Lost in Translation

Lessons from the IPCC's Sixth Assessment on the Urgent Transition from Fossil Fuels and the Risks of Misplaced Reliance on False Solutions

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Introduction

The Sixth Assessment Cycle (AR6) of the Intergovernmental Panel on Climate Change (IPCC) will conclude in March 2023 with the release of a Synthesis Report (SYR) and Summary for Policymakers (SPM). This assessment cycle covers six major reports that the IPCC has released since 2014: three special reports (Global Warming of 1.5°C; Climate Change and Land; and The Ocean and Cryosphere in a Changing Climate) and the reports of the three Working Groups (The Physical Science Basis; Impacts, Adaptation and Vulnerability; and Mitigation of Climate Change).

These reports taken together reflect an undeniable scientific consensus about the urgency of the climate crisis, its primary causes, and the irreversible harm that will occur if warming surpasses 1.5°C, even temporarily. The Sixth Assessment of the IPCC makes clear: A rapid fossil fuel phaseout and rollout of renewable energies alongside energy efficiency and demand-side measures remain the clearest and most certain path to avoid overshoot. The IPCC also reaffirms the dangers of governments' and industries' reliance on the future availability of problematic technologies that are not proven at scale, like carbon capture and storage (CCS), technological carbon dioxide removal (CDR), and other geoengineering approaches, while taking grossly insufficient action **now** to immediately, urgently, and drastically reduce emissions.

However, most modeled IPCC mitigation pathways and associated policy scenarios that inform government decisions do not foreground the types of measures that should follow from these scientific conclusions. Built-in biases and assumptions in the models, such as endless and inequitable growth and exclusion of costs of future climate impacts, lead to dangerous overemphasis on largely speculative technologies and future action. This bias is due to the fact that until recently, the IPCC has only had a few models to build on that do not have these shortcomings. For now, policymakers must weigh oversimplified projections in existing models with great caution.

This brief draws on two analyses that the Center for International Environmental Law (CIEL) and the Heinrich Böll Foundation published in 2022 on the IPCC's Working Group II (WGII) and Working Group III (WGIII) reports and includes references from other reports of the AR6 cycle and additional relevant academic literature to inform interpretations of the AR6 Synthesis Report.

Because clear findings and warnings are often buried and downplayed in the Summary for Policymakers, this brief is meant as a metric and counterpoint — to weigh the IPCC's AR6 SYR SPM against the underlying AR6 reports to highlight findings that are significant and essential to understanding the climate actions necessary to prevent and minimize the risk of catastrophic impacts of overshoot, and to design the just and equitable path ahead.

I. The IPCC Sixth Assessment Report unequivocally warns that exceeding 1.5°C warming (overshoot) has dangerous and irreversible consequences, even if temperatures might eventually be brought back below that level.

A world that returns from overshoot looks fundamentally different from one that limits warming to 1.5°C, if a return would even be possible. Even temporary overshoot of 1.5°C would result in adverse and potentially catastrophic impacts that are irreversible on time-scales from centuries to millennia, or in the case of species extinctions, simply irreversible. "Even if the Paris temperature goal is still reached by 2100," after warming exceeds 1.5°C or 2°C around mid- century, "this 'overshoot' entails severe risks and irreversible impacts on many natural and human systems." [WGII TS.C.13.1 at TS-69; see also Table 6.1 of the Special Report on the Ocean and Cryosphere for an assessment of abrupt and irreversible phenomena related to the ocean and cryosphere at p. 595]

Every fraction of a degree matters when it comes to preventing dangerous global warming. "Risks to ecosystem integrity, functioning and resilience are projected to escalate with every tenth of a degree increase in global warming *(very high confidence)*." [WGII TS.C.1.2 at TS-55] Each incremental change in temperature will generate corresponding "increases in the frequency and intensity of hot extremes, marine heatwaves, heavy precipitation, and, in some regions, agricultural and ecological droughts; an increase in the proportion of intense tropical cyclones; and reductions in Arctic sea ice, snow cover and permafrost." [WGI SPM B.2 at SPM-15]

We cannot simply turn back the thermostat. Overshoot also increases the chance of triggering climate "tipping points" and self-reinforcing feedback loops, such as permafrost thawing and the collapse of forest ecosystems. Such events would greatly amplify warming and associated adverse impacts [WGI SPM C.3.2 at SPM-27; WGII TS.C.13.2 at TS-69] and make "return to a given global warming level or below...more challenging." [WGII SPM B.6.2 at SPM-20]

There are significant scientific and technical uncertainties around the potential for reversing overshoot by removing large quantities of carbon dioxide from the atmosphere. For example, scientists anticipate a rebound of carbon dioxide from natural land and ocean sinks in response to large-scale human-mediated atmospheric removals, such that "an extra amount of CDR" would be required to compensate for the rebound "to attain the same change in atmospheric CO_2." [WGI TS.3.3.2 at TS-99; WGI Ch. 5, ES at p. 678 & 5.6.2.1.4, Figure 5.35 at p. 761; see also Special Report on Climate Change and Land (SRCCL), Ch. 7, 7.2.3.2 at p. 686] This risk of rebound after removal, coupled with the impermanence of removals, undercuts the projected role of CDR in climate pathways and complicates the ability to predict whether and how CDR may operate to alter conditions after overshoot. [WGI Ch. 5, 5.6.2.1 at p. 757]

II. The IPCC Sixth Assessment Report clearly sets out the near-term actions and fossil fuel phaseout required to keep temperature rise below 1.5°C, with minimal to no overshoot.

Immediate and rapid phaseout of all fossil fuels is the cornerstone of any and all mitigation strategies. "The achievement of long-term temperature goals in line with the Paris Agreement requires the rapid penetration of renewable energy and a timely phasing out of fossil fuels, especially coal, from the global energy system." [WGIII Ch. 17, 17.3.2.2 at p. 1742] In scenarios with the greatest probability of limiting warming to 1.5°C with no or limited overshoot, and without CCS, the use of coal, oil, and gas must decline by a median of 100, 60, and 70 percent, respectively, by 2050. [WGIII SPM C.3.2 at SPM-24]

Abated fossil fuels only exist in models. Although the Summary for Policymakers of Working Group III included references to "abated" fossil fuels (as those with carbon dioxide emissions capture rates greater than 90 to 95 percent) [WGIII SPM B.7.2 at footnote no. 36, SPM-16; WGIII SPM C.4.1 at footnote no. 54, SPM-28], and several modeled scenarios include carbon capture in their pathways, the underlying WGIII report clearly articulates the limitations of CCS. For one, "CCS always adds cost." [WGIII Ch. 6, 6.4.2.5 at p. 643] Rather than anticipate significant cost reductions, WGIII notes: "Emerging evidence since AR5 indicates that small-scale technologies (e.g., solar, batteries) tend to improve faster and be adopted more quickly than large-scale technologies (nuclear, CCS) *(medium confidence)*." [WGIII TS.3 at TS-67] They further elaborate on the source of cost and its unavoidability. "CO_2 capture costs present a key challenge... The capital cost of a coal or gas electricity generation facility with CCS is almost double that of one without CCS… Additionally, the energy penalty increases the fuel requirement for electricity generation by 13–44%, leading to further cost increases." [WGIII Ch. 6, 6.4.2.5 at p. 642]

CCS remains the highest cost approach, with the least potential, in the near term — the period when rapid emissions cuts are most important. [WGIII Figure SPM.7 at SPM-38] The IPCC is direct about the implications of the significant costs of carbon dioxide capture: "the economic feasibility of [CCS] deployment is not yet clear." [WGIII Ch. 4, 4.2.5.4 at p. 438]

There is enormous potential to scale up real solutions — including energy demand reduction measures — for the rapid reductions needed to keep temperature rise below 1.5°C. Working Group III concluded that "phasing out fossil fuels from energy systems…is technically possible and is estimated to be relatively low in cost." [WGIII Ch. 17, 17.5 at p. 1771]

As noted above, the costs of renewable energy (notably solar photovoltaics (PV), wind power, and batteries) have declined rapidly, and their pace of adoption has exceeded that of other technologies like nuclear and CCS. [WGIII TS.5.1 at TS-89] "Energy efficiency and energy use reduction strategies are…flexible and cost-effective, with the potential for large-scale deployment." [WGIII Ch. 6, 6.6.2.5, at p. 679] Implementing demand-side mitigation strategies across all sectors has the potential to reduce greenhouse gas (GHG) emissions by 40 to 70 percent by 2050. [WGIII Ch. 5, ES at p. 505]

Near- and long-term action will require societal transformations. "Limiting warming to 2°C or 1.5°C will require substantial energy system changes over the next 30 years." [WGIII TS.5.1 at TS-89] Included among the potential pathways forward are measures that would reduce energy demand, replace fossil fuels with renewables, and massively increase electrification. [See WGIII Box TS.5 at TS-77-78; WGIII Ch. 1, 1.5 at p. 173] Beyond energy efficiency, a mitigation strategy called "sufficiency" entails deep reductions in (or even avoidance of) energy demand through non-technological measures like smarter design or downsizing. [WGIII TS 5.4 at TS-101; WGIII Ch. 9, ES at p. 955 & Box 9.1 at p. 957 & 9.9.3.1 at p. 1008]

III. Most IPCC scenarios rely on large-scale CDR to bring temperatures back below a certain threshold in the second half of the century. At the same time, AR6 provides clear warnings about the technological infeasibility, significant financial and environmental costs, and human rights impacts of large-scale CDR.

Technological CDR approaches, such as bioenergy with carbon capture and storage (BECCS) and direct air carbon capture and storage (DACCS), are unproven at scale. [WGIII Ch. 7, 7.4.4 at p. 799; WGIII Ch. 12, 12.3.1 at p. 1266] There are significant risks and harms associated with both approaches; they entail great financial costs that may not follow anticipated cost curves; and they create additional demand for energy and other resources. Moreover, as they are dependent on the development and deployment of CCS for storage of carbon, they face the additional hurdle that the technology has not scaled or achieved cost reductions despite existing for decades (Robertson and Mousavian 2022 at pp. 1, 16, & 32).

DACCS and BECCS would both require massive quantities of resources (including land, water, chemicals, and energy) for their operation at the scales imagined in many IPCC mitigation scenarios. For example, to remove 10 gigatons of carbon dioxide per year, DAC could require up to 100 exajoules of energy, which is **equivalent to the current total** annual global electricity production and one-sixth of the total energy supply. [WGIII Ch. 12, 12.3.1.1 at p. 1265] DACCS could also "require a significant land footprint" and "significantly impact food prices via demand for land and water," with the most severe impacts on vulnerable populations in the Global South. [WGIII Ch. 12, 12.3.1.1 at p. 1266; WGII Ch. 4, 4.7.6 at p. 654]

The immense land and resource implications of large-scale bioenergy production associated with BECCS will conflict with a number of sustainable development goals, including through "competition with food crops, implications for biodiversity, potential deforestation to support bioenergy crop production, energy security implications from bioenergy trade, point-of-use emissions and associated effects on air quality, and water use and fertiliser use." [WGIII Ch. 6, 6.4.2.6 at p. 645; see also SRCCL, Ch. 7, 7.2.3.2 at p. 687] Diverting water to irrigate BECCS plantations could "double the global area and population living under severe water stress compared to the current baseline." [WGII Ch. 4, 4.7.6 at p. 654]

Large-scale CDR threatens human rights (both indirectly and directly), whether or not it can achieve modeled effects. Direct threats can arise through immediate impacts of large-scale CDR projects and their implementation on surrounding communities, and indirectly due to the diversion of resources from proven and necessary mitigation measures and/or a delay of fossil fuel phaseout. Land diversion for afforestation or production of biomass for bioenergy (with or without CCS) or biochar "can compound climate-related risks" to biodiversity, food and water security, local livelihoods, and the rights of Indigenous Peoples. [WGII SPM B.5.4 at SPM-19; see also SRCCL, Ch. 7, 7.2.3.2 p. 687]

Pathways that are designed to include large-scale CDR are inherently overshoot pathways. Even in optimistic scenarios, where the "volumes of future global CDR deployment assumed…are large compared to current volumes of deployment," carbon removal technologies like BECCS and DACCS would not begin removing carbon dioxide from the atmosphere at any meaningful scale until 2050 or later,[1] with DACCS annual CO_2 removal amounting to "0 [0–0.02] $GtCO_2$ yr^{-1} by 2030" and barely reaching "0.02 [0–1.74] $GtCO_2$ yr^{-1} by 2050." [WGIII Ch. 12, 12.3 at pp. 1264–1265; see also WGIII Ch. 12, Figure 12.3 at p. 1264] "Two extensive reviews (Lawrence et al., 2018; Nemet et al., 2018) conclude that it is implausible that any CDR technique can be implemented at the scale needed by 2050." [WGI Ch. 4, 4.6.3.2 at p. 622] In other words, if it were effective — which is far from certain — CDR could only ever help bring us back from overshoot in the second half of this century. Keeping temperatures below 1.5°C of warming is only possible through rapid, immediate, and sustained emission reductions in the coming decade. In the words of the IPCC, "CDR cannot serve as a substitute for deep emissions reductions." [WGIII Ch. 12, Box 8 at p. 1261; see also WGIII Ch. 6, 6.6.2.7, at p. 681]

IV. Because of how they are designed, IPCC models and future mitigation scenarios disproportionately favor CDR and CCS, particularly technologies like BECCS that have huge environmental costs and may not ever be feasible at scale. However, other models and other futures are possible and necessary.

Integrated Assessment Models (IAMs) are a central tool used for imagining climate futures in IPCC assessments. At the same time, their outputs should be carefully interpreted with the structural biases and narrow assumptions made in the crafting of the models in mind.[2]

Despite the IPCC's strong warnings about the consequences of exceeding a 1.5°C temperature threshold, most IAMs are structured to allow overshoot, which gives BECCS and other CDR technologies undue prominence. For example, most models include "insufficient

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[1] The fact that technological CDR couldn't meaningfully affect temperatures until after 2050 is also true for natural restoration. Dooley and colleagues (2022) show that removals from natural restoration cannot be scaled up quickly enough to noticeably reduce peak global temperatures, but will contribute to lowering temperatures in the second half of the century.

[2] "The assumptions flowing into the model essentially define what is considered politically feasible…placing policy options that conform to the assumptions of the model on the table, and obscuring those [such as degrowth or demand-side approaches] that do not conform to the model's parameters." (Möller at p. 53)

representation" of renewables, "a high discount rate that tends to increase initial carbon budget overshoot and therefore inflates usage of CDR," and "limited deployment of demand-side options." [WGIII Ch. 12, 12.3 at p. 1265] Because "the vast majority of IAM pathways do not consider climate impacts," they ignore the enormous future costs of overshoot. [WGIII Ch. 3, 3.2.2 at p. 304]

Models provide a storyline until 2100, but it is the actions that will be taken during *this coming decade* that will determine whether or not the 1.5°C threshold is breached. Most models are designed to reach a particular temperature threshold only by 2100, which is another way that overshoot and CDR are engineered into models. In contrast, "[a]ll global modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot…involve rapid and deep and in most cases immediate GHG emission reductions in all sectors." [WGIII SPM C.3 at SPM-24]

A small but growing number of researchers are critically challenging existing IAM approaches and exploring alternative scenarios to expand the range of design parameters (such as degrowth, demand-side measures, and equity) and thus the set of alternative futures that might be imagined by models. (Grubler et al. 2018; Keyßer and Lenzen 2021; Riahi et al. 2021; van Vuuren et al. 2018)[3]

V. The IPCC does not include solar radiation modification (SRM) in its climate modeling because of large uncertainties, knowledge gaps, substantial risks, and institutional and social constraints, and in no uncertain terms warns against its risks and dangers.

The IPCC has considered SRM. Multiple reports in the AR6 cycle have sounded the alarm about the risks of deploying SRM as a response to the climate emergency — highlighting "large uncertainties and knowledge gaps as well as substantial risks and institutional and social constraints to deployment related to governance, ethics, and impacts on sustainable development." [SR15 SPM C.1.4 at SPM-12]

The IPCC delivers clear warnings on the uncertainty and risks of SRM. SRM "could generate substantial impacts on large-scale biogeochemical cycles" and its "risks and potential for risk reduction for marine and terrestrial ecosystems and biodiversity remain largely unknown." [WGII Ch. 16, Cross-Working Group Box SRM: Solar Radiation Modification at p. 2477] SRM does nothing to stop the accumulation of atmospheric carbon dioxide, nor would it "reduce resulting ocean acidification under continued anthropogenic emissions *(high confidence)*." [WGII TS.C.13.4 at TS-69] Once deployed, SRM cannot be stopped without triggering even more rapid warming and negative impacts, a risk referred to as "termination shock."

SRM cannot be a plan B. In contrast to climate mitigation activities, SRM "introduces a 'mask' to the climate change problem by altering the Earth's radiation budget, rather than attempting to address the root cause of the problem, which is the increase in greenhouse gases (GHGs) in the atmosphere." [WGII Ch. 16, Cross-Working Group Box SRM: Solar Radiation Modification at p. 2474] It cannot serve as plan B both because it has no impact on the emissions causing warming, and because there is high confidence that it would endanger human and natural systems.

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[3] The literature in this area continues to expand. Recent articles published post-AR6 include Grant et al. 2021; Kanitkar et al. 2023; and Muttitt et al. 2023.

Conclusion

Justice provides the final powerful lens through which to view AR6, including how to prevent the injustices of exceeding 1.5°C of warming and relying on largely speculative, highly risky technologies to justify prolonging the fossil fuel age. The IPCC recognizes that to avoid exacerbating existing inequalities and vulnerabilities, climate responses must center justice. [WGII TS.D.3.4 at TS-86; WGII SPM C.5.6 at SPM-28 & D.2 at SPM-29] Climate response technologies and approaches that place disproportionate risks on vulnerable or marginalized populations — who are least equipped to cope with heightened risks due to limited resources, mobility, and support structures — are deeply incompatible with such a justice-centered approach.

A justice-centered approach, to protect Indigenous rights and the most vulnerable, and to protect rights to the water, food, and land resources essential to human survival, must guide an evaluation of the outcomes of the Sixth Assessment Cycle and the urgent work to define and undertake the immediate actions necessary to stop climate change.

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