2023-IP07: IPCC Synthesis Report of the 6th Assessment Cycle

On 20 March 2023, the IPCC released the Synthesis Report (SYR) of the 6th Assessment Report (AR6). It integrates the main finding of the three AR6 Working Group reports (Climate Change 2021: The Physical Science Basis; Climate Change 2022: Impacts, Adaptation and Vulnerability; and Climate Change 2022: Mitigation of Climate Change) and the three AR6 Special Reports (Global Warming of 1.5°C (SR1.5); Climate Change and Land (SRCCL); and The Ocean and Cryosphere in a Changing Climate (SROCC)). The final version of AR6 SYR addressed 6,841 review comments from governments and observer organisations. IEAGHG is an observer organisation and provided 8 review comments to the FOD, mostly on sociocultural and legal barriers and public perception issues of DACCS and water issues of CCS, which were acted upon.

<u>Headline statements</u>

Current Status and Trends

<u>Observed Warming and its Causes:</u> **Human activities**, principally through emissions of greenhouse gases (GHGs), **have unequivocally caused global warming**, with global surface temperature reaching 1.1°C above 1850–1900 in 2011–2020. Global greenhouse gas emissions have continued to increase, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production across regions, between and within countries, and among individuals (high confidence).

<u>Observed Changes and Impacts:</u> **Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred**. Human-caused climate change is already affecting many weather and climate extremes in every region across the globe. This has led to **widespread adverse impacts and related losses and damages to nature and people** (high confidence). Vulnerable communities who have historically contributed the least to current climate change are disproportionately affected (high confidence).

<u>Current Progress in Adaptation and Gaps and Challenges</u>: Adaptation planning and implementation has progressed across all sectors and regions, with documented benefits and varying effectiveness. **Despite progress, adaptation gaps exist, and will continue to grow** at current rates of implementation. Hard and soft **limits to adaptation have been reached in some ecosystems and regions**. **Maladaptation is happening in some sectors and regions**. Current global financial flows for adaptation are insufficient for, and constrain implementation of, adaptation options, especially in developing countries (high confidence).

<u>Current Mitigation Progress, Gaps and Challenges</u>: Policies and laws addressing mitigation have consistently expanded since AR5. Global GHG emissions in 2030 implied by nationally determined contributions (NDCs) announced by October 2021 make it likely that warming will exceed 1.5°C during the 21st century and make it harder to limit warming below 2°C. There are **gaps between projected emissions from implemented policies and those from NDCs** and **finance flows fall short** of the levels needed to meet climate goals across all sectors and regions. (high confidence)

Future Climate Change, Risks, and Long-Term Responses

Future Climate Change: **Continued GHG emissions will lead to increasing global warming**, with the best estimate of reaching 1.5°C in the near term in considered scenarios and modelled pathways. **Every increment of global warming will intensify multiple and concurrent hazards** (high confidence). **Deep, rapid, and sustained reductions in GHG emissions would lead to a discernible slowdown in global warming within around two decades**, and also to discernible changes in atmospheric composition within a few years (high confidence).

Climate Change Impacts and Climate-Related Risks: For any given future warming level, many climate-related risks are higher than assessed in AR5, and projected long-term impacts are up to multiple times higher than currently observed (high confidence). **Risks and projected adverse impacts and related losses and damages from climate change escalate with every increment of global warming** (very high confidence). Climatic and non-climatic risks will increasingly interact, creating compound and cascading risks that are more complex and difficult to manage (high confidence).

Likelihood and Risks of Unavoidable, Irreversible or Abrupt Changes: **Some future changes are unavoidable and/or irreversible but can be limited by deep, rapid and sustained global GHG emissions reduction**. The likelihood of abrupt and/or irreversible changes increases with higher global warming levels. Similarly, the probability of low-likelihood outcomes associated with potentially very large adverse impacts increases with higher global warming levels. (high confidence)

Adaptation Options and their Limits in a Warmer World: **Adaptation options that are feasible and effective today will become constrained and less effective with increasing global warming**. With increasing global warming, losses and damages will increase and additional human and natural systems will reach adaptation limits. Maladaptation can be avoided by flexible, multi-sectoral, inclusive, long-term planning and implementation of adaptation actions, with co-benefits to many sectors and systems. (high confidence)

Carbon Budgets and Net Zero Emissions: **Limiting human-caused global warming requires net zero CO_2 emissions**. Cumulative carbon emissions until the time of reaching net-zero CO_2 emissions and the level of GHG emission reductions this decade largely determine whether warming can be limited to 1.5°C or 2°C (high confidence). **Projected CO_2 emissions from existing fossil fuel infrastructure without additional abatement would exceed the remaining carbon budget for 1.5°C** (50%) (high confidence).

Mitigation Pathways: All global modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot, and those that limit warming to 2°C (>67%), involve rapid and deep and, in most cases, immediate GHG emissions reductions in all sectors this decade. **Global net zero CO_2 emissions are reached for these pathway categories**, in the early 2050s and around the early 2070s, respectively. (high confidence)

Overshoot: Exceeding a Warming Level and Returning: If warming exceeds a specified level such as 1.5°C, it could gradually be reduced again by achieving and sustaining net negative global CO_2 emissions. **This would require additional deployment of carbon dioxide removal (CDR)**, compared to pathways without overshoot, leading to greater feasibility and sustainability concerns. **Overshoot entails adverse impacts, some irreversible**, and additional risks for human and natural systems, all growing with the magnitude and duration of overshoot. (high confidence)

Responses in the Near Term

Urgency of Near-Term Integrated Climate Action: **Climate change is a threat to human well-being and planetary health** (very high confidence). **There is a rapidly closing window of opportunity to secure a liveable and sustainable future for all** (very high confidence). Climate resilient development integrates adaptation and mitigation to advance sustainable development for all, and is enabled by increased international cooperation including improved access to adequate financial resources, particularly for vulnerable regions, sectors and groups, and inclusive governance and coordinated policies (high confidence). The choices and actions implemented in this decade will have impacts now and for thousands of years (high confidence).

The Benefits of Near-Term Action: Deep, rapid and sustained mitigation and accelerated implementation of adaptation actions in this decade would reduce projected losses and damages for humans and ecosystems (very high confidence), and deliver many co-benefits, especially for air quality and health (high confidence). **Delayed mitigation and adaptation action would lock-in high-emissions infrastructure, raise risks of stranded assets and cost-escalation, reduce feasibility, and increase losses and damages** (high confidence). Near-term actions involve high up-front investments and potentially disruptive changes that can be lessened by a range of enabling policies (high confidence).

Mitigation and Adaptation Options across Systems: **Rapid and far-reaching transitions across all sectors and systems are necessary** to achieve deep and sustained emissions reductions and secure a liveable and sustainable future for all. These system transitions **involve a significant upscaling** of a wide portfolio of mitigation and adaptation options. **Feasible, effective, and low-cost options for mitigation and adaptation are already available,** with differences across systems and regions. (high confidence)

Synergies and Trade-Offs with Sustainable Development: Accelerated and equitable action in mitigating and adapting to climate change impacts is critical to sustainable development. **Mitigation and adaptation actions have more synergies than trade-offs with Sustainable Development Goals (SDGs)**. Synergies and trade-offs depend on context and scale of implementation. (high confidence)

Equity and Inclusion: **Prioritising equity, climate justice, social justice, inclusion and just transition processes can enable adaptation and ambitious mitigation actions and climate resilient development.** Adaptation outcomes are enhanced by increased support to regions and people with the highest vulnerability to climatic hazards. Integrating climate adaptation into social protection programs improves resilience. Many options are available for reducing emission-intensive consumption, including through behavioural and lifestyle changes, with co-benefits for societal well-being. (high confidence)

Governance and Policies: Effective climate action is enabled by **political commitment, well-aligned multilevel governance, institutional frameworks, laws, policies and strategies and enhanced access to finance and technology**. Clear goals, coordination across multiple policy domains, and inclusive governance processes facilitate effective climate action. Regulatory and economic instruments can support deep emissions reductions and climate resilience if scaled up and applied widely. Climate resilient development benefits from drawing on diverse knowledge. (high confidence)

Finance, Technology and International Cooperation: **Finance, technology and international cooperation are critical enablers for accelerated climate action**. If climate goals are to be achieved, **both adaptation and mitigation financing would need to increase many-fold**. There is sufficient global capital to close the global investment gaps but there are barriers to redirect capital to climate action. Enhancing technology innovation systems is key to accelerate the widespread adoption of technologies and practices. Enhancing international cooperation is possible through multiple channels. (high confidence)

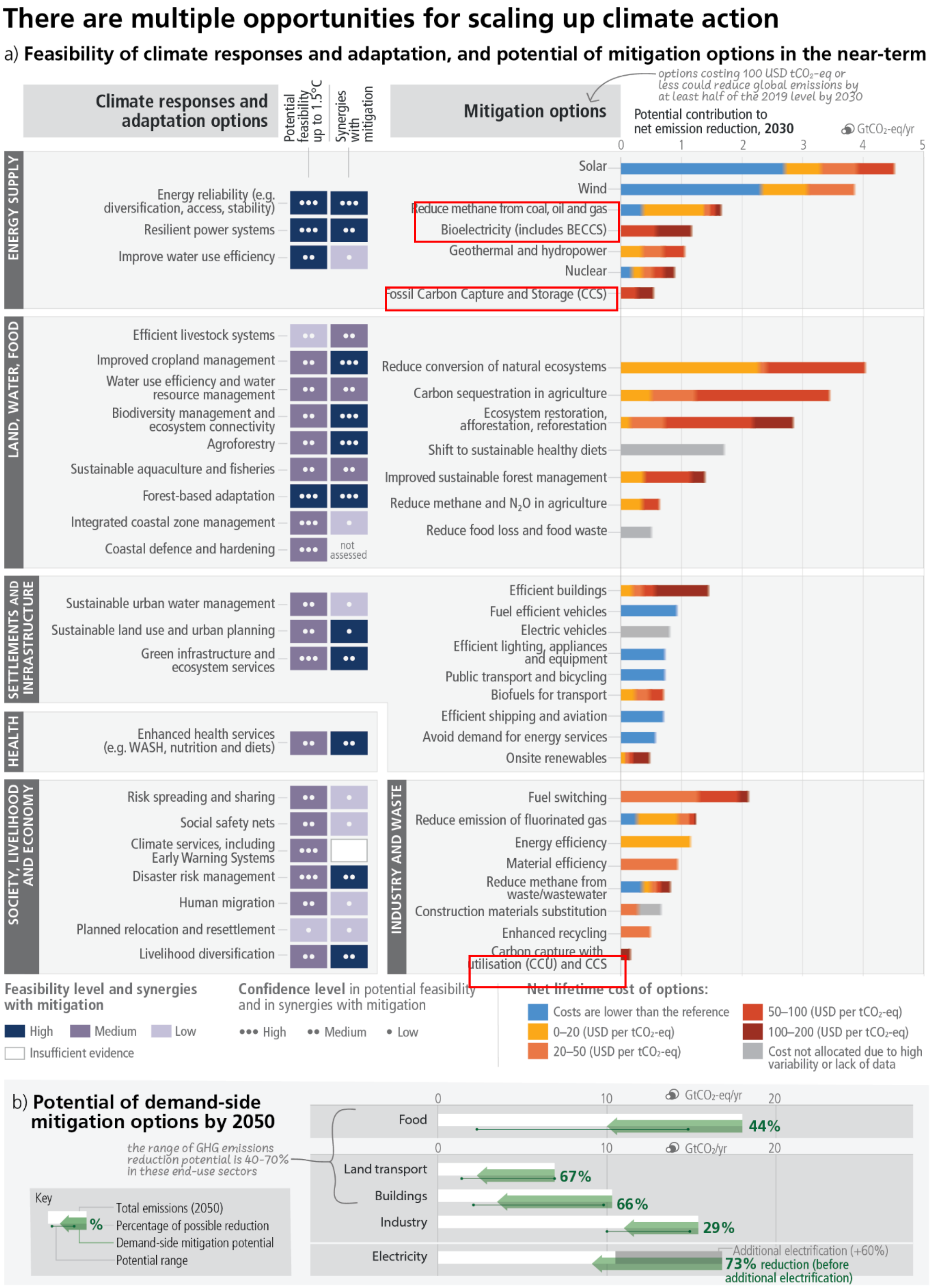

Figure 1 Multiple opportunities for scaling up climate action [IPCC AR6 SYR SPM.7, IPCC 2023]

Key messages from the Longer Report related to carbon capture, utilisation and storage (CCUS) and CDR

- 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 CDR.
- Reaching net zero GHG emissions primarily requires deep reductions in CO_2, methane, and other GHG emissions, and implies net-negative CO_2 emissions. CDR will be necessary to achieve net-negative CO_2 emissions…While reaching net-zero CO_2 or net-zero GHG emissions requires deep and rapid reductions in gross emissions, the deployment of CDR to counterbalance hard-to-abate residual emissions (e.g., some emissions from agriculture, aviation, shipping, and industrial processes) is unavoidable (high confidence).
- Achieving global net zero GHG emissions requires all remaining CO_2 and metric-weighted non-CO_2 GHG emissions to be counterbalanced by durably stored CO_2 removals (high confidence).
- Light industry and manufacturing can be largely decarbonized through available abatement technologies (e.g., material efficiency, circularity), electrification (e.g., electrothermal heating, heat pumps), and switching to low- and zero-GHG emitting fuels (e.g., hydrogen, ammonia, and bio-based and other synthetic fuels) (high confidence), while deep reduction of cement process emissions will rely on cementitious material substitution and the availability of CCS until new chemistries are mastered (high confidence). Reducing emissions from the production and use of chemicals would need to rely on a life cycle approach, including increased plastics recycling, fuel and feedstock switching, and carbon sourced through biogenic sources, and, depending on availability, CCU, direct air CO_2 capture (DAC/DACCS), as well as CCS.
- There is also reference in a footnote to some CCS conclusions from WGIII SPM, acknowledging that: (1) CCS is an option to reduce emissions from large-scale fossil-based energy and industry sources; (2) CO_2 capture and subsurface injection are mature technologies for O&G; (3) geological storage capacity is ~1000 $GtCO_2$, which exceeds requirements through 2100 to limit global warming to 1.5°C; and (4) geological storage can be permanently isolate CO_2 from the atmosphere. However, it also mentions that: (1) CCS is less mature in the power, cement and chemicals sectors; (2) regional availability of geological storage could be a limiting factor; (3) CCS deployment rates are far below those in modelled pathways for 1.5°C and 2°C; and (4) CCS currently faces technological, economic, institutional, ecological environmental and socio-cultural barriers.
- With every increment of warming, climate change impacts and risks will become increasingly complex and more difficult to manage…risks can arise from some responses that are intended to reduce the risks of climate change, e.g., adverse side effects of some emission reduction and CDR measures. (high confidence)
- In addition to deep, rapid, and sustained emission reductions, CDR can fulfil three complementary roles: lowering net CO_2 or net GHG emissions in the near term; counterbalancing 'hard-to-abate' residual emissions (e.g., some emissions from agriculture, aviation, shipping, industrial processes) to help reach net zero CO_2 or GHG emissions, and achieving net negative CO_2 or GHG emissions if deployed at levels exceeding annual residual emissions (high confidence)… Afforestation, reforestation, improved forest management, agroforestry and soil carbon sequestration are currently the only widely practiced CDR methods (high confidence).

- More rapid reduction in CO_2 and non-CO_2 emissions, particularly methane, limits peak warming levels and reduces the requirement for net negative CO_2 emissions and CDR, thereby reducing feasibility and sustainability concerns, and social and environmental risks (high confidence).
- Reforestation, improved forest management, soil carbon sequestration, peatland restoration and coastal blue carbon management are examples of CDR methods that can enhance biodiversity and ecosystem functions, employment and local livelihoods, depending on context. However, afforestation or production of biomass crops for bioenergy with carbon dioxide capture and storage or biochar can have adverse socio-economic and environmental impacts, including on biodiversity, food and water security, local livelihoods and the rights of Indigenous Peoples, especially if implemented at large scales and where land tenure is insecure. (high confidence)
- AFOLU mitigation options, when sustainably implemented, can deliver large-scale GHG emission reductions and enhanced CO_2 removal; however, barriers to implementation and trade-offs may result from the impacts of climate change, competing demands on land, conflicts with food security and livelihoods, the complexity of land ownership and management systems, and cultural aspects.
- Modelled pathways that assume using resources more efficiently or shift global development towards sustainability include fewer challenges, such as dependence on CDR and pressure on land and biodiversity, and have the most pronounced synergies with respect to sustainable development (high confidence).
- A foot note on CDR acknowledges that: The impacts, risks, and co-benefits of CDR deployment for ecosystems, biodiversity and people will be highly variable depending on the method, site-specific context, implementation and scale (high confidence).

All materials related to the AR6 SYR are available on the following website:
https://www.ipcc.ch/report/ar6/syr/

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