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Roundtable on carbon capture and storage

Technology brief: Carbon capture, utilization and storage

Note by the Task Force on Carbon Neutrality

I. Introduction

1. This document is developed by the United Nations Economic Commission for Europe (ECE) Task Force on Carbon Neutrality as part of implementation of the extrabudgetary project on "Enhancing the understanding of the implications and opportunities of moving to carbon neutrality in the ECE region across the power and energy intensive industries by 2050" (Carbon Neutrality project).

2. The technology brief on Carbon Capture (Use) and Storage (CCS/CCUS) is the first in a series of technology briefs that will be developed as part of the workstream on assessment of contribution of selected technologies to attain carbon neutrality under the Carbon Neutrality project implementation.

3. The purpose of this document is to introduce the CCS/CCUS technology and its potential in the ECE region to achieve carbon neutrality. This draft will be refined at the workshop on CCS/CCUS on 25 September 2020. The document was prepared by the Task Force on Carbon Neutrality for the Group of Experts on Cleaner Electricity Systems (Group of Experts).

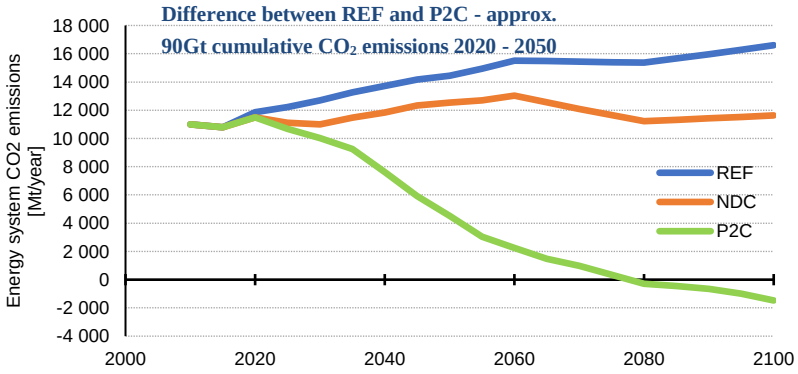
4. This document is a summary of experts input and an in-depth analysis that will be discussed at the workshop on "Attaining Carbon Neutrality" during the high-level roundtable on carbon capture and storage at the sixteenth session of the Group of Experts on 24 November 2020. The objective of the roundtable is to initiate a policy dialogue and prepare foundation for the development of financial guidelines for the modernisation of the power and energy intensive industries. The Group of Experts will report the findings from the workshop to the Committee on Sustainable Energy at its twenty-ninth session on 25 November 2020.

II. Background

5. Energy is critical for assuring quality of life and underpins attainment of the 2030 Agenda for Sustainable Development (2030 Agenda). The role that energy plays in modern society is recognized, but there remains an important disconnect between countries' agreed energy and climate targets and what countries are doing in reality.

6. Results from the ECE project called "Strengthening the Capacity of the ECE member States to Achieve the Energy-related Sustainable Development Goals – Pathways to Sustainable Energy" (Pathways Project) show that the countries in the ECE region will need both reduce its dependence on fossil fuels from over 80% to around 50% by 2050, and to achieve significant negative carbon emissions. The countries in the ECE region need to cut or capture at least 90Gt of CO_2 emissions by 2050 to stay on a pathway to meet the 2ºC target (see ECE/ENERGY/GE.5/2020/3).

Figure I
CO_2 Emissions in the ECE Region by Policy Scenario



7. As fossil fuels are likely to continue to play an important role for ECE member States in the short and medium term, achieving carbon neutrality will require deployment of CCS/CCUS technologies to allow reduced and negative carbon emissions to bridge the gap until innovative, next generation low-, zero-, or negative-carbon energy technologies are commercialized (see ECE/ENERGY/GE.5/2020/8).

III. Technology

8. CCS/CCUS technology is widely recognised as an essential technology for large scale decarbonisation for the coal and gas power and heavy industry sectors with costs on strong downwards trajectory.

9. When included on a coal (or gas) power plant, CCS can ensure flexible and effective dispatchable power performance with low CO_2 emissions. This can provide the inertia necessary to stabilise power grid operation when such systems are loaded with variable renewable energy inputs. Given the importance of fossil fuels within their current economic structures, and the recognition that robust reliable dispatchable energy is essential to their strategic aims, for many countries in the ECE region CCS/CCUS technology can play a critical role in the transition to a net-zero CO_2 emissions future.

10. From a technological viewpoint, CCS/CCUS components for capture, transport and storage are readily deployable at commercial scale and good progress has been made in reducing the cost of CCS/CCUS through the early commercial-prototype demonstration projects where 'learning by doing' has led to some very positive costs savings being identified for future application.[1] However, despite the advances that have been achieved to

[1] Bruce C, Giannaris S, Jacobs B, Srisang W, Janowczyk D (2018) Post combustion CO2 capture retrofit of SaskPower's Shand Power Station: Capital and operating cost reduction of a 2nd generation capture facility, 14th Int Conf on Greenhouse Gas Control Technologies, GHGT-14, Melbourne, Australia, 10 pp (Oct 2018)

date, CCS/CCUS has been deployed in relatively few countries and in most cases has relied on the revenue stream from enhanced oil recovery (EOR). While first pilot projects have started, the policies currently in place are insufficient to facilitate the commercial deployment of CCS/CCUS.

11. In order to maximise its positive impact on ensuring lower cost reliable grid performance, CCS/CCUS needs to achieve commercial scale prototype roll out for which there is a critical need for political action to encourage private investment in such projects. This requires strong policy related drivers that can lead to powerful government supportive financial and regulatory framework conditions that can permit industry to deploy their best capabilities, in ways that the capital markets can embrace.

IV. Policy enablers

12. To date, the policies currently in place are either inappropriate or insufficient to enable extensive deployment of commercial scale CCS/CCUS technologies at the rates required to meet global climate targets. The rollout of CCS/CCUS that is needed represents a strategic demand to ensure comprehensive capture from various coal (gas) power and probably industrial units, supported by a hub-based CO_2 transport network with the CO_2 either being used for EOR applications or neutralised through geological storage. This requires in most countries the need for a cooperative approach between government and industry and action to:

(a) Ensure awareness and building case for CCS/CCUS so that it is positively included within national agendas;

(b) Establish policy driven enablers that will establish international frameworks that will lead to CCS/ CCUS reducing carbon emissions, facilitate deployment of CCS/ CCUS and build regional skills and capacity capabilities;

(c) Identify and counter policy barriers so that (government led) framework conditions can permit industry to deploy their best capabilities, in ways that the capital markets can embrace. It is stressed that clearly defined fiscal policies will be very important to encourage deployment of commercial scale additional CCS/CCUS units.

13. Whilst a comprehensive framework to support the wide-scale roll out of CCS/CCUS remains to be established, supportive policy mechanisms and project conditions exist. The ECE Task Force on Carbon Neutrality highlights following mechanisms to scale commercialization of the CCS/CCUS projects:

(a) **Developer financing** – For pilot projects and the early demonstration plants, a proportion of the increased operating costs may be absorbed by the project developer as part of a wider business strategy, for example to improve their environmental image, ease government approval for a specific project, or help promote their own CCUS technology;[2]

(b) **Revenue from EOR applications** – Value placed on CO_2 capture for EOR has been the primary financial mechanism supporting 14 out of 21 CCS/CCUS demonstration projects. Current revenues are in the range of 10-35 US$/t$CO_2$;

(c) **Tax credits** - The use of tax credits to reduce the stakeholder liability subject to CO_2 being captured and stored in conformance with national requirements. This option is well established in the context of climate change mitigation, having been used to supplement the revenues from EOR projects and to provide an incentive for the geological storage of CO_2. These credits seek to link directly the financial compensation to the amount of CO_2 stored and are a major enabler of the 6 large-scale facilities in the United States that have come on stream since 2011;

(d) **Carbon pricing** - More positive carbon price signals would drive the growth in CCS/CCUS. Whether the carbon price is effectively valued through carbon emitted, emissions trading schemes or tax credits on the amount of CO_2 stored, studies based on

[2] Lockwood T (2018) Overcoming barriers to carbon capture and storage through international collaboration. CCC/284, London, UK IEA Clean Coal Centre, 91 pp (Mar 2018)

demonstration projects suggest that the value needs to be around 40-80 US$/tCO$_2$ in 2020, increasing to 50-100 US$/tCO$_2$ by 2030.[3] However, this will be a challenge since there are currently very few carbon pricing regimes that are consistent with these levels. In addition, while carbon pricing may be the most effective way to reduce emissions socio-economic implications show that actual implementation of such policy mechanics, can be more difficult than anticipated;

(e) **Emissions trading schemes (ETS)** – A policy mechanism that limits CO_2 emissions based on allocated permits that allow a discharge of specific quantity of CO_2 emissions over defined timeframe. In Europe, the latest EU ETS review in 2018 strengthened the Market Stability Reserve (the mechanism to reduce the surplus of emission allowances) and increased the pace of emissions cuts. The overall number of emission allowances will decline at an annual rate of 2.2% from 2021 onwards, compared to 1.74% currently. This review has delivered a stronger carbon price, which fluctuated at around US$28 for most of 2019. However, for the European Union, this will not benefit CCS/ CCUS since the EC Green Deal plan that is being put together will curtail coal use in all applications. As such, the possible inclusion of CCUS is being abandoned within this region.

(f) **Capital grants** – As development of CCS/CCUS facilities requires large capital investments, governments can provide grant support to bridge funding deficits.[4] Such funding rewards early projects for the knowledge they create, which can be used later by subsequent project developers, so making investments more attractive to private sector investors by improving the rate of return on investment and reducing financing risk.[5]

(g) **State ownership of CCUS facilities** – Supporting CCS/CCUS projects through state ownership has several advantages, such as direct support of the development of new industries, access to lower interest rates that eventually bring down the overall project costs and existing track-record in dealing with contractors with naturally monopolistic characteristics in transport and storage infrastructure projects.

14. Such an approach can deliver more positive carbon pricing signals, provide investment for carbon transport and storage infrastructure and provide more accessible debt and equity financing on the back of lowering CCS/CCUS specific project risk. It is stressed that deployment will only take place with strong positive government support in partnership with the private industrial sector.

V. Financing of CCS/CCUS projects and reducing risks

15. The availability of debt financing for CCS/CCUS projects needs to increase significantly and banks have a critical role to play. For capital intensive investment projects such as establishing CCS/CCUS facilities, the cost of debt and equity can have a significant impact on a project's financial viability. To qualify for debt financing, project developers will need to provide assurance that key risks are identified with mitigations in place and that hard to manage risks are allocated to government in the short term. The cost of debt will need to reduce from the current 14–15% level to closer to less than 10% in the medium term, as successive CCS/CCUS projects are able to address risk and drive down the cost of debt risk premium.

16. In terms of a possible technology package, the hub and cluster approach should be adopted to enable the sharing of transport and storage networks. This can improve the

[3] World Bank (2019) State and Trends of Carbon Pricing, Available from: https://openknowledge.worldbank.org/handle/10986/31755, World Bank Group, Washington DC, 97 pp (Jun 2019)

[4] Sloss L (2019) Technology readiness of advanced coal-based power generation systems. CCC/292, London, UK, IEA Clean Coal Centre, 113 pp (Feb 2019)

[5] CIAB (2019) Learning by doing: The cost reduction potential for CCUS at coal-fired power plants. Available from: https://CCUSknowledge.com/pub/CIAB_Report_LessonsByDoing_CCUS_onCoal_Nov2019(1).pdf, Coal Industry Advisory Board Submission to the International Energy Agency, 43 pp (Nov 2019)

economics of CCS/CCUS due to economies of scale and overall de-risking of storage liability and cross-chain risk.[6]

17. Fossil fuel power plants with CCS/CCUS could form the anchor for these clusters with local industries feeding in their captured CO_2. There is, however, likely to be an initial investment barrier to the shared hub and cluster infrastructure where the balance of risk and return is insufficient for initial private sector investment. In this case, the government could consider taking this role to kickstart a hub and cluster development. For any storage aspect that does not depend on CCUS, a co-ordinated CO_2 storage assessment programme is required, very early in any project development plan.

VI. Multi-stakeholder policy dialogue and awareness raising

18. CCS/CCUS must be a key component of achieving a net zero carbon footprint in the ECE region by 2050. Any major CCS/CCUS projects need to be positively supported by high profile champions both to ensure government support but also to maintain momentum and interest with the general public. CCS/CCUS champions such as investors and non-governmental organisations need to be coordinated to provide proactive support for the commercial introduction of CCS/CCUS technology. These need to include the Carbon Sequestration Leadership Forum (CSLF) and the Global Carbon Capture and Storage Institute (GCCSI), since these two high-profile international organisations have prominently campaigned for greater political action on CCS/CCUS deployment. They have focussed on raising public and political awareness to keep CCS/CCUS on the political agenda, particularly through raising its profile at international forums such as the United Nations Climate Change Conferences (COP) and the Clean Energy Ministerial. They need to present a compelling vision of the key role that CCS/ CCUS needs to fill in ensuring a successful move towards carbon neutrality. This must include building the global case for CCS/CCUS so that it is positively included and acted upon as part of national agendas. This represents a far greater impact than has been achieved to date.

19. The challenge for building a case for CCS/CCUS technology as a key component of sustainable energy future does not have adequate resonance in the ECE region due to its still high cost as well as its association with use of coal in power generation. This has led to the fact that various multi-lateral development banks no longer support new coal projects having thus also negative effect on CCS/ CCUS plants developments. Without access to competitive finance options, it will be difficult to put together viable business plans, even if tax credits and other incentives are made available from a host country's government.

20. As the coal remains the energy source of choice for many countries in the ECE region to meet their technical, financial and socio-economic needs, a capacity building on achieving low carbon coal systems is critical.

21. This is not an easy message to formulate and disseminate but it is essential to do so if the case for CCS/CCUS is to be made successfully. This will require the provision of carefully prepared policy statements that can make the case to government officials and other policymakers. It will also be more effective if similar messages can be used in communications with the public and other stakeholders.

22. Awareness of CCS/CCUS among the general public is low in most regions, but surveys of better-informed groups suggest that acceptance of CCS is improved when it is presented as one component of a lower-carbon energy mix. Based on experiences of early pilot and demonstration projects, and drawing on established public engagement techniques from other industries, several best practice guidelines for CCS/CCUS communications with the public could be adopted, including:

[6] Zapantis A, Townsend A, Rassool D (2019) Policy Priorities to Incentivise Large Scale Deployment of CCUS, Available from: https://www.globalCCUSinstitute.com/wp-content/uploads/2019/04/TL-Report-Policy-prorities-to-incentivise-the-large-scale-deployment-of-CCUS-digital-final-2019-1.pdf, Global CCUS Institute, Melbourne, Australia, 32 pp (Apr 2019)

(a) Identify key local stakeholders and evaluate local demographics and attitudes;

(b) Engage as early as possible – ideally before the site is finalised;

(c) Actively seek and respond to public feedback;

(d) Tailor key messages to the audience and emphasise community benefits; and

(e) Get coal (and gas) CCS/CCUS units built and operational.

23. Ongoing deployment of the recent CCS/CCUS demonstration projects worldwide is already helping to improve public familiarity with the technology, and these working examples should be fully exploited by outreach and education campaigns to dispel the lingering perception that CCS/CCUS is an unproven technology. A path forward for CCS/CCUS communication should aim to reach a wider audience, and would benefit from greater collaboration between government officials, industry leaders, and researchers to formulate a consistent positive message, which is aligned with policy and scientific consensus.

VII. Next steps and timeline

24. The Group of Experts is invited to participate actively in policy-dialogues and developments of materials on CCS/CCUS and to support the Task Force on Carbon Neutrality in project implementation. The following activities are planned to take place in the period from November 2020 – October 2021:

(a) October 2020 - January 2021: Verification of data and CCS/CCUS technology assumptions;

(b) 23 November 2020: Roundtable on Carbon Capture and Storage;

(c) December 2020 - February 2021: Finalisation of technology brief on CCS/CCUS;

(d) January - May 2021: Series of workshops on modelling results and refinement of CCS/CCUS technology inputs;

(e) February- June 2021: Workshop on development of financial guidelines for the modernisation of the power and energy intensive industries and drafting of guidelines;

(f) July - August 2021: Project reporting and preparation of outreach materials;

(g) September 2021: Policy dialogue at the 30th session of the Committee on Sustainable Energy;

(h) October 2021: Policy dialogue and final project presentation at the seventeenth session of the Group of Experts on Cleaner Electricity Systems.