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Towards the International Standardization of Carbon Dioxide Capture, Transportation, Utilization and Storage (CCUS) Technologies: Current Challenges and Future Directions

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Climate change poses a serious threat to the development of the current and future generations. Therefore, Carbon Dioxide Capture, Transportation, Utilization and Storage (CCUS) has emerged as an essential tool to mitigate such impacts of global warming along with other initiatives and strategic decisions such as energy transition and conservation, sustainable practices amongst others. This article is focused on the CCUS practices and more specifically the peculiarities of CCUS vis-à-vis the standardization rules at the International Organization for Standardization (ISO). The main question this article aims to address is to determine if CCUS should have its own standing technical committee (TC) or if it should be somehow related to the existing Carbon Capture and Storage (CCS) technical committee.

Keywords: Climate Change; Energy Transition; CCS, CCUS, ISO, CO_2, GHG and Standards.

1. INTRODUCTION

The aim of this article is to examine the legal and institutional questions associated with the international standardization of Carbon Capture Utilization and Storage (CCUS) technologies. Climate change is impacting human health and safety in ways probably never experienced throughout human history.[1] Over the past two hundred years, since the industrial revolution, human activities have resulted in continuous and rapid increases in production and emission of greenhouse gases (GHG).[2] As a result, climate change now constitutes one of the most complex and serious perils facing mankind, with especially grievous consequences predicted to befall socially and economically vulnerable populations.[3] As part of the Paris Agreement[4], countries agreed to limit global warming to below 2 degrees Celsius and ideally to 1.5 degrees.[5] The latest science shows that in order to meet these goals and prevent the worst impacts of climate change, emissions will need to drop by half by 2030 and reach net-zero by mid-century.[6] To mitigate undesirable effects of GHG, the main sources need to be the target of effective actions in a timely manner to reduce and eliminate emissions.

One of the primary endeavors implemented to meet these requirements is Carbon Capture and Storage ("CCS"). CCS is recognised as a key, proven technology in reducing greenhouse gas emissions around the world. It involves the capture of carbon dioxide (CO_2) emissions from industrial processes, such as steel and cement production, or from the

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1 Michel Frojmovic, Jennifer Graeff, and Asad Mohammed, 'Planning and Climate Change in the Caribbean', (Lincoln Institute of Land Policy 2013) <https://www.lincolninst.edu/sites/default/files/pubfiles/2336_1676_Frojmovic_WP13MF1.pdf> accessed 15 May .2021. See also Damilola Olawuyi, Climate Change Law and Policy in the Middle East and North Africa Region (Routledge, 2021) 1-11.

2 Ibid.

3 Sheila R. Foster and Paolo Galizzi, 'Human Rights and Climate Change: Building Synergies for a Common Future' (2015)<https://www.researchgate.net/publication/280301473_Human_Rights_and_Climate_Change_Bilding_Synergies_for_a_Common_Future>accessed 15.November.2021; also Damilola Olawuyi, The Human Rights Based Approach to Carbon Finance (Cambridge University Press, 2016).

4 United Nation 'Conference of the Parties, Adoption of the Paris Agreement' Dec. 12, 201. U.N. Doc. FCCC/CP/2015/L.9/Rev/1 (Dec. 12, 2015).

5 Paris Agreement, ibid, Article 2(1)(a).

6 IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L.Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R.Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press.

burning of fossil fuels in power generation.[7] This carbon is then transported from where it was produced, via ship or in a pipeline, and stored deep underground in geological formations.[8] Analysis by the International Energy Agency (IEA) suggests CCS could prevent 6 $GtCO_2$ per annum from being released into the atmosphere in 2050, and contribute about 13% of the cumulative emissions reductions required to achieve the 2°C target through 2050.[9] CCS, however, does not come without its challenges. The main issue with this system is its unprofitability combined with highly expensive machinery. Due to this economic issue, CCS is barely in use.[10] In response to this challenge, scientists conceptualized Carbon Capture Utilization (or sometimes this is termed 'usage') and Storage ("CCUS"). The idea is that, instead of storing carbon, it could be re-used in industrial processes by converting it into, for example, hydrogels, chemicals, plastics, concrete or synthetic fuels. Through this profitable system, carbon can become a renewable source that supplies a demand in a less polluting manner.

To make the implementation of CCS more sustainable and to ensure its applications globally are practiced in a correct and safe manner, the International Organization for Standardization (ISO) has been developing international standards for CCS since 2012.[11] Developed by global experts, ISO standards are widely accepted around the world for ensuring that technologies, products, and services are safe, reliable and of good quality. So as to enforce these standards for CCS, an ISO Technical Committee (ISO/TC265) has

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7 See further Rackley, Stephen A. Carbon Capture and Storage.(Butterworth-Heinemann, 2017).

8 National Grid, 'What is Carbon Capture and Storage?',https://www.nationalgrid.com/stories/energy-explained/what-is-ccs-how-does-it-workaccessed 02 June 2021.

9 International Energy Agency, 'Energy Technology Perspectives 2015: Mobilising Innovation To Accelerate Climate Action", (OECD/IEA France,2015)

10 Rosa M. Cuellar-Franca and Adisa Azapagic, "Carbon Capture, Storage and Utilisation Technologies: A Critical Analysis and Comparison of their Life Cycle Environmental Impacts" (2015) Journal of CO_2Utilisation 982–102.

11 Majid Nasehi, 'ISO Standards for Carbon Capture Utilisation and Storage: A Critical Requirement to Facilitate Global Implementation of CCS', (2020)<https://ptrc.ca/media/blog/the-iso-standards-to-facilitate-global-imple-mentation-of--carbon-capture-and-storage> accessed 10 June 2021.

been established. This TC monitors and implements the standards for CCS technology and helps to provide a common basis for commercial and business transactions while encouraging safe and effective use of CCS. Some of the expected benefits include *inter alia* the sharing of knowledge, innovation, cooperation and coordination, the facilitation of the deployment and integration of systems and technologies needed to safely implement and operate CCS projects, and the reduction of risks and adverse consequences of accidental, intentional and natural mishaps.[12]

Standards establish consistent rules that can be universally understood and adopted. They help to ensure, for example, product functionality, compatibility and interoperability. Standards also define terminologies and methodologies so that products, processes and services can be more easily understood, characterized and compared. Remarkably, however, notwithstanding the development of CCS technology to include utilization or usage, no TC has been established for the enforcement and monitoring of CCUS standards, despite their marked difference, and additional requirements.

This article will accordingly examine whether CCUS can be encapsulated in the mandate of the ISO-TC 265 or whether a separate TC is necessary for the implementation of CCUS standards. This discussion will be dissected into four separate sections. After this introduction, section 2 discusses the importance of international standardization as a tool for promoting the safe, orderly and environmentally responsible development of CCUS and other climate technologies. It also examines the procedures regarding technical committees at ISO. Section 3 discusses current legal and institutional challenges with the current situation of CCS and CCUS at ISO. Section 4offers recommendations on the essential steps to address the procedural challenges associated with ISO standardization of the CCUS. Section 5 is the concluding section.

12 ISO/TC 265, 'Carbon Dioxide Capture, Transportation and Geological Storage, Business Plan' https://www.iso.org/committee/648607.html> acessed 02 June 2021.

2. CCUS STANDARDIZATION AND SUSTAINABLE DEVELOPMENT: UNDERSTANDING THE LINKAGES

2.1 International standardization process at ISO

ISO is a transnational network of standards bodies, not a traditional international organization. [13]ISO has a consultative status within the United Nations Economic and Social Council.[14] Its main object, according to Article 2 of ISO Statutes, is "to promote the development of standards in the world with a view to facilitating international exchange of goods and services and to developing cooperation in the sphere of intellectual, scientific, technological,[15] and economic activity". [16]

Technical standards are established in a variety of ways, such as when private standards become de facto industry norms because of market dominance, or when firms negotiate common standards in consortia. An alternative to these arrangements is ISO's approach, which is based on broader consensus. ISO standards have a certain authority as quasi-official 'international standards' when compared to de facto and consortia standards, which is frequently attributed to the technical knowledge and broad consensus that ISO seeks in its work. ISO has neither the authority nor the mission to enforce its standards, relying instead on their acceptance and willingness to be used by other organizations and businesses. While ISO standards are voluntary in theory, their implementation might become mandatory in practice. Many multinational corporations demand ISO certification

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13 OECD,'International Regulatory Co-operation and International Organizations. The case of ISO' (2016). accessed 27 September 2021< https://-www.oecd.org/gov/regulatory-policy/ISO_Full-Report.pdf> accessed 27 September 2021

14 United Nations Department of Economic and Social Affairs. Non-Government Organizations Branch. < https://esango.un.org/civilsociety/-display AdvancedSearch.do?method=search&sessionCheck=false>accessed 27 September 21

15 ISO (2018) – ISO Statutes, accessed 27.09.21 <https://www.iso.org/files-/live/sites/isoorg/files/archive/pdf/en/statutes.pdf>

16 Yasuda H, Standardization activities on multimedia coding in ISO (1989) 1(1), Signal Processing: Image Communication, 3–16.

from their supply chain partners and subcontractors. As a result, compliance with ISO standards may become a requirement for access to global markets.[17]

The governance structure of ISO is shown in Figure 1. The General Assembly is an annual meeting, attended by ISO members and ISO Officers, that have the ultimate authority of the organization. The ISO Council is a governance body that meets three times a year and reports to the General Assembly. The Council is made up of 20 member bodies, which rotates among all member bodies to make sure it is representative of the members community, the ISO Officers, and the Chairs of the Policy Development Committees[18] CASCO, COPOLCO and DEVCO. Besides these policy-related bodies, the Council has also direct responsibility over other advisory bodies which also report to Council.[19] Finally, the management of the technical work is taken care of by the Technical Management Board (ISO/TMB), which reports to Council. This body is also responsible for the technical committees that lead standards development and any strategic advisory boards created on technical matters.[20]

17 Heires M, The international organization for standardization (ISO) (2008) 13(3), New Political Economy, 357–367<https://doi.org/10.1080/135634-60802302693>

18 ISO/CASCO, which provides guidance on conformity assessment, ISO/-COPOLCO, which provides guidance on consumer issues and ISO/-DEVCO, which provides guidance on matters related to developing countries <https://www.iso.org/structure.html>.

19 The President's Committee, which advises Council on matters decided by Council; The Council Standing Committees (ISO/CSC), which address matters related to finance (ISO/CSC/FIN), strategy and policy (ISO-/CSC/SP), nominations for governance positions (ISO/CSC/NOM) and have oversight over the organization's governance practices (ISO-/CSC/OVE); and advisory groups which provide advice on matters related to ISO's commercial policy (ISO/CPAG) and information technology (ISO/ITSAG) (https://www.iso.org/structure.html).

20 Available in ISO portal. <https://www.iso.org/structure.html> accessed 27 October 21

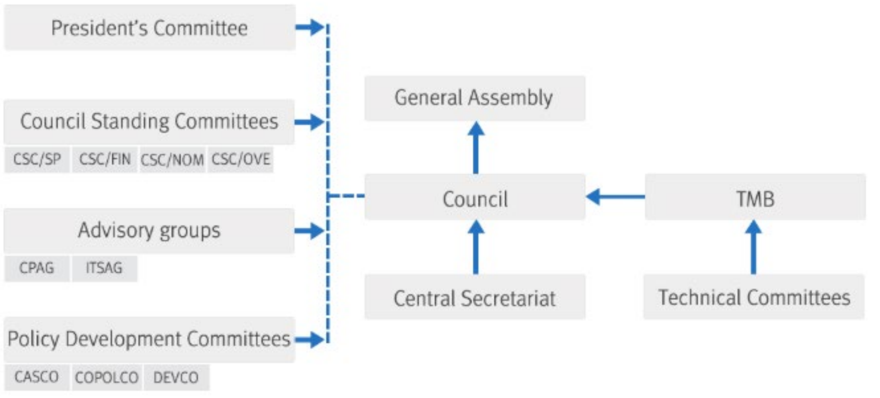

Figure 1 – The ISO governance structure (https://www.iso.org/structure.html)

The next section will discuss the environment where the standards are developed at ISO, the technical committees (ISO/TCs) and their relevance, followed by a section dedicated to analyzing the stakeholders and process involved in establishing a new ISO/TC.

2.2. ISO/TCs and their relevance

The ISO Central Secretariat and the ISO/TMB coordinate the highly decentralized work of the experts in the so-called technical committees (ISO/TCs). Each technical committee has a business plan (BP), which also covers the activities of its subcommittees (SCs). The business plans should analyze the conditions and trends in the market sector served by the technical committee and will be required explicitly to link work programs and sector needs. Thus, priorities for which standards are needed can be set. An ISO/TC may assign sub-committees (SCs) with working groups (WGs) to cover certain areas of work.[21] The actual standardization work takes place in the WGs and SCs.[22]

The standardization development at ISO spreads over hundreds of technical fields in some thousands of technical committees (TCs), subcommittees (SCs) and working groups (WGs) which convene usually once a year at different venues around the world.[23] The members of these are designated by the national member organizations and can include experts from industry, research, and government, and sometimes also representatives of consumer organizations and other Non-Government Organizations(NGOs).[24]

The standardization process is conducted in the form of consensus building in the technical committees.[25] This can be a lengthy and sometimes painstaking process: the development of an ISO standard usually takes 36 months or longer.[26] New standardization projects can be proposed by a national member organization, one of ISO's policy committees or the Board itself,[27] which also has the final say on the start of a new project. [28]

The process begins with the development of a draft that meets a specific market need (New Project/New Work Item Proposal, NP/NWIP). This is then shared for commenting and further discussion, and if approved, it becomes a Working Draft (WD) to be discussed at the respective ISO/TC. The voting process is the key to consensus. If that

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21 Antonatus E, and SundströmB,–'International Standardization'in Antonatus E and Troitzsch J (Eds.), Plastics Flammability Handbook (Hanser. 4th ed.2021). 9 pp. 257–286). <https://doi.org/https://doi.org/10.3139/978156-9907634.009>

22 Heires M,'The international organization for standardization (ISO)' (2008) 13(3)New Political Economy, 357–367<https://doi.org/10.1080/135634-60802302693>

23 Ibid.

24 Yasuda, H, 'Standardization activities on multimedia coding in ISO' (1989) 1(1) Signal Processing: Image Communication, 3–16.

25 Chimalakonda S, and Hyung Lee D, 'A family of standards for software and systems product lines. Computer Standards and Interfaces' (2021)78. <http-s://doi.org/10.1016/j.csi.2021.103537>

26 Ibid.

27 Heires M,'The international organization for standardization (ISO)' (2008)13(3) New Political Economy357–367<https://doi.org/10.1080/13563460802302693>

28 Yasuda, H, 'Standardization activities on multimedia coding in ISO' (1989) 1(1) Signal Processing: Image Communication, 3–16.

is achieved, then the draft is on its way to becoming an ISO standard. If an agreement is not reached, then the draft will be modified further and voted on again. Discussion and voting processes are repeated, generating new Committee Draft (CD) versions until the ISO/TC achieves a consensus to move to Draft International Standard (DIS) stage.[29] After another round of discussion and voting a Final Draft International Standard (FDIS) is created, which is then finally analyzed before publication as an International Standard (IS). From the first proposal to the final publication, developing a standard usually takes about 3 years (https://www.iso.org/developing-standards.html).[30] This development process is schematically presented in Figure 2.[31]

[29] Chimalakonda Sand Hyung Lee D 'A family of standards for software and systems product lines.' (2021). Computer Standards and Interfaces 78. <https://doi.org/10.1016/j.csi.2021.103537>

[30] Ibid.

[31] Džemić Z, Memić, H, Vitt, M. P, and Badnjević, A. 'Need for standards and their development. (2019). Elsevier, Clinical Engineering Handbook, Second Editionpp. 715–721. <https://doi.org/10.1016/B978-0-12-813467-2.00101-2>

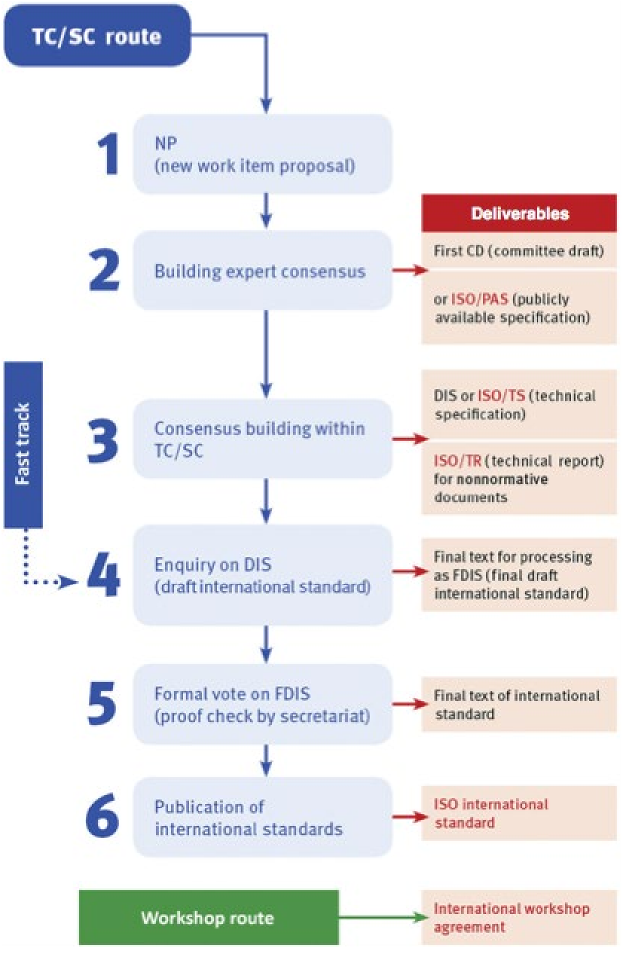

Figure 2 – Scheme of ISO standards development process (https://www.iso.org/developing-standards.html).

Although every ISO member is officially welcome to participate in the standardization process, not every country has the infrastructure or technical expertise to do so effectively. The standardization process's consensual and highly technical structure is intended to avoid and minimize disagreements, but it can also act as an implicit barrier to participation. New projects frequently begin with a draft document, and it might be difficult to criticize those proposals without proposing a well-thought-out alternative. Furthermore, the members of the various committees are usually professionals in their professions who have collaborated for a long period.[32] This makes it more difficult for new members who lack experience and skills to join the discussions. [33]

As a result, active participation in technical committees is a necessary condition for influencing standardization. If ISO members choose to participate in a committee, they can do so as O-members (observers) or P-members (participants). P-members are required to attend all meetings and vote on standards and are thus more devoted to the organization's work. Every committee is overseen by a single national organization that has been designated by the Board to carry out this function.[34] Members with a significant interest in the standards being established frequently hold the secretariat and chair positions.[35]

2.3 Stakeholders and the process involved in establishing a new ISO/TC

A proposal for a new field of technical activity shall be submitted to the ISO Central Secretariat which will process the proposal in accordance with the ISO/IEC Directives (Part 1, Subclause 1.5). According to ISO/IEC Directives (Part 1, Subclause 1.5.3) [36], the proposer may be:

"**1.5.3** (…)

a) a National Body;
b) a technical committee or subcommittee;
c) a project committee;
d) a policy level committee;
e) the technical management board;
f) the Chief Executive Officer;
g) a body responsible for managing a certification system operating under the auspices of the organization;

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32 Heires M,'The international organization for standardization (ISO)'(2008) 13(3), New Political Economy357–367.<https://doi.org/10.1080/1356346-0802302693>

33 Silva, P. P. A 'Metrologia nas normas, normas na metrologia.' (2003).

34 Heires M,'The international organization for standardization (ISO). (2008) 13(3),.New Political Economy, 357–367. <https://doi.org/10.1080/135634-60802302693>

35 Silva, P. P. A,'Metrologia nas normas, normas na metrologia' (2003).

36 ISO (2021). ISO Directives, Part 1. accessed 27 October 2021. <https://-www.iso.org/sites/directives/current/consolidated/index.xhtml>

h) another international organization with National Body membership."

According to ISO/IEC Directives (Part 1, Subclause 1.5.4) [37], the main topics that should be covered in a new proposal are:
"**1.5.4** (…):

a) the proposer;
b) the subject proposed;
c) the scope of the work envisaged and the proposed initial programme of work;
d) a justification for the proposal;
e) if applicable, a survey of similar work undertaken in other bodies;
f) any liaisons deemed necessary with other bodies."

Guidelines for proposing and justifying a new field of technical activity are given in the ISO/IEC Directives (Part 1, Annex C).[38] Proposers are strongly encouraged to conduct informal consultations with other National Bodies in the preparation of proposals. In some instances, the ISO/TMB may consider it appropriate to carry out an informal exploratory enquiry.

ISO/IEC Directives (Part 1, Subclause 1.5.5) [39] highlight the establishment process and the fundamental role of the ISO/TC Business Plan (BP):

> "**1.5.4** (…):
>
> Technical committees are established by the ISO/TMB on a provisional basis. Following the initial meeting of the technical committee, but no later than 18 months, provisionally established technical committees are required to prepare a strategic business plan for review by the ISO/TMB. The committees are formally established by the ISO/TMB at the time of acceptance of the business plan. This

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[37] Ibid.
[38] Ibid.
[39] Ibid.

> does not preclude the initiation of standardization projects during this 18 month period."

The proposal is then sent to ballot among all ISO NSB members, arguing if they support the formation of a new ISO/TC, as well as whether they intend to actively engage in the new ISO/TC's activities. Responses to the proposal must be received within 12 weeks. The ISO/TMB reviews the responses and decides on the formation of a new ISO/TC if a two-thirds majority of the National Bodies voting are in favor of the proposal (abstentions are not considered) and at least 5 National Bodies that voted in favor have expressed an active desire to participate.[40]

A new ISO TC's title and scope must be agreed upon following its establishment, being approved by a two-thirds majority of the P-members voting. An ISO/TC's scope is a statement that accurately defines the extent of its activities. The scope of a technical committee's definition should begin with the words "Standardization of..." or "Standardization in the field of..." and be written as succinctly as feasible. Recommendations on scope are given in ISO/IEC Directives (Part 1, Annex J).[41]

Sometimes, when the new field proposed is objectively related to one standard project, an ISO/PC (Project Committee) can be established, which can be later transformed into an ISO/TC. As an example, ISO established in 2008 the "ISO/PC 242 – Energy management" tasked to develop a standard regarding energy management systems, which resulted in publishing ISO 50001:2011 – Energy management systems — Requirements with guidance for use. ISO/PC 242 then transitioned to ISO/TC 242[42] developing standards and guidance related to the implementation of ISO 50001 [43]. In other cases, when the

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40 Ibid.

41 Ibid.

42 "ISO/TC 242 – Energy management" has merged with "ISO/TC 257 – Energy savings", resulting in "ISO/TC 301 – Energy management and Energy savings" in 2016.

43 Lieback, J. U., Buser, J., Kroll, D., Behrendt, N., and Oppermann, S 'Standards, Regulations and Requirements Concerning Energy and Resource Efficiency. In Resource Efficiency of Processing Plants'. (John

proposer has already a set of standards to be developed, an ISO/TC can be established, like the "ISO/TC 265 – Carbon dioxide capture, transportation, and geological storage" [44], as will be further discussed in this article.

Finally, when the technical activity is already covered by an existing ISO/TC, the proposer can then direct its project proposal to create an SC or WG inside the existing ISO/TC. As an example, Stokes et al. (2020)[45] reports that after the publication of the first edition of the Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines in 2002, ISO set up a WG (now identified as ISO/TC 20/SC 14/WG 7) to transform guidelines and best practices from the IADC into a set of international standards on space debris mitigation.

A study by Castka and Balzarova (2008)[46] has investigated the views ISO members and invited participants had on the proposal to move from one type of standard to another in a particular development case. The authors conducted inquiries to capture how previous standardization processes (ISO 9000 and ISO 14000) were affecting a particular new standard development (ISO 26000), which moved from a meta-standard approach towards a guidance standard. The authors focused on three main research areas (management system standards, process approach, and certification) and considered three elements related to each stakeholder: which group the stakeholder belongs to, what the position of this stakeholder is, and which rationale supports its position.

Wiley & Sons, Ltd, 2018)pp. 19–43 <https://doi.org/https://doi.org/10.10-02/9783527804153.ch2>

44 Carpenter S. M., and Koperna, G,'Development of the first internationally accepted standard for geologic storage of carbon dioxide utilizing Enhanced Oil Recovery (EOR) under the International Standards Organization (ISO) Technical Committee TC-265'(2014) 63. Energy Procedia, 6717–6729. <ht-tps://doi.org/10.1016/j.egypro.2014.11.707>

45 Stokes H, Akahoshi Y, Bonnal C, Destefanis R, Gu Y., Kato A., Kutomanov A., LaCroix A., LemmensS., Lohvynenko A., OltroggeD., Omaly P., Opiela J., Quan H., Sato K., Sorge M., and TangM, 'Evolution of ISO's space debris mitigation standards'(2020) 7(3),. Journal of Space Safety Engi-neering, 325–331. <https://doi.org/10.1016/j.jsse.2020.07.004>

46 Castka P, and Balzarova M. A. 'The impact of ISO 9000 and ISO 14000 on standardisation of social responsibility-an inside perspective'(2008) 113(1). International Journal of Production Economics, 74–87. <https://doi.org-/10.1016/j.ijpe.2007.02.048>

2.4 Relevance of standardization on CCUS

CCUS potential to mitigate climate change has been recognised for decades, but deployment has been slow and so has had only a limited impact on global CO2 emissions. This slow progress is a major concern in view of the urgent need to reduce emissions across all regions and sectors to reach global net-zero emissions as quickly as possible[47].

Widespread commercial implementation of CCUS has not occurred for several reasons including the high cost, concerns about health and safety, lack of carbon pricing, doubts about its efficacy, and uncertain public acceptance[48]. Another major obstacle is the lack of clear regulations and standards. This last obstacle can be addressed with International Standards and should be addressed promptly because industry and governments have indicated that CCUS is a priority.

As a matter of fact, ISO already recognizes the importance on CCUS standardization in the context of climate change mitigation on a recent guidance for ISO standard developers, the ISO Guide 84 (Guidelines for addressing climate change in standards) developed by the ISO Climate Change Coordination Committee (ISO/TMBG/CCCC). In ISO Guide 84 it is provided the following guidance:

> Standards developers should monitor the advancement of carbon dioxide capture and storage (CCS) technology and possible other long-term carbon sequestration through natural processes for improvements so that legacy fossil fuel combustion facilities and process industries can implement CCS when investments become more economically feasible or when implementation or retrofitting is required by regulation. Standards developers should take into consideration the level of maturity of CCS

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

48 Ibid.

> technologies and the potential of other carbon sequestrations before introducing any specific provisions in their standards development.
> (…)
>
> Standards developers should also consider carbon dioxide capture and utilization (CCU) in addition to CCS. CO2, as a source of carbon, has the potential to be used in the manufacture of fuels, carbonates, polymers and chemicals. Due to its inherent potential, CCU is considered a complementary alternative to geological CO2 storage and should be taken into consideration by standards developers according to technology maturity."[49]

Standardization in the CCUS field would provide a necessary element of the framework that could be used to facilitate widespread appropriate implementation. To date, proponents are using different guidelines, best practices, and related standards to select, design, develop, operate, and close CCUS projects. There is a need therefore for standards that are specific to CCUS and which would address the unique requirements that these projects require. This would be an immense benefit to proponents, regulators, and the public because it could provide assurances that projects have followed internationally accepted practices for safety and environmental integrity. Furthermore, because a CCUS project is an integrated system, it is necessary to ensure that carbon capture, transportation, injection, and utilisation/storage are all interconnected.

Standardization in the CCUS field would be an important component of the framework that could be leveraged to make wider deployment easier. CCUS projects are currently selected, designed, developed, operated, and closed utilizing a variety of guidelines, best practices, and associated standards. As a result, there is a need for CCUS-specific standards that satisfy the unique requirements that these projects necessitate. This would be extremely beneficial

[49] ISO (2020). ISO GUIDE 84:2020 – Guidelines for addressing climate change in standards. Geneva: ISO.

to project proponents, regulators, and the general public because it would ensure that projects followed internationally accepted safety and environmental principles.

International standards are desirable because they take advantage of growing global expertise and experience in CCUS and acknowledge that CCUS projects may traverse jurisdictions. Furthermore, many countries that would benefit from the quick implementation of CCUS may lack the extensive competence needed to develop their own CCUS standards. The development of international standards for CCUS answers a critical need and is an essential step toward widespread adoption of CCUS as a climate change mitigation strategy.

Given this overview on the standardization process at ISO, including the different discussion environments and the stakeholders and process involved in establishing a new committee, the next section will present the international movement on standardization of CCS-related activities and where Utilization activities fit in from a standardization perspective.

3. STANDARDIZATION ON CCS & CCU

3.1. Current international perspective

Internationally, there is an emergent understanding that CCS and CCU (i.e., Carbon Capture and Utilization) share the same core foundations, insofar as carbon capture is integral to both matters. Similarly, however, it is also understood that both matters diverge on the broader point of CCS being designed to secure the end-goal of permanent storage, whereas CCU endeavours to upcycle captured carbon into something that can be utilized as a chemical, fuel, etc. Cuéllar-Franca and Azapagic summarise the generally understood core distinction between CCS and CCU as follows:

> The difference between CCS and CCU is in the final destination of the captured CO_2. In CCS, captured CO2 is transferred to a suitable site for long-term

> storage, while in CCU, captured CO2 is converted into commercial products.[50]

Eco-nnect, the widely-read sustainability newsletter, has commented that "CCS… [is] an innovation that captures existing carbon and stores it underground. Today, scientists are adapting CCS into a more profitable system named 'Carbon Capture and Utilization' (CCU)".[51] This notion of scientists "*adapting CCS into*" CCU catches the spirit of the way in which the international community exhibits a tendency to view CCU as having *emerged out of* the CCS engineering and technological tradition, and it is therefore frequently viewed as being a part of that same overall stream of innovation. The European Union, for example, operated originally within a relatively narrowly confined CCS-oriented remit, including via its flagship Carbon Capture and Storage Directive,[52] but there has been a detectible subsequent trend towards broadening these CCS considerations into the utilization sphere; see, for example, the extensive 2019 report produced by the EU's CCS network on CCUS.[53] Such factors and trends contribute to CCS and CCU often being viewed in a mutual manner, and therefore it is perhaps unsurprising that these spheres are frequently conjoined by the international community as CCUS.[54] These tendencies in international perspectives on CCS/CCU/CCUS indicate that a TC committee that deals cumulatively with these interests – that is to say, both CCS and CCU – would not appear to be in any significant conflict with international norms; however, this in itself does not necessarily mean that it will be optimal for a TC committee

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50 Cuéllar-Franca, R.M., and Azapagic,A. Carbon capture, storage and utilisation technologies: a critical analysis and comparison of their life cycle environmental impacts. (2015) Journal of CO_2Utilization 9, 82-102, 83.

51 Traversone, V. (2020) Carbon Capture Storage vs Carbon Capture Utilization Eco-nnect, August 4 2020 (unpaginated online edition): <https:-//eco-nnect.com/research2/2020/8/4/carbon-capture-storage-vs-carbon-capture-utilization>

52 Carbon Capture and Storage Directive 2009 (2009/31/EC).

53 European Gas Regulatory Forum, (2019) The Potential for CCS and CCU in Europe, European Union.

54 See, e.g., International Energy Agency, (2021) Carbon Capture, Utilisation and Storage, IEA online database:<https://www.iea.org/fuels-and-technologies/carbon-capture-utilisation-and-storage>

to deal cumulatively with CCUS, given that much also depends on the ISO's particular structures, capacities and approaches.[55]

There may be an argument from a generalist international perspective that "utilization" has been assumed to fall within the purview of the sorts of matters dealt with by ISO/TC 265 for some time. In a scholarly analysis in 2014, for instance, Carpenter and Koperna noted with reference to developments in the context of CCS and Enhanced Oil Recovery that: "the U. S. Department of Energy has rebranded CCS to include the 'utilization' of carbon dioxide for the added extraction of additional hydrocarbon recovery – CO_2-EOR, suggesting that CCS is now CCUS – Carbon, Capture, 'Utilization' and Storage."[56] The authors add that "With the obvious issues of funding in today's economic times, an additional impediment to the international advancement of commercial scale CCS is a result of very difficult and sometimes protracted international agreements and a lack of international CCS standards."[57] They also note that "the International Standards Organization (ISO) has created a technical committee to advance the development of comprehensive international standards that address CCUS."[58] Although this commentary is somewhat dated and as such is dealing with CCUS in a more rudimentary way – and with primary reference to EOR - than is now typical, it indicates an underlying assumption that a committee like ISO/TC 265

55 These matters are considered further below.

56 Carpenter, S. M., and Koperna, G,'Development of the first internationally accepted standard for geologic storage of carbon dioxide utilizing Enhanced Oil Recovery (EOR) under the International Standards Organization (ISO) Technical Committee TC-265'(2014)63, Energy Procedia, 6717–6729, 6718.

57 Carpenter, S. M., and Koperna, G, 'Development of the first internationally accepted standard for geologic storage of carbon dioxide utilizing Enhanced Oil Recovery (EOR) under the International Standards Organization (ISO) Technical Committee TC-265'(2014) 63, Energy Procedia, 6717–6729, 6718.

58 Carpenter, S. M., and Koperna, G, Development of the first internationally accepted standard for geologic storage of carbon dioxide utilizing Enhanced Oil Recovery (EOR) under the International Standards Organization (ISO) Technical Committee TC-265.(2014) 63, Energy Procedia, 6717–6729, 6718.

can amount to a suitable forum for CCUS ISO leadership, without it being assumed necessarily that a need for a separate committee arises automatically by default.

It is to be recalled that TCs have a facility to establish SCs and WGs. This latter facility in particular - the creation of "Working Groups" that engage with targeted areas or items of work – has a capacity to serve a useful function in the context of international norms. Most particularly, it means in principle that ISO/TC 265 has a significant degree of flexibility in the context of ISO approaches to create WGs and structure their interests in a manner that can target utilization issues. Again, taking these circumstances in terms of broad principle, this suggests that the substantial commonalities between traditional CCS and broader CCUS considerations can likely be catered to effectively to a significant extent, at least in structural/governance terms, by ISO/TC 265. However, where commonalities / overlaps between CCS-CCUS may cease to hold or otherwise diverge in the context of ISO governance, his may pose challenges for default ISO approaches. In principle, where utilization standards range beyond narrower CCS issues to the extent that they involve or engage a specific product itself, it will potentially be the cases that the product in question may be subject to its own particular ISO standards, and that those standards fall typically within the work remit of an entirely different TC. Such circumstances may likely pose problems for ISO/TC 265 in this setting, to the extent that CCU cannot be fulsomely accommodated within ISO/TC 265.

This sub-section has addressed relevant matters in principle, with reference to broader international perspectives and standards; the following sub-sections will move beyond principle to concretise considerations more directly in the specific governance arrangements of ISO/TC 265.

3.2. Scope and mandate from ISO/TC 265

CCS as a new field of technical activity for ISO was proposed by Canada in 2011. In the Canadian proposal, the subject scope is described as follows (ISO, 2011):

> Standardization of materials, equipment, environmental planning and management, risk

> management, quantification and verification, and related activities in the field of carbon capture and storage (CCS). Excluded: equipment and materials used in drilling, production, transport by pipelines already covered by ISO/TC 67.

The proposal argues that standardization in the CCS field would provide a necessary element of the framework that could be used to facilitate widespread appropriate implementation of CCS as a climate change mitigation measure. They consider that theoretically CCS standardization could be administered under ISO through three options: by a new TC, by SCs and/or WGs under existing TCs, or by joint WGs between existing TCs. The discussion between the interested parties involved in this proposition led to the decision to propose a new TC as the best option. As reasons for that they claim that: CCS does not fall comfortably under the scope of any existing TC; CCS is an integrated system or chain and all of the different elements and considerations should not be artificially separated; finally, the experts in CCS are rarely the same people that populate the existing ISO TCs, SCs and WGs.

Although the committee would establish its work program, it was suggested in the proposal itself that an ISO/TC organizational structure consisting of five working groups (WG) reporting to the ISO/TC would be advisable, as illustrated in Figure 3. According to the proposal, it was expected that each WG would be responsible for the development of at least one standard, with the possibility of additional standards being required to cover specific issues within a WG's scope. There is a need to guarantee that the relationships between the WGs are adequately studied, which implies that there would be a clear need for significant liaison between the WGs. Further, it is evident that Risk, Quantification, and Verification WGs would need to be well-connected to the other WGs.

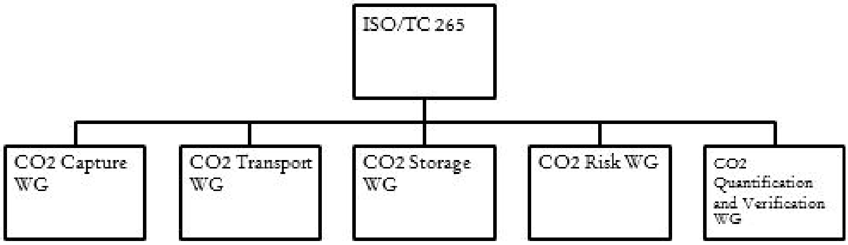

Figure 3 – ISO/TC 265 organizational structure from the original Canadian proposal in 2011

As a consequence of these developments, ISO/TC 265 was established in 2011, with Canada (Standard Council of Canada, SCC) holding the Secretariat, twinned with China (Standards Administration of China, SAC). According to ISO/TC 265 BP from 2016 (ISO, 2016), the committee had atthat time 18 P-members[59] and 9 O-members.[60] ISO/TC 265 considers that its members have a strong stakeholder interest in the development of standards for CCS due to one or more of the following reasons (ISO, 2016):

- A demonstrated commitment to reducing the impact of CO2 emissions.
- Having a strong reliance on hydrocarbons (e.g., coal, natural gas, etc.) as a basis for power generation and industrial manufacturing.
- The production and export of hydrocarbons provide significant revenue to a country's economy.
- Having expertise and experience with aspects of CCS.

In ISO/TC 265 BP from 2016 (ISO, 2016), the committee scope was refined from the initial proposal and is described as follows:

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59 Australia, Canada, China, France, Germany, India, Italy, Japan, Korea, Republic of Malaysia, Netherlands, Norway, Qatar, Saudi Arabia, South Africa, Spain, Sweden, Switzerland, United Kingdom and United States.

60 Argentina, Czech Republic, Egypt, Finland, Serbia, Iran, Sri Lanka and New Zealand.

> "The objective for ISO/TC 265 is to prepare standards for the design, construction, operation, environmental planning and management, risk management, quantification, monitoring and verification, and related activities in the field of carbon dioxide capture, transportation, and geological storage.
>
> The intent is that the International Standards will include all aspects related to the capturing of CO2 from large stationary point sources to storing it in suitable underground formations so as to prevent it from entering the atmosphere.
>
> Excluded from the work of the ISO/TC 265 will be: Ocean storage of CO2 by direct injection; Mineral carbonation storage; Industrial uses of CO2 not related to CCS; Capture and storage by forest and forest products; and Legal liability and permitting."

As a strategy to achieve the ISO/TC's defined objectives, ISO/TC 265 adopted an internal scoping document that describes the activities of the committee. The scoping document is a living document which will be revised as new technologies or innovations emerge, and therefore is not intended to contain only elements that are ready for standards today, but to also be forward looking to allow for the inclusion of elements that could require standards in the future, helping with long term planning.

Regarding the organizational structure, the ISO/TC 265 had established in 2016 six working groups (WG), as highlighted in Figure 4. Compared to the initial proposal from 2011, two main differences arise: (1) CO2 Risk WG was absorbed by a broader WG called "Cross Cutting Issues"; (2) a specific WG for CO2-EOR (CO2 Enhanced Oil Recovery) was created, which is an interesting development that will be discussed in the next section.

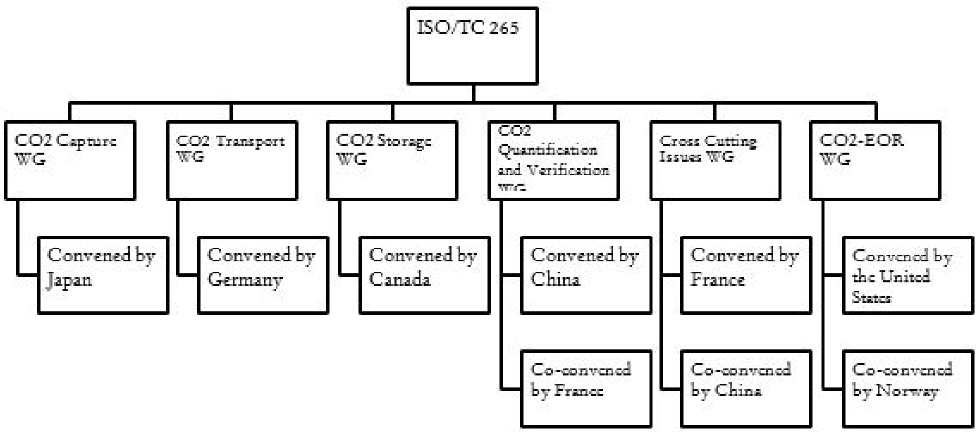

Figure 4 – ISO/TC 265 organizational structure from the ISO/TC 265 BP from 2016

Finally, according to the last update on ISO/TC 265 BP from early 2021[61], the committee scope was slightly changed from the last BP and is described as follows (changes are highlighted in italics):

> "The objective for ISO/TC 265 is to prepare standards for the design, construction, operation, environmental planning and management, risk management, quantification, monitoring and verification, and related activities in the field of carbon dioxide capture, transportation, and geological storage.
>
> The intent is that the International Standards will include all aspects related to the capturing of CO2 from large stationary point sources to storing it in suitable underground formations so as to prevent it from entering the atmosphere.

[61] ISO, Carbon Dioxide Capture, Transportation and Geological Storage, Business Plan'(ISO/TC 265, 2021)

> In due course numerous variations of carbon capture and storage will emerge and may provide alternative material decarbonisation opportunities. At present, excluded from the work of the ISO/TC 265 will be: Ocean storage of CO2 by direct injection; Mineral carbonation storage; Industrial uses of CO2 not related to CCS; Capture and storage by forest and forest products; and Legal liability and permitting."

This section presented a brief overview of the scope and mandate from ISO/TC 265 and how the objectives of this standardization environment has changed over the years. Considering this scenario, the next section will subsequently discuss whether CCU should be considered within ISO/TC 265 or other(s) TC(s), either existing TCs or a new one.

3.3 Where should the standardization process on utilization take place?

In terms of the present study's core interest in whether CCU can be encapsulated in the mandate of ISO/TC 265, or, alternatively, whether a separate committee is necessary for the implementation of CCU standards, it is especially notable that, from its conception until recently, the TC's scope uses the following words: "Excluded from the work of the ISO/TC 265 will be… Industrial uses of CO2 not related to CCS."[62] In principle this type of wording could be interpreted as extending to certain "uses" falling within the purview of conventional CCU "utilization". Furthermore, mineral carbonation storage and capture and storage by forest and forest products are also considered excluded from scope and they may also be considered as potential CCU activities.

However, one could debate the extent to which this relatively wording might fenced out utilization within the work remit of ISO/TC 265 in any broad or sweeping sense. For example, an industrial use of CO_2 not related to CCS can be the process for urea production with CO_2, the main use of

[62] ISO/TC 265 BP from 2016 (ISO, 2016), as quoted above.

CO_2 according to IEA[63]. In this case, the process and product standardization would be better fit in other TC's like ISO/TC 47 – Chemistry. However, when this process is integrated in a carbon capture chain, becoming a CCU project, it might be interesting to have guidance and this guidance scope may fit in ISO/TC 265. It may also be unlikely that the *purpose* that inspired this framing, which is an issue that is slightly distinct from the actual wording itself, involved an active intention to constrain any expansion of typical CCS standardization work from opening to incorporate slightly broader CCUS issues.

ISO/TC 265 created an Ad-hoc group to address CO_2 utilization with a view to exploring standardisation in this area,[64] which arguably represents a significant widening of traditional ISO/TC 265 interests in order to bring utilization more directly within its purview. The group reported in Paris in July 2018 at an ISO/TC 265 plenary meeting. Here, amongst a range of conclusions and observations, the group outlined that the common point of overlap between CCS and CCU is carbon dioxide: "capture and transport CO_2 to use or to store it."[65] While a strong emphasis has been placed on engagement with utilization in the context of TC 265, as this process demonstrates, it was emphasised that matters pertinent to broader committees are indeed engaged in this area, e.g., NEN Energy summarises for ISO that "CO_2utilisation for mineralization / chemicals / fuels / bioconversion: CO_2 based products belong to other technical committees (i.e. product-specific standards)."[66]

In other words, CCU cannot easily be dealt with as a meta-issue within the traditional confines of TC 265 concerns when market reality means that diverse utilization

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63 IEA,Putting CO2 to Use – Creating value fromemissions. Paris: (OECD-/IEA Publishing,2019).

64 Dakhorst, J., Standardisation developments in field of carbon capture, storage and utilisation (Presentation 5 November 2019)https://www.co2value.eu/wp-content/uploads/2019/08/4-Workshop-on-CO2standards. Pre-sentation-dy-Jarno-Dakhorst-of-NEN.5-Nov-2019.pdf>

65 Darkhorst, J., Overview of ISO/TC 265 standards on CCS, NEN Energy(Summary Policy Note for ISO, 2019)p.4. A<https://www.co2value.eu/wp-content/uploads/2019/08/1-Overview-of-ISO-TC-265-activities-on-CCS.Oct-2019.Jarno-Dakhorst.pdf> accessed 22 October 2019

66 Darkhorst, J., Overview of ISO/TC 265 standards on CCS, NEN Energy, (Summary Policy Note for ISO, 2019) 4.

outputs will tend to engage product-specific standards that attach to various products falling within other TC remits. The body also discussed the "Proposition to work on a Technical Report for assessing the gap between other technical committees and ISO/TC 265 for the need of 'standards' for CCU / CCS".[67] It is notable that there is some emphasis here on detecting and closing gaps as and where needed via harmonious action between a range of committees and ISO/TC 265 where relevant, as opposed to a primary stress falling on the creation of a *new* committee.

The debate on ISO/TC 265 scope changes completely after the new Business Plan from early 2021[68]. These changes could be a result of the work from the Ah-hoc group concerning CCU or other interested parties' action within the TC, whichever the case, the new ISO/TC 265 BP objectives includes the expression "At present" before the list of excluded subjects of work within the TC, which is a movement justified by a sentence concerning the emergence of new solutions for material decarbonization opportunities and in this matter CCU could have a step in.

This section has presented discussions on where the standardization process on utilization should take place, considering the scope of ISO/TC 265 and CCU Ad-hoc group results from this same TC. The next chapter is dedicated to make recommendations regarding where CCU standardization should be administered within ISO, considering the discussions from this section and the previous experience from ISO/TC 265 constitution process.

4. RECOMMENDATIONS

The process geared towards standardization is an exceedingly lengthy and technical one, requiring a great deal of expert instruction and international negotiation. Additionally, in order for a new ISO/TC to be established, the creation of same must be established by a qualified proposer in

67 Darkhorst, J., Overview of ISO/TC 265 standards on CCS, NEN Energy (Summary Policy Note for ISO 2019) 5.

68 ISO (2021). ISO/TC 265, Carbon Dioxide Capture, Transportation and Geological Storage, Business Plan.

accordance with the ISO/IEC Direction. This painstaking process may motivate the question as to whether the creation of a new TC is a fruitful, or even feasible, endeavour. As highlighted above, it is notable that these technical committees have the capacity to establish "Working Groups" which target areas of items of work, providing ISO/TC 265 with a considerable degree of flexibility to encapsulate utilization standardization. However, the creation of a working group to address the standardization components of utilisation may not be a straightforward exercise, as where these standards supersede narrower CCS issues, to the extent that they incorporate a specific product, said product may require its own ISO standards. As a result, the original question remains: can CCUS, in particular, the component of utilisation, be holistically accommodated within ISO/TC 265?

4.1 Creation of a new CCU technical committee

The first discernible, though admittedly laborious proposition, is, in fact, the creation of a new CCU technical committee in accordance with ISO/IEC Directive.[69] All the elements, considerations, and processes in CCU are interlinked, meaning that once the cumbersome of task of forming the committee is established, all elements can be regulated together in view of the ultimate use of the captured carbon, that being utilisation, which undoubtedly, does require additional standardization and scrutiny. Therefore, the creation of an entirely new committee may serve many beneficial purposes: Firstly, CCU and its various components do not fall comfortably within any existing committee. Certain constituents of carbon capture and storage already exist within ISO/TC 265, however, there is no committee which relates to utilization, as such, the governance and regulation of same requires the use of working groups, or reliance on other technical committees which enforce standards for particular products. As such,

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69 ISO,ISO/IEC Directives Part 1 - Procedures for the Technical Work, Consolidated ISO Supplement Procedures Specific to ISO<https://www.-iso.org/sites/directives/current/consolidated/index.xhtml> accessed 31 Juk21

this may invariably result in loopholes being formed where, for instance, a particular product or process emanating from utilisation, has not already been addressed by any existing technical committee. Secondly, another rational motivating the creation of a new technical committee for CCU is that the proponents of carbon capture and utilisation constitute an integrated system, and should therefore, ideally not be separated. Utilisation, as the final and fundamental element in the chain, will require specific materials, risk management, monitoring, and quantification challenges, which, as part of an integrated system, must be considered in accordance with the prior stages. Finally, the establishment of a new technical committee may be necessary to ensure that properly qualified and skilled experts are implemented to oversee the various functions of the TC. If the persons currently populating the existing technical committees do not have the requisite qualifications or skills to properly enforce CCU standardization, this may result in failure to meet the required standards, especially as it relates to utilisation.

It would therefore be an effective and efficient means of standardization to treat CCU as a new field of technical activity and for it to come under the responsibility of a new technical committee. This committee would oversee the full process of CCU system, from capturing the carbon dioxide, transporting it to a final location, and finally utilising the carbon for specific products. It would contemplate and provide specific technology, terminology, environmental considerations, risk management, GHG quantification and verification, health and safety, and other related CCU activities. Additionally, like all other technical committee, specific subgroups responsible for different processes would be implemented.

In fact, when determining how to administer CCS, it was ultimately decided, on the basis of these foregoing reasons, that the creation of a new technical committee was the most effective and fruitful route. It was determined that the creation of a new technical committee would result in the better regulation all the components of CCS including specific technologies, terminologies, environmental considerations, risk management, GHG quantification and verification, and health and safety concerns. Additionally, with so many interwoven elements, the creation of a new committee, with specific working groups geared towards the standardization of each salient element would be far more productive and would better ensure the tandem of the various stages. As a result, it was determined that the new committee would have various working groups overseeing the standards for each of the stages including: Capture, Transport, Storage, Risk Management, and Quantification and Verification.

However, as highlighted above, the process of establishing a new committee is cumbersome at best and may not provide the most expeditious process.[70] In fact, one of the main obstacles would be the scope delimitation, which shall not overlap current ISO/TC 265 prerogatives, mainly related to carbon capture and transportation. As such, alternative recommendations must be appraised.

4.2 Hybrid option

The second possible recommendation is for the elements of CCU to be administered under ISO/TC 265 as well as working groups and subcommittees under existing technical committees. This has already been undertaken, to an extent, whereby ISO/TC 265 has established a WG dedicated to CO_2-EOR, which is a CCU solution. Additionally, ISO/TC 265 has established an ad-hoc group related to CO_2utilisation to look into the standardization needs and potential standardization activities for ISO/TC 265.[71] CCU, insofar as it concerns the operations of carbon capture and storage, does constitute an extension on the existing CCS process. As a result, it in terms of efficiency, it has been contemplated, in light of the substantial overlap between traditional CCS and broader CCU considerations, whether CCU can be catered to effectively, at least in structural terms, by ISO/TC 265. Additionally, where these commonalities diverge, namely, where utilisation standards supersede narrower CCS issues

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70 Chimalakonda and Hyung Lee, 'A Family of Standards for Software and Systems Product Lines', (2021) Computer Standards and Interfaces, 78. <https://doi.org/10.1016/j.csi.2021.103537> accessed 02 August 21

71 Darkhorst, Overview of ISO/TC 265 Standards on CCS, NEN Energy(Summary Policy Note for ISO 2019), p.4. <https://www.co2value.eu/wp-content/uploads/2019/08/1-Overview-of-ISO-TC-265-activitieson-CCS.Oct-2019.Jarno-Dakhorst.pdf> accessed 01 August 2021

and concern a specific product, these products can be regulated under working groups or subcommittees of other technical groups. Indeed, the so-called product-standards shall not be discussed within ISO/TC 265, but rather within a specific TC which scope covers the concerned CCU product. The benefits to this approach are obvious: Firstly this would be far more efficient and timely than the process to create an entirely new committee. Second, as many of the standards between CCS and CCU coincide, this would mean that the recruitment and involvement of additional qualified experts would not be necessary, in light of their ability to man the overlapping processes under one committee. Thirdly, by regulating utilisation standards under a plethora of different committees, this would ensure that specific products, created from the utilisation of the stored carbon, are regulated under relevant, distinct committees, which specifically relate to the product, instead a broad application of standards under a new committee. However, while time may be saved in using existing technical committees, rather than creating a new one, this does not mean that the process of applying CCU to existing committees will be straightforward. Certain aspects of CCS and CCU overlap, therefore, in order to ensure that there are standards which sufficiently relate to all aspects and products of utilisation, a meticulous and carefully operated plan must be implemented to ensure that the right committee is assigned to each product and that no lacunae emerge. As a result, albeit a more efficient route, this may render a timely process.

Therefore, in light of the above, it is evident that CCU cannot be fulsomely encapsulated within the ISO/TC 265 mandate, owing, of course, to the components like utilisation which surpass original contemplation. Recent changes on ISO/TC 265 scope create an opportunity to discuss whether CCU should be formally included as a standardization topic in this TC. In order to properly standardize CCU, efforts must be made either to form and establish a brand-new technical committee, or to utilise the existing ISO/TC 265 and incorporate the involvement and expertise of working groups and subcommittees from other existing technical committees. Both recommendations provide benefits and drawbacks, however, both, with the correct application, can be feasible and effectual.

5. CONCLUSION

In the question of whether CCU can be encapsulated in the mandate of the ISO/TC65, CCS and CCU are directly interconnected but they do possess a key distinction in terms of the result. Both are dealing with capturing CO_2 which highlight the relevancy of this topic due to ongoing climate change crisis. However, the first is focused on the storage of CO_2 and the second is focused on CO_2 utilization. Therefore, in order to answer the question of whether a new committee was necessary, it was first necessary to ascertain the utility of international standards as a tool for promoting safe, orderly and environmentally responsible development of CCU, as well as the processes and procedures undertaken by the technical committees themselves. Additionally, an exploration of the current legal and institutional challenges with the current situations of CCS and CCU at the ISO was crucial. It is natural to expect far more technological challenges and developments in terms of utilization in comparison to storage which indicates that CCU should be properly addressed. However, as seen in the recommendations provided, it is possible to suggest that we have found reasonable arguments to create a dedicated new TC for CCU or to use the existing ISO/TC 265 as both options come with their own advantages and weakness. Recent changes on ISO/TC 265 scope create an opportunity to include CCU discussions, which gives some advantage to the second strategy. Nevertheless, in both cases certain adjustments and formalities should be observed in order to address the peculiarities and challenges that CCU might entail either as a stand-alone TC or to broaden the scope of ISO/TC 265.

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