GLOBAL CCS INSTITUTE

Brief

CCS in the latest IPCC report “Mitigation of Climate Change”

Global CCS Institute

Noora Al Amer, Senior International Climate Policy Advisor

April 2022

Contents

Introduction

The much anticipated Intergovernmental Panel on Climate Change (IPCC) Working Group III (WG3) Report: Mitigation of Climate Change was published on April 4 2022, six hours later than expected in a line-by-line virtual approval process involving 195 member governments. The WG3 report is preceded by Working Group I (WG1): the Physical Science Basis of Climate Change and Working Group II (WG2): Impacts, Adaptation and Vulnerability, marking the final, and arguably most contentious, instalment of the work of Sixth Assessment Report (AR6). The 6 to 7 year reporting cycle of AR6 is scheduled to effectively end in September, with the publication of its Synthesis Report. During this reporting cycle, the IPCC also published three Special Reports, namely "Global Warming of 1.5˚C", "Climate Change and Land", and "Ocean and Cryosphere in a Changing Climate", with the first being of most relevance to CCS.

The work of the IPCC aims to provide policymakers with regular scientific assessments on climate change. Over a backdrop of the highest levels of emissions in human history shown in the last 10 years (2010-2019), WG3 goes onto deliver its remit to provide an updated assessment of mitigation progress and pledges, laying the groundwork for pathways that meet the objectives of the Paris Agreement. WG3 is the chapter directly related to CCS, where the Institute has correspondingly participated in the submissions of two rounds of comments in the process of the report's writing.

To echo the IPCC , the next few years are critical. The message of the report is clear: the time for action is now. Global GHG emissions need to peak between 2020 or at the latest before 2025 to limit warming to 1.5˚C, and this will require major transitions in the energy sector.

Key Takeaways from the Report

- Carbon capture and storage (CCS) is an option to reduce emissions from large-scale fossil-based energy and industry sources, provided geological storage is available
- The technical geological CO_2 storage capacity exceeds the CO_2 storage requirements through 2100 to limit global warming to 1.5°C, although regional availability could be a limiting factor
- If geological storage sites are appropriately selected and managed, CO_2 can be permanently isolated from the atmosphere
- CO_2 capture and subsurface injection is a mature technology for gas processing and enhanced oil recovery
- Compared to the oil and gas sector, CCS is less mature in the power sector as well as cement and chemical production, where it is a critical mitigation option
- Current global rates of CCS deployment are far below those in modelled pathways to limit global warming to 1.5°C or 2°C
- CCS implementation currently faces technological, economic, institutional and ecological-environmental and socio-cultural barriers

- Policy instruments, greater public support and technological innovations could reduce barriers to CCS deployment
- Government policy instruments for CCS include financial instruments such as emission certification and trading, legally enforced emission restraints, and carbon pricing
- When CO_2 is captured directly from the atmosphere through Direct Air Carbon Capture and Storage (DACCS) or from Bioenergy with Carbon Capture and Storage (BECCS), CCS provides the storage component of these carbon dioxide removal (CDR) methods
- While the future of hydrogen (H_2) is still uncertain, CCS may kick-start the H_2 economy, through fossil fuels reforming with CCS "blue" sources

CCS in Mitigation Pathways

To limit warming to 1.5°C with no or limited overshoot involves rapid, deep and largely immediate GHG emission reductions in all sectors. Compared to the Special Report on 1.5˚C, WG3 brings to the table the assessment of near term (to 2030) future pathways to join medium term (up to 2050) and long term (to 2100) timescales. This sets the stage for urgent mitigation action needed this decade, for which CCS is one of the main deep decarbonisation options. Correspondingly, CCS is included in almost all of the mitigation pathways to limit warming to 1.5°C. The following is an overview of the report's main observations by sector.

Energy

Reducing emissions across the full energy sector requires major transformation, where the transition to fossil fuels with CCS is now more necessary than ever. Current fossil fuel infrastructure will need to be either retired early, used less, or retrofitted with CCS to contribute to aligning future CO_2 emissions from the power sector. The report clarifies that CCS will allow fossil fuels to be used longer, thereby considerably reducing the potential for stranded infrastructure assets

In modelled pathways that limit warming to 1.5˚C and 2˚C, in 2050 almost all electricity is supplied from zero to low-carbon sources, such as fossil fuels with CCS. Net zero CO_2 systems are mentioned to entail the minimal use of unabated fossil fuels, and the use of CCS in the remaining fossil system, where CDR will be needed to counter-balance residual emissions in the energy sector (for more on CDR, please see the Update on CDR section in this report).

WG3 mention that CCS deployment depends on national and regional circumstances, including appropriate legal and regulatory conditions and technology availability. It should be noted that capture rates for new installations with CCS are assumed to be 90-95%+, with comparable capture rates for retrofit installations if plants are specifically designed for CCS retrofits.

Zooming in, variations exist based on the type of fossil fuel in the energy sector. Here, coal is under particular pressure. Pathways to limit warming involve near elimination of coal use without CCS. According to the scenarios, without carbon capture, a coal power plant would need to retire 23 years earlier than expected in its lifetime, with assets projected to be most at risk of being stranded before 2030. Slightly more leeway seems to be available for the oil & gas industry, where it shows a 17 year reduction in lifetime expectancy of a gas power plant without CCS and an increased risk for oil & gas without CCS being stranded by mid-century. How unburned fossil fuels and stranded asset risk will look on balance sheets is also demonstrated, with a combined discounted value to the tune of 1 to 4 trillion dollars from 2015 – 2050 to limit global warming to 2°C (and higher if warming is to be limited by 1.5°C).

Meanwhile, CCS networks and adapted infrastructure are set to become more sustainable in future geo-economics. Hydrogen, CCU, and CCS are all said to require significant new or adapted infrastructure. The full report gives Rotterdam and Teeside clustering 'eco-park' projects as examples of more physical and cost-effective sharing of electricity.

Industry

The mitigation potential in the Industrial sector differs depending on the subsector and the availability of CCS, where the largest potential reductions are found to be in the manufacture of cement and steel. Similar to energy, asset stranding also features as a looming risk in these industries, where blast furnaces and cement factories without CCS could face stranding under strong climate policy. For many existing cement and steel plants, the lowest cost, fastest and largest potential for abatement path is shown to be through retrofitting CCS.

In the cement industry, WG3 clarifies that until new chemistries are mastered and commercialized - which is not expected in the near to medium term - CCS is essential for deep reduction in emissions. This is key when looking at making clinker for Portland cement, which currently represents 60% of GHG emissions in plants with the best available technology. In the steel industry, along with material efficiency and recycling, various levels of CCS applications will be required for production decarbonization. This requires very low and zero-emission production based on high-capture CCS technologies. For the production and use of chemicals, the report mentions that reducing emissions partially depends on the availability of CCU, DACCS and CCS. Emissions-intensive and highly traded materials industries also include CCS as a mitigation option, which is defined as 'other abatement infrastructure'.

CCS Economics

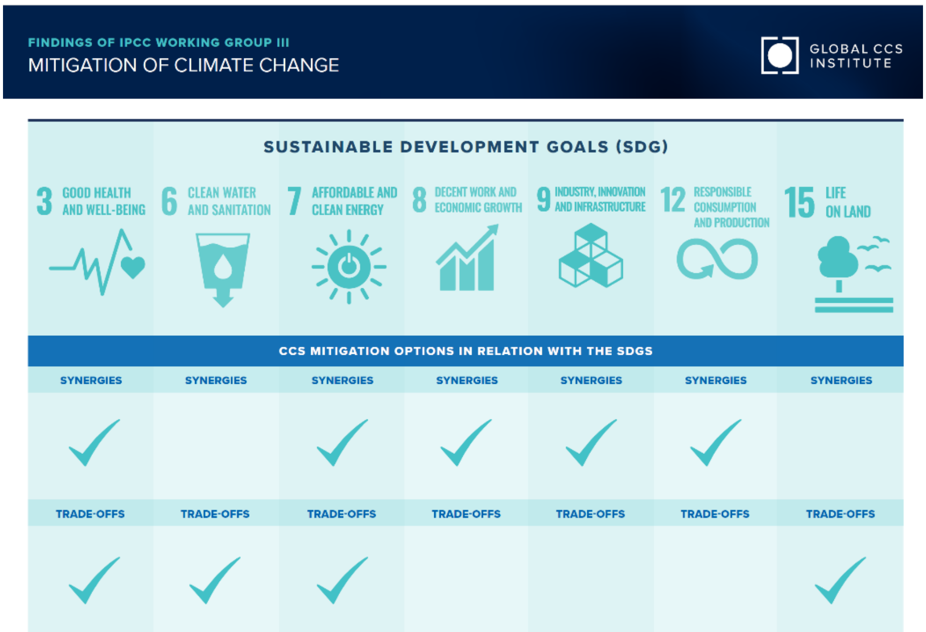
The report compares the rapid progress in cost, performance and adoption of low-carbon technologies like solar, wind and batteries with the slower than expected adoption of CCS in the electricity sector. This is an unfair comparison. From a purely economic perspective, wind and solar produce a valued commodity – electricity. CCS instead avoids the damage of CO_2 being released into the atmosphere, and unless there is a monetary value associated to this action, there will be inherent economic and deployment limitations. This can be addressed on a policy level using examples found in the report from the United States, where CCS is promoted by the recent offering of nationwide tax credits for CO_2 capture projects, which offset CO_2 capture costs at some efficient plants, as well as through benefits for low-carbon fuel standards in some industrial facilities for CO_2 capture in California.

Update on CDR

The increase in published literature on CDR corresponds with the release of the Global Warming of 1.5°C report in 2018, which has given impetus for a comprehensive assessment of CDR in the WG3 report. Development on CDR includes taxonomy building, where the lines between 'nature-based' and 'tech-based' CDR were necessarily blurred. DACCS (removing CO_2 from the atmosphere) and BECCS (capturing and storing CO_2 from biomass electricity generation) are shown to display the highest timescale of storage - ten thousand years or longer. The value of CDR as a mitigation option was found to accelerate near-term mitigation and be 'unavoidable' and 'necessary' to counterbalance residual emissions from hard-to-abate sectors (where emissions cannot be avoided), as well as help achieve net-negative emissions. It was clarified that when it comes to the use of fossil fuels, CCS and CCU reduce, rather than remove, CO_2 emissions and are therefore not considered CDR.

CCS in Global Sustainable Development

As CCU and CCS are identified as playing key roles in the transition of industry to net-zero, they will have direct and indirect interactions with global broader economic, social and environmental objectives. Keeping with the 2030 Agenda for Sustainable Development, WG3 considers CCS and CCU through the prism of the 17 Sustainable Development Goals (SDGs). The relationship found is depicted below:



For further reading, please see Figure SPM.8

CCS in Country Studies

The scaling of CCS depends on a number of factors by country and region. From a research perspective, WG3 report that CCS is present in many accelerated mitigation scenarios in the literature. Below is an overview of individual analyses by country included in section 4.2.5.4 of the full report:

TABLE OF FINDINGS FROM IPCC WORKING GROUP III: MITIGATION OF CLIMATE CHANGE	
COUNTRY/REGION	CCS IN ACCELERATED MITIGATION SCENARIOS
Brazil	BECCS and CCS in hydrogen generation more feasible than CCS in thermal power plants
Latin America	33-50% of total electricity generation could be covered by CCS
Japan	CCS and increased bioenergy adoption plus waste-to-energy and hydrogen-reforming from fossil fuel are all considered necessary in the power sector
Parts of the EU	After 2030, CCS could become profitable with rising CO_2 prices
France and Sweden	CCS and BECCS included to meet net zero emissions by 2050
Italy	Propose a zero-emission electricity scenario with a combination of renewable and coal, natural gas and BECCS
China	CCS is necessary for remaining coal and natural gas generation 2050 under 1.5°C and 2°C compatible pathways
India	Some studies indicate that CCS would be necessary while others do not

Public Engagement

The WG3 report mentions that the public is largely unfamiliar with CCS, where many people may not have formed stable attitudes and risk perceptions on the technology. The report also reports low public support for the technology, and that although few totally reject CCS, specific CCS projects have faced strong local resistance, which has contributed to the cancellation of CCS projects. It must also be noted that the majority of the literature cited in this section of WG3 dates back to before the Global Warming of 1.5°C report in 2018, and therefore may not reflect current public views. In a published thought leadership report, Scaling up the CCS market to deliver net-zero emissions, GCCSI provides several insights into the survival rates of CCS projects over the past decade which demonstrates an improving story over time. This highlights an opportunity and indeed, need for, cyclical research and community engagement that can assist in connecting the CCS industry and the public as the mitigation technology landscape evolves.

Conclusion

In a growing world with growing needs, a conscious and comprehensive technological approach that includes CCS will enable us to deliver the action required to strengthen the global response to climate change needed today. WG3 shows us the effectiveness of widescale deployment of CCS across various scenarios and sectors, demonstrating the level of opportunity that the technology offers us. Acting within the heart of the solution, the deployment of CCS can help resolve the lion's share of emission reduction in energy and industry needed in the near and medium term to achieve the objectives of the Paris Agreement. With global ambition for net-zero and net-negative CO_2 emissions taking center stage, the report opens up the CCS toolbox with a closer look at DACCs and BECCs, while highlights the role of CCS in the promise for blue hydrogen.