g. EU's NER300), being withdrawn (e.g. UK CCS Competition), or imposing a sense of buyer remorse upon those that spent the money (as in Alberta; see Zakkour et al., 2021).

However, the development of a gigatonne geological CO_2 storage industry, taking CO_2 captured from various sources and depositing it in multiple geological repositories, remains critical to achieving longer-term climate mitigation goals. As such, the Paris Agreement – and in particular its Article 6 mechanisms – must both build upon previous forms of cooperation through the carbon market and establish significant new forms of cooperation between countries that can address the past points of failure for CCS.

The Paris Agreement's central goal of net zero refocuses attention not only on the need to reduce emissions of GHGs to the atmosphere, but also to enhance carbon sinks to remove CO_2 from the atmosphere. Redressing the imbalance in current climate policies that focusses solely on emission reductions, into complementary systematic and enduring for support for actions that can continuously increase the rate at which carbon is stored in enhanced sinks seems essential. A carbon storage unit (CSU), that measures the amounts of CO_2 added to non-atmospheric carbon reservoirs could offer a complementary and supplementary policy tool through which to support sink enhancements.

In the next section, the key features of Article 6 are described to elucidate the types of cooperation, policies and mechanisms that might be envisaged to support this goal.

2.3. Article 6 of the Paris Agreement

Within the Paris Agreement, what is called "the markets article", Article 6 of the Paris Agreement deals with international voluntary cooperation where mitigation outcomes generated in one country are transferred to another country that uses it to meet its NDC targets. In practice, it goes beyond markets by providing a framework for general international cooperation to implement the Paris Agreement.

Generally speaking, Article 6 is comprised of four modules:

- **Cooperative approaches (Paragraph 6.1).** This paragraph covers the general concept that Parties may choose, on a voluntary basis, to cooperate in the implementation of their Nationally Determined Contributions (NDC). The interpretation may be that it is meant to cover all specific cases of cooperation in Article 6, and others that may emerge in the future.
- **Transfers of mitigation outcomes (Paragraphs 6.2-6.3)**. These paragraphs cover the concept that Parties, when involved in the specific case of cooperative approaches, which involve mitigation outcomes being transferred internationally, need to observe CMA guidance on accounting and avoiding double counting.
- **Mechanism to contribute to mitigation and support sustainable development (Paragraphs 6.4-6.7).** These paragraphs refer to the establishment of a mechanism to produce mitigation outcomes and support sustainable development, and which operates under the authority of the COP. It produces mitigation outcomes which can then be used to fulfill the NDC of another Party.
- **Framework for non-market approaches (paragraphs 6.8–6.9).** The establishment of a framework for non-market approaches that will aim to address the three issues that are outlined in article 6.8

When negotiating the Paris Agreement, Parties wanted to include different options for international cooperation to achieve the Paris Agreement goals. The further sections in the paper will focus on Art 6.2 and 6.4 as relevant options for recognising, scaling up and trading CSUs. These Articles recognize the importance of market approaches and lay the foundation for the development of a global carbon market.

While details on the guidance for Art 6.2 and the rules, modalities and procedures for Art 6.4 has been agreed upon at COP26, it is clear that Art 6.2 will have a less centralised governance mode, whereas Art 6.4 governance will be relatively centralized under UNFCCC auspices.

Article 6.2

In general, one could look at Art 6.2 as a framework on how transfers of mitigation outcomes between Parties can be accounted for including conditions such as promoting sustainable development and protecting environmental integrity. The resulting internationally transferred mitigation outcomes (ITMOs) can be produced from any mitigation approach agreed by cooperating Parties.

The broadly defined concept of ITMOs allows Parties to structure cooperation anyway they want, as long as robust accounting is implemented. Article 6.2 allows Parties to create bilateral and multilateral agreements to trade ITMOs.

Article 6.4

Art 6.4 is very different in that regard as it establishes a mechanism to produce mitigation outcomes that will operate under the guidance of a Supervisory Body (SB). Members of the SB are elected by the CMA and tasked with operationalising the mechanism, supporting its implementation, including certification of mitigation outcomes, and reporting to the CMA.

The Art 6.4 mechanism can be considered a successor of the Clean Development Mechanism (CDM) under the Kyoto Protocol. Therefore, CCS projects certified under the CDM can be seen as precedents whereby existing methodologies can be updated and transferred to the post-2020 system. However, it is important to consider that much has changed since the Kyoto Protocol including the perception of negotiators.

3. Concepts

There are different concepts that need to be outlined and be well defined to understand the concept that is being put forward in this paper. First some overall considerations.

The Paris Agreement, like the UNFCCC it is established under, refers to two distinct processes impacting upon atmospheric GHG concentrations: anthropogenic '*emissions by sources*' and '*removals by sinks*'.

Drawing on these contexts, climate policy to date has largely sought to restrict, at source, flows of GHGs to the atmosphere by emitters. The promotion of actions to increase flows of GHGs out of the atmosphere (removals) has generally received less attention, although this has changed significantly over recent years with a growing body of work exploring the role of removals in stabilising atmospheric GHG concentration. The concepts presented herein build upon nascent ideas for removals policy, focussed on measures and mechanisms that could be used to promote actions that enhance carbon sinks and reservoirs.

One concept differentiates between different terminologies used in discussing capturing and storing CO_2. This is illustrated below and shows the differentiation between carbon removal (removal from the atmosphere) and emission reductions (capture and storage at the source of the emission).

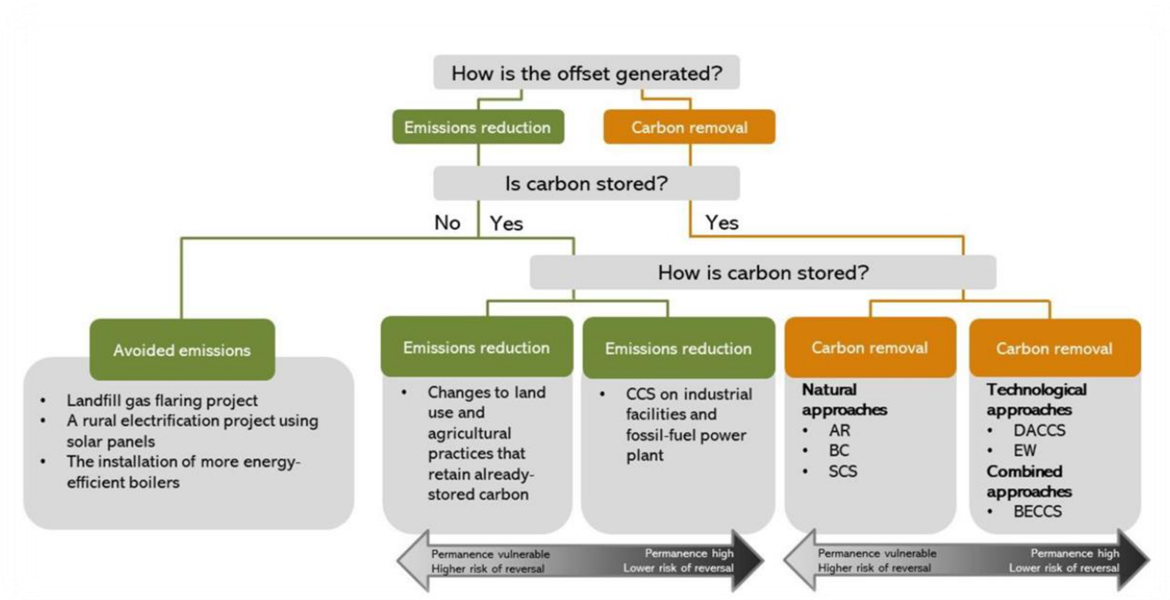

Figure 3-1 Taxonomy of carbon offsets

A second concept identifies the several points in carbon cycle where neutrality can be demonstrated, which are natural points in the life cycle of fossil fuels.

- **The point of production or extraction**. At this stage the carbon embedded in the extracted fossil fuel can be neutralized if an equivalent amount of carbon is stored in the geosphere.
- **The point of distribution**. Distributors of fossil fuels can show that an amount of carbon equivalent to the amount of carbon embedded in fossil fuels distributed is stored in the geosphere. In both these two cases carbon neutrality can be achieved through storing an equivalent of carbon in the geosphere.

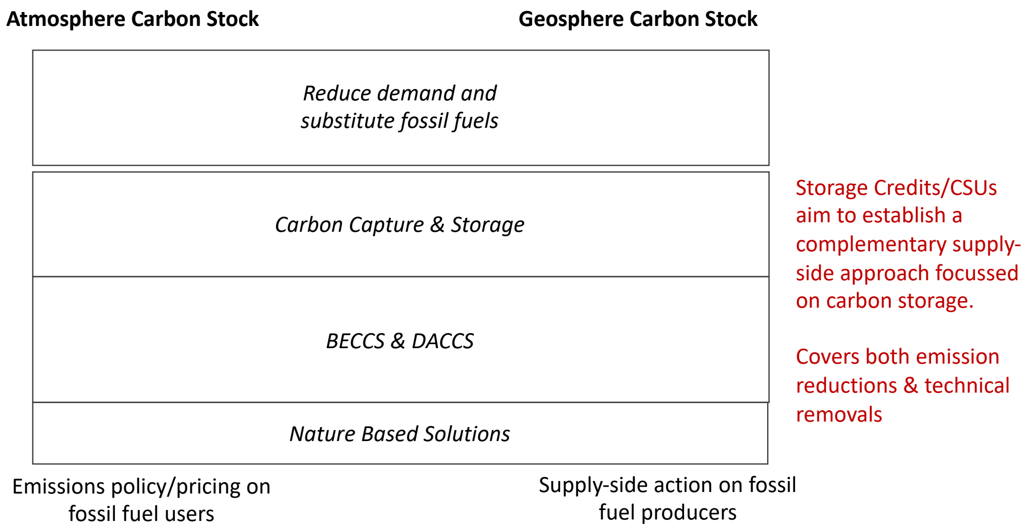

Figure 3-2 Aligning demand and supply-side action

These two approaches are different from the one that looks at the point of CO_2 emission in the atmosphere, which is currently addressed broadly through existing market mechanisms, such as an ETS. In this case, the idea is to cap the number of emissions and ensure that enough allowances are available, or a net neutrality is achieved, by reducing emissions as much as possible (included through CCUS) and then use direct air capture to remove the remaining CO_2 from the atmosphere or use available offsets.

In both cases, the availability of CO_2 storage capacity is an issue, as discussed earlier in this paper. There are two issues that impact the availability of carbon storage – one is the technical aspects of CCUS which is not the object of this paper. The second one is the legislative and regulatory framework that would provide the incentives to ensure that geo-sequestration through storage is a viable option to address climate change and reach net neutrality.

The current incentives do not provide the needed level of incentives as described in Chapter 2. The approach advocated by this paper calls for the creation of multiple obligations that would ensure that there are economic incentives to create carbon storage availability /supply.

3.1. CSU and CSO

Carbon pricing places the responsibility to reduce emissions entirely upon the users of fossil fuels, an approach that is consistent with the polluter pays principle. While there continue to be greater calls to increase the scope of carbon pricing, its potential limitations have been noted elsewhere (CPLC 2017).

This has led even its most ardent advocates to suggest that carbon pricing may need to be complemented by a mix of other well-designed policies (CPLC 2017).

Another way to explore complementary carbon pricing policies and measures is to look at other metrics – and points in the economy – where carbon may be priced separately to the pricing of emissions. This can allow for secondary carbon price signal to be established that incentivizes another set of actors to take climate action. For example, one option is to price the carbon content of imported heat and power (Scope 2 emissions) used by large electro-intensive consumers. Alternatively, the carbon embodied in fossil fuels (Scope 3 emissions, from the perspective of the producer) is an area where carbon taxes are applied by governments (e.g. in the many OECD countries). These pricing systems can apply in addition to carbon pricing applied at the point of fuel combustion (Scope 1 emissions). Building upon "supply side" concepts,[1] it is also possible to consider the potential to build mechanisms that incentivise carbon sequestration based on the carbon embodied in fossil fuels. Such a mechanism could complement and supplement carbon pricing policies applied to emitters, and in doing so, address some of the challenges for CCS deployment seen in the past.

Within this ambit, the concept of a carbon storage unit (CSU) has been mooted. A CSU as proposed would provide a verified and trusted measure and record of the addition of 1 tCO2 to a terrestrial carbon sink (Zakkour and Heidug, 2019; Zakkour et al., 2021). While conceptually a CSU could apply to any terrestrial carbon sink or reservoir, the literature to date, and this paper, focuses only on geological carbon reservoirs.

There are two fundamental concepts that need to be outlined here.

- One is the concept of a Carbon Storage Obligation (CSO), which is the obligation to geo-sequester a percentage of carbon embedded in a product, in this case extracted or distributed hydrocarbons. This can be expressed as an increasing percentage, arriving eventually 100% for the target date of net carbon neutrality.
- The second concept is that of a Carbon Storage unit (CSU). It would be the only unit that can be used to meet a CSO.

Since enhancement of these sinks is a central objective of carbon capture and storage technologies, the establishment of a CSU can provide new ways to incentivise actions to both reduce emissions from point sources of CO2 and to remove CO2 from the atmosphere by technological means (DACCS and BECCS).

Thus, a CSU as proposed reflects a stock increase in the geosphere, irrespective of CO2 source; emissions reductions or removals to/from the atmosphere are only inferred by proxy. Consequently, CSUs are relevant only to those entities responsible for modifying geosphere carbon stocks: primarily fossil fuel resource holders and producers.

If these entities are incentivised to balance flows of carbon out of (extraction) and into (injection) the geosphere as measured by CSUs, net zero CO2 can be achieved. The generation of a CSU in these

[1] Supply-side here refers to supply of fuels to global energy markets, as opposed to demand-side actions that relate to the users of fossil fuels (and therefore the emitters of CO_2).

circumstances will have an entirely reciprocal effect on emissions or removals to/from the atmosphere, but it would not replace these metrics. Rather, CSUs would be used to establish new complementary and supplementary types of climate policy mechanisms focussed on incentivising fossil fuel producers to store carbon.

The concept is illustrated below, whereby the entity that does the storage and is liable for its permanence will receive a certificate for 1 ton of CO2 geo-sequestered. In principle the CO2 capture, transportation and storage could be done by three different entities, with the one receiving the CSU being the storage entity.

In this case, there is a balance between the carbon embodied in a product and the carbon stored in the geosphere, whereby we reach a net zero.

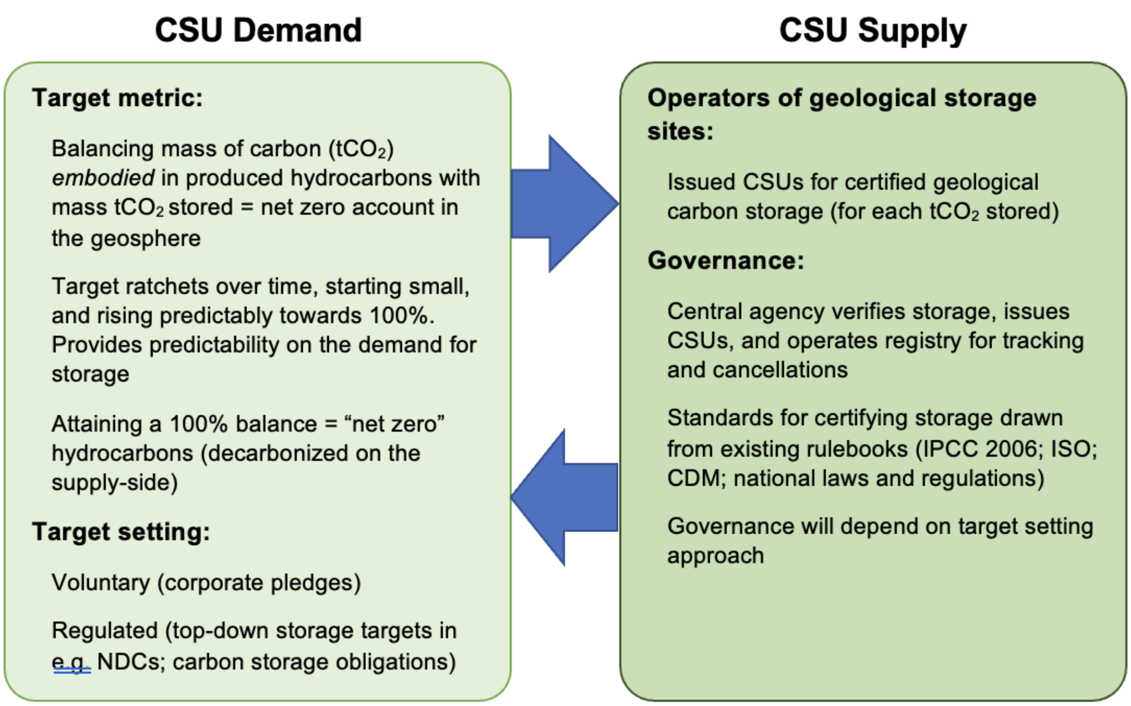

Figure 3-3 CSU Market concept

What is also important to note is the fact that by creating a CSO obligation that is met only through CSUs, there is a demand created for CSUs and therefore a new stream of financing. Currently, as outlined above there are incentives but these incentives in the case of the EU and EU ETS only provide a value equivalent to an EU Allowance, which is not sufficient. New incentives are being created at higher values in some jurisdictions (e.g. USA) but what is needed is to move up the value curve, as illustrated in Figure 3-4, and create additional value for sequestration.

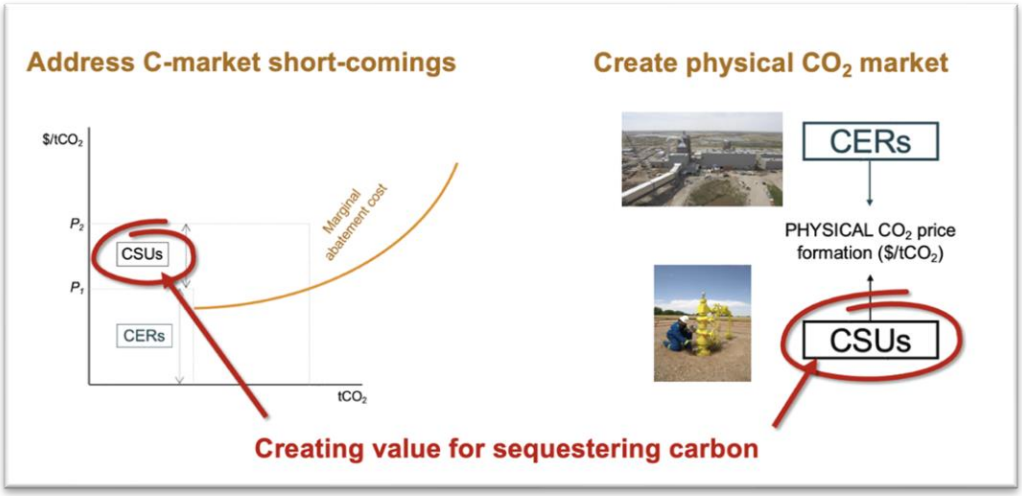

Figure 3-4 Value curve for carbon sequestration

3.2. Article 6 & CSU

For the purposes of this paper, these two concepts, the CSO and CSU need to be married with international cooperation under Article 6 of the Paris Agreement. Article 6 of the Paris Agreement allows for the transfer and accounting of International Transferred Mitigation Outcomes (ITMOs) to be used towards a country National Determined Contribution (NDC) under the Paris Agreement. If designed appropriately, potentially, a CSU can be viewed as an ITMO for the purposes of NDCs and Article 6.

Article 6 as currently outlined in the Paris Agreement does not seem to put any restrictions as to how to define an NDC or an ITMO. There have been strong debates in the Article 6 rule book negotiations as to the metrics that can be used for ITMOs, but since a CSU is expressed in tons of CO_2 this is unlikely to pose any problems. Expressing an NDC obligation through a CSO that will be met through CSUs only, is also unlikely to pose problems, based on the discussions that have taken place so far, both in formal negotiations as well as informal fora.

Using Article 6 governance, infrastructure and modalities and procedures to utilize CSUs from one jurisdiction to another will ensure that a CSO can be part of the NDC and will also add to the credibility and transparency of CSUs and CSO. It would also raise the profile of storage as a technology to reach net zero emissions.

Using Article 6 (and most likely Art 6.2) would allow storage capacity being created in places where it is physically available to be matched with jurisdictions where a CSO in place, whatever form and governance that CSO might take.

Both Art 6.2 and Art 6.4 could be used for the purposes of transferring CSUs to be used with a CSO. However, owing to its centralized governance and with the complexity and politicization of the CDM still fresh in mind, Art 6.4 is likely to pose significant challenges to including the CSU as a unit.

Art 6.2 has largely bilateral or plurilateral governance, with the CMA approved rules broadly in accounting and transparency. This makes Art 6.2 as a better candidate to be used in transferring CSUs between different Parties to meet CSP obligations in the NDCs (if any).

It must be noted that Article 6 will not contribute anything if CSUs are transferred in voluntary markets unless there is an obligation on Parties to undertake a corresponding adjustment even if a mitigation outcome transferred internationally is not used towards an NDC.

It must be noted that Article 6 will not contribute anything if CSUs are transferred in voluntary markets unless there is an obligation on Parties to undertake a corresponding adjustment if a mitigation outcome transferred internationally is consistent with the NDCs of the participating countries.

4. Operationalization

Policy must establish tangible and predictable demand for CSUs that can unlock a flow of funds to build geologic CO2 storage capacity. Ideally, the demand for CSUs can be aligned to a pathway consistent with achieving global net zero. In concert with carbon pricing policies, demand for CSUs can drive the deployment of CO2 capture that is positioned to supply the volumes of CO2 needed to generate CSUs by geologic storage activities.

As such, addressing both the storage of CO2 through policies based on fossil carbon supply, and the capture of CO2 based on policies built around emissions (and removals) pricing, can establish a two-pronged market that supports the transfers of physical CO2 across CCS chains, a vital element to underpin the virtual carbon markets.

The key means by which CSU demand can be established is through the setting of a ratcheting rate by which a percentage of carbon production from the geosphere must be offset by geological carbon storage. Allen et al. (2009) referred to this rate as a 'sequestered adequate fraction of extracted' carbon (SAFE-carbon). As SAFE-Carbon applies to geosphere carbon stocks, rather than flows of CO_2 to and from the atmosphere (like conventional carbon pricing policy), the policy architecture must be based on the fossil fuel producers and the supply side of global fossil fuel markets.

The establishment of a 100% SAFE-carbon rate would require fossil fuel producers to geologically sequester an amount of carbon equal to the amount of carbon they extract from the geosphere. To smooth the transition, interim 'adequate fractions' allows the rate to be built up predictably over time consistent with CCS infrastructure development, until such a time where a sustained balance is reached between carbon extraction and carbon sequestration.

At such a point, annual carbon stock changes in the geosphere should be equal to zero, meaning fossil carbon-driven stock changes of CO_2 in the atmosphere can also be assumed to equal net zero. The flows of carbon to and from the atmosphere and geosphere are mirror accounts on the same ledger: flows of carbon to the atmosphere can only be reduced if geosphere carbon stock levels are maintained either by reducing and eliminating extraction ("leaving it in the ground") or offsetting extraction through increased carbon geosequestration.

4.1. Pathways for implementation of CSU based policies

Two primary pathways for implementing CSU-based policies based on a SAFE-carbon rate can be envisaged, with possibilities for hybrid or multi-step approaches to be integrated thereunder. These encompass both voluntary actions and regulatory approaches.

4.1.1. Voluntary actions based on CSUs

Firms producing fossil carbon could voluntarily pledge to achieve net zero (or carbon neutrality) on the 'scope 1' and 'scope 3' CO_2 (or all GHGs) emissions associated with their activities. Thereunder, firms would need to offset, through geologic CO_2 storage, the emissions from their inhouse activities (extraction, transportation, transformation of fossil fuels – scope 1 emissions) and those of their customers who use the fossil carbon products (emitters of carbon – scope 3 emissions). The combined carbon content of scope 1 and scope 3 emissions of fossil fuel producers is equivalent to the amount of carbon they extract from the geosphere.

CSUs could be used to demonstrate the level of supported geo-sequestration activities aligned with such corporate net zero pledges. Where the level of CSU acquisition and retirement is balanced by the level of reported scope 1 and scope 3 emissions, these firms could claim net zero or carbon neutrality.

Presently, several oil and gas producing firms, all of which are OGCI member companies, have made various pledges regarding the achievement of net zero that also encompasses their customer emissions, namely: BP, Shell, Total, ENI, Equinor, Repsol and Occidental. The scope of this paper does not extend to an examination of these pledges nor consideration of any specific conditions set therein. Rather, our aim here is to provide an illustration of how CSUs could support these goals.

These seven companies accounted for around 10 percent of global oil and natural gas supply in 2020, within which was embodied around 2.1 to 2.3 $GtCO_2$. [2] Their operations involve a further 0.16 $GtCO_2e$ of

[2] In house analysis by Carbon Counts, based on annual corporate reported production of crude oil, liquids, natural gas liquids and natural gas, including operated and equity shares in 2020. Converted based on 0.42 tCO_2/bbl crude oil & liquids, and 0.0022 tCO_2/scm natural gas.

scope 1 emissions. [3] Under the fossil fuel demand curve of the IEA's net zero emissions scenario (IEA 2021), [4] and assuming these firms share of global production remains the same over time, their activities could be associated with around 1 GtCO_2 of scope 1 and scope 3 emissions in 2050.

For these firms to demonstrate their corporate net zero commitments using CSUs alone, a ratcheting level of geological storage up to around 1 GtCO_2 would therefore need to be achieved over the next 30 years or so (i.e. origination of 1 billion CSUs in 2050). Expanding the scope of the commitment to all OGCI member companies could perhaps treble the level of CSU demand in 2050. These calculations assume achievement of a 100% SAFE-carbon rate in 2050, while lower percentages, coupled with other mechanisms to achieve net zero, would lead to a commensurate reduction in level of CSU demand.

To operationalise the approach independently, the firms would need to collectively appoint a third party offset service provider to establish a methodological standard for generating CSUs, and to use the service providers registry system to originate, trade and retire CSUs. Corporate reports, coupled to an open registry, could provide a basis for tracking such actions in a transparent way. These actions, to an extent, could also be supported through partial regulatory approaches, as discussed below.

4.1.2. Regulatory approaches based on CSUs

Rather than relying solely on corporate led actions, governments could also implement policies that generate demand for CSUs. A number of variants can be foreseen in these respects (see also Zakkour et al., 2021) including either top-down collective approaches driven through multilateral processes (e.g. the Paris Agreement of G20), or bottom-up, more fragmented, unilateral approaches.

Multilateral action

Under a multilateral approach, governments could establish targets for the mass of CO_2 to be geologically stored at future points in time. These targets could be specified in NDCs alongside more conventional metrics of emission reductions against a base year or business-as-usual trajectory.

Countries could establish such targets encompassing both their own domestic ambitions for CCS deployment and/or broader ambitions to support geological storage across the world. In either case, the decision should be guided by the quantities of carbon produced in their territory in the way of fossil fuels, and the quantities of imported CO_2 embodied in fossil fuels. The latter may be particularly pertinent to countries lacking storage capacity but remaining strongly reliant on fossil fuels within their primary energy mix.

---

[3] Reported emissions data for 2020.

[4] Around 24 million barrels a day crude oil and 61 EJ natural gas in 2050 (IEA 2021).

However, the establishment of national CO_2 storage targets is not relevant to all 197 parties to the Paris Agreement. As such, a plurilateral approach could be considered working under the auspices of Article 6.2 of the Paris Agreement. Thereunder, **a CCS club** of like-minded countries could cooperate to pilot the CSU approach (Zakkour and Heidug, 2019).

In the pilot phase, this could entail a more basic pledge to simply support CCS or the setting of targets for geological carbon storage. The club members could set up a joint fund to procure CSUs, establish a procurement process and configure the modalities for CSU origination (e.g. agreed methodological, governance and transparency framework). In a pilot phase, CSUs would act as a currency to measure results-based finance (RBF), rather than them counting as transferable mitigation outcomes under the Paris Agreement.

Club membership could be drawn from major fossil fuel producers, major importers and those countries expressing support for CCS in their NDCs. The level of financial contributions could be tied to their levels of fossil fuel supply and/or use. Over time as experience grows through a piloting phase, the CCS club could move away from CSUs being used only as the currency of RBF towards the firm establishment of geological CO_2 storage targets in NDCs.

At this stage, CSUs would be become transferable mitigation outcomes that could be counted towards NDCs, as per Article 6 of the Paris Agreement. Club members could also consider parallel national measures through which the acquisition and surrender of CSUs could be devolved to the private sector, as described below.

Unilateral action

As an alternative or as a complement to the club approach, CSU acquisition could be devolved to the private sector through unilateral (national) policy measures. Various forms can be envisaged, depending on the specific circumstances of the country.

Offsetting embodied carbon in produced and imported fossil fuels. Such measures could include the establishment of a national carbon storage obligation (CSO) or through integration into other existing mechanisms such as low carbon fuel standards (Zakkour and Heidug, 2020).

Under this approach, fossil fuels produced or imported into a jurisdiction would be subject to a ratcheting obligation to offset the embodied carbon, with CSUs providing the means of compliance. The CSUs would be surrendered to government, which it in turn could also use towards fulfilment of a geological CO_2 storage target in its NDC. Proposals have been made to introduce such a system for natural gas in the Netherlands (Kuijper et al., 2021), while similar suggestions have been made for the U.K. (Hepburn et al. 2020).

The California low carbon fuel standard presently allows for the net removal of CO_2 using DACCS to absolve fuel suppliers of obligations under the scheme, with possibilities to extend the principle to include CCS more broadly.

Decarbonizing produced fossil fuels. Major fossil fuel exporting countries could establish targets to virtually 'decarbonise' the fossil fuels they produce (Zakkour and Heidug, 2020; Zakkour et al. 2021).

The approach would essentially mirror that of fossil fuel producing firms (see Voluntary action based on CSUs above), but instead applied at a country rather than corporate level. Thus, major fossil fuel exporting economies could establish storage targets in their NDCs based on the mass of carbon they extract from the geosphere. The storage target could form the core basis of their contribution to the Paris Agreement.

Setting an extraction-based target would mean that their primary system for tracking action under the Paris Agreement would need to switch from territorial emissions accounting to extraction-based accounting. [5] In other words, although they may still report using standardised GHG inventory methods, they would need to adapt their monitoring and reporting to also account for CO_2 extracted from, and injected to, the geosphere.

Where CCS is undertaken domestically, the related emission reductions would need to be reported as still emitted, whereas the resultant storage would instead be counted. This would allow CSUs to be bundled with exported fossil fuels and used to allow for 'decarbonization' downstream in the supply chain.

While seemingly far-fetched, the same method of accounting is applied to biomass energy today. Under current IPCC methodological approaches, emissions from combustion of biomass is zero-rated because the changes in forest carbon stocks are counted upstream as either a removal or an emission. A decarbonized fuel could be established by applying the same principle to geological carbon stocks within a territory. Further assessment of the potential to integrate such an approach with Paris Agreement accounting frameworks is needed.

Conceivably, the unilateral approaches described could operate in tandem with the voluntary corporate approaches described previously. In this situation, CSUs could be originated and used by corporate entities to demonstrate progress against voluntary targets, with the same units also being available to discharge an obligation in jurisdictions operating a CSO. The idea of a 'double-tabbed' CSU for use in these contexts is presently being considered by the OGCI.

4.2. Universal conditions for implementation

Certain other universal conditions can also be envisaged for implementation to avoid double counting:

- A storage target or CSO can only be met with CSUs.

[5] Under the Article 13.7 of the Paris Agreement, all Parties are committed to provide a national inventory report of anthropogenic emissions by sources and removals by sinks of GHGs, prepared using good practice methodologies accepted by the IPCC and agreed upon by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement; and, information necessary to track progress made in implementing and achieving its nationally determined contribution under Article 4.

- A storage target in an NDC could be implemented through a national level CSO (i.e., acquisition devolved from public to private sector).
- Article 6 of the Paris Agreement would allow for CSUs created in a jurisdiction to be used by entities in other jurisdictions.
- The potential for the systems to run in parallel, with a CSU being used to both to meet a CSO (regulatory obligation) as well as the carbon neutrality pledge of a company (voluntary obligation), could be explored.
- The approach could augment the streams of funding for geological CO_2 storage:
  - Carbon pricing to promote emission reductions and removals (CO_2 capture)
  - CSOs to promote the geological storage of CO_2

5. Assessing the needs and potential of CSU-based policies

5.1. Technical factors

The standards for originating CSUs pose few, if any, significant barriers for implementation. The wealth of experience established over the past 15 years in terms of measurement, reporting and verification (MRV) standards for CCS – as outlined in Section 2.1 – provides a sound basis upon which to regulate the geological storage of CO_2.

Issuance of CSUs for the mass of CO_2 stored can readily draw from these MRV systems. Indeed, any country wishing to report the emission reductions or removals achieved through CCS towards their NDCs would need to have these systems in place. As noted previously (Section 2.1), the 2006 IPCC Guidelines

Guidelines for reporting emissions from geological storage:

Prior to the start of the geological storage operation, the national inventory compiler where storage takes place should obtain and archive the following:

- Report on the methods and results of the site characterization
- Report on the methods and results of modelling
- A description of the proposed monitoring programme including appropriate background measurements
- The year in which CO_2 storage began or will begin
- The proposed sources of the CO_2 and the infrastructure involved in the whole CCGS chain between source and storage reservoir

The same national inventory compiler should receive annually from each site:

- The mass of CO_2 injected during the reporting year
- The mass of CO_2 stored during the reporting year
- The cumulative mass of CO2 stored at the site
- The source (s) of the CO_2 and the infrastructure involved in the whole CCGS chain between source and storage reservoir
- A report detailing the rationale, methodology, monitoring frequency and results of the monitoring programme - to include the mass of any fugitive emissions of CO_2 and any other greenhouse gases to the atmosphere or sea bed from the storage site during the reporting year
- A report on any adjustment of the modelling and forward modelling of the site that was necessary in the light of the monitoring results
- The mass of any fugitive emissions of CO_2 and any other greenhouse gases to the atmosphere or sea bed from the storage site during the reporting year
- Descriptions of the monitoring programmes and monitoring methods used the monitoring frequency and their results
- Results of third-party verification of the monitoring programme and methods.

There may be additional reporting requirements at the project level where the site is part of an emissions trading scheme.

Box 5-1 2006 IPCC Guidelines: Reporting and Documentation requirements for geological CO2 storage

set down significant *de facto* regulatory standards for how such mitigation actions are to be measured and recorded by national inventory compiler (Box 5-1).

The CCS CDM modalities and procedures further reinforce these requirements by also requiring host countries to address, *inter alia*, the following aspects of CCS projects:

- Net reversal of storage (i.e. leaks of CO_2 from storage sites).
- Liability in the case of a net reversal of storage, and long-term liability for stored CO_2.

- Methods and procedures for site characterisation and selection.
- Participation Requirements for country's wishing to host CCS projects as CDM project activities.

In respect of legal and regulatory requirements, the final bullet is particularly focussed on the design of national laws and regulations governing CCUS, as outlined below (Box 5-2).

Section F, Participation requirements

Because of concerns over permanence – and the potential approaches to address these and other concerns as well as other risks posed by CO_2 storage – paragraph 8 the CCS M&Ps require Parties wishing to host CCS projects to establish laws and regulations which:

a) Set procedures that include provisions for the appropriate selection, characterisation and development of geological storage sites, recognising the project requirements for CCS project activities under the CDM (set out in appendix B of the CCS M&Ps);
b) Define means by which rights to store carbon dioxide in, and gain access to, subsurface pore space can be conferred to project participants
c) Provide for timely and effective redress for affected entities, individuals and communities for any significant damages, such as environmental damage, including damage to ecosystems, other material damages or personal injury, caused by the project activity, including in the post-closure phase;
d) Provide for timely and effective remedial measures to stop or control any unintended seepage of carbon dioxide, to restore the integrity of a geological storage site, and to restore long-term environmental quality significantly affected by a CCS project activity;
e) Establish means for addressing liability arrangements for carbon dioxide geological storage sites, taking into account the provisions set out in paragraphs 22 to 25 of appendix B of the CCS M&Ps. The provisions on liability in appendix B relate to how any local damages arising from a CO2 storage site leak can be remediated under national laws, as per (c) above;
f) For a host Party that accepts the obligation to address a net reversal of storage (i.e. liability for permanence), establish measures to fulfil such an obligation. Under paragraph 26(b), host Parties accepting liability for a net reversal of storage must transfer an amount of units (e.g. CERs) equivalent to the level determined to have leaked from the storage site in the event that (1) the project participant hasn't fulfilled this requirement; or (2) the liability for the storage site has been transferred to the host country Party.
g) Parties are also required to submit an expression of agreement to host CCS projects to the UNFCCC secretariat prior to allowing the implementation of CCS project activities in its territory.

Box 5-2 CDM Participation Requirements for CCS, Source: UNFCCC (2011)

Most developed countries and regions have already established these regulatory requirements in national law, as described in Section 2.1.

5.2. Regulatory factors

In addition to the technical aspects of storage certification described above, several other regulatory aspects can be foreseen for implementing CSU based approaches in climate policy. The nature of these factors depends on the method of operationalisation (Section 4), and primarily relate to the accounting frameworks and compliance points for different implementation systems.

In respect of accounting, the concept sitting behind CSUs is that they would operate in parallel with emissions accounting and carbon pricing policies; essentially a shadow extraction-based account tracking the mass of carbon extracted from, and injected into, the geosphere. These accounts would complement and dovetail with emissions accounts as recorded in national GHG inventories: each tCO_2 captured from a point source and/or each tCO_2 removed from the atmosphere, for the purpose of geological storage, will have a reciprocal in both ledgers.

As proposed by Zakkour and Heidug (2019), the application of a separated target for the CSUs could allow both sets of accounts operate in parallel, and thereby act as an incentive to different operators: entities involved in CO_2 capture could gain an incentive from the emission reduction or removal achieved, while the entities involved in storage could originate CSUs for use against a separated set of targets related to geological CO_2 storage. Under a CSO, the CSUs have value to fossil fuel supply companies in allowing them access to market.

As such, the general condition for CSUs is that they must only count towards carbon storage targets, any CSO thereunder and/or corporate net-zero goals for fossil fuel producers. Such requirements obviate the risk of CSUs being counted towards emission reduction goals or targets, and therefore the risk of double counting the CSU as an emission reduction or emissions allowance. A separate registry system will also therefore be needed that originates, tracks and cancels CSUs independently of emissions-based units.

Notwithstanding the reasonably straightforward possibilities to account for CSUs, the compliance point against which CSUs would be counted requires further articulation. These variations are briefly reviewed below.

Corporate targets

The reporting of hydrocarbon production varies across companies, with the use of different product categories (e.g. crude oil; liquids; natural gas liquids; natural gas) and reporting units. In addition, there is variation and inconsistencies between the way ‘own production’ (operated assets) and production from equity-owned assets is reported.

The treatment of different scope 1 emissions (different GHGs, different sources, including fugitive sources that may include venting of produced reservoir CO_2 resulting from gas sweetening) also needs to be taken into consideration. Most hydrocarbon producers also operate sales and trading businesses, through which they buy and sell third party hydrocarbon products, including refined products.

Any cross-industry initiative involving CSUs will need to find common ground upon which to develop metrics against which a voluntary commitment to use CSUs towards net zero pledges would be measured.

Government targets

Under a unilateral patchwork of CSOs, different types of hydrocarbon products are likely to flow within and across the borders of a regulated jurisdiction. This may include crude oil (indigenous production), raw natural gas (indigenous production), refined products, and pipeline and liquified natural gas (LNG). As such, further consideration is needed for how the embodied carbon metric can be established against which to apply the CSO.

The most straightforward method is to establish compliance based on the mass of embodied carbon produced at the wellhead (indigenous production) and arriving in imported fuel products at the border. However, this poses some potential issues in respect of the treatment of variable upstream emissions from different supply sources for imported fuels.

The traceability of refined products will be particularly challenging to establish. In considering a carbon takeback obligation in the Netherlands, Kuijper et al. (2021) suggested that a correction factor could be applied to imported natural gas to account for the variable upstream emissions associated with different supply sources.

Environmental integrity

In some situations, emissions occurring in the fuel supply chain may be captured and stored and used to generate CSUs that may be counted towards a target. This could affect the environmental integrity of the CSU based policies and targets in different ways.

Where a company counts CSUs only against customer (scope 3) emissions, emissions from upstream operations would be excluded from the corporate target metric. As such, any CSUs originated in its own upstream operations and counted against this target would be double counted. For this reason, a corporate target against which CSO would count would need to encompass both scope 1 and scope 3 emissions.

Similarly, if a CSO applies only to the embodied carbon in fuel products at a border (excluding upstream emissions), the environmental integrity of a CSO policy could be undermined by the same type of double counting risks. To illustrate by way of an extreme example: an imported fuel shipment could contain 500 $ktCO_2$ of embodied carbon, with upstream emissions associated with its supply of 500 $ktCO_2$. If all the downstream emissions were captured and stored and used to generate CSUs, these could be bundled with the supplied fuel to give the impression of a fully decarbonized product. But in fact, only 50% of the full lifecycle emissions had been mitigated through CCS.

While these are important details to consider for policy design, conceivably such discrepancies could be tolerated in the early stages of development where the policy goal is primarily to kick start CCS. Ensuring transparency over the source of CSUs and any aspects not included in the policy implementation will, however, remain critical to maintain public trust. In later stages of implementation, such potential loopholes would need to be more comprehensively addressed to ensure the environmental integrity of the system as progress is made towards net zero.

Other market features

Several other features are important for the design of comprehensive CSU based policies.

These include:

- **Inter-year banking**. The potential for imbalances in supply and demand of CSUs suggest the need for a means to bank units or defer obligations to future points in time. In early years of deployment, supply of CSUs will be lumpy, driven by the effect of the start-up of new geological CO_2 storage sites. Over time, the supply curve should smooth as a result of greater liquidity. The precise modalities of how such inter-year variation could be effectively managed, and how it could be altered over time, requires further assessment.
- **Non-compliance**. Taking into account possibilities for banking and deferrals, a meaningful policy based on CSUs needs to include some form of penalty for non-compliance. This would obviously need to be set at a level that does not make it economically attractive to simply 'buy-out' the obligation. Ensuring that the penalty does not absolve the operator of the obligation (i.e. by rather offering a means to defer the obligation) would be prudent.

5.3. Political factors

The notion of CCS as a potential mitigation option is not as universally accepted when compared to technologies such as renewables, forestry, and land use mitigation. This can be primarily associated with factors such as: countries focusing largely on '*removals*' instead of '*storage*', perceived competition with other lock out fossil fuel technologies, high capital and operating costs and lack of support from local bodies due to previous failures. This has resulted in fluctuating political support for CCS technologies in previous years and tapering off the high gains and potential of CCS.

This disconnect is largely reflected in NDCs where only a limited number of countries acknowledge CCS as a potential mitigation option. The table below provides an overview of countries that either have explicit reference to CCS, list CCS as a source sector category or express potential interest.

Group	Countries	
Countries with explicit reference to CCS technology	Bahrain, China, Egypt, Iran, Iraq	Malawi, Norway, Saudi Arabia, South Africa, United Arab Emirates
Countries listing CCS as a source sector category in their NDC	European Union*, Japan	Mexico, Montenegro

Countries not mentioning CCS but with potential interests	Australia [1], Brazil [1,2], Canada [1,2], Colombia [1], Indonesia [3], South Korea [1]	Malaysia [3], Russia [1], Thailand [3], Trinidad & Tobago [3], United States [1,3], Vietnam [3]

Table 5-1 Source: Zakkour & Heidug (2019), Notes: 1 = Member Country of either CSLF, IEA Greenhouse Gas R&D Programme or Global CCS Institute; 2 = Active CCS pilot, demonstrator or large-scale plant(s) in operation. 3 = Significant energy sector emissions and potential for low cost CCS from high purity sources.

A significant level of support for CCS as a mitigation option exists. Those countries which have a collective interest in kick-starting CCS need to take initiative to pilot CSO systems at national level to demonstrate the viability of these approaches and create large scale deployment and acceptability.

For large scale deployment and acceptability of CCS vis-à-vis CSU approaches, it is critical to conceive a structured governance mechanism to promote bilateral agreements via Art 6.2 and targeted policy support (including measures such as incentives) for the private sector (plausible governance frameworks discussed in detail in chapter 6) to create a sense of credibility among the crucial stakeholders, particularly for government and corporate buy-ins. This can be embarked upon by putting forth defined vision, scope, and intentions on the applicability of CSU through adopting either of the previously defined voluntary or regulatory-based approaches, which would result in:

- **Overcoming political uncertainty for large scale deployment of CCS.** The wider adoption of CCS technologies has been restrictive so far primarily because they have been operating in silos. However, with the formation of 'CCS clubs' approach under Art 6.2 inclusive of countries with CCS in practice, it could result in collective interest and help obliterate persistent doubts regarding the technology. Furthermore, significant transfer of knowledge and sharing best governance practices within the CSO club can result in faster and wider adoption of technology, potentially driving down the associated technology costs.
- **Inflow of new funding streams.** Political support in providing policy signal with incentive structure in place can have persuasive influence over the competition levels in the private sector driving innovation and hence, upscaling of technology. This approach might result in access to more international finance via collaborations and funding within the 'CCS club'.

5.4. <u>*Commercial factors*</u>

Two important factors impacting upon the financial viability of CCS deployment were summarised previously, namely: lack of sufficient, or sufficiently stable, carbon price signal and cross chain risks. Experience over the past 15 years suggest that carbon pricing alone struggles to sufficiently address these challenges, at least over the near-term. As such, targeted policies are needed to support CCS deployment.

The OGCI, in its position paper on CCS (OGCI 2021), notes the variety of different financial incentive structures that could be used to support CCS deployment, including both the establishment of CSUs and support for CCS under Article 6 of the Paris Agreement, as well as other methods.

CSU-based approaches have the potential to unlock some of the challenges of the past.

Features include:

- **A change of emphasis for developing geological CO_2 storage**. By establishing a policy mechanism applicable to the producers of fossil fuels, it places the impetus to establish geological CO_2 storage into the hands of those firms with the skills, know-how and imperative to develop CCS technologies.
- **Predictability and stability of the incentive**. Policies based around a SAFE-carbon method injects greater predictability into the requisite levels of geological storage needed at future points in time. This can allow for better planning of CCS infrastructure development and investment needs.
- **Establishing markets for the transfer of physical CO_2**. By creating an incentive and price signal for the storage of CO_2, policies based on CSU can complement and supplement policies – such as carbon pricing – that focus only on the capture (and potentially, removal) of CO_2. The dual price signal can in turn allow for a market to form for physical volumes of CO_2 to be traded between capturers and storers of CO_2, which can help to address the cross-chain risks associated with incentivising CCS only at the point of capture. Under a dual system, cross-chain risks are diminished since each operator in the chain is acting against an independent set of drivers. While these may change over time, the effect should be to simply vary the market value of physical CO_2 transfers between the capturer and storer, rather than to drive a wholesale turndown of the operation.
- **Providing a coherent pathway for technological CO_2 removals**. The storage of CO_2 captured from point sources will not be sufficient to fully balance carbon extracted from the geosphere. Many end-uses of fossil fuels are dispersed and not amenable to CO_2 capture (e.g. in the transport sector), while other large point sources may not have ready access to CO_2 transport and storge infrastructure. Thus, the meeting a ratcheting CSO will inevitably drive the need to capture CO_2 from sources other than point source fossil. Options can include biogenic sources or direct air capture. Presently such CO_2 removal technologies are largely excluded from carbon pricing policies (e.g. like the EU ETS). CSU based policies can therefore provide a firm and clear basis upon which to develop the technological CO_2 removals industry.

The features outlined are some of the anticipated requirements and beneficial potential of a CSU based approach. There may be other features that could inhibit the commercial case or add to it. Further discussion and analysis to support the commercial viability of the CSU based approach seems warranted at the time of writing.

In terms of operationalising approaches, the voluntary system faces challenges. If a CSU is earned through expenditure on CO_2 geo-sequestration – with the cost of capture or removal being covered by carbon pricing – these costs would need to be entirely covered by the participating firms. Using the same data as presented previously (i.e. 1 $GtCO_2$ embodied in produced crude oil and natural gas; Section 4.1.1), and assuming a figure of USD 50/tCO_2 stored, the cost pass-through need would be in the order of USD 21 per barrel of oil, and USD 110 per billion cubic metres of natural gas at a 100% SAFE-carbon rate. As this relates to only 10% of global oil and gas supply, these firms would be at a significant competitive disadvantage compared to the other 90% of supplied oil and gas (Section 4.1.1). Thus, a voluntary system would likely need the backing of a regulatory CSO system in some jurisdictions to guarantee a base for product supply. For example, the European Union and Japan import around 2 $GtCO_2$ and 1.3 $GtCO_2$ respectively embodied in oil and natural gas. Even if demand were to half in the period to 2050, this would exceed the supply of carbon embodied in fossil fuel products from companies taking on net zero targets (see Section 4.1.1).

A similar set of considerations would play out for fossil fuel exporting countries under a decarbonized fuel paradigm. For example, countries in the Middle East export more than 2.5 $GtCO_2$ embodied in fossil fuels. Considerations in these contexts are described elsewhere (Zakkour and Heidug 2020).

The implications of such flows of carbon across borders is that bi- or multilateral cooperation to support the offtake of CSUs will be a cornerstone of any moves in these directions.

6. Features of Potential Governance Frameworks

As highlighted in Section 4, there are multiple ways in which a CSU and CSO arrangement can be structured (e.g. purely voluntary, purely compliance and a hybrid). Given the main driver of this paper is to consider how a CSU and CSO obligation may work in the context of Article 6, we have considered the governance framework below, only in the context of Article 6. Further, as we explain at Section 3.2, since our recommendation is that Article 6.2 is more suitable for a CSU and CSO framework than Article 6.4, the governance framework that we discuss below is that in respect of Article 6.2 only.

Prior to embarking on that, we first need to distinguish between Governance, Legal and Regulatory Frameworks. While there are indeed overlaps between the three, there are crucial differences that should be noted.

6.1. Potential frameworks

The three Frameworks can be distinguished as follows:

Governance Framework

A rule of the rulers, it is the process by which authority is conferred on the rulers, by which they make the rules, and by which those rules are enforced and modified. In the context of the CSU and CSO Article 6.2 (the **CSU/CSO Cooperative Approach**), this is the process by which the countries that are participating in the CSU/CSO Cooperative Approach are ensuring that their cooperative approaches fit within the Paris Agreement, the Article 6.2 guidelines and the respective public international law obligations of the respective participating countries.

The Governance Framework would consist of an underlying process by which the Legal and Regulatory Framework are established, by providing the basis in which a set of rules are enforced;

Legal/Legislative Framework

A broad system of rules that governs and regulates decision making and is reflected in laws. In the context of the CSU/CSO Cooperative Approach, this would be the legislative framework by which the CSU/CSO Cooperative Approach is agreed between the participating countries.

As set out in Section 4.1.2, a multilateral approach involving a number of participating countries would need to agree on a multitude of issues at the apex level, including determining the relevant bodies and authorities that will carry out and implement the objectives of the CSU/CSO Cooperative Approach. One of the issues the legal framework will need to address is how precisely private sector entities will be able to participate in the CSU/CSO Cooperative Approach.

A specific and detailed authorisation regime is likely to be needed in order to ensure fossil fuel producers, major importers and storage operators are able to participate in the regime and the extent of their participation. What is important is the ability for the private sector to fully participate in the Carbon Club model, which not only requires the authorisation of private sector participants to act on behalf of the participating Paris Agreement countries, but also ensuring certainty to safeguard the rights of the private participants. Although a Cooperative Approach is legally binding between the Paris Agreement countries, this authorisation helps to provide legal certainty to private sector participants to deal in CSUs as authorised by a country (and accepted by another participating country to the CSU/CSO Cooperative Approach).

This could take multiple forms and discussion on this is outside the scope of the paper. Nonetheless, for further information, we refer you to the World Bank's paper on Country Policy Frameworks for Cooperative Approaches under Article 6.2.[6] This legal framework could be in the form of a multilateral international treaty or agreement. The degree of the formality of this legal framework will be determined by the public international law requirements of each participating country; and

Regulatory Framework

The existence of the necessary infrastructure to support the control, direction or implementation of a proposed or adopted course of action, rule, principle or law.[7] The purpose of the regulatory framework, in the context of the CSU/CSO Cooperative Approach, is to deliver on the objectives of the countries involved. The Regulatory Framework is the necessary infrastructure to ensure the efficacy of the Legal

[6] The World Bank, "Country Policy Framework for Cooperative Approaches under Article 6.2", World Bank Working Paper, Washington D.C.

[7] Peter Zaman, Adam Hedley, World Bank Group, The Regulatory Framework to Support Carbon Market Linkage – A Concept Paper, April 2016

and Governance Framework. For example, this may require the establishment of a group or set of bodies, or a secretariat.

In terms of a hierarchy, the three frameworks are best depicted as follows:

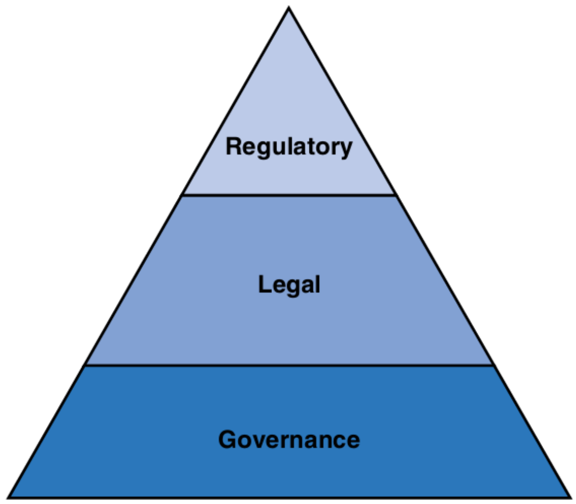

Figure 6-1 Hierarchy of Frameworks, Source: Zaman & Hedley (2016)

The three types of frameworks, overlap and are intricately linked. However, in the context of this paper, this Section focuses on the Regulatory Framework for Governance of a CSU/CSO Cooperative Approach between two or more Paris Agreement countries who wish to create a market mechanism between those countries by recognising and accepting a CSU together with a CSO.

6.2. *Why the carbon club model for a Regulatory Framework?*

Under a CSU/CSO Cooperative Approach, there are different types of models that the participating countries may wish to explore in terms of expanding the linkage relationship between the interested countries. As a starting point, this paper assumes that a Legal Framework is already in place to support the development of the Regulatory Framework. Given that Article 6.2 of the Paris Agreement is silent on private sector participation (unlike its Article 6.4 counterpart), we assume the Legal Framework will establish an authorization mechanism to facilitate the participation by private sector participants, such as storage operators and fossil fuel producers and importers.

For the purposes of a CSU/CSO Cooperative Approach, there are a number of models that may be considered – bilateral, multilateral and regional / smaller multilateral (i.e. carbon clubs).

a) In the bilateral model, it creates a common market between two Paris Agreement countries for the trading of CSUs and accepting a CSO in their NDC. Either directly or indirectly, bilateral linkages allow for networking between the two Paris Agreement countries depending on how homogenous the linkage between both countries. However, in the context of the CSU/CSO Cooperative Approach, bilateral linkages do not have the desired effect of scaling up the CSU as an asset class. This will be a limiting factor, for example, in the Switzerland and Peru Article 6 arrangements.

b) An example of the indirect linking model is where for example Japan enters into a serious of bilateral arrangements and in effect becomes an indirect source of price and supply competition affecting the various countries with whom the lead country is linked. In the context of a CSU/CSO Cooperative Approach, this approach may require the lead country to be a fossil fuel dependent country and the other countries to simply be the storage providing countries otherwise, it is hard to see how the indirect linkage would be established. As with the bilateral approach, the main challenge is whether a single lead country would create sufficient demand for the CSO countries to be able to justify the cost of geological storage development.

c) Therefore, both in respect of direct and indirect approaches, we do not recommend this for a CSU/CSO Cooperative Approach.

Figure 6-2 Direct bilateral linking, Source: Zaman & Hedley (2016)

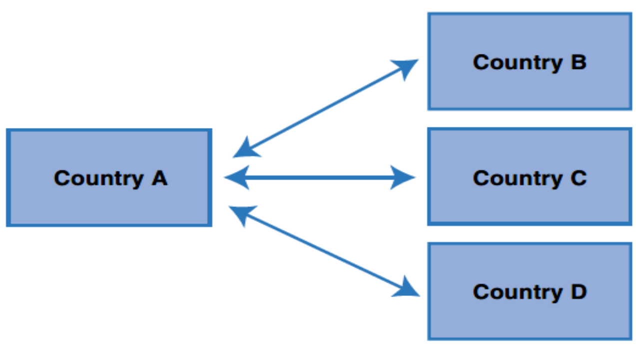

Figure 6-3 Indirect bilateral linking, Source: Zaman & Hedley (2016)

d) Another model that may be adopted is the multilateral trading model, where a number of countries may sign up to a common set of rules that governs the relationship between all the countries. The issue with a multilateral trading model is that, given the varied nature of the countries participating, it is hard to come out with a developed set of rules that would be effective yet acceptable by the multiple participants.

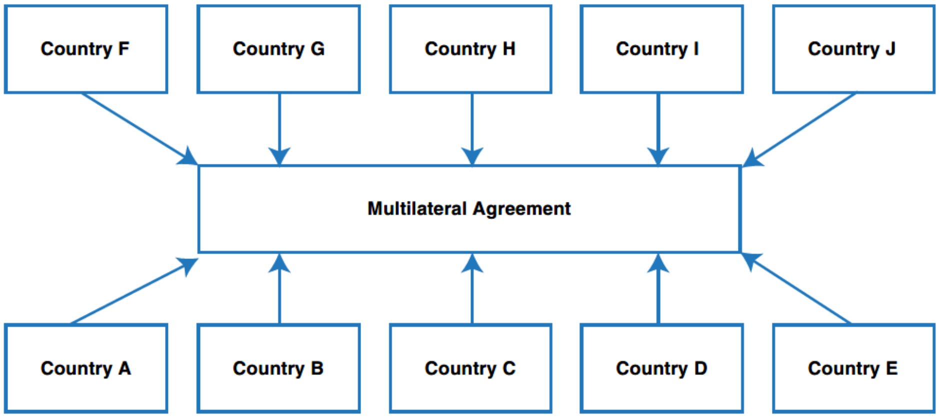

Figure 6-4 Multilateral trading model, Source: Zaman & Hedley (2016)

e) The Carbon Club model is essentially, a smaller multilateral model, whereby several countries with similar views and affiliations and aligned economic objectives sign up to a common set of rules that they agree to apply among themselves. Such a model would be a more attractive in the context of a CSU/CSO Cooperative Approach given that it would only encompass countries who share a common viewpoint on the utility of CSUs as an asset class in meeting Paris Agreement obligations and adopting a CSO to ensure that some countries provide the supply (i.e. the CSUs) and other countries the demand (see for example the countries named in Table 5-1). The success of the Carbon Club model requires a mix of countries that are willing to impose the CSO and those that are willing to supply CSUs. A Carbon Club model ensures the founding countries get to set the benchmark for quality and can determine whether the club should be exclusive or open the future countries who may wish to join. If the latter, then this would need to be enabled by the Legislative Framework and implemented by the Regulatory Framework

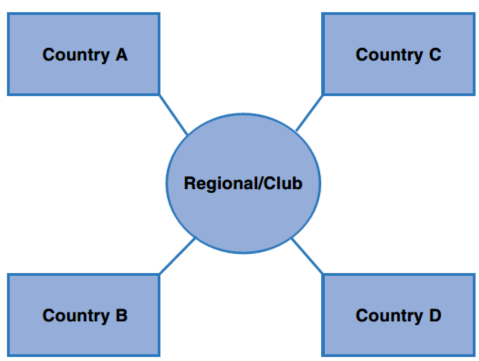

Figure 6-5 Carbon club model, Source: Zaman & Hedley (2016)

Regardless of the type of model that is ultimately implemented, the Regulatory Framework considerations remain broadly the same, with the primary focus to ensure the integrity of the CSU as an asset class and to facilitate cooperation between the Carbon Club countries to develop the technology for CSO. For the remainder of the paper, we will focus on the Carbon Club model as the suggested model to be adopted under a CSU/CSO Cooperative Approach.

6.3. Outline of a potential Regulatory Framework

In order to operationalize a Carbon Club model for a CSU/CSO Cooperative Approach, there are a number of different bodies that need to be established to ensure an effective Regulatory Framework is in place (the **Regulatory Bodies**). Such Regulatory Bodies are likely to be as follows:

a) Decision Making Body;
b) Administrative Body;
c) Sub-Administrative Bodies;
d) technical committees and working groups; and
e) a Secretariat.

Decision Making Body

Sitting at the top, a Decision Making Body is required to make the necessary decisions, made up of the most senior representatives of the Carbon Club. The Decision Making Body should deal with key decisions such as the induction of new Paris Agreement countries. This body will meet once or twice a year and deal with the most important decisions. Examples of important decisions that will need resolution would be reviewing the acceptability of scope of the CSO obligation as adopted in the relevant participating jurisdiction or determining the acceptability of a qualifying geo-storage arrangement that would be acceptable for the purposes of CSU issuance by the relevant participating country in the CSU/CSO Cooperative Approach. This body could be empowered to act as an appeal body in respect of disputes related to liability dealing with permanence risk (e.g. from leakages arising from $CO2_e$ stored in a participating jurisdiction). If that storage facility was privately owned, the adjudication could be determined at the level of a private law adjudication forum (e.g. an identified arbitral forum). However, if under the CSU/CSO Cooperative Approach permanence liability framework, a country would take ultimate responsibility for the failure of a private sector geological storage operator, then the Decision Making Body may be a necessary forum for final resolution of liability.

To be clear, the role of the Decision Making body will be to mostly act as the final authority for signing off on items that cannot be signed off at any lower level body. In the instances of the immediate above examples, the actual vetting process would be carried out by another body (e.g. a Sub-Administrative Body) but the final approval/endorsement may be required to come from the Decision Making Body.

The make-up of the Decision Making Body would be almost exclusively at governmental level involving the relevant ministry authorised to lead on the CSU/CSO Cooperative Approach pursuant to the Legislative Framework as implemented in the participating country.

Administrative Body

The role of the Administrative Body is to deal with the day-to-day functions of the Carbon Club. They will oversee the administrative details and will be empowered under the Legal Framework and by the Decision Making Body to determine a set of procedures, rules, formulate policies or establish Sub-Administrative Bodies and Technical committees and working groups. The Administrative Body is crucial especially in the early stages of the Carbon Club, to facilitate the smooth functioning of the Carbon Club.

The body will meet more regularly than the Decision Making Body but need not be permanently in sitting, unlike the Secretariat to the CSU/CSO Cooperative Approach. The Decision Making Body is likely to delegate a large number of decisions to the Administrative Body. For example, this may be the body that determines the criteria by which each participating country's responsible authority authorises participants in their own jurisdiction.

Sub-Administrative Bodies

Under the Carbon Club, there will also be several Sub-Administrative Bodies that are essential for the functionality of the Carbon Club. Examples of Sub-Administrative Bodies may relate to dealing with fiscal, budgetary or dispute resolution and enforcement issues relating to any breaches by a Paris Agreement country in the Carbon Club.

An example of a specific Sub-Administrative Body could be one dealing with the accounting treatment of a CSU (the **CSU Accounting Body**). The CSU Accounting Body could have functions such as ensuring consistency in the accounting treatment of a CSU in the various participating countries in the CSU/CSO Cooperative Approach (e.g. whether it will be a +1 or -1 when transferred or surrendered). The CSU Accounting Body could also oversee the transfer mechanism of a CSU or perhaps act as the operator of the common registry for the CSU/CSO Cooperative Approach (although each participating may have its own registry, in which case the CSU Account Body can oversee the linkage arrangements).

Other Sub-Administrative Bodies may include a body that assesses and approves the methodology requirements for reporting emissions form geological storage facilities (**MRV Assessment Body**) in participating countries (see Section 5.1 and Box 5-1). Although these may be calculated at national level, the role of the MRV Assessment Body could be to ensure consistency in the application of the standards across the participating countries or to approve verifiers or auditors whose status will be recognised by all the countries participating in the CSU/CSO Cooperative Approach.

Technical Committees

At a technical and working group level, these bodies are important to deal with specific technical work so that the Decision Making Body or the Administrative Body is able to make decisions based on the technical advice from such working groups and technical committees. The task of these committees is to develop regulatory measures such as the collating of technical data (emissions data, monitoring reports, verification and validation), developing methodologies to ensure a consistent application by the Carbon

Club, or refining pre-existing regulatory measures. Such technical committees and working groups are crucial in the functioning of the Carbon Club, as they provide the scientific and technical backing in which sound decision making can be made. They are also essential in establishing thresholds and benchmarks so that CSU/CSOs are high integrity and quality.

Technical committees and working groups are also where private sector participants can provide most valuable input, by providing their technical expertise, technology know-how and experience to facilitate the development of sound technical reports and guidelines. By way of example, it would be the role of the technical committee to consider and recommend which or the various possible methodologies available for monitoring, reporting and verification (**MRV Working Group**) should be adopted by the CSU/CSO Cooperative Approach. Once a recommendation was adopted, the Technical Committee might propose that to the MRV Assessment Body for adoption or for upward confirmation by the relevant Administrative Body or Decision Making Body (as applicable).

A separate technical committee could also consider the applicability of other third-party methodologies, such as the current methodology developed by Verra for Carbon Capture and Storage Solutions and the suitability for adoption by those standards for the purposes of the CSU/CSO Cooperative Approach. By utilising existing standards and their methodologies and processes (assuming they passed the test at the working group level and were politically acceptable by the Administrative Body or Decision Making Body), would allow for CSU/CSO Cooperative Approach to be rolled out more speedily.

Secretariat

A Secretariat should be a permanent body supporting the CSU/CSO Cooperative Approach. The head of this body is likely to be appointed by the Decision Making Body and is likely to be empowered with a broad mandate including that of appointing staff, determining their roles and responsibilities and terms of employment or service. This Secretariat must be impartial to the interests of the participating countries in the CSU/CSO Cooperative Approach. It is the likely to be, apart from any national level authority, the main point of contact between the private sector participants and the CSU/CSO Cooperative Approach. It will also act as coordinator of the different bodies to ensure that their meetings and operations run smoothly and effectively.

See the diagram below for an example of the various regulatory bodies for CSU/CSO Cooperative Approach.

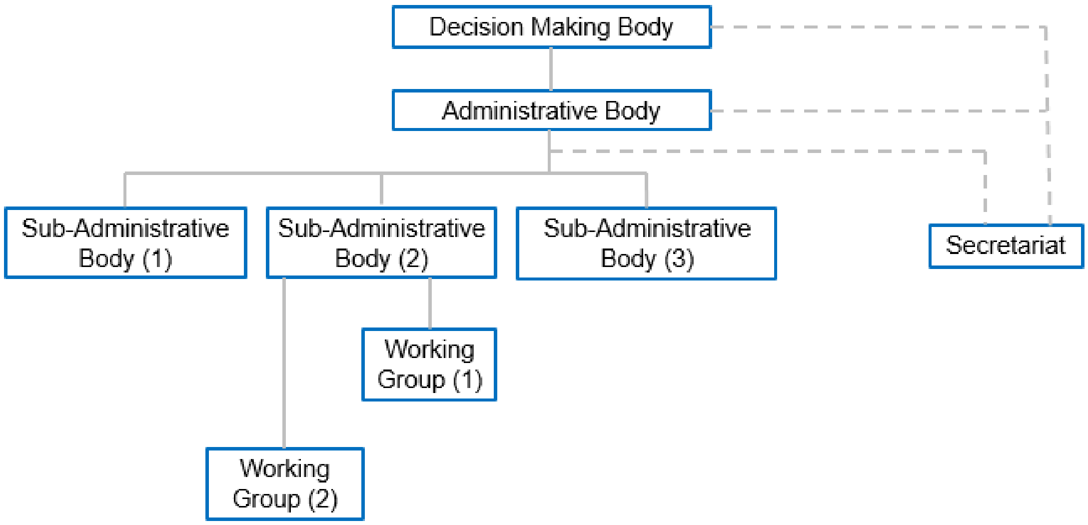

Figure 6-6 example of the various regulatory bodies for CSU/CSO Cooperative Approach

7. Conclusions and Recommendations

This paper does not discuss the merits and/or feasibility of CSO, CSU, CCUS or Article 6 by themselves. These in themselves are important issues that merit attention and have many issues to address.

The issue covered by this paper is whether CCUS in Art 6 is a concept that is important, and if it is, how to implement it. The objectives of the Paris Agreement and the net neutrality clearly point to the importance of storage in general, and in the case of this discussion, that of geo-sequestration. It is difficult to imagine how net carbon neutrality can be reached without this instrument.

Two obvious conclusions need to be highlighted as well as one important issue that will require, in our view a political decision. The one political issue is what will CCUS be used for – a deliberate limited use for hard to abate sectors or will there be a policy and political decision and mandate, accompanied by the necessary support to use CCUS on a much broader scale. This will point to the demand for storage.

One of the two issues mentioned above is the need for international cooperation. The analysis clearly shows the need for international cooperation given the distribution between the supply of carbon storage and where the demand of CSU will emerge from. Units that provide credit for storage will need to be transferable.

The second issue is the need for additional financial incentives to make CCUS a reality. The fact that incentives emerging from carbon trading which focuses on constraints on the number of emissions to the atmosphere are not sufficient is also mathematically correct and has also been documented. CO2 prices are rising but in is not foreseen that they will reach, in the immediate future, levels required to make widescale CCUS deployment commercially feasible.

This leads to the conclusion that the CSO constraint to be met with CSUs only, can provide that additional value and associated incentive needed.

The chain and relationship become obvious: net neutrality requires CCUS, but to make CCUS viable additional value needs to be created. This value can emerge from CSOs, which for widescale CCUS deployment, will need be adopted in both CSU-supplying countries and countries with limited domestic storage potential, which makes CCUS in Art 6 a necessity, not a luxury.

7.1 Concrete way forward

Socializing CSU & CSO

The concept of CSU and CSO, while not the main object of this paper, is fundamental and needs to be further socialized. It continues to be the domain of a small number of people who are engaged in CCUS policy discussions and has not entered the vocabulary and consciousness of a broad cross section of stakeholders. It needs to be consistently and clearly brought to those that are engaged in national climate change policy as well as Art 6 implementation.

One element that is important to recognize is the timeframe, which in terms of legislation and regulation related to energy transition is getting shorter. The European Green Deal is European, but it seems to be rapidly reverberating across borders, especially with the CBAM entering the phase of legislative negotiations in the EU.

This implies using all possible forums where the issue of transitions is discussed, and especially introducing it very rapidly in the EGD discussion, to have any chance of including CSOs in the package. This will not be an easy objective as any new initiative brought into the fray at this stage will have to come at a very senior level to be considered. The current energy crisis in the EU will open an avenue for many issues to be highlighted that will help ensure that this is not repeated many times in the future (even if the time frames may not totally match).

In addition, all avenues that are available to OGCI will need to be utilized and the organization itself will need to initiate public debates on a much larger scale than the public events that have been part of this project.

Clean Energy Ministerial, WBCSD, OECD, IEA, WEF, IETA, CPLC are all useful platforms for the concept of a CSO to be introduced in the public debate.

International Art 6 negotiators will continue to be of interest as this, for the moment, continues to be a small community, which is expected to keep the spotlight on issues that are of interest. A dual track should be considered. Art 6.2 which does not require any special UNFCCC rules will require piloting and interested countries such as Norway or Canada should be approached as potential champions.

Art 6.4 will get off the ground and introducing methodologies at a very early stage will also spotlight opportunities for CCUS.

In addition, it may be useful to initiate international cooperation under Art 6.8 – bringing a CSO "Club" together under Art 6.8 is also an initiative that will be visible and attract attention – which is what CSO needs.

<u>CSO in NDC</u>

An obvious signal of support and commitment is to have a group of Parties putting CSOs in their NDCs. While this may seem bold, many bolder commitments have been taken in terms of climate change and this is one that can be delivered, especially if the initial commitment is not overly ambitious and undeliverable. The signal that would be given matters.

It needs to be remembered that the EU, and many others have just updated their NDCs. It is unlikely that there will a further revision ahead of the 2023 stock take, but the preparation starts with the next SBs in June and then the COP in Egypt. Approaches to the UAE, the COP Presidency after Egypt, should be initiated as soon as possible, as discussions in the Arab Group may start at an early stage.

As such, approaches have to be initiated in EU member states, as well as many in the Umbrella Group to bring up CSOs as a potential part of an updated NDC.

This also needs to be part of the narrative introduced in the Ministerial Roundtables agreed by the CMA, as well as in all the discussions and initiatives which are part of the Glasgow Compact.

Operationalization

Operationalization needs to start with an anchor, and large multilateral institutions with technical depth, public credibility and sufficient resources need to be considered as prime candidates. Institutions such as the World Bank, ADB and EBRD are obvious candidates for such roles, given their history in starting new initiatives in this space.

All this needs to be complemented with putting the CSU/Art 6 concept in front of groups of Parties as well as business organizations that have the resources, knowledge and have shown interest to explore such solutions. The Clean Energy Ministerial is an obvious such platform.

Conclusion

The concepts are clear, and the regulatory obstacles in terms of Art 6 should not be insurmountable, especially if the focus is on using Art 6.2. The same goes for introducing CSO in an NDC group. It needs an impulse and a champion.

It also needs firm commitment from OGCI leadership for a more public presence, as well as the realization that material resources may need to be committed. This will be a significant effort with a significant level of intensity which will require financial and human resource commitments.

References

Allen, M.R., Frame, D.J., & Mason, C.F., 2009. The case for mandatory sequestration. *Nature Geoscience*, 2(12), 813–814. https://doi.org/10.1038/ngeo709

Allen, M.R. 2019. *What will it take to limit global warming to 1.5°C? – and how the fossil fuel industry could help*. Presentation at "Paris Agreement CCS Policy and Mechanisms" workshop, King Abdullah Petroleum Studies and Research Center, Riyadh, 9 April 2019.

Carbon Pricing Leadership Coalition (CPLC), 2017. *Report of the high-level commission on carbon prices*. Supported by the World Bank, ADEME and the Ministry of Environment, France. May 2017.

International Energy Agency (IEA), 2009. *Technology Roadmap - Carbon Capture and Storage 2009*. IEA/OECD, Paris, May 2021.

Hepburn, C., Allas, T., Cozzi, L., Liebreich, M., Skea, J., Whitmarsh, L., Wilkes, G., and Worthington, B., 2020. *Sensitive intervention points to achieve net-zero emissions: Report of the Policy Advisory Group of the Committee on Climate Change*. University of Oxford/UK Climate Change Committee, December 2020.

IEA, 2020. *Energy Technology Perspectives 2020. Special Report on Carbon Capture Utilisation and Storage (CCUS) in clean energy transitions*. IEA/OECD, Paris, May 2021.

IEA 2021. *Net Zero by 2050: A Roadmap for the Global Energy Sector*. IEA/OECD, Paris, May 2021.

IETA 2021. *The Potential Role of Article 6 Compatible Carbon Markets in Reaching Net-Zero*. Working Paper. 18 October 2021

IPCC, 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Prepared by the National Greenhouse Gas Inventories Programme [H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara and K. Tanabe (eds).] Published: IGES, Japan.

IPCC, 2018. *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kuijper, M., Holleman, E., van Soest, J-P., 2021. *Carbon Takeback Obligation: A Producers Responsibility Scheme on the Way to a Climate Neutral Energy System*. Report by Margriet Kuijper Consulting, Royal Haskoning DHV and DeGemeynt, January 2021.

Lipponen, J., McCulloch, S., Keeling, S., Stanley, T., Berghout, N., & Berly, T. (2017). The politics of large-scale CCS deployment. *Energy Procedia*, 114, 7581–7595. https://doi.org/10.1016/j.egypro.2017.03.1890

Martin-Roberts, E., Scott, V., Flude, S., Johnson, G., Haszeldine, R.S. and Gilfillan, S. Carbon capture and storage at the end of a lost decade. *One Earth*, October 2021. https://doi.org/10.1016/j.oneear.2021.10.002

OGCI 2021. OGCI position on policies to scale up carbon capture, use and storage (CCUS). Oil & Gas Climate Initiative, February 2021.

Zaman. P, Hedley. A, 2016 *The regulatory framework to support carbon market linkage – a concept paper*

UNFCCC, 2011. *Modalities and procedures for carbon dioxide capture and storage in geological formations under the clean development mechanism*. Decision 10/CMP.7

Zakkour, P. D, Cook, G., Carter, A., Streck, C. and Chagas, T., 2011. *Assessment of climate finance sources to accelerate carbon capture and storage deployment in developing countries*. A report by Carbon Counts and Climate Focus for the World Bank. 16th June 2011. Washington D.C

Zakkour, P.D. and Heidug, W., 2019. *A Mechanism for CCS in the Post-Paris Era: Piloting Results-Based Finance and Supply Side Policy Under Article 6*. King Abdullah Petroleum Studies and Research Center discussion paper. April 2019. https://doi.org/10.30573/KS--2019-DP52

Zakkour, P.D. and Heidug, W, 2020. *Supply-side Climate Policy for Crude Oil Producers*. Discussion Paper ks--2020-dp19, King Abdullah Petroleum Studies and Research Center. Papers. https://doi.org/10.30573/KS--2020-DP19

Zakkour, P.D., Heidug, W., Howard, A., Haszeldine, R.S., Allen, M.R., and Hone, D., 2021. Progressive Supply Side Policy under the Paris Agreement to Enhance Geological Carbon Storage. *Climate Policy* 21 (1), p. 63-77. https://doi.org/10.1080/14693062.2020.1803039