Additional information on domestic mitigation measures

This addendum provides additional information on domestic mitigation measures synthesized from the 168 latest available nationally determined contributions communicated by 195 Parties to the Paris Agreement and recorded in the registry of nationally determined contributions as at 9 September 2024.

Abbreviations and acronyms

AFOLU	agriculture, forestry and other land use
AR	Assessment Report of the Intergovernmental Panel on Climate Change
CCS	carbon dioxide capture and storage
CCUS	carbon dioxide capture, use and storage
CH_4	methane
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
COP	Conference of the Parties
GDP	gross domestic product
GHG	greenhouse gas
H_2	hydrogen
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
N_2O	nitrous oxide
NDC	nationally determined contribution
SDG	Sustainable Development Goal
SR1.5	Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5 °C
UNEP	United Nations Environment Programme

I. Global efforts and mitigation options covered in recent decisions[1]

A. Tripling global renewable energy capacity by 2030

1. Increasing renewable energy has an estimated net mitigation potential of, inter alia, 3.30 Gt CO_2 eq/year for solar energy and 3.08 Gt CO_2 eq/year for wind energy at costs below USD 20/t CO_2 eq in 2030; and 4.50 Gt CO_2 eq/year for solar energy and 3.85 Gt CO_2 eq/year for wind energy at costs below USD 100/t CO_2 eq in 2030 (see figure 12 in document FCCC/PA/CMA/2024/10[2]).[3] Corresponding measures were indicated by 92 per cent of Parties, accounting for 93 per cent of total global electricity generation from fossil fuels in 2022.[4]

2. In *Renewable Energy Statistics 2024*,[5] IRENA projects that total global renewable power capacity reached a record high of 3,865 GW in 2023, following the largest annual increase to date of 473 GW (a 14 per cent increase from 2022 to 2023). Annual average additions of about 1,000 GW or an annual average growth rate of 16.4 per cent for the rest of this decade would be needed to achieve a tripling of total global renewable power capacity above the 2022 level to 11,500 GW, which is the estimated total global renewables capacity in 2030 consistent with 1.5 °C pathways with no or limited overshoot in IEA *From Taking Stock to Taking Action*.[6]

3. A total of 41 per cent of Parties, accounting for 51 per cent of total global electricity generation from fossil fuels in 2022,[7] indicated quantitative targets for total or additional installed capacity of renewables-based electricity generation by 2030, amounting to a total of 1,818 GW.[8] Considering the existing installed capacity relevant to the targets for additional renewables capacity by 2030,[9] the aggregated quantitative target for total installed capacity of renewables-based electricity generation by 2030 is estimated at 1,921 GW, which accounts for half of projected global installed capacity in 2023 and 17 per cent of the 11,500 GW referred to in paragraph 2 above (see figure 1). Of this 1,921 GW, 16 per cent (315 GW) was communicated in relation to achieving conditional mitigation targets in the NDCs, which highlights Parties' need for enhanced support and cooperation for effectively implementing these targets. On the other hand, in *COP28 Tripling Renewable Capacity Pledge*,[10] IEA finds that the total combined commitments announced domestically for renewables capacity are projected to reach 7,903 GW by 2030. This figure is more than four times the target capacity outlined in the NDCs, indicating that the next round of NDCs presents major opportunities

[1] Decisions 1/CMA.3, 1/CMA.4 and 1/CMA.5.

[2] Available at https://unfccc.int/documents/641792.

[3] The aggregate net mitigation potential of increasing renewable energy has not been estimated since the contribution of Working Group III to the AR6 states that mitigation potentials are assessed independently for each option and cannot necessarily be summed. This also applies to the aggregate net mitigation potential of other options as applicable.

[4] Estimated on the basis of data from IEA. 2024. *World Energy Balances*. Paris: IEA. All rights reserved; as modified by the secretariat. IEA data used in this report are subject to IEA terms and conditions, available at www.iea.org/terms.

[5] IRENA. 2024. *Renewable Energy Statistics 2024*. Abu Dhabi: IRENA. Available at https://www.irena.org/Publications/2024/Jul/Renewable-energy-statistics-2024.

[6] IEA. 2024. *From Taking Stock to Taking Action: How to implement the COP28 energy goals*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/from-taking-stock-to-taking-action. Global installed capacity of renewables-based electricity generation triples from 3,660 GW in 2022 to 11,500 GW in 2030 under the IEA "COP28 Full Implementation Case"; and from 3,396 GW in 2022 to 11,174 GW in 2030 under the IRENA "1.5°C Scenario".

[7] As footnote 4 above.

[8] This encompasses both unconditional and conditional targets, as well as pre-2030 targets that fall within the time frame for NDC implementation.

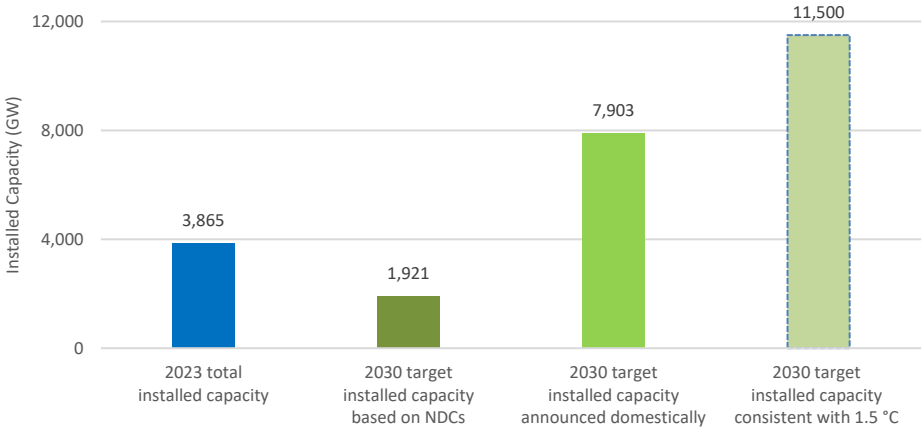
[9] The existing installed capacity is assumed as total renewables-based power capacity in 2019 considering that about 80 per cent of the submitted NDCs started the implementation in 2020 or 2021.

[10] IEA. 2024. *COP28 Tripling Renewable Capacity Pledge: Tracking countries' ambitions and identifying policies to bridge the gap*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/cop28-tripling-renewable-capacity-pledge.

for reflecting the announced commitments. Moreover, a total of 15 per cent of Parties, accounting for 3 per cent of total global electricity generation from fossil fuels in 2022,[11] reported in their NDCs targets for at least tripling their own total renewables capacity above the 2022 level.[12]

4. According to IEA *From Taking Stock to Taking Action*, expediting permitting processes, extending and modernizing electricity grids, and enhancing energy storage capacity can play a major role in tripling global renewables capacity by 2030.

Figure 1
Aggregated installed capacity targets for renewables-based electricity generation by 2030



Notes: (1) 2030 target installed capacity based on NDCs includes the existing installed capacity relevant to for the targets for additional renewables capacity by 2030 as referred to in para. 3 above. (2) 2030 target installed capacity consistent with 1.5 °C represents a global milestone consistent with the 1.5 °C pathway with no or limited overshoot in IEA *From Taking Stock to Taking Action*.

B. Doubling the global average annual rate of energy efficiency improvement by 2030

5. Improving energy efficiency has an estimated net mitigation potential of, inter alia, 1.14 Gt CO_2 eq/year for energy efficiency improvement in industry, 0.73 Gt CO_2 eq/year for efficient lighting, appliances and equipment, and 0.56 Gt CO_2 eq/year for avoidance of demand for energy services, at costs below USD 20/t CO_2 eq in 2030 (see figure 12 in document FCCC/PA/CMA/2024/10[13]). Corresponding measures were indicated by 93 per cent of Parties, accounting for 90 per cent of total global energy supply in 2022.[14]

6. According to *Tracking SDG 7: The Energy Progress Report 2024*,[15] primary energy intensity,[16] the energy used for producing a unit of GDP, improved by 2.1 per cent per year globally between 2010 and 2015, 1.3 per cent between 2015 and 2020, and just 0.8 per cent (4.59 MJ/United States dollar in 2017 purchasing power parity) in 2021 owing to the

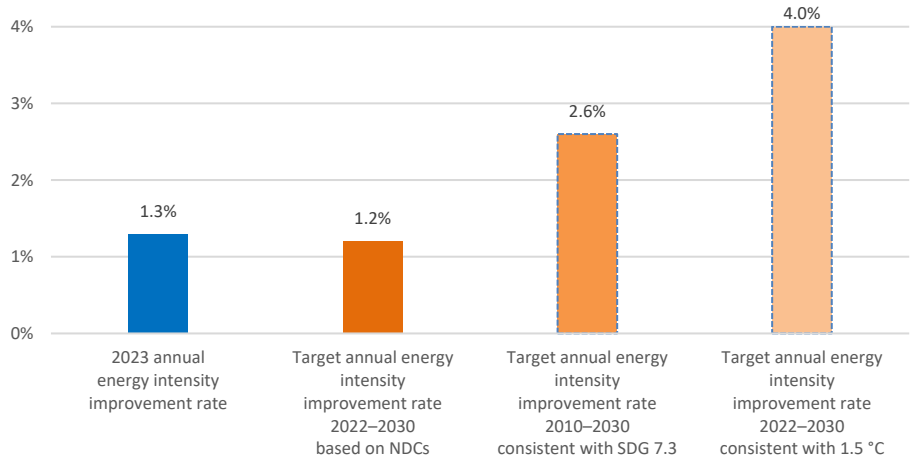
[11] As footnote 4 above.
[12] Estimated on the basis of data from IRENA. 2024. *Renewable Capacity Statistics 2024*. Abu Dhabi: IRENA.
[13] As footnote 2 above.
[14] As footnote 4 above.
[15] IEA, IRENA, United Nations Statistics Division, World Bank and World Health Organization. 2024. *Tracking SDG 7: The Energy Progress Report 2024*. World Bank: Washington, D.C. Available at https://www.irena.org/Publications/2024/Jun/Tracking-SDG-7-The-Energy-Progress-Report-2024.
[16] Defined as the ratio of total energy supply to GDP (in United States dollars in 2017 purchasing power parity). In *From Taking Stock to Taking Action*, IEA identifies primary energy intensity as the most comprehensive measure of energy efficiency as it reflects all changes that improve the ratio of economic activity to energy inputs. However, the use of primary energy intensity for tracking the progress of ambition for this global effort does not preclude any other relevant tracking indicators. The same applies to all other global mitigation efforts and mitigation options referred to in this chapter.

pandemic exacerbating the already slowing trend. Preliminary estimates for 2023 indicate a return to the long-term trend of about 1.3 per cent annual improvement, which is half of the average annual improvement rate required to achieve SDG target 7.3 (2.6 per cent).

7. A total of 29 per cent of Parties communicated quantitative targets for increasing economy-wide energy efficiency improvement by 2030; and some of them (4 per cent of all Parties), accounting for 4 per cent of total global energy supply in 2022[17] and 3 per cent of total global GDP in 2022,[18] communicated targets for increasing the annual average improvement rate of primary energy intensity by 2030. Half of those Parties (2 per cent) reported them in relation to achieving conditional mitigation targets in their NDCs. The aggregated average annual improvement rate target through to 2030 is estimated as 1.2 per cent,[19] which is less than half of SDG target 7.3 and one third of the doubled global average annual improvement rate of primary energy intensity above the 2022 level (4 per cent) that is consistent with the 1.5 °C pathway with no or limited overshoot in IEA *From Taking Stock to Taking Action*[20] (see figure 2). Additionally, 1 per cent of Parties, accounting for 0.3 per cent of total global energy supply in 2022[21] and 0.1 per cent of total global GDP in 2022,[22] reported targets for increasing their own average annual improvement rate of primary energy intensity by 2030 to 4 per cent or more. However, no Parties reported targets for at least doubling their own average annual improvement rate above the 2022 level.

8. In *From Taking Stock to Taking Action*, IEA projects the three main levers for doubling the global annual average rate of energy efficiency improvement by 2030 to be implementing technical efficiency improvements in all sectors; shifting to use of more efficient fuels through electrification, renewables and universal access to clean cooking fuels; and avoiding energy demand through material efficiency gains, modal shifts in transport and enhanced recycling.

Figure 2
Aggregated targets for average annual improvement rate of primary energy intensity by 2030



[17] As footnote 4 above.
[18] Estimated on the basis of data from International Monetary Fund. 2024. *World Economic Outlook (April 2024)*. Available at https://www.imf.org/external/datamapper/datasets/WEO (accessed 16 July 2024).
[19] Estimated on the basis of data from IEA. 2024. *World Energy Balances*. Paris: IEA. All rights reserved; World Bank. 2024. *World Development Indicators 2024*. Available at https://data.worldbank.org/indicator/. International Monetary Fund. 2024. *World Economic Outlook (April 2024)*. Available at https://www.imf.org/external/datamapper/datasets/WEO (accessed 16 July 2024).
[20] IEA indicates that the average annual rate of improvement in primary energy intensity needs to be doubled from 2 per cent in 2022 to 4 per cent through to 2030 to be on its 1.5 °C pathway with no or limited overshoot.
[21] As footnote 4 above.
[22] As footnote 18 above.

Notes: (1) 2023 annual energy intensity improvement rate is based on preliminary estimates as referred to in para. 6 above. (2) Target annual energy intensity improvement rate 2022–2030 consistent with 1.5 °C represents a global milestone consistent with the 1.5 °C pathway with no or limited overshoot in IEA *From Taking Stock to Taking Action*.

C. Phasing down unabated coal power

9. A total of 12 per cent of Parties, accounting for 58 per cent of total global electricity generation from coal in 2022,[23] indicated measures for phasing down unabated coal power, such as replacing coal-fired power plants with combined-cycle gas power plants with CCS-ready specifications.

10. On its *COP28: Tracking the Energy Outcomes* web page,[24] IEA estimates that total global electricity generation from coal reached a record high of 10,580 TWh in 2023, an increase of 168 TWh (1.6 per cent) from 2022. Unabated coal power generation was the single largest source of energy-related CO_2 emissions globally in 2022 (10 Gt CO_2), or 27 per cent of the total, and accounted for almost 75 per cent of electricity sector emissions in 2022,[25] with 2 million jobs provided by more than 8,000 coal-fired power plants operating in some 90 countries.[26] The contribution of Working Group III to the AR6 finds that new investments in coal-fired electricity without CCS are inconsistent with limiting likely warming to 2 °C or below. In *From Taking Stock to Taking Action*, IEA projects total global electricity generation from unabated coal to sharply decline to 5,360 TWh by 2030 and 1,550 TWh by 2035 on its 1.5 °C pathway with no or limited overshoot.

11. A total of 8 per cent of Parties, accounting for 0.2 per cent of total global electricity generation from coal in 2022,[27] communicated quantitative targets for reducing coal power generation by 2030, amounting to an aggregated reduction of 30 TWh by 2030,[28] which accounts for 0.6 per cent of the total reduction (5,220 TWh) required to reach the 5,360 TWh referred to in paragraph 10 above. In this context, 6 per cent of Parties mentioned the need and/or measures for a just transition for communities and workers dependent on coal. Further, in the 2023 update to its Net Zero Roadmap,[29] IEA projects the share of unabated coal in total global electricity generation to decline from 36 per cent in 2022 to 13 per cent by 2030 on its 1.5 °C pathway with no or limited overshoot. 8 per cent of Parties, accounting for 0.5 per cent of total global electricity generation from coal in 2022,[30] communicated targets for reducing the share of unabated coal in electricity generation to 13 per cent or less by 2030,[31] such as phasing out use of unabated coal to produce electricity by 2025.

12. In the 2023 update to its Net Zero Roadmap, IEA projects that tripling total global installed capacity for renewables-based electricity generation by 2030, together with doubling the average annual rate of energy efficiency improvement globally by 2030, will reduce fossil fuel demand and contribute to putting an end to new approvals of unabated coal power plants. Meanwhile, in *Accelerating Just Transitions for the Coal Sector*,[32] IEA finds

[23] As footnote 4 above.

[24] IEA COP28: Tracking the Energy Outcomes, available at https://www.iea.org/topics/cop28-tracking-the-energy-outcomes (accessed 16 July 2024); all rights reserved.

[25] IEA. 2023. *Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach – 2023 Update*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach.

[26] IEA. 2022. *World Energy Outlook 2022*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/world-energy-outlook-2022.

[27] As footnote 4 above.

[28] The existing total coal-based electricity generation is assumed from historical generation in 2019 given that about 80 per cent of the submitted NDCs started the implementation in 2020 or 2021.

[29] As footnote 25 above.

[30] As footnote 4 above.

[31] As footnote 25 above. The share of unabated coal in total global electricity generation declines to 3 per cent by 2035 and 0 per cent by 2040 under the 2023 IEA Net Zero Emissions by 2050 Scenario.

[32] IEA. 2024. *Accelerating Just Transitions for the Coal Sector*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/accelerating-just-transitions-for-the-coal-sector.

that three-quarters of the world's coal plants today (accounting for about 1,500 GW) will not have reached their average technical lifetime of 50 years by 2040.

D. Shifting to zero- and low-carbon fuels for net zero emission energy systems well before or by around mid-century

13. Shifting to zero- and low-carbon fuels[33] has an estimated net mitigation potential of, inter alia, 0.23 Gt CO_2 eq/year for biofuels in transport at costs below USD 20/t CO_2 eq in 2030; and 1.95 Gt CO_2 eq/year for fuel switching in industry and 0.69 Gt CO_2 eq/year for biofuels in transport at costs below USD 100/t CO_2 eq in 2030. A total of 36 per cent of Parties, accounting for 68 per cent of total global energy supply from fossil fuels in 2022,[34] communicated corresponding measures, such as providing funding to support fuel switching to bioenergy in order to accelerate industrial heat decarbonization.

14. According to IEA,[35] global energy-related CO_2 emissions, predominantly emissions from combustion and extraction of fossil fuels, increased by 1.1 per cent to a record high in 2023 (37.4 Gt CO_2). Coal has contributed by far the most to the increase in energy-related CO_2 emissions since 2019. In *From Taking Stock to Taking Action*, IEA projects global energy-related CO_2 emissions to fall steeply to 25.1 Gt in 2030 and 13.5 Gt in 2035 on its 1.5 °C pathway with no or limited overshoot.[36] The contribution of Working Group III to the AR6 clarifies that net zero CO_2 energy systems[37] entail using alternative energy carriers, such as modern bioenergy, low-emission hydrogen and low-emission hydrogen-based fuels, in applications less amenable to electrification such as long-distance transport and heavy industry.

15. In the 2023 update to its Net Zero Roadmap, IEA projects modern bioenergy, such as biomethane and biofuels, to be one of the pillars of clean energy transition over the remainder of this decade and beyond, doubling from 6 per cent of total energy supply today to 13 per cent by 2030 and tripling to 18 per cent by 2050 thanks to its ability to be used as a drop-in substitute for fossil fuels. This projection assumes a shift from use of conventional feedstocks towards advanced bioenergy feedstocks from waste and residues to avoid trade-offs between bioenergy supply and food and feed production, which also contributes to a circular economy approach.

E. Transitioning away from fossil fuels in energy systems in a just, orderly and equitable manner, accelerating action in this critical decade

16. A total of 95 per cent of Parties, accounting for 92 per cent of total global energy supply from fossil fuels in 2022,[38] indicated measures for transitioning away from fossil fuels in energy systems, such as scaling up on-grid renewable energy, reducing electricity produced from fossil fuel power plants and replacing pet coke with biomass in cement production.

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[33] The 2023 update to the IEA Net Zero Roadmap refers to modern bioenergy, low-emission hydrogen and low-emission hydrogen-based fuels (e.g. ammonia and synthetic hydrocarbons produced from low-emission hydrogen) as low-emission fuels. It defines modern bioenergy as bioenergy excluding traditional use of biomass (e.g. wood, wood waste) and renewable waste, while defining low-emission hydrogen as hydrogen produced through water electrolysis with electricity generated from a low-emission source such as renewables, nuclear, biomass or fossil fuels equipped with CCUS.

[34] As footnote 4 above.

[35] IEA. 2024. *CO_2 emissions in 2023*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/co2-emissions-in-2023. Energy-related CO_2 emissions refer to CO_2 emissions from fossil fuel combustion, industrial processes, and fugitive and flaring CO_2 from fossil fuel extraction. Coal accounted for 70 per cent of the increase in energy-related emissions in 2023.

[36] Total global CO_2 emissions from the energy sector are projected to reach net zero in 2050 under the 2023 IEA Net Zero Emissions by 2050 Scenario, with residual gross emissions of 1.7 Gt counterbalanced by CO_2 removals of the same magnitude.

[37] The term "energy systems" covers both energy supply and energy end-use sectors.

[38] As footnote 4 above.

17. Total global energy supply from fossil fuels reached a record high of 503 EJ in 2022, increasing by 1.2 per cent from 2021.[39] In *From Taking Stock to Taking Action*, IEA projects total global energy supply from fossil fuels to decline to 375 EJ in 2030 and 240 EJ in 2035 on its 1.5 °C pathway with no or limited overshoot. The contribution of Working Group III to the AR6 clarifies that net zero CO_2 energy systems entail a substantial reduction in overall fossil fuel use, minimal use of unabated fossil fuels, and electricity systems that emit no net CO_2. In the 2023 update to its Net Zero Roadmap, IEA projects the share of unabated fossil fuels in total global energy supply to decline from 80 per cent in 2022 to 62 per cent by 2030 on its 1.5 ºC pathway with no or limited overshoot[40] that is projected to achieve net zero CO_2 emissions by 2050.

18. A total of 3 per cent of Parties, accounting for 1 per cent of total global energy supply from fossil fuels in 2022, indicated quantitative targets for reducing the share of total energy supply from unabated fossil fuels to 62 per cent or less by 2030, such as producing 60 per cent of energy from green sources by 2030, including phasing out coal use before 2030. All of those Parties communicated them in relation to achieving conditional mitigation targets. Further, total global electricity generation from fossil fuels reached a record high of 17,764 TWh in 2022, increasing by 1 per cent from 2021.[41] In the 2023 update to its Net Zero Roadmap, IEA projects the share of unabated fossil fuels in total global electricity generation to decline from 61 per cent in 2022 to 29 per cent by 2030 on its 1.5 °C pathway with no or limited overshoot. A total of 11 per cent of Parties, accounting for 0.1 per cent of total global electricity generation from fossil fuels in 2022,[42] indicated quantitative targets for reducing the share of unabated fossil fuels in electricity generation by 2030 to 29 per cent or less,[43] such as committing to the target of a fossil fuel free electricity sector by 2030.

19. Meanwhile, IEA projects in the 2023 update to its Net Zero Roadmap that 30 million new clean energy jobs will be added, while close to 13 million jobs in fossil-fuel-related industries will be lost, by 2030 under its Net Zero Emissions by 2050 Scenario, meaning that around two clean energy jobs will be created for every fossil-fuel-related job lost. A total of 28 per cent of Parties reported the need and/or measures for a just transition for communities and workers dependent on fossil fuels, such as connecting and providing job seekers with the training required to access good jobs, especially in the clean energy sector where employers are looking for skilled workers.

20. In addition, the 2023 update to the IEA Net Zero Roadmap highlights the importance of sequencing the shift in energy investment for orderly and secure transition, pointing out the risk of price spikes by scaling back fossil fuel investment before ramping up clean energy.

21. Further, according to IEA A Vision for Clean Cooking Access for All,[44] 2.3 billion people worldwide, nearly one third of the global population, still cook their meals by burning coal, charcoal and firewood, inhaling hazardous smoke every day that causes millions of premature deaths. IEA projects in *From Taking Stock to Taking Action* that this traditional use of biomass will be phased out by 2030 on its 1.5 ºC pathway with no or limited overshoot, reducing the premature deaths by 2.5 million and achieving net GHG emission reductions of 1.5 Gt CO_2 eq by 2030. A total of 21 per cent of Parties reported corresponding measures, such as installing 500,000 improved cookstoves by 2025, with a focus on rural areas.

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[39] As footnote 4 above.

[40] In its contribution to the AR6, Working Group III projects the share of fossil fuels in total energy supply to decline to 59–69 per cent in 2030 on its 1.5 ºC pathways with no or limited overshoot. Total energy supply from coal, oil and natural gas is projected to decline by 75 (65–80), 10 (0–25) and 10 (0–30) per cent respectively below the 2019 level by 2030 on 1.5 ºC pathways.

[41] As footnote 4 above.

[42] As footnote 4 above.

[43] This includes quantitative targets for increasing the share of low-emission sources of electricity in electricity generation by 2030 to 71 per cent or more. The share of unabated fossil fuels in total global electricity generation is projected to decline to 9 per cent by 2035 and 0.2 per cent by 2050 under the 2023 IEA Net Zero Emissions by 2050 Scenario.

[44] IEA. 2023. *A Vision for Clean Cooking Access for All*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all.

F. Accelerating zero- and low-emission energy technologies

22. Accelerating zero- and low-emission energy technologies[45] has an estimated net mitigation potential of, inter alia, 3.3 Gt CO_2 eq/year for solar energy, 3.08 Gt CO_2 eq/year for wind energy and 0.35 Gt CO_2 eq/year for nuclear energy at costs below USD 20/t CO_2 eq in 2030; and 0.43 Gt CO_2 eq/year for bioelectricity and 0.27 Gt CO_2 eq/year for CCS at costs below USD 100/t CO_2 eq in 2030. A total of 95 per cent of Parties, accounting for 92 per cent of total global energy supply from fossil fuels in 2022, indicated corresponding measures, such as developing 5 GW low-carbon hydrogen production capacity by 2030 and introducing an investment tax credit for capital invested in CCUS projects.

23. The contribution of Working Group III to the AR6 finds that net zero CO_2 energy systems entail electricity systems that emit no net CO_2; use of CCS in the remaining fossil fuel systems after a substantial reduction in overall fossil fuel use; deployment of CO_2 removal to counterbalance hard-to-abate residual emissions;[46] and use of alternative energy carriers in applications less amenable to electrification as referred to in paragraph 14 above.

24. Nuclear power is the second-largest low-emission source of electricity after hydropower, supplying 9 per cent of total global electricity in 2022.[47] In *From Taking Stock to Taking Action*, IEA projects total global installed capacity of nuclear power to increase from 420 GW in 2022 to 550 GW in 2030 on its 1.5 °C pathway with no or limited overshoot. A total of 2 per cent of Parties communicated quantitative targets for total or additional installed capacity of nuclear-based electricity generation by 2030, amounting to a total aggregated capacity of 15 GW. Considering the existing installed capacity relevant to the targets for additional nuclear capacity by 2030,[48] the aggregated quantitative target for total installed capacity of nuclear-based electricity generation by 2030 is estimated to reach 20 GW, which accounts for 4 per cent of the above-mentioned 550 GW. Of the 20 GW, 21 per cent was reported for achieving conditional mitigation targets.

25. For CCUS, IEA projects in *From Taking Stock to Taking Action* total global carbon capture capacity to steeply increase from 40 Mt CO_2 annually in 2022 to 1,020 Mt CO_2 in 2030 on its 1.5 °C pathway with no or limited overshoot. A total of 3 per cent of Parties communicated quantitative targets for increasing carbon capture capacity by 2030, amounting to a total aggregated capture capacity of 32 Mt CO_2, which accounts for 3 per cent of the 1,020 Mt CO_2. On the other hand, IEA finds in *From Taking Stock to Taking Action* that, if all CCUS projects currently under development are completed, the total aggregated capture capacity could reach 435 Mt CO_2 annually in 2030. This would account for 43 per cent of the 1,020 Mt CO_2 and be over 13 times the target capacity outlined in the NDCs, indicating that the next round of NDCs presents major opportunities for reflecting the projects.

26. As to the production of low-carbon hydrogen, in *From Taking Stock to Taking Action* IEA estimates that less than 1 Mt H_2 was produced globally in 2023 despite global hydrogen production reaching 97 Mt H_2. It projects low-carbon hydrogen production to rapidly increase to 65 Mt H_2/year by 2030 on its 1.5 °C pathway with no or limited overshoot. A total of 2 per cent of Parties communicated quantitative targets for increasing production of low-carbon hydrogen by 2030, amounting to production of 3.9 Mt H_2/year in total, which accounts for 6 per cent of the 65 Mt H_2/year. Of the 3.9 Mt H_2/year, 48 per cent was reported for achieving conditional mitigation targets. Meanwhile, in its *Global Hydrogen Review 2024*,[49] IEA finds that, if all announced projects are realized, production of low-emission hydrogen could reach

[45] Defined as energy technologies that produce little or no CO_2 or that remove CO_2 from the atmosphere in the contribution of Working Group III to the AR6.

[46] The contribution of Working Group III to the AR6 finds that CO_2 removal is necessary to achieve net zero CO_2 and GHG emissions, counterbalancing hard-to-abate residual emissions, and is also essential in scenarios of limiting warming to 1.5°C or likely below 2°C by 2100. Counterbalancing hard-to-abate residual emissions such as CO_2 from industrial activities, long-distance transport and CH_4 and N_2O from agriculture will contribute to reaching net zero CO_2 or GHG emissions.

[47] As footnote 4 above.

[48] As footnote 8 above.

[49] IEA. 2024. *Global Hydrogen Review 2024*. Paris: IEA. All rights reserved. Available at https://www.iea.org/reports/global-hydrogen-review-2024.

49 Mt H_2 in 2030, although 23 of the 49 Mt H_2 comes from projects at early stages of development. This would account for 75 per cent of the 65 Mt H_2/year and be about 13 times the target production reported in the NDCs, suggesting major opportunities for reflecting the announced projects in the next round of NDCs.

G. Accelerating substantial reduction of CH_4 and N_2O emissions from agriculture by 2030

27. Reducing CH_4 and N_2O emissions from agriculture has an estimated net mitigation potential of 0.35 Gt CO_2 eq/year at costs below USD 20/t CO_2 eq in 2030 and 0.63 Gt CO_2 eq/year at costs below USD 100/t CO_2 eq in 2030. A total of 40 per cent of Parties, accounting for 53 per cent of total global CH_4 emissions from agriculture in 2021[50] and 59 per cent of total global N_2O emissions in 2020, communicated corresponding measures, such as providing training on better ruminant livestock feeding for key stakeholders to increase uptake of leguminous fodder shrubs, and constructing biodigesters at rural farms to replace fuelwood consumption with biogas from anaerobic digestion of manure.

28. According to the IEA Methane Tracker Data Explorer, agriculture is the largest source of global anthropogenic CH_4 emissions (accounting for 40 per cent).[51] Given that agricultural CH_4 and N_2O emissions are considered hard-to-abate GHG emissions,[52] constrained by cost, diversity and complexity of agricultural systems, and increasing demands for agricultural and livestock products, the contribution of Working Group III to the AR6 states that both supply- (e.g. agricultural intensification) and demand- (e.g. reducing food loss and food waste) side measures are important for realizing the full mitigation potential.

H. Accelerating substantial reduction of CH_4 emissions from fossil fuel operations by 2030

29. Reducing CH_4 emissions from fossil fuel operations has an estimated net mitigation potential of 0.92 Gt CO_2 eq/year for oil and gas operations and 0.45 Gt CO_2 eq/year for coal mining at costs below USD 20/t CO_2 eq in 2030. Some of the estimated net mitigation potential for oil and gas operations (0.31 Gt CO_2 eq/year) comes at a negative cost.[53] Corresponding measures were communicated by 15 per cent of Parties, accounting for 58 per cent of total global CH_4 emissions from energy in 2023,[54] such as achieving zero routine flaring by 2030.

30. According to the IEA Methane Tracker Data Explorer, global CH_4 emissions from energy supply, primarily fugitive emissions from production, processing, storage and transportation of fossil fuels, remained at a near record high of about 118 Mt (about 3.3 Gt CO_2 eq) in 2023 since 2019, representing the second largest source of global anthropogenic CH_4 emissions (37 per cent) after agriculture. In *From Taking Stock to Taking Action*, IEA projects CH_4 emissions from fossil fuel operations to sharply decline by 75 per cent to about 1 Gt CO_2 eq by 2030 on its 1.5 °C pathway with no or limited overshoot.

31. While 2 per cent of Parties, accounting for 4 per cent of total global CH_4 emissions from energy in 2022, indicated quantitative targets for reducing CH_4 emissions from fossil fuel operations by 2030, none of them indicated targets for reducing them by 75 per cent or

[50] Estimated on the basis of data from IEA Methane Tracker Data Explorer, available at https://www.iea.org/articles/methane-tracker-data-explorer (accessed 16 July 2024). All rights reserved; as modified by the secretariat.

[51] As footnote 50 above.

[52] According to the contribution of Working Group III to the AR6, with foreseen technology developments, some CH_4, N_2O and fluorinated gas emissions from agriculture and industry will remain over the course of this century. Net negative CO_2 emissions will therefore be needed to counterbalance these remaining non-CO_2 emissions so that net zero GHG emissions can be achieved at a point in time after net zero CO_2 emissions has been reached.

[53] According to the contribution of Working Group III to the AR6, negative costs mean that lifetime monetary revenues are higher than lifetime monetary costs.

[54] As footnote 50 above.

more. According to the contribution of Working Group III to the AR6, as CH_4 has a short lifetime but is a potent GHG, strong, rapid and sustained reductions in CH_4 emissions can limit near-term warming and improve air quality by reducing global surface ozone.

I. Rapidly deploying zero- and low-emission vehicles and necessary infrastructure for accelerating reduction of emissions from road transport

32. This global effort has an estimated net mitigation potential of, inter alia, 0.23 Gt CO_2 eq/year for biofuels in transport at costs below USD 20/t CO_2 eq in 2030, and 0.56 Gt CO_2 eq/year for electric light-duty vehicles and 0.21 Gt CO_2 eq/year for electric heavy-duty vehicles in 2030.[55] A total of 74 per cent of Parties, accounting for 86 per cent of total global vehicle sales in 2023, indicated corresponding measures, such as increasing tax concessions for electric vehicles and facilitating deployment of charging stations, and swapping and replacing vehicle batteries in 2021–2030.

33. Global CO_2 emissions from road transport reached a record high of 6.1 Gt in 2023, bouncing back to the 2019 level from before the pandemic.[56] IEA projects in *From Taking Stock to Taking Action* global CO_2 emissions from road transport to decline to 4.6 Gt by 2030 and 2.9 Gt by 2035 on its pathway to 1.5 ºC with no or limited overshoot. Accounting for 13 per cent of total global vehicle sales in 2023,[57] 15 per cent of Parties indicated quantitative targets for reducing CO_2 emissions from road transport by 2030.

34. According to the contribution of Working Group III to the AR6, electric vehicles powered by low-emission electricity offer the greatest decarbonization potential for land-based transport on a life cycle basis. In the 2023 update to its Net Zero Roadmap, IEA projects that most emission reduction in transport on its 1.5 °C pathway with no or limited overshoot in 2023–2030 will result from deploying electric vehicles.[58] In *From Taking Stock to Taking Action*, IEA projects the share of electric cars[59] in global sales to increase from 14 per cent in 2022 to 67 per cent by 2030 and 99 per cent by 2035 on its 1.5 °C pathway with no or limited overshoot, thus contributing to doubling energy efficiency improvement and transitioning away from fossil fuels in energy systems.

35. Of the 23 per cent of Parties that indicated quantitative targets for increasing the sales share of electric cars, 4 per cent, accounting for 3 per cent of total global car sales in 2023,[60] reported target shares of 67 per cent or more by 2030. Half of those Parties (2 per cent of all Parties) communicated them in relation to achieving conditional mitigation targets. Further, 17 per cent of Parties, accounting for 20 per cent of total global car sales in 2023,[61] indicated target shares of 99 per cent by 2035, with 1 per cent of Parties communicating them in relation to achieving conditional mitigation targets.

J. Phasing out inefficient fossil fuel subsidies that do not address energy poverty or just transition as soon as possible

36. Removing fossil fuel subsidies is projected in the contribution of Working Group III to the AR6 to lead to global GHG emission reductions of up to 10 per cent by 2030 as well as yielding other environmental and financial benefits. According to the Fossil Fuel Subsidy Tracker,[62] global fossil fuel subsidies more than quadrupled from USD 373 billion in 2020

[55] According to the contribution of Working Group III to the AR6, no estimated costs of mitigation potentials could be allocated to this mitigation option owing to high variation in or lack of data.

[56] As footnote 24 above.

[57] Estimated on the basis of data from the International Organization of Motor Vehicle Manufacturers, available at https://www.oica.net/category/sales-statistics/ (accessed 7 August 2024).

[58] Defined as plug-in hybrid, battery and fuel cell electric vehicles in the 2023 update to the IEA Net Zero Roadmap.

[59] Electric cars refers to passenger light-duty electric vehicles.

[60] As footnote 57 above.

[61] As footnote 57 above.

[62] Fossil Fuel Subsidy Tracker, available at https://fossilfuelsubsidytracker.org/ (accessed 16 July 2024).

to USD 1,529 billion in 2022 as energy prices rose with the rebound of the global economy after the pandemic.

37. A total of 6 per cent of Parties, accounting for 13 per cent of total global fossil fuel subsidies in 2022,[63] identified measures for removing fossil fuel subsidies. Some of them (1 per cent of all Parties), accounting for 0.01 per cent of total global fossil fuel subsidies in 2022,[64] reported targets that are deemed consistent with global efforts to phase out inefficient fossil fuel subsidies that do not address energy poverty or just transition as soon as possible, such as shifting subsidies from buses with internal combustion engines to electric buses, and redirecting the funds to effectively incentivize decarbonization of public transport while ensuring affordable transportation.

38. In *From Taking Stock to Taking Action*, IEA projects that only 14 per cent of fossil fuel consumption subsidies in 2023 were targeted at specific-use cases such as agricultural operations or use of liquefied petroleum gas and kerosene in households. Furthermore, it finds that the poorest 20 per cent of households by income receive 10 per cent of all residential and transport fossil fuel consumption subsidies globally, while the richest 30 per cent of households receive half of these subsidies, indicating that many fossil fuel consumption subsidies could be phased out while protecting low-income households, including through targeted subsidies.

K. Conserving, protecting and restoring nature and ecosystems

39. This option has an estimated net mitigation potential of, inter alia, 2.28 Gt CO_2 eq/year for reduced conversion of forests and other ecosystems and 0.38 Gt CO_2 eq/year for improved sustainable forest management at costs below USD 20/t CO_2 eq in 2030; and 4.03 Gt CO_2 eq/year for reduced conversion of forests and other ecosystems, 2.18 Gt CO_2 eq/year for ecosystem restoration, afforestation and reforestation and 1.16 Gt CO_2 eq/year for improved sustainable forest management at costs below USD 100/t CO_2 eq in 2030. A total of 67 per cent of Parties, accounting for 67 per cent of total global forest cover in 2020[65] and 34 per cent of total global wetlands,[66] communicated corresponding measures, such as promoting intensive agriculture in savannahs and replacing traditional inefficient wood stoves with energy-efficient cookstoves to disincentivize deforestation of natural forests, and reforesting about 12,000 ha annually through community and school programmes.

40. According to the Food and Agriculture Organization of the United Nations *Global Forest Resources Assessment 2020*, the world has lost a net area of 178 million ha forest since 1990, with an estimated net forest loss of 4.7 million ha/year in 2010–2020 derived from an estimated deforestation rate of 10 million ha/year in 2015–2020.[67] It is estimated in the contribution of Working Group III to the AR6 that deforestation accounts for 45 per cent of total AFOLU emissions. The SR1.5[68] projects a significant increase in forest cover on 1.5

[63] Estimated on the basis of data from the Fossil Fuel Subsidy Tracker.

[64] As footnote 63 above.

[65] Estimated on the basis of data from Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020*. Rome: Food and Agriculture Organization of the United Nations. Available at www.fao.org/documents/card/en/c/ca9825en. The world has lost 420 million ha forest through deforestation since 1990, with an estimated annual deforestation rate of 10 million ha in 2015–2020.

[66] Estimated on the basis of data from the Center for International Forestry Research global wetlands map, available at https://www2.cifor.org/global-wetlands/ (accessed 16 July 2024); and Xu J, Morris P, Liu J, et al. 2018. PEATMAP: Refining estimates of global peatland distribution based on a meta-analysis. *Catena*. 160: pp.134–140. Available at https://core.ac.uk/download/pdf/227455185.pdf.

[67] As footnote 65 above.

[68] IPCC. 2018. *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, et al. (eds.). Geneva: World Meteorological Organization. Available at www.ipcc.ch/sr15.

and 2 °C pathways compared with 'no climate policy' baselines[69] as a result of reduced deforestation and forest degradation, and afforestation, reforestation and revegetation. Accounting for 11 per cent of total global forest cover in 2020,[70] 15 per cent of Parties communicated quantitative targets for increasing national forest cover by 2030.

L. Preserving and restoring oceans and coastal ecosystems

41. This option has an estimated net mitigation potential of, inter alia, 0.17 Gt CO_2 eq/year for reduced conversion of coastal wetlands and 0.1 Gt CO_2 eq/year for restoration of coastal wetlands at costs below USD 100/t CO_2 eq in 2030. A total of 27 per cent of Parties, accounting for 34 per cent of total global wetlands,[71] communicated corresponding measures, such as exploring public–private partnerships for protecting and restoring mangroves.

42. The contribution of Working Group III to the AR6 states that coastal ecosystems have among the largest carbon stocks of any ecosystem and provide numerous co-benefits, while the vulnerability of coastal wetlands to climatic and other anthropogenic stressors may limit the permanence of climate mitigation.

M. Scaling up circular economy approaches for transitioning to sustainable lifestyles and sustainable patterns of consumption and production

43. This option has an estimated net mitigation potential of, inter alia, 0.44 Gt CO_2 eq/year for reducing CH_4 emissions from solid waste at costs below USD 20/t CO_2 eq in 2030; 0.93 Gt CO_2 eq/year for material efficiency in industry and 0.48 Gt CO_2 eq/year for enhanced recycling in industry at costs below USD 100/t CO_2 eq in 2030; and 1.70 Gt CO_2 eq/year for shifting to balanced and sustainable healthy diets and 0.48 Gt CO_2 eq/year for reducing food loss and food waste in 2030.[72] A total of 56 per cent of Parties, accounting for 73 per cent of total global energy supply from fossil fuels in 2022,[73] communicated measures for circular economy approaches, such as promoting eco-industrial parks to scale up resource efficiency through intra-firm recycling.

44. According to the contribution of Working Group III to the AR6, circular economy approaches, such as material efficiency improvements and circular material flows, can help to significantly reduce emissions by avoiding using the large amount of energy required for processing virgin materials, and mitigate material supply risks for critical minerals for clean energy applications. In the 2023 update to its Net Zero Roadmap, IEA projects that demand for critical minerals for clean energy applications will quadruple by 2030 compared with the 2022 level.

II. Trends in and conditionality of measures for the global efforts and mitigation options

45. For most of the global efforts and mitigation options that relate to those referred to in recent CMA decisions,[74] there has been an increase in the share of Parties mentioning corresponding measures since the 2023 version of this report. The largest increase (by 16 percentage points) was seen in relation to rapidly deploying zero- and low-emission vehicles and necessary infrastructure. On the other hand, the share of Parties mentioning

[69] According to the SR1.5, on 1.5 °C-consistent pathways, land needs to be converted to forest land at a rate of –4.8–23.7 Mha/year in 2010–2030 compared with 'no climate policy' baselines of –13.6–3.3 Mha/year. The extent of expansion of forest cover varies greatly across the models in the SR1.5, with some projecting virtually constant and some slightly declining forest cover.

[70] As footnote 65 above.

[71] As footnote 66 above.

[72] As footnote 55 above.

[73] As footnote 4 above.

[74] As footnote 1 above.

corresponding measures has most declined (by 14 percentage points) in relation to scaling up circular economy approaches.

46. Parties reported measures for achieving conditional mitigation targets in their NDCs most frequently in relation to transitioning away from fossil fuels in energy systems (65 per cent of Parties), followed by accelerating zero- and low-emission energy technologies (64 per cent), improving energy efficiency and increasing renewable energy (62 per cent) and conserving, protecting and restoring nature and ecosystems (50 per cent). The share of Parties indicating measures for achieving conditional mitigation targets has increased most since the 2023 version of this report in relation to rapidly deploying zero- and low-emission vehicles and necessary infrastructure, shifting to zero- and low-carbon fuels and reducing CH_4 and N_2O emissions in agriculture (by 2 percentage points).

47. Further, the largest conditionality gap[75] between the shares of Parties referring to mitigation options for achieving conditional and unconditional mitigation targets was found in relation to scaling up circular economy approaches (at 14 percentage points), followed by conserving, protecting and restoring nature and ecosystems (12 percentage points), and reducing CH_4 and N_2O emissions in agriculture (11 percentage points). This conditionality gap has increased most since the 2023 version of this report in relation to scaling up circular economy approaches (by 14 percentage points).

[75] Calculated by subtracting the share of Parties referring to mitigation options for achieving unconditional mitigation targets from that for achieving conditional mitigation targets. For example, the conditionality gap for solar energy (17 percentage points) is the difference between the share of Parties referring to solar energy measures for achieving conditional mitigation targets (42 per cent) and that for achieving unconditional mitigation targets (25 per cent).