Brief

CCS in the IPCC Sixth Assessment (AR6) Synthesis Report

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Contents

Overview

The Intergovernmental Panel on Climate Change (IPCC), now on its sixth assessment cycle, published its "*Climate Change 2023: Synthesis Report*" on 20 March 2023. The Synthesis Report is based on the content of the three Working Groups Assessment Reports and the three Special Reports which have been previously released[1].

As the 28th Conference of the Parties (COP 28) hosted by the United Arab Emirates in November is approaching, this latest IPCC report aims to inform discussions and negotiations at the upcoming COP, including the first Global Stocktake. Building on the Special Report of 1.5 °C and the WGIII Report on Mitigation, the Synthesis Report once again highlights the importance of carbon capture and storage (CCS) in addressing climate change.

Key Takeaways on CCS and Climate Change

Carbon Capture and Storage and Climate Targets

The IPCC AR6 Synthesis Report reiterates that global modelled mitigation pathways reaching net zero CO_2 and GHG emissions include transitioning from fossil fuels without CCS to very low- or zero-carbon energy sources, such as renewables or fossil fuels with CCS, demand-side measures and improving efficiency, reducing non-CO_2 GHG emissions, and carbon dioxide removal (CDR).

Touching on the value of CCS in other hard-to-abate sectors, the report refers to the technology as a critical CO_2 mitigation option for the power sector, along with cement and chemical production, but acknowledges that its application in these industries is currently less mature compared to its deployment in the oil and gas sector.

It is worth noting that in the IPCC Special Report on 1.5˚C, three of the four pathways depicted involve major use of CCS. According to these three pathways, somewhere between 350 and 1200 gigatonnes of CO_2 will need to be captured and stored within this century (see Appendix 1). The scenario that does not utilise CCS requires the most radical change in human behaviour.

In the IPCC WG III report on Mitigation, most pathways also incorporate CCS, including the pathway that heavily relies on renewable technologies. The scenario that does not include CCS requires a significant reduction in global energy demand. The IPCC states that net-zero CO_2 energy systems entail a substantial reduction in overall fossil fuel use, minimal use of unabated fossil fuels, and use of CCS in the remaining fossil system (see Appendix 2).

[1] The Synthesis Report is based on the content of the three Working Groups Assessment Reports: *WGI – The Physical Science Basis*, *WGII – Impacts, Adaptation and Vulnerability*, *WGIII – Mitigation of Climate Change*, and the three Special Reports: *Global Warming of 1.5°C*, *Climate Change and Land*, *The Ocean and Cryosphere in a Changing Climate*

Geological Storage

Timely development of CO_2 storage resources is critical for accelerating the scaling up of CCS deployment. The Synthesis Report notes that there is enough potential CO_2 storage to scale up CCS to where global warming can successfully be capped at 1.5°C degrees, pointing out that "The technical geological storage capacity is estimated to be on the order of 1000 $GtCO_2$, which is more than the CO_2 storage requirements through 2100 to limit global warming to 1.5°C[2]." The report also confirms that "If the geological storage site is appropriately selected and managed, it is estimated that the CO_2 can be permanently isolated from the atmosphere[3]."

Carbon Dioxide Removal

According to the Synthesis Report, CDR technologies, such as Direct Air Carbon Capture and Storage (DACCS), will be needed to counter residual emissions from hard-to-abate industrial processes and sectors such as aviation, shipping, and chemical industries. The report adds: "When CO_2 is captured directly from the atmosphere (DACCS), or from biomass (BECCS), CCS provides the storage component of these CDR methods[4]", underlining the close synergies between these critical climate technologies.

Solutions to Move CCS Forward

The IPCC notes that currently global rates of CCS deployment are far below those in modelled pathways limiting global warming to between 1.5 °C to 2°C and stresses that enabling conditions such as policy instruments, greater public support and technological innovation are needed to scale up deployment.

[2] IPCC, 2023: *Climate Change 2023: Synthesis Report, Summary for Policymakers, p.22*
[3] IPCC, 2023: *Climate Change 2023: Synthesis Report, Summary for Policymakers, p.22*
[4] IPCC, 2023: *Climate Change 2023: Synthesis Report, Summary for Policymakers, p.22*

References

IPCC, 2023: *Climate Change 2023: Synthesis Report*. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, (in press)

IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, (in press).

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

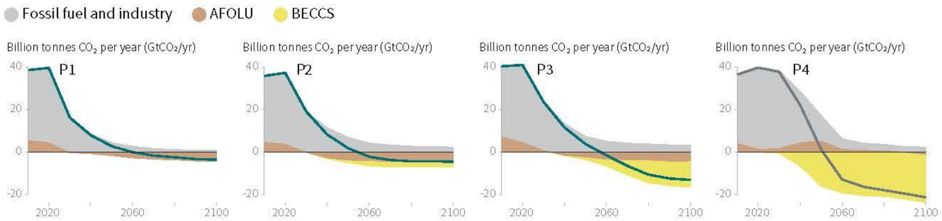
IPCC, 2022*: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926

Appendix 1: CCS across the four illustrative pathways in the IPCC Special Report on Global Warming of 1.5°C

Characteristics of four illustrative model pathways

Different mitigation strategies can achieve the net emissions reductions that would be required to follow a pathway that limits global warming to 1.5°C with no or limited overshoot. All pathways use Carbon Dioxide Removal (CDR), but the amount varies across pathways, as do the relative contributions of Bioenergy with Carbon Capture and Storage (BECCS) and removals in the Agriculture, Forestry and Other Land Use (AFOLU) sector. This has implications for emissions and several other pathway characteristics.

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways



P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Global indicators	P1	P2	P3	P4	**Interquartile range**
Pathway classification	No or limited overshoot	No or limited overshoot	No or limited overshoot	Higher overshoot	No or limited overshoot
CO_2 emission change in 2030 (% rel to 2010)	-58	-47	-41	4	(-58,-40)
↳ in 2050 (% rel to 2010)	-93	-95	-91	-97	(-107,-94)
Kyoto-GHG emissions in 2030 (% rel to 2010)*	-50	-49	-35	-2	(-51,-39)
↳ in 2050 (% rel to 2010)	-82	-89	-78	-80	(-93,-81)
*Final energy demand** in 2030 (% rel to 2010)*	-15	-5	17	39	(-12,7)
↳ in 2050 (% rel to 2010)	-32	2	21	44	(-11,22)
Renewable share in electricity in 2030 (%)	60	58	48	25	(47,65)
↳ in 2050 (%)	77	81	63	70	(69,86)
Primary energy from coal in 2030 (% rel to 2010)	-78	-61	-75	-59	(-78, -59)
↳ in 2050 (% rel to 2010)	-97	-77	-73	-97	(-95, -74)
from oil in 2030 (% rel to 2010)	-37	-13	-3	86	(-34,3)
↳ in 2050 (% rel to 2010)	-87	-50	-81	-32	(-78,-31)
from gas in 2030 (% rel to 2010)	-25	-20	33	37	(-26,21)
↳ in 2050 (% rel to 2010)	-74	-53	21	-48	(-56,6)
from nuclear in 2030 (% rel to 2010)	59	83	98	106	(44,102)
↳ in 2050 (% rel to 2010)	150	98	501	468	(91,190)
from biomass in 2030 (% rel to 2010)	-11	0	36	-1	(29,80)
↳ in 2050 (% rel to 2010)	-16	49	121	418	(123,261)
from non-biomass renewables in 2030 (% rel to 2010)	430	470	315	110	(245,436)
↳ in 2050 (% rel to 2010)	833	1327	878	1137	(576,1299)
Cumulative CCS until 2100 ($GtCO_2$)	0	348	687	1218	(550,1017)
↳ of which BECCS ($GtCO_2$)	0	151	414	1191	(364,662)
Land area of bioenergy crops in 2050 (million km²)	0.2	0.9	2.8	7.2	(1.5,3.2)
Agricultural CH_4 emissions in 2030 (% rel to 2010)	-24	-48	1	14	(-30,-11)
in 2050 (% rel to 2010)	-33	-69	-23	2	(-47,-24)
Agricultural N_2O emissions in 2030 (% rel to 2010)	5	-26	15	3	(-21,3)
in 2050 (% rel to 2010)	6	-26	0	39	(-26,1)

NOTE: Indicators have been selected to show global trends identified by the Chapter 2 assessment. National and sectoral characteristics can differ substantially from the global trends shown above.

** Kyoto-gas emissions are based on IPCC Second Assessment Report GWP-100*
*** Changes in energy demand are associated with improvements in energy efficiency and behaviour change*

Appendix 2: CCS across the scenarios in the IPCC WGIII Report on Mitigation of Climate Change

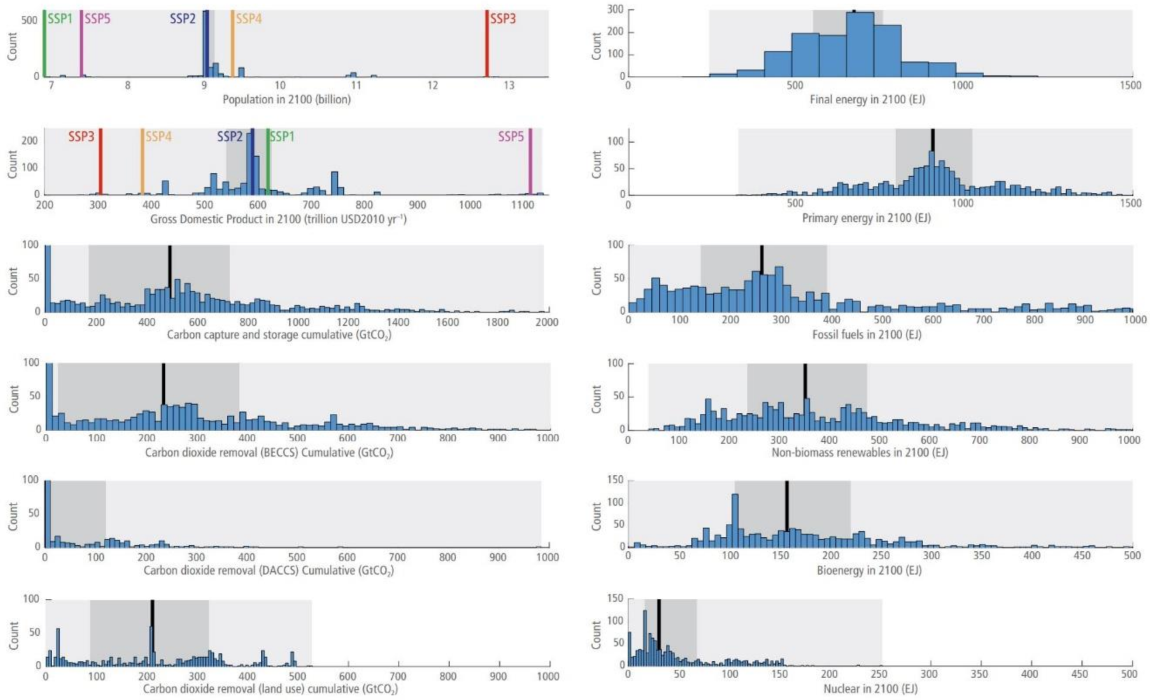


Figure 3.4 | Histograms for key categories in the AR6 scenario database. Only scenarios that passed vetting are shown. For population and GDP, the SSP input data are also shown. The grey shading represents the 0–100% range (light grey), 25–75% range (dark grey), and the median is a black line. The figures with white areas are outside of the scenario range, but the axis limits are retained to allow comparability with other categories. Each sub-figure potentially has different x- and y-axis limits. Each figure also potentially contains different numbers of scenarios, depending on what was submitted to the database. Source: AR6 scenarios database.